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A Case Study Of Elementary Teachers' Conceptions Of Environmental Literacy In Relationship To A Tall Grass Prairie Restoration Project

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A CASE STUDY OF ELEMENTARY TEACHERS' CONCEPTIONS OF ENVIRONMENTAL LITERACY IN RELATIONSHIP TO A TALL GRASS PRAIRIE RESTORATION PROJECT

by

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This dissertation, submitted by Teresa J. Shume in partial fulfillment of the requirements for the Degree of Doctor of Philosophy from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done, and is hereby approved.

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April 24, 2013
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Title	A Case Study of Elementary Teachers' Conceptions of Environmental Literacy in Relationship to a Tall Grass Prairie Restoration Project
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Teresa J. Shume
May 11, 2013

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To Wil, Quinn, and Reid

ABSTRACT

The purpose of this qualitative case study was to describe seven elementary teachers' conceptions of environmental literacy in relationship to a tall grass prairie restoration project and to explore ways in which the tall grass prairie restoration project for third grade contributed to enhancing educational learning experiences. The research questions were: 1. What are teachers' conceptions of environmental literacy for third grade students? 2. How does the prairie restoration trip contribute to teachers' capacity to teach for environmental literacy of third grade students? 3. What is the pedagogical value of the prairie restoration project? The theoretical frameworks underpinning this study were David Sobel's (1996) model for developmental progression in children's relationships with nature, and the North American Environmental Education Association's (2011) framework for environmental literacy.

The first assertion derived from thematic data analysis of interviews, field trip observations, classroom observations, and artifacts was, "The participating teachers' visions of environmental literacy for third grade students included components that spanned across a developmentally appropriate progression from cultivating empathy for living things, to fueling discovery of nature, to fostering a sense of responsibility toward the natural world." Components of environmental literacy described by teachers included being at ease in the natural environment, appreciation and respect, wonder and curiosity,

awareness and interdependence, sense of agency, responsibility and service, and environmental knowledge.

The second assertion stemming from thematic data analysis was, “The prairie restoration project and related curriculum have pedagogical value that included and exceeded addressing state science standards.” In addition to addressing state science standards identified by teachers, the curriculum related to the prairie restoration project served as an agent of curricular cohesion to integrate a variety of subject areas, developed scientific ways of thinking, provided life experience for children, and fostered authentic learning experiences through concrete connections. It also provided a means to enhance the presence of science and social studies in elementary curriculum.

Themes emerging from qualitative data analysis resonated with Sobel’s model of progressive stages in children’s relationships with nature, and resulted in a tool potentially useful for design of elementary curriculum aimed at developing environmental literacy.

CHAPTER I

INTRODUCTION

Given the rapidly deteriorating integrity of our planet's ecological systems, a cultural shift toward pro-environmental perspectives is of critical importance to the viability of our collective future on Earth (Bowers, 1993, 2006; Orr, 1992; Vitek & Jackson, 2008; Wessels, 2006). The planet's biogeochemical systems are straining to maintain integrity in the face of explosive human population growth and ever-expanding consumption patterns. It is vital that current and future generations understand the functioning of natural systems, recognize the environmental problems facing the planet today, and are motivated to work towards solutions that are equitable and sustainable. Developing environmentally-aware knowledge, skills, attitudes, values, and behaviors among the next generation of citizens through environmental and science education is paramount for improving the Earth's prospects for environmental sustainability in the coming decades.

Environmental education, decanted to its essence, aims to develop an environmentally literate citizenry who is equipped to navigate the complex interface between social and natural systems (Kennedy & Stromme, 2008). An environmentally literate person is "someone who, both individually and together with others, makes informed decisions concerning the environment; is willing to act on these decisions to improve the well being of other individuals, societies, and the global environment; and

participates in civic life" (Hollweg et al., 2011, p. 2-3). Environmental education is of critical importance for moving towards a path of environmental sustainability on local and global scales.

Environmental education and science education share a common purpose in that both aim to prepare students to be responsible citizens (American Association for the Advancement of Science [AAAS], 1989; North American Association for Environmental Education [NAAEE], 2010). Science education is a field that seeks to produce citizens who are equipped with the scientific knowledge and skills necessary to live responsible, engaged lives, and to contribute to a democratic society (AAAS, 1989; National Research Council [NRC], 1996). According to the American Association for the Advancement of Science, the central purpose of science education is,

> To help students to develop the understandings and habits of mind they need to become compassionate human beings able to think for themselves and to face life head on. It should equip them also to participate thoughtfully with fellow citizens in building and protecting a society that is open, decent, and vital. (AAAS, 1989, p. xiii)

Both science education and environmental education contribute to developing environmentally literate students.

Experiences with nature during childhood are an important aspect of environmental education and have been shown to contribute to the development of responsible environmental behaviors during adulthood (Chawla, 1999, 2006; Wells & Lekies, 2006). In order to cultivate commitment to protecting the Earth, knowledge about

the natural world should be anchored in concrete, personal experiences with the local natural environment during childhood (Sobel, 1996, 2005, 2008).

In this era of school accountability, however, P-12 school curriculum is heavily focused on achievement scores in English language arts and mathematics, thus marginalizing non-tested components of school curriculum (Zastrow & Janc, 2004) including outdoor and environmental education (Chepesiuk, 2007). Indeed, the Center on Education Policy reported that after the fifth year of implementing No Child Left Behind (NCLB) legislation, "approximately 62% of school districts increased the amount of time spent in elementary schools on English language arts and or math, while 44% of districts cut time on science, social studies, art and music, physical education, lunch or recess" (McMurrer, 2007, p. 1). The discourses of achievement and accountability suppress environmental education in U.S. schools and result in children lacking meaningful learning experiences to develop rapport with nature (Gruenewald, 2005; Gruenewald & Manteaw, 2007; Stevenson, 2007).

Further, it is profoundly ironic that children are more familiar with exotic tropical rainforest animals than the ones that live in their local bioregion (Sobel, 1996), and that most American 12-year olds can name over 1000 corporate logos but fewer than ten plants or animals native to the region (Orr, 1999). There is an urgently growing need to reverse the trend of children spending less time in natural environments and being less connected to nature (Charles, Louv, & St. Antoine, 2010; Louv, 2005).

Even though opportunities for children to bond with the local natural environment are important for developing responsible environmental behavior and ultimately an environmentally literate citizenry, many schools do not prioritize such experiences

(Gruenewald & Manteaw, 2007). School learning environments structured to provide children with potent experiences to connect with their local bioregion are paramount to developing an environmentally literate society. This case study examined how seven third-grade teachers from two Upper Midwest schools made room for instruction about a local ecosystem, the tall grass prairie, in the third grade curriculum. Teachers' perspectives on the impacts of locally-based environmental education on students' readiness to act responsibly towards the environment, and approaches to integrating tall grass prairie learning experiences into third grade curriculum were explored.

Prairie Restoration Project

Local school districts in the area where I reside have been participating in a prairie restoration project that has been underway at a regional science center since 1994. In 2010, I wrote an op-ed article for my local newspaper that explained why it is important to help children learn to love nature before being burdened with the responsibility to heal it (Shume, 2010). That column became the basis for a book chapter that explored developmentally appropriate stages for learning to connect with nature (Shume, forthcoming). In the book chapter, I selected the prairie restoration project as an example to correlate with middle childhood, and thus began my earnest interest in this project.

Every fall, all the third grade classes from the local school district are bussed to the science center where they explore the tall grass prairie, seeking out evidence of the area's natural and cultural history. During the visit, students also collect ripe seeds from native plants. During the winter months, students plant some of the collected seeds in their classrooms. Towards the end of the school year, typically during the month of May,

the children return to the science center for another set of learning activities centered on the prairie habitat. At that time, they plant their seedlings and sow additional seeds that were collected in the fall. Though the project is primarily educational in focus, over two thousand third graders have been involved in the restoration of approximately ten acres of tall grass prairie over the past two decades.

Pilot Study

In the fall of 2011, I undertook a pilot study involving one of the third grade teachers who has participated in the prairie restoration project for 15 years. She permitted me to observe her class' fall 2011 prairie field trip, as well as one of the related science lessons taught in her classroom. Detailed field notes including observer comments were prepared for each observation. She also participated in two interviews that I conducted and transcribed. Artifacts collected included photos of plants that she split apart during the classroom lesson in order to reveal diverse sources of seeds, an electronic version of the slideshow she created for her students using images of plants she photographed during the field trip, a copy of the relevant section of the student text used in class, as well as lyrics for a song to which she referred during one of the interviews.

Three themes emerged from the pilot study. First, the teacher introduced the term "eco-minded" fairly early in the first interview when describing what she hoped her students would gain from participation in the prairie restoration project. Analysis of the data indicated her conception of eco-mindedness encompassed an array of beliefs that resonated fundamentally with living a simple, frugal, healthy life close to nature that contributes to sustaining the land and a viable natural food supply. Second, a prominent set of codes that emerged during analysis was centered on advocacy. She advocated for

healthy lifestyle and wellness choices that she saw as part of eco-mindedness, and advocated to keep the prairie visit as part of the third grade curriculum after the state science standards were revised. Third, the teacher was sensitive to monitor certain boundaries around her advocacy for eco-mindedness. She voiced concern for not indoctrinating her students or teaching eco-mindedness as dogma. She expressed a strong commitment to fostering openness to new experiences and critical thinking skills among her students.

The pilot study aimed to understand a teacher's perspective on the value of environmental education grounded within a local natural area, and to explore approaches to integrating tall grass prairie learning experiences into her third grade curriculum. I employed qualitative research methods because these research questions involved capturing and understanding a teacher's perspective and making meaning of her interpretations of aspects of teaching, inherently a socially complex endeavor. Given the suitability of a qualitative research paradigm for the pilot study, I also employed qualitative methodology for the present study.

Need for the Study

Even though environmental education aims to prepare students to act responsibly while navigating the complex terrain at the nexus of human and environmental systems, few schools hold environmental literacy as a principal goal of schooling experiences (Gruenewald & Manteaw, 2007). Examining cases where schools make space for educational activities focused on learning about the local natural environment is valuable because such experiences offer potential for enhancing students' environmental literacy. Understanding teacher's conceptions of environmental literacy and how these relate to

science curriculum as it unfolds in the classroom and in the field is paramount to better positioning schools to foster a sense of environmental responsibility among future generations.

Multiple research efforts have been undertaken to measure environmental literacy among teachers (e.g., Çakir, Irez, & Dogan, 2009; Kennelly, Taylor, & Maxwell, 2008). Many of these studies utilize quantitative research designs that aim to measure teachers' levels of knowledge or attitudes towards the natural environment (e.g., Dillon & Gayford, 1997; Flogaitis & Agelidou, 2003; Forbes & Zint, 2011). These studies verify the extent to which researchers' ideas are present among a sample population of teachers, rather than asking teachers to express their ideas relating to environmental literacy in their own voices.

Additionally, an array of documents has been produced by state, national, and international entities striving to generate an explicit definition of environmental literacy (e.g., Kennedy & Stromme, 2008; NAAEE, 2010; UNESCO, 1978). Many studies about teachers' environmental literacy draw upon conceptions of environmental literacy influenced by or produced by international initiatives to improve environmental education worldwide such as the Tibilisi Declaration (UNESCO, 1978), the Brundtland Report (World Commission on Environment and Development, 1987), and the United Nations General Assembly's (2005) declaration of the Decade of Education for Sustainable Development (e.g., Cutter-Mackenzie & Smith, 2003; Yavetz, Goldman, & Pe'er, 2009).

In short, research literature about environmental literacy is comprised largely of quantitative research that verifies the presence of researcher-generated ideas within

sample populations of teachers, as well as formal policy documents from national and international entities that strive to explicitly define environmental literacy. Lacking in the research literature about environmental literacy, however, are efforts to capture teachers' voices about what constitutes environmental literacy from their perspective. Additionally, no studies were found that seek to elicit teachers' views on how learning experiences exploring the local bioregion may impact teachers' capacity to teach for environmental literacy. A small number of studies were located that aimed to organically describe teachers' views on facets of environmental education such as the complexity and internal consistency of teachers' conceptions of environmental education (Bengtson, 2010), teacher identity struggles pertaining to environmental education (Hwang, 2009), and teachers' perspectives while implementing environmental education curriculum (Christenson, 2004; Winther, Volk & Schrock, 2002; Witz & Lee, 2009) or professional development pertaining to environmental education (Gayford, 2002).

Extensive efforts were made to locate any studies that capture teachers' voices about environmental literacy. The principal data bases consulted were EBSCO Host and Sage Journals Online. Various combinations of search terms were used over the course of multiple searches, including broad searches that garnered hundreds of hits using the terms "environmental literacy teachers," "ecological literacy teachers," and "sustainability literacy teachers." Further, the reference lists of any related findings were combed and potential sources were exhausted.

Purpose of the Study

With an intent to fill a pronounced gap in the research literature, the purpose of this research project was to describe elementary classroom teachers' conceptions of

environmental literacy as it pertained to a prairie restoration environmental education project's impact on their students' readiness to act responsibly towards the environment.

Research Questions

The research questions guiding this study were:

1. What are teachers' conceptions of environmental literacy for third grade students?
2. How does the prairie restoration trip contribute to teachers' capacity to teach for environmental literacy of third grade students?
3. What is the pedagogical value of the prairie restoration project?

The first two questions were closely related and thus examined the prairie restoration project in relationship to teachers' perceptions of environmental literacy among third grade students. The third question sought to explore the ways that the prairie restoration project offered pedagogical value that extended beyond its immediate relationship to environmental literacy.

Conceptual Framework

Two conceptual frameworks underpinned this study: a framework for environmental literacy produced by the one of the largest environmental education organizations in the world, and a model for fostering developmentally appropriate relationships between children and nature designed by David Sobel (1996), an established scholar and environmental educator.

A historical review of efforts to create frameworks that capture key components of environmental literacy revealed that the most current, research-based conceptualization of environmental literacy was released by NAAEE in 2011 (Hollweg et al., 2011). The

NAAEE 2011 framework is consistent with literature that divides environmental literacy into four principal components: knowledge, dispositions, competencies, and environmentally responsible behavior (e.g., Cook & Berrenberg, 1981; Hungerford & Volk, 1990; Stern, 2000), and it states,

> Environmental literacy consists of knowledge and understanding of a wide range of environmental concepts, problems, and issues, a set of cognitive and affective dispositions, a set of cognitive skills and abilities, and the appropriate behavioral strategies to apply such knowledge and understanding in order to make sound and effective decisions in a range of environmental contexts. (Hollweg et al., 2011, p. 3-1)

Feedback loops among the interactive components of the framework designed by Hollweg et al. (2011) are shown in Figure 1. Knowledge, competencies, and dispositions interact with each other and influence environmentally responsible behavior in particular personal, social, and physical contexts. The components of this framework served as some of the key organizational categories for coding data which, according to Maxwell (2005, p. 97), "function primarily as 'bins' for sorting data for further analysis."

The second conceptual framework utilized in this study was David Sobel's (1996) model of developmentally appropriate stages for the progression of children's relationships with nature, as depicted graphically in a representation of my own design in Figure 2.

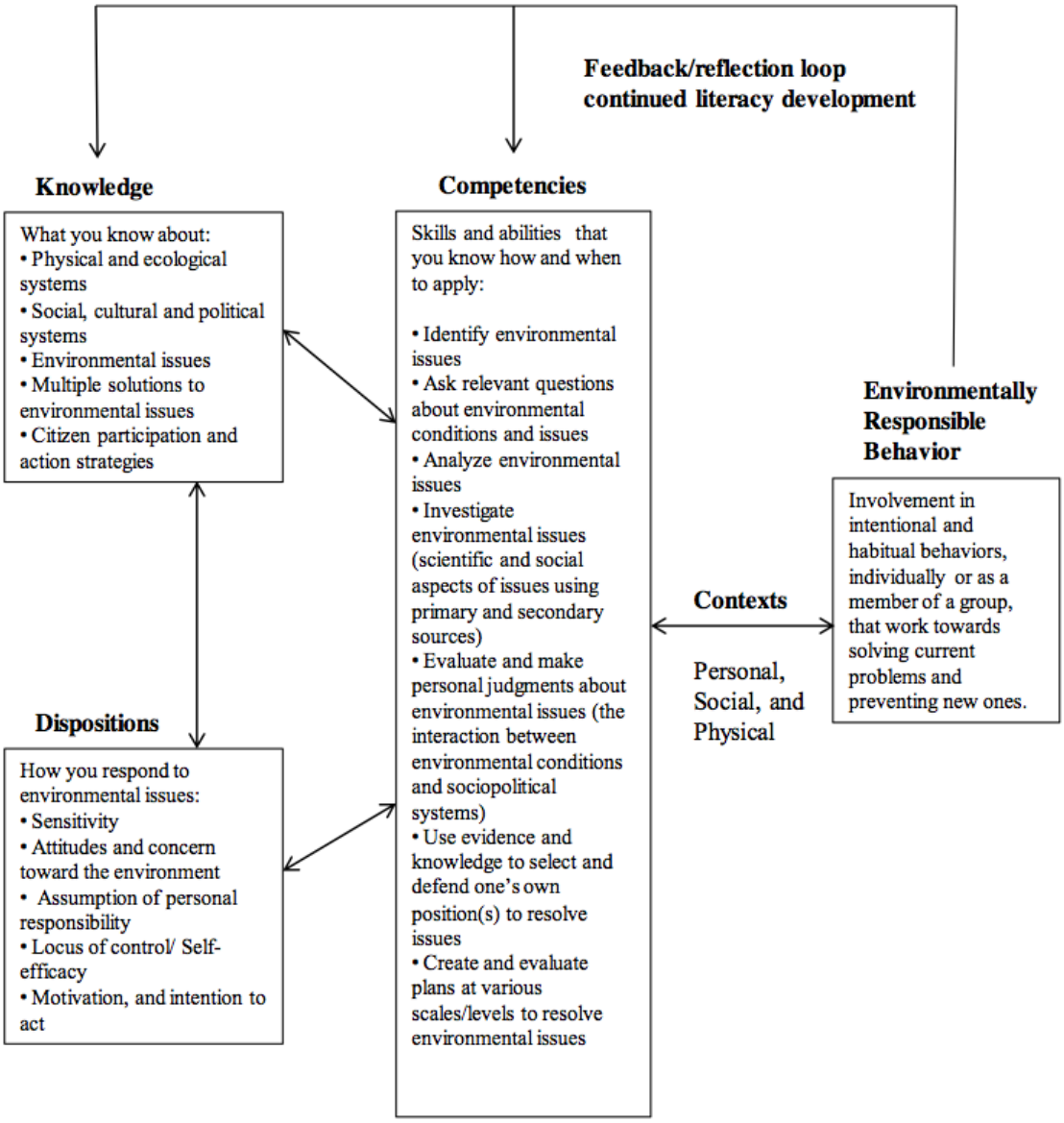


Figure 1. Environmental Literacy Framework. Produced by Hollweg et al. (2011).

Sobel posits that the focus in children's relationships with nature during early childhood should center on developing empathy for living things. Young children, approximately four to seven years old, need opportunities to connect with animals, plants,

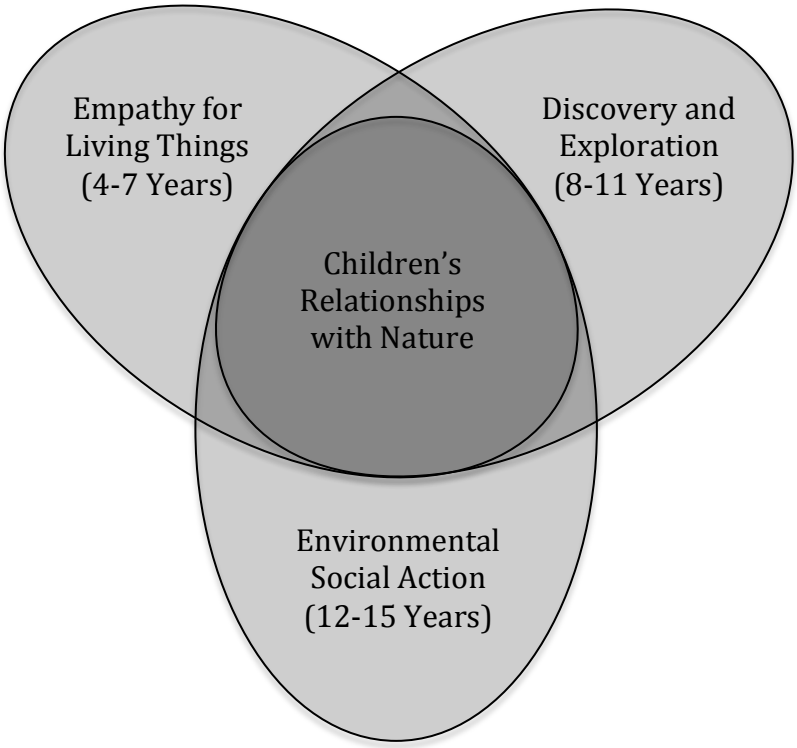


Figure 2. Sobel's Model of Stages for Children's Relationships With Nature.

and other living things, and to develop an ethic of care, empathy, and compassion. According to Sobel's model, middle childhood should be characterized by discovery, a time for children aged approximately eight to eleven years to explore and bond with the natural environments near their homes. Finally, Sobel's model reserves social action towards preserving and protecting the natural environment primarily for the final stage. At this stage, an established personal connection to nature fuels a sense of responsibility and stewardship towards nature among youth aged twelve years and older.

Benefits of Study

A case study that aims to develop an in-depth understanding of teachers' perceptions of environmental literacy contributes to formulating teacher education

experiences that aptly bring in-service teachers' voices and ideas into dialogs about the value of environmental literacy and provides insights into the translation of K-12 science standards into environmental education experiences. The Minnesota State Legislature adopted new Academic Science Standards in 2009 with state-wide full implementation required by 2011-12 (Minnesota Department of Education, 2009). This study sheds light on how seven teachers respond to a sampling of these new state science standards, and how the value of learning experiences orchestrated by elementary schools can extend beyond the confines of meeting standards. Perhaps the most potent benefit of this study, however, is its contribution to strengthen the presence of teachers' voices in the research literature on environmental literacy and its relationship to curriculum development and implementation.

Researcher Reflexivity

According to Creswell, reflexivity "means that the writer is conscious of the biases, values, and experiences that he or she brings to a qualitative research study" (2007, p. 243). What follows is a reflection about experiences and perspective I bring to this study. One function of researcher memos is to unveil potential manifestations of researcher bias (Creswell, 2007). Over the course of this study, I used memos for such a purpose as the need arose.

Before becoming a high school science teacher, I worked seasonally at four outdoor recreation or outdoor education programs over a span of nine years. I have taught canoeing, archery, swimming, rock climbing, rappelling, and an array of other outdoor pursuits. While I was a high school teacher, I taught field-based biology classes in the summer and learned how to kayak on white water. In my teenage years, I participated in

several two-week canoe trips in remote wilderness areas in Canada. As a child, I camped frequently with my family and spent much time on my grandmother's farm. Today, I camp, garden, and pursue outdoor activities with my own children. In short, I have long valued spending time in the outdoors for purposes that are both recreational and educative in nature.

Transformative experiences in the outdoors together with extensive reading and reflection about human relationships with nature have led me to recognize that ecocentric worldviews are significantly more congruent with environmental sustainability than anthropocentric ones. Anthropocentrism is a perspective that pits humans against nature and aspires for human dominance over nature (Devall & Sessions, 1985). The natural environment is regarded as a cornucopia of resources for humans to use and control. Material and economic growth for an ever-growing human population is viewed as vital and unquestionable. Consumerism, a cornerstone of this worldview, is a means to enhance comfort and convenience for humans at the expense of the natural world. Technological fundamentalism (Orr, 2002), an unbridled and unexamined enthusiasm for technological progress, pervades an anthropocentric worldview, as does a deep-seated arrogance about human ingenuity to outwit nature. A quote from Bill Vitek and Wes Jackson (2008) aptly captures the essence of an anthropocentric worldview, "The recipe for success is simple: unleash human ingenuity; utilize it to harness and commodify nature's immense and complex forces; enjoy the new and improved world that results; repeat" (p. 8).

The fundamental difference between anthropocentric and ecocentric perspectives is that the latter regards humans an integral part of nature rather than lords and masters

over it. According to Drengson (1994), ecocentrism "recognizes, appreciates, and respects the multitude of intrinsic values found throughout the natural world" (p. 12). In other words, living and non-living things are seen as having intrinsic value, regardless of their level of instrumental value to humans. Rather than conquering nature, an ecocentric worldview strives for humans to live in harmony with nature (Devall & Sessions, 1985). A guiding principal in ecocentrism, "simple in means, rich in ends" (Devall, 1988), captures the idea that humans should aim to fulfill only vital needs, rather than amassing as many consumer goods and creature comforts as our wallets will permit. It should be noted that Devall and Sessions (1985) define vital needs more broadly than biological needs such as food, water, and shelter; vital human needs encompass "love, play, creative expression, intimate relationships with a particular landscape (or Nature taken in its entirety) as well as intimate relationships with other humans, and the vital need for spiritual growth, for becoming a mature human being" (p. 65). Another key element of an ecocentric worldview is a restrained and responsible approach to using and developing technology, a perspective that rejects unbridled enthusiasm for technological progress. Rather than a consumerist perspective, an ecocentric approach strives to reduce, reuse, and recycle. And finally, an ecocentric worldview is steeped in a sense of prudence, humility, and precaution, essential attributes that resonate with a reverence for nature (Vitek & Jackson, 2008).

While I strive to live by principles that underpin an ecocentric worldview, I know my lifestyle choices are not always entirely congruent with my beliefs. I also recognize that anthropocentrism is the dominant discourse in most of the industrialized world, and that many if not most people have not thought deeply about human relationships with

nature. Worldviews that underpin relationships with nature are relevant to this research study because individual teachers' relationships with nature will invariably influence their views on environmental literacy, and shape the way they approach environmental learning activities related to the tall grass prairie. As a researcher, it was important for me to consistently recognize that the purpose of this study was to capture teachers' perspectives with fidelity rather than to judge them for congruence with my own worldview.

Definitions

Environmentally literate: possessing capacities within the domains of knowledge, skills, affect, and behavior needed to act responsibly towards the natural environment in order to increase environmental sustainability.

Environmental education: approaches to education that aim to enhance students' environmental literacy.

Tall grass prairie: grassland ecosystem that receives approximately 30 inches of rain annually and where some grasses can grow to approximately five feet in height. Mixed grass and short grass prairie occur where there is somewhat less rainfall, deserts occur where there is significantly less rainfall, and forests grow where there is more rainfall. Prairies are often situated between forests and deserts.

Prairie restoration: efforts to replant native species of tall grass prairie plants in areas where they have been lost, with intention to heal and restore the prairie habitat and ecosystem.

Bioregion: local area defined by natural systems such as watershed drainage rather than by geo-political boundaries.

CHAPTER II

LITERATURE REVIEW

History of Conceptualizing Environmental Literacy

Early Roots

Charles E. Roth was the first to use the term "environmental literacy" in 1968 (Cutter-Mackenzie & Smith, 2003; McBeth & Volk, 2010; Roth, 1992) in a journal article that challenged educators from a wide range of formal and informal contexts to better prepare citizens to make responsible decisions about the natural environment. In this sense, the term "literacy" has been expanded beyond its traditional meaning of the ability to read and write, and instead "includes the concepts of internalizing information in order to make daily decisions based on real life experiences, and relates to notions such as adult literacy, computer literacy, visual literacy, cultural literacy, and so on" (Environmental Education and Training Partnership, 1997, p. 1). Attempts to define environmental literacy center on efforts to identify key skills, knowledge, and dispositions required for competencies to make responsible personal and social decisions that lead to environmental sustainability.

Current visions for environmental literacy have been shaped, in part, by the history of environmental education, a diverse field that stems from nature, conservation, and outdoor education (Hollweg et al., 2011). A number of international summits, intergovernmental conferences, and international commissions have produced a variety of

reports for global audiences offering cogent visions for purposes underpinning environmental education, and advocating for increased environmental education. The Belgrade Charter (UNESCO-UNEP, 1976) and The Tbilisi Declaration (UNESCO, 1978) are, however, often regarded as foundational documents that offer a widely shared perspective of what constitutes effective environmental education (NAAEE, 2010). Indeed, the broad goals for environmental education articulated in the Tbilisi Declaration have shaped much of the work in the field of environmental education since 1978 (NAAEE, 2010); these broad goals were,

1. To foster clear awareness of, and concern about, economic, social, political, and ecological interdependence in urban and rural areas.
2. To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment.
3. To create new patterns of behaviors of individuals, groups, and society as a whole towards the environment. (UNESCO, 1978, p. 1)

Aiming to impact both social groups and individuals, the categories of specific environmental education objectives articulated in the Tbilisi Declaration were:

1. Awareness: To help social groups and individuals acquire an awareness of, and sensitivity to, the total environment and its allied problems.
2. Knowledge: To help social groups and individuals gain a variety of experience in, and acquire basic understanding of, the environment and its associate problems.
3. Attitudes: To help social groups and individuals acquire a set of values and

feelings of concern for the environment, and the motivation for actively participating in environmental improvement and protection.

4. Skills: To help social groups and individuals acquire the skills for solving environmental problems.
5. Participation: To provide social groups and individuals with an opportunity to be actively involved at all levels in working toward resolution of environmental problems. (UNESCO, 1978, pp. 26-27)

The goals and objectives established in the Tbilisi Declaration have been seminal to the development of subsequent definitions of environmental education and environmental literacy (NAAEE, 2010).

As the field of environmental education has evolved, it has been shaped by further efforts to establish shared international visions for environmental literacy. The Brundtland Commission (World Commission on Environment and Development, 1987), the United Nations Conference on Environment and Development in Rio (UNCED, 1992), the Thessaloniki Declaration (UNESCO, 1997), and more recently the Rio+20 United Nations Conference on Sustainable Development (UNCED, 2012) have produced landmark reports that critiqued and expanded conceptions of effective environmental education targeting cogent understandings of environmental literacy.

Frameworks Defining Environmental Literacy

During the 1990's, a number of scholars built on the Tbilisi Declaration and associated international documents to produce frameworks that aimed to define environmental literacy (e.g., Hungerford & Volk, 1990; Roth, 1992; Simmons, 1995; Wilke, 1995). Many of these frameworks reconceptualized the Tbilisi objectives of

awareness, knowledge, attitudes, skills, and participation by subdividing or combining some of them, or redistributing them into other components of environmental literacy such as dispositions, behaviors, awareness and cognitive skills.

One such document was published in 1992 by Charles E. Roth, the scholar who coined the term "environmental literacy" in 1968. His seminal monograph drew on an array of sources to capture key historical elements of the construct's evolution, offered a refinement and clarification of the construct, and looked ahead at how to stimulate and nurture environmental literacy in the coming years. Roth (1992) offered this perspective on the essence of environmental literacy:

> Environmental literacy involves human discourse about inter-relationships with the environment. It is essentially the degree of our capacity to perceive and interpret the relative health of environmental systems and to take appropriate action to maintain, restore, or improve the health of those systems. (p. 9)

According to Roth (1992), environmental literacy could be conceptualized along four strands: knowledge, skills, affect, and behavior. Key elements of the knowledge strand pertained to understanding how self-regulating systems sustain life on our planet, how social systems interact with natural systems, and knowledge of strategies available to remediate various environmental problems. The skills strand focused on critical and creative thinking, healthy skepticism, decision-making skills, and the ability to plan ahead. The affective component subsumed environmental sensitivity, attitudes, and values, elements that Roth had initially separated as individual categories. Finally, the behavior strand was a composite of personal investment in environmental issues, sense of responsibility towards the environment, and active involvement to remediate

environmental problems. Roth's (1992) strands bore strong resemblance to the categories of objectives identified in the Tbilisi Declaration (UNESCO, 1978): awareness, knowledge, affect, skills, and participation.

In 1993, NAAEE launched the *National Project for Excellence in Environmental Education*, anchored in the question, "What does it mean to be environmentally literate?" Released in 1999 and revised in 2010, NAAEE's *Guidelines for Excellence in Environmental Education Project* defined environmental literacy and set a vision for developmentally appropriate learning goals in K-12 settings. Now also offering a set of companion documents and tools for educators, the *National Project for Excellence in Environmental Education* is underpinned by the following definition of environmental literacy:

> Environmentally literate students possess the knowledge, intellectual skills, attitudes, experiences, and motivation to make and act upon responsible environmental decisions. Environmentally literate students understand environmental processes and systems, including human systems. They are able to analyze global, social, cultural, political, economic and environmental relationships, and weigh various sides of environmental issues to make responsible decisions as individuals, as members of communities, and as citizens of the world. (NAAEE, 2010, p. 2)

The guidelines generated through this project aim to support environmental education in both formal and non-formal settings, as well as across developmental stages from early childhood through grade twelve.

History of Measuring Environmental Literacy

Historical Overview

In the 1970's, a series of studies focusing on measuring environmental knowledge and attitudes in students emerged (e.g., Bohl, 1977; Eyers, 1976; Perkes, 1974; Richmond, 1977). More recently, efforts to measure environmental literacy have expanded beyond focusing on knowledge and attitudes to include other components of environmental literacy as well (e.g., Kuhlmeier, Van Den Bergh, & Lagerweij, 2005; Makki, Abd-El-Khalick, & Boujaoude, 2003). In an effort to more effectively represent variations in sophistication within different components of environmental literacy, Roth (1992) operationalized the construct of environmental literacy into a spectrum with three continuous categories: nominal environmental literacy, functional environmental literacy, and operational environmental literacy. Environmental knowledge, affect, skills, and participation increased in sophistication and depth across this continuum. It is useful to note that Roth (1992) rejected a binary conception of environmental literacy. It was not a question of being or not being environmentally literate, but rather a matter of the extent to which one was environmentally literate. Cutter-Mackenzie and Smith (2003), Yavetz, Goldman, and Pe'er (2009), and Balgopal and Wallace (2009) undertook studies that utilized Roth's continuous categories (or modifications of them) to assess environmental literacy.

Large Scale Assessments of Environmental Literacy

In the United States, an ambitious, large scale, multi-phase project is underway to measure knowledge, affect, cognitive skills, and behaviors comprising environmental literacy among middle school students. Begun in 2006, The *National Environmental*

Literacy Assessment Project used the Middle School Environmental Literacy Instrument (MSELI) to establish baseline measures for sixth and eighth grade students in 48 randomly selected middle schools (McBeth, Hungerford, Marcinkowski, Volk, & Meyers, 2008). These scores were later compared with the results for the second phase of the project, where the MSELI was utilized to survey sixth, seventh, and eighth grade students who participated in established environmental education program at 64 middle schools across 27 states (McBeth, Hungerford, Marcinkowski, Volk, & Cifranick, 2011). With a calibrated instrument in place, baseline measures established, and data generated from thousands of student surveys, additional phases are planned for this national project.

Presently, NAAEE is calling for expanded measurement of environmental literacy at national and international levels and has produced a framework to support such research efforts, *Developing a Framework for Assessing Environmental Literacy* (Hollweg et al., 2011). This extensive project produced a conceptual framework, Figure 1 in Chapter I, that depicted relationships and feedback loops between various components of environmental literacy, defined as:

> Environmental literacy consists of knowledge and understanding of a wide range of environmental concepts, problems, issues, a set of cognitive and affective dispositions, a set of cognitive skills and abilities, and the appropriate behavioral strategies to apply such knowledge and understanding in order to make sound and effective decisions in a range of environmental contexts. (2011, p. 3-1)

This ambitious framework project provided thorough descriptions of several components of environmental literacy and discussed key decisions involved in designing and developing measures of environmental literacy.

Methodologies to Measure Environmental Literacy in Teachers

Components of Environmental Literacy

Within the landscape of literature on measuring environmental literacy resides a body of research that aims to measure environmental literacy of pre-service and in-service teachers. Many of these studies focused exclusively on measuring particular facets of the knowledge component of environmental literacy (e.g., Çakir et al., 2009; Robinson, 1998; Summers, Kruger, Childs, & Mant, 2000). Other studies aimed to measure ambitious combinations of environmental knowledge, skills, affect, and behavior, as well as other closely related aspects of environmental literacy. For example, Tuncer et al. (2009) undertook a large scale quantitative study (n= 684) to evaluate environmental literacy along all four strands defined by Roth (1992). Wright (2008), in turn, directed his efforts to measure environmental literacy at levels of knowledge, beliefs, opinions, and self-perceptions regarding decision-making. Yavetz et al. (2009) focused their study on dimensions of knowledge, attitude, and behaviors of Israeli pre-service teachers' environmental literacy. Van Petegem, Blieck, and Van Ongevalle (2007) investigated knowledge of environmental issues and involvement in environment-related activities.

Echoing methodologies employed to measure environmental literacy on a broader scale, methodologies employed to investigate pre-service and in-service teachers' levels of environmental literacy were primarily quantitative in nature (e.g., Dillon & Gayford, 1997; Flogaitis & Agelidou, 2003; Forbes & Zint, 2011), and frequently employ established research instruments (e.g., Dunlap, 2008). Less common were studies that employ mixed methods (e.g., Balgopal & Wallace, 2009; Cutter-Mackenzie and Smith,

2003; Sosu, McWilliams, & Gray, 2008) or qualitative methods (e.g., Corney & Reid, 2007; Summers et al., 2000.)

Use of Established Instruments to Measure Environmental Literacy in Teachers

National Educational Education and Training Foundation (NEETF)/Roper Survey. Portions of the NEETF/Roper Survey on Environmental Knowledge, Attitudes, and Behaviors (Coyle, 2005) were used in a number of studies to measure teachers' environmental knowledge. For example, Robinson (1998) and Wright (2008) used this survey instrument in the United States, while Tuncer et al. (2009) deemed it suitable for use in Turkey. This instrument was well established because the NEETF used it for large scale sampling (n=1500 each) to regularly create "national report cards" for over a decade (Coyle, 2005). Further, with only 12 items and none that are specific to any particular bioregion, this instrument was conveniently not geographically restricted. On the other hand, it could not capture survey participants' knowledge of the local environment, pivotal to a sense of place that is sometimes regarded as crucial to environmental literacy (Berg, 2005; Orr, 1992; Sobel, 2005).

New Ecological Paradigm Scale. Another instrument for which a pattern of use with teachers emerged was the New Ecological Paradigm (NEP) Scale, utilized, for example, by Dunlap, Van Liere, Mertig and Jones (2000), Manoli et al. (2007), Tuncer et al. (2009), Wright (2008), and Yavetz et al. (2009). This survey instrument was originally created by Dunlap and Van Liere in 1978 to capture an emergent ecocentric worldview and to contrast it with the dominant social paradigm of the time: anthropocentrism. In 2000, Dunlap et al. published a revised version of this instrument to correct some flaws

and update the language, including a shift from the terms "environmental paradigm" to "ecological paradigm." This 15-item survey instrument targeted three facets of ecological worldviews: the balance of nature, limits to growth, and human domination over nature. It provided potent insights into attitudes and beliefs pertaining to environmental literacy, and "has become the most widely used measure of environmental concern in the world and been employed in hundreds of studies in dozens of nations" (Dunlap, 2008, p. 3).

After acknowledging the Revised NEP's renowned reliability as a quantitative scale, Lundmark (2007) offered a critique of the Revised NEP through an environmental ethics lens. She pointed out that, "the greener shades of environmental ethics are treated with less sophistication by the scale constructors than the anthropocentric ones" (Lundmark, 2007, p. 343). The essence of her principal argument was that setting up a bipolar spectrum that contrasted valuing nature against valuing humans was a false dichotomy because "ecocentrism both extends intrinsic value and rights to individual organisms and to ecosystems. This ethical position is not covered by the scale" (Lundmark, 2007, p. 343). On the other hand, her work also aptly described the extensive work undertaken to successfully validate this scale, and provided an informative discussion of the philosophical underpinnings of this instrument.

Psychometric Instruments. Dillon and Gayford (1997) developed a psychometric approach to measuring environmental beliefs, intentions, and behaviors of pre-service teachers based on a psychometric model stemming from Ajzen and Fishbein's (1980) theory of reasoned action and Ajzen's (2005) theory of planned behavior. According to Dillon and Gayford (1997) this model has been used successfully to investigate human behavior pertaining to drug use, seatbelts, alcohol, as well as fat and

salt intake in diet. Sosu et al. (2008) and, to a lesser extent, Tuncer et al. (2009) also built upon the robust and established field of social psychology to apply stringent statistical manipulations to evaluate aspects of human behavior that are more measurable and quantifiable than nebulous constructs such as affect.

Dillon and Gayford (1997) regarded their study's focus on individualism to be a strength of their methodological approach, stating, "The way that the study was applied here placed the emphasis firmly upon the individual and his/her personal intentions, rather than what was considered to be what those in society at large ought to do" (p. 287). This perspective clearly stemmed from a Western worldview where individualism was valued and regarded as highly desirable. A potential shortcoming of Dillon and Gayford's methodological approach was that it may not adequately capture viewpoints of survey participants who hold non-Western worldviews. The vital role of community in non-Western collectivist cultural environments has compelling impacts on adult learning (e.g., Merriam & Muhamed, 2000; Merriam & Ntseane, 2008). Merriam, Caffarella and Baumgartner (2007) elegantly stated a simple but powerful observation, "Non-Western systems emphasize interdependence versus independence" (p. 240). Dillon and Gayford's (1997) psychometric approach was anchored in established social psychology research, but may benefit from further development so as to gauge cultural sensitivity.

Use of Novel Instruments to Measure Environmental Literacy in Teachers

Most research studies identified for review utilized existing data-collection instruments, or modified existing instruments to meet their needs. Others, however, developed their own original instruments (e.g., Çakir et al., 2009; Flogaitis & Agelidou,

2003; Forbes & Zint, 2011; Summers et al., 2005; Van Petegem et al., 2007), with two of these particularly worthy of note due to their unique approaches.

Flogaitis and Agelidou (2003) collected questionnaires from 110 kindergarten teachers in Greece asking them to write down 15 words that came to mind associated with each of the terms "nature" and "environment." They then coalesced the words into logical groups as needed; for example, the words "anemones" and "daisies" were replaced by the term "flowers." Next, these terms were classified into emergent categories such as biophysical dimensions, emotional dimensions, dimensions of destruction, and others. The word frequency was calculated, and Chi Square tests were used to differentiate between words chosen by teachers who had participated in environmental education training and those who had not. This study had some weaknesses such as the lack of a theoretical foundation in linguistics, and the vexing problems of having collapsed potentially hierarchical categories before calculating frequencies. For example, decisions to collapse "daisies" into "flowers" and "flowers" into "plants" will directly impact word frequencies. Nonetheless, this novel methodological approach offered intriguing potential for ascertaining teachers' conceptions of nature and the environment.

The other approach, unique among the quantitative studies, was found in the survey question design of Forbes and Zint (2011). Drawing upon influential documents in science education and environmental education, they combined essential features of science inquiry with the construct of environmental education *about* the environment to create a set of survey questions. They also designed a parallel set of questions using essential features of design in science with the construct of environmental education *for*

the environment. The fit between the essential features in science education and core constructs in environmental education was clever and perceptive, and may be unique to this fresh study.

Qualitative and Mixed Methods Studies to Measure Environmental Literacy in Teachers

Despite concerted efforts to locate research that examined teachers' levels of environmental literacy using methods other than quantitative approaches, only two studies emerged that measured teachers' environmental literacy utilizing exclusively qualitative methods: Corney and Reid (2007) and Summers et al. (2000). I regarded these studies as juxtaposed because one was particularly strong in terms of robustness and credibility while the other was less so. Corney and Reid (2007) captured student teachers' conceptions of subject matter and pedagogy related to education for sustainable development embedded in their pre-service teacher program. They used a grounded theory approach, employing phenomenographic procedures such as written surveys comprised of open-ended essay questions, audio-recorded university-based sessions, and written student assignments. Their study stemmed from an elaborate theoretical framework spanning the realms of education for sustainable development (ESD), geography education and initial teacher education. Inductive categorizing of data collected from 22 student teachers and their 15 mentor teachers at 15 schools yielded six themes subdivided into 14 categories. The themes, representing dimensions of student teacher learning, included,

1. Understanding the nature of sustainable development for teaching;
2. Knowledge of approaches/strategies for teaching about sustainable

development;

3. Awareness of preferred teaching stance related to personal views about sustainable development issues;

4. Awareness of desired learning outcomes;

5. Awareness of Geography Department practice in ESD;

6. Awareness of a potential for cross-curricular work in ESD. (Corney & Reid, 2007, p. 40)

Summers et al. (2000), on the other hand, interviewed 12 practicing primary school teachers by presenting cartoons depicting images related to each of four environmental issues. Participants were prompted to explain their ideas related to each environmental issue based on their interpretation of the cartoon image. Participants' responses were then judged descriptively against the research team's scientific explanations prepared before the interviews, an unusual procedure for qualitative research which typically aims to capture, describe, and analyze participants' experience rather than judge it (Creswell, 2007). Summers et al. (2000) admitted these scientific explanations "represent no more than our own shared and distilled professional judgments of what might be appropriate for primary teachers, and we claim no status for them beyond this" (p. 296). Nonetheless, they did not consult any teacher preparation literature, or even the K-12 school standards or curriculum that their participant teachers were responsible to teach. Further, this study offered only a very limited theoretical context and no framework for their methodological design. Indeed, the entire article hinged upon only 14 references, a full half of which Summers was the lead author. This

study was considered for elimination from the review but was kept because of the limited amount of qualitative research in this area.

The work of Cutter-Mackenzie and Smith (2003), in contrast, was one of the most cogent studies in this entire review. A multifaceted theoretical framework provided a compelling underpinning for an original design of four well-specified levels of eco-literacy along three dimensions. This mixed methods study, based on 26 elementary teacher interviews averaging ninety minutes each, followed by sending 90 surveys to elucidate the interview findings (84% return rate), resulted in a large quantity of data that was analyzed extensively to yield insightful findings, discussed below, that shed light on ecological literacy levels of elementary teachers. Cutter-Mackenzie and Smith's (2003) approach was sufficiently sensitive to capture some of Lundmark's (2007, p. 343) "greener shades of environmental ethics." This study was primarily qualitative, but augmented by quantitative data. The inclusion of teacher participants' voices through the use of transcribed interview quotes differentiated this study from the typical quantitative studies located through this review.

Findings From Studies on Elementary Teachers' Environmental Literacy

This section examines trends in the findings of studies that investigated environmental literacy of pre-service and in-service elementary teachers. The differences in teacher education program requirements between elementary and secondary are typically substantial regarding preparation in science and thus findings on studies from pre-service secondary teachers (as well as other university students and children) are excluded from this portion of the literature review.

Levels of Environmental Literacy Among Pre-service Elementary Teachers

Overall, studies found that pre-service elementary teachers tended to demonstrate inadequate levels of environmental literacy. Cutter-Mackenzie and Smith (2003) classified most participants in their compelling mixed methods study as ecologically illiterate or nominally ecologically literate, the two lowest levels of their four-level scale adapted from the landmark work of Roth (1992). Yavetz et al. (2009) concluded that despite an overall improvement in environmental literacy in terms of engagement in environmentally-responsible behaviors, an increase in pro-environmental attitudes, and an improvement in ecological knowledge, "the environmental literacy of teacher students towards the end of their studies is discouraging and insufficient for educators" (p. 403). Yavetz et al. (2009) also found that pre-service elementary teachers' worldviews remained anthropocentric even through there appeared to be a shift away from egocentric perspectives (focus on personal well being) and towards homocentric perspectives (concerns for human beings in general). Kennelly, Taylor, and Maxwell (2008), on the other hand, concluded that a 13-week course in environmental education improved pre-service elementary teachers' confidence in their content and pedagogy knowledge, though such knowledge was not directly evaluated and the improvements were modest.

In particular, pre-service elementary teachers' knowledge of environmental issues and concepts was shown to be lacking. Çakir et al. (2009) found that Turkish pre-service elementary teachers held limited knowledge of biodiversity, carbon cycle, and global warming, as well as "critically weak" (p. 31) knowledge related to ozone layer depletion. Several studies found that pre-service elementary teachers held misconceptions about

environmental concepts (Çakir et al., 2009; Cutter-Mackenzie & Smith, 2009; Tuncer et al., 2009). Tuncer et al. (2009) concluded that a majority of pre-service teachers "did not possess enough knowledge to be classified as having an acceptable level of environmental knowledge" (p. 433). Tuncer et al. (2009), however, did find that pre-service teachers exhibited positive attitudes and a high degree of concern for environmental problems. Though modest gains in environmental literacy were sometimes found and affective aspects were sometimes positive, none of the studies deemed pre-service elementary teachers' levels of environmental literacy sufficient given the responsibilities inherent in the roles of educators.

Levels of Environmental Literacy Among In-service Elementary Teachers

The findings in studies involving in-service elementary teachers echoed the results for pre-service elementary teachers. Flogaitis and Agelidou (2003) determined the dominant conception of nature among kindergarten teachers in Greece was "naturalistic, simplistic, limited, and enriched with romantic elements" (p. 475). Further, they noted the teachers' perspective on the environment:

> Focuses on biophysical dimensions; there is a complete absence of the economic and moral dimensions, while the socio-political dimensions are not developed. The complexity, the multidimensional character, global and systemic considerations are all absent. (p. 475)

Summers et al. (2000) also raised concerns regarding in-service elementary teachers' knowledge of biodiversity, ozone depletion, carbon cycle, and global warming, noting that many gaps in conceptual knowledge and misconceptions were revealed by the study.

It is important to recognize, however, that this particular study exhibited some methodological weaknesses.

Teachers' Voices About Environmental Literacy

To this point, the studies described in this research literature review have described the history of conceptualizing and measuring environmental literacy, as well as methodologies and findings for measuring environmental literacy in teachers. International declarations and national frameworks provided widely shared definitions of environmental literacy, and studies that measured environmental literacy in teachers consistently were grounded in sound and clear definitions of the targeted components of environmental literacy established by the researchers. To put it succinctly, the research literature about environmental literacy is constituted primarily of quantitative research that measures the extent to which researchers' ideas about environmental literacy, grounded in national and international frameworks, are present in representative populations of teachers.

A significant gap in the literature is revealed when shifting from measuring teachers' levels of environmental literacy toward listening to their voices to conceptualize environmental literacy and to describe how it unfolds within their students' learning experiences. After extensive searching, few studies were found that aimed to capture teachers' voices about describing their visions for the purpose of environmental education, and none of these interrogated the impacts of bioregional learning experiences on environmental literacy. The following studies sought to understand conceptions of environmental education and environmental literacy that were generated by teachers.

Hwang (2009) conducted a narrative inquiry with five Korean secondary teachers in order to explore teachers' constructions of environmental education and related ongoing identity work as professional educators. Her study probed discursive spaces for exploring "how permeable science teachers' professional identities are to environment-related teaching" (Hwang, 2009, p. 709). She described rhetorical themes emerging from the teachers' narratives that revealed how teachers struggled with tensions between what they were mandated to do as teachers and what they envisioned as possible and desirable with regards to "green education" (Hwang, 2009, p. 703).

Bengtson (2010) undertook a case study of four teachers in the United States to explore the complexity and internal consistency of their conceptions of environmental education. Her study compared elementary teachers' perceptions of environmental education, their perceptions of ideal environmental education, and their perceptions of the reality of teaching environmental education. She concluded that efforts to support and implement environmental education in elementary school settings should attend to "the complexity and diversity in the expression of teacher's environmental education perceptions" (Bengston, 2010, p. iii).

Witz and Lee (2009) explored value orientations that motivated U.S. secondary teachers in their work regarding socio-scientific issues pertaining to the environment. By posting a call on one state and one national listerv, they identified thirty secondary school teachers who regularly incorporated socio-scientific issues into their teaching, and who were willing to participate in in-depth interviews. Their work contrasted a "traditional" view of science as value-free and objectively seeking truth with a "higher vision of science" that was imbued with "strong metaphysical, moral, or aesthetic connotations"

(Witz & Lee, 2009, p. 412). Though their study provided limited details about their methodology, Witz and Lee concluded that teacher education programs should take into account teachers' orientations towards teaching socio-scientific issues, rather than working against teachers' orientations or ignoring them altogether.

Christenson (2004) undertook a yearlong collaborative inquiry alongside five elementary teachers in the United States utilizing children's literature to explore different perspectives on controversial environmental issues. Data were collected through a 47 item survey comprised of teachers' responses to relevant science and social studies standards, and during 19 weekly meetings that were audiotaped, transcribed, and coded. Further, the lead researcher took field notes during weekly classroom visits as well as typed and coded the contents of participants' weekly journals. The study's principal findings included the importance of tying environmental education goals directly to required curriculum guidelines, perceived benefits to children that demonstrated the value of incorporating multiple perspectives into environmental education curriculum, and the complexities surrounding the role of controversial issues in curriculum for early grades.

Gayford (2002) analyzed the learning experienced by secondary science teachers in the UK who participated in a professional development program in order to implement education for environmental literacy. Using a participatory action research approach, the teacher-researchers developed a hierarchical model of knowledge and skills to show a relationship between science education and environmental literacy for their students.

Through qualitative analysis of three sets of interviews with eight teacher-participants, Winther, Volk, and Schrock (2002) examined teachers' decision-making during the first year of an environmental education program's implementation in the

United States. Teachers reported that the environmental education training was difficult at first because it was different from their usual classroom practices. All teacher participants indicated they received some level of positive feedback for participating from peers and building administrators. Some of their colleagues, however, did not appear to understand the purpose of the training or were indifferent. Administrators tended to laud aspects of the training program that resonated with existing school goals such as authentic assessment or project-based learning.

The scarcity of research that aims to capture teachers' voices about conceptualizing environmental literacy and about describing the impacts of an environmental education project on teachers' capacity to teach for environmental literacy is a pronounced gap in the research literature. The present study aims to contribute towards remedying this gap.

Summary of Chapter II

Since the first use of the term "environmental literacy" in 1968, the construct of environmental literacy has evolved considerably. Several international documents have contributed to establishing and shaping fundamental underpinnings of environmental literacy and its relationship to environmental education. Through the 1990s and continuing today, scholars have endeavored to create frameworks and other tools to express increasingly sophisticated visions of environmental literacy. Accompanying the extensive efforts to conceptualize and define environmental literacy have been efforts to measure this complex and multifarious construct.

From the 1970s until today, measurements of environmental literacy have evolved from a nearly exclusive focus on knowledge and attitudes towards increasingly complex

methods to measure diverse components of environmental literacy. For example, Roth's (1992) efforts to operationalize his four components of environmental literacy across three categories offered a useful tool for describing environmental literacy as a continuum rather than a binary condition. Large scale projects such as the National Environmental Literacy Assessment Project (McBeth et al., 2008; McBeth et al., 2011) and NAAEE's extensive framework designed to support national and international studies of environmental literacy (Hollweg et al., 2011) offer rich potential for underpinning continued efforts to measure environmental literacy within and across countries.

A subset of studies that focuses on measuring environmental literacy in teachers exists within the broader body of environmental literacy measurement research. Primarily quantitative in approach, these studies frequently employed established instruments such as the NEETF/Roper Survey (Coyle, 2005) or the NEP Scale (Dunlap, 1978; 2008), or built upon established psychometric theory from social psychology such as Ajzen and Fishbein's (1980) theory of reasoned action and Ajzen's (2005) theory of planned behavior. Still others designed novel quantitative instruments (e.g., Çakir et al., 2009; Flogaitis & Agelidou, 2003; Forbes & Zint, 2011; Summers et al., 2005; Van Petegem et al., 2007). Very few studies employed qualitative methods (e.g., Corney & Reid, 2007; Summers et al., 2000) or mixed methods (e.g., Balgopal & Wallace, 2009; Cutter-Mackenzie & Smith, 2003; Sosu et al., 2008).

Findings from studies that measured environmental literacy in both pre-service and in-service elementary teachers tended to identify patterns of inadequate levels of environmental literacy. Though some modest gains were detected in some studies and

affective components were sometimes positive, the knowledge component was frequently identified as weak. These studies employed mostly quantitative methodologies and essentially verified the presence of established conceptions of environmental literacy within representative population samples of teachers.

A significant gap in the literature appears, however, when seeking studies that organically describe teachers' conceptions of environmental literacy in their own words, instead of comparing teachers' conceptions against pre-determined definitions of environmental literacy inherent in various quantitative instruments. After exhaustively sifting through extensive amounts of literature, only a handful of studies were found that aimed to describe teachers' conceptions about what constitutes environmental literacy and effective environmental education, and no studies examined the impacts of environmental education projects on teachers' perceptions of their capacity to teach for environmental literacy. The present study offers help to remediate this pronounced hole in the research literature.

CHAPTER III

METHODS

Theoretical Framework

Qualitative Research Paradigm

Qualitative and quantitative research answer fundamentally different types of questions (Maxwell, 2005). Quantitative approaches are most useful for identifying variability between factors that are measurable and quantifiable. Qualitative research, on the other hand, is best suited to answering questions that are context-specific, value-laden, and weave together multiple levels of complexity. This study aimed to develop a rich understanding of teachers' conceptions about meanings of environmental literacy. It sought to understand teachers' perceptions of the broad, pedagogical value of curriculum related to the prairie restoration project. Consequently, the questions this research project sought to study were suited to a qualitative research paradigm.

Interpretivist Theory

This study stemmed from an interpretivist worldview, a paradigm that posits the world is socially-constructed and reality is ultimately interpreted through the mind (Glesne, 2011). Ontological beliefs underpinning an interpretivist paradigm acknowledge that different people interpret reality in different ways, thus there is not a singular, monolithic reality to which researchers can claim access (Creswell, 2007). Rather, reality is regarded as complex and messy, and is interpreted through the human mind and thus

there are multiple realities that exist. From an interpretivist perspective, the world is socially-constructed because humans mediate and interpret meaning.

Instructional environments such as elementary classrooms and associated field trip contexts are rife with socially-constructed ideas, norms, and perspectives. Complex and rich social interactions form the basis of a classroom community and the teacher is a principal agent of social orchestration. In sum, an interpretivist paradigm was highly suitable for delving into teachers' perspectives on folding environmental education focused on the local bioregion into third grade curriculum.

Case Study Methodology

A case study approach is suitable to research that seeks to understand a case deeply or aims to compare various cases with clearly defined boundaries (Yin, 2009). Setting logical and appropriate boundaries for each case can be challenging, but determining the unit of analysis for the study is of paramount importance to case study design (Yin, 2009). Case studies build and analyze portraits stemming from multiple sources of data such as observations, interviews, and artifacts such as documents, archival records, or physical artifacts (Yin, 2009).

This study sought to understand how teachers from two schools approached the translation of third grade state science standards into curriculum surrounding a prairie restoration project, and how instruction stemming from the prairie restoration project impacted the teachers' capacity to teach for environmental literacy. A total of seven teachers, three from one school and four from another, formed the basis of this single case study. While I gave serious consideration to dividing the teachers into two cases along school boundaries, I realized fairly early in the data analysis process that few

patterns of similarities and differences between teachers appeared to be congruent with school affiliation; thus, separating the participants into two cases would have been disingenuous and contrived. This case study was also bounded by time; data were collected in association with the fall and spring prairie field trips during the first academic year that the new science standards took effect, and the fall prairie field trips near the start of the following academic year. Congruent with Yin (2009), analysis of the case utilized a variety of data sources, including field trip observations, classroom observations, interviews, and artifact review.

Context and Participants

Location

This research project took place in a school district located in a small city with a population of approximately 38,000 situated in the Upper Midwest region. Teachers were recruited from two K-5 schools that were located just over two miles apart, and had similar demographics. Both schools were Title I eligible and the numbers of students eligible for free and reduced lunch at each school, 41% and 44%, were above the state average of 36%. One school housed approximately 713 students while the other was slightly larger with a student population of 780.

The field trip observations occurred at the science center where the prairie restoration project took place, about 15 miles away from the schools. Located on 300 acres comprised primarily of tall grass prairie with some wooded and riparian areas, the science center housed a 13,000 square foot interpretive center and an observatory. It sat immediately adjacent to a 1,300 acre state park and a 5,800 acre Nature Conservancy tall grass prairie preserve. The science center was managed by a local university and

collaborated frequently with many partners including the near-by state park and the state Department of Nature Resources.

Participants

Teachers were invited to participate in this study based on their classes' involvement in the prairie restoration project located at the science center. When recruiting participants, I employed purposive sampling (Glesne, 2011) in order to assure congruence between the sample and the research questions. In other words, participants were sought who had strong potential to contribute to data that helped to answer the targeted research questions. Participants sought for this study were third grade elementary classroom teachers from an Upper Midwestern school district whose classes participated in the prairie restoration project during the 2011-12 and/or 2012-13 academic year. Five teachers were invited from one school and four from the other. This represented all the third grade teachers providing instruction in English at both schools.

One of the schools had a multi-age Spanish Immersion program that spanned kindergarten to fifth grade; even though some of the Spanish Immersion classrooms that included third grade students participated in the prairie project, I did not invite any Spanish Immersion teachers into my study because I do not speak Spanish, and because the science curricula in those classrooms were designed to incorporate standards from various grades simultaneously. All teachers who were invited from both schools initally accepted, but one from each school eventually withdrew due to scheduling conflicts regarding field trip and classroom observation dates. Ultimately, data from seven teachers formed the evidence for this study.

One teacher of the seven teachers was observed and interviewed as part of a pilot study in the fall of 2011; she granted consent for her previously existing data to be included in this study, as well as to continue participating in the study the following year. I approached third grade classroom teachers at their schools after I received written consent from the building principals and school district administration. The consent form for most teacher participants appears in Appendix A. The consent form for the pilot study teacher appears in Appendix B; her identity was kept confidential and she was not identifiable in the data or presentation of findings as the pilot study teacher.

The classroom observations occurred in each participating teacher's room, with the exception of one observation that included a significant portion of time in the school library. Participants were permitted to choose the times and locations for the interviews, and most chose their classroom when students were not present.

Participating teachers had varying levels of overall teaching experience, third grade teaching experience, and years of experience participating in the prairie restoration project. As noted in Table 1, years of experience teaching overall ranged from eight to twenty-one. Years of teaching third grade paralleled the number of years participants had participated in the prairie restoration project, and ranged from one to fifteen years. In order to protect participant identity, participants were identified with numbers rather than pseudonyms on Table 1, because associating years of experience with pseudonyms could compromise participant anonymity. All participants but one were female. In order ensure the protection of the identify of the lone male participant, the title "Ms." was used in all pseudonyms.

Table 1. Teacher Participants' Years of Experience.

Participant Number	Overall Teaching Experience (years)	Third Grade Teaching Experience (years)	Participation in Prairie Restoration Project (years)
1	9	1	1
2	16	4	4
3	20	5	5
4	8	8	8
5	21	13	13
6	16	15	15
7	20	15	15

Data Collection

Data collected for this study came from three principal sources:

1. observations of teacher participants during field trips to the prairie at the science center as well as related classroom science lessons;
2. interviews with teacher participants including the construction of charts using three by five inch cards listing terms generated by the participants;
3. artifacts such as curricular materials.

A pilot study involving one teacher conducted in the fall of 2011 and completed in the spring of 2012 contributed to shaping and honing the data collection methods designed for this research study. Further, the data from the pilot study were recoded and incorporated into the present study.

Observations

I observed teachers during fall prairie field trips when learning activities included harvesting seeds, and again in spring when learning activities included transplanting

seedlings. Typically, schools arranged for the full-day prairie trips to occur during May and September or October each year. Because two classrooms of children typically filled a single school bus, the classes were often scheduled to visit the science center in pairs. On two occasions during spring prairie trips, I stayed with a teacher for the entire day. Most of the time, however, there were two classes out at the prairie at the same time, and I spent the morning with one class and the afternoon with the other. I aimed to visit each teacher during one fall prairie trip and one spring prairie trip; this was accomplished with the exception of a single teacher who I observed during a spring trip but who had a substitute during her class' fall trip because of a death in her family.

In addition to prairie field trips, I observed each teacher during one or two science lessons that took place in a classroom in preparation for a field trip or as a follow up afterwards. During observations, I attended primarily to each teacher's words and actions, though my observations notes captured specific elements of context as well. During field trips, learning activities were led by professional naturalists with support from the classroom teachers. Congruent with recommendations in Emerson, Fretz, and Shaw (1995), field notes that included researcher comments were produced during and shortly after each observation.

Interviews

One-on-one interviews were conducted with teacher participants in locations selected by each one. The teacher involved in the pilot study participated in three interviews, two in the fall of 2010 as part of the pilot study and one in the spring of 2011. After identifying the key research purpose and specifying research questions, an interview protocol was developed based on the pilot interview protocol. The two

interview protocols can be found in Appendices C and D respectively, one for most of the participants and one for the pilot study teacher. It should be noted that following recommendations of Roulston (2010), draft interview questions were revised in response to the pilot study and the observations. Further, the interview questions in Appendix C and D were adjusted slightly during each interview in order to enhance the conversational flow and to probe for further details.

The interview protocols included a request for participants to list what they hoped children would gain with regards to relating to the natural environment after being a student in their classrooms for an academic year, and to write each item on a separate three inch by five inch index card. Participants were then asked to construct a graphic representation of their ideas by organizing the cards into a pattern on an 18 inch by 24 inch sheet of poster paper. The cards were taped down and participants were asked to draw lines that connected the cards in a way that showed relationships between their ideas. Participants were then asked to identify places on their charts where the prairie restoration project may have had impact, as well as places where the changes to science standards may have had impact. Samples of charts appear in Appendix E.

Artifact and Document Analysis

Artifacts can be powerful sources of data for case study research projects (Yin, 2009; Creswell, 2007; Glesne, 2011). Artifacts collected for this study included copies of the relevant sections of the student textbook produced by a publishing company, copies of worksheets or other materials distributed to students during the class periods or field trips, electronic versions of slide shows and PowerPoint presentations prepared by teachers, and lyrics for a song to which one participant referred during an interview.

Other documents, not affiliated with specific observations or interviews but relevant to the study, included the previous and current academic science standards for third grade. Also reviewed was a prairie restoration project curriculum guide prepared by the science center that hosted the prairie restoration project. The science standards listed in this document predated 2003. Even though the document was undated and no longer circulated, it still provided a helpful historical context. Last, with consent from teachers, I took photos during some of prairie field trips; I was careful to take images very close up (e.g., hands only) or very far away (e.g., groups in the distance) or with subjects positioned with backs turned to me so that no image included any recognizable features that could reveal personal identities. It should be noted that the research questions centered on teachers, and that IRB approval was sought for observation of teachers; thus, no student work or student observational data were collected for this study.

Consent and Confidentiality

To protect participant confidentiality, all final transcripts and observation notes were anonymous and findings were reported without any identifiers that could reveal participant, school, or school district identity. Pseudonyms were applied to the teachers as an additional aspect of risk management. There were no major unforeseen risks of any type associated with participation in this study. A minor risk was that a teacher's identity could possibly have been revealed due to my arrivals and departures for observations and interviews with the teachers. No concerns or complaints arose during any component of this research project.

I provided a written consent form (Appendix A) to participants before data collection for this study. Each participant was offered time to read the consent and ask

questions. The consent was signed by both the participant and myself, and the participant received a copy of the signed consent. The consent form (Appendix B) for the teacher who participated in the pilot study was slightly different because it sought permission to include previously collected data.

Data and analysis files are being kept on a password protected computer and are backed up on an external hard drive. Printed materials, except for participant consent forms, are stored in a lidded box. Consent forms are stored separate from paper and electronic forms of data. All data and analysis materials, both electronic and paper, are stored in appropriately secure locations. My dissertation adviser and I are the only ones with access to the study's data. Since the conclusion of the study, data and analysis files have been stored electronically on an external hard drive. Digital audio files will be deleted after five years. Written documents will be shredded after five years, with the exception of interview transcripts which will be kept indefinitely in a secure location. Throughout the study and for five years after its completion, consent forms will be stored separately from data and analysis materials.

Data Analysis

Case Boundaries

Yin (2009) notes that establishing boundaries for cases can be a challenging aspect of case study research, and that a logical rationale for bounding cases is paramount for an effective research study. For the purpose of this study, the seven teachers served as a single case. The rationale underpinning this approach to bounding the case stems from the fact that these teachers were from the same grade level in the same school district, worked with the same district-approved curriculum materials based on the same set of

academic standards, and participated in the same prairie restoration project. Indeed, many similarities emerged across the data for the seven teacher participants with differences more pronounced between teachers than between schools. Another type of boundary for this case study research project was time. Data was collected during the first year that the newly-adopted state science standards were implemented as well as the fall of the following academic year.

Ongoing Thematic Analysis

Thematic analysis permits researchers to identify patterns and themes that emerge from data (Glesne, 2011). Data analysis that is ongoing throughout the data collection process results in richer and more thorough findings than analysis left as a discrete step after data collection has been completed (Glesne, 2011). Thus, I transcribed interviews shortly after conducting each one and prepared field notes that included descriptions of the teachers' actions and words as well as observer comments during and immediately after each classroom or field trip observation. I undertook preliminary coding relatively soon after the preparation of each transcript and set of field notes. Artifacts such as student hand-outs provided during observed lessons were also reviewed as they emerged. As described by Creswell (2007), memos were an important strategy used regularly to capture researcher reflections about emergent insights throughout the data collection and analysis processes.

Coding and Analysis

The purpose of coding is to "fracture" (Maxwell, 2005, p. 96) data in order to break it apart and rearrange it so as to compare and contrast emergent patterns. Maxwell (2005) identifies three types of codes: organizational codes that capture general topics

and act as "bins" to broadly parse apart chunks of data, substantive codes that seek to uncover what is going on and often end up being subcategories of organizational codes, and theoretical codes that situate coded data in more abstract frameworks. Maxwell (2005) cautions against data analysis techniques that remain at the organizational coding level without delving into the realms of substantive and theoretical coding.

Consequently, I initially reviewed data for the purpose of identifying organizational codes. Components of the 2011 NAAEE model of environmental literacy served as a source of some categorical codes, functioning as "bins" to classify data into general categories. For example, terms such as "dispositions," "competencies," and "behaviors" were used as general categories both on the 2011 NAAEE environmental literacy framework as well as for the purposes of initial data review. Data attached to these "bin" codes were further categorized using an open coding process to inductively identify patterns of emic origins (i.e., from the participants' own words) and deductively identify patterns of etic origins (i.e., researcher's ideas, existing theoretical constructs).

Once the data were coded, I undertook the process of categorizing the codes in order to identify relationships among groups of codes. Maxwell (2005) explains that various connecting strategies can be used to seek out relationships between codes, rather than simply identifying similarities across categories of codes. I think about strategies for fracturing and connecting data as mirroring catabolic and anabolic biological processes in living beings. Metabolic pathways are comprised of both catabolic processes that break down particles of food to molecular constituents, as well as anabolic processes that build up molecules into complex components that are used for life functions. Similarly,

qualitative data are fractured through catabolic-like processes and then reconnected through anabolic-like strategies.

In order to identify relationships within data for this study, codes stemming from all data for each teacher were aggregated, sorted alphabetically, and changed into a unique color. Once I completed this process for each of the seven teacher participants, I aggregated and sorted all the codes from all the data for the entire research project, producing a single-spaced, forty-two page master code list. Initially, the master code list was sorted alphabetically by categories derived from the "bin" codes, but I reviewed it carefully and honed its organization by aggregating logical sets of codes into additional categories as needed. The product was a master code list sorted into categories. During analysis, I selected only the categories and related codes that were relevant to the research questions. These categories and codes, as well as definitions for categories, are listed in Appendix F.

Analysis of the master code list resulted in emergent themes through the process of identifying patterns within various categories. At a glance, I was able to ascertain the proportion of codes for any given category that came from each teacher's data by using the color scheme. Thus, I assured that themes were truly representative of overall patterns and I was well positioned to discuss particularities and exceptions. Further, the colorful master code list became a useful tool for back-tracing codes to particular pieces of data for individual teachers, thus facilitating the presentation of evidence drawn directly from the data to support each theme. Table 2 lists the thirteen themes that emerged through data analysis, including themes seven and thirteen which were minor themes that

contributed to the discussion of the findings but do not appear on the data analysis maps for the sake of increased clarity.

Following Creswell's (2007) recommendations for case study analysis, I aggregated codes into categories and searched for patterns of relationships among codes and categories, resulting in the emergence of themes. Creswell describes qualitative analysis as resulting in "a 'family' of themes with children, or subthemes, and even grandchildren, sub-subthemes representing segments of data" (2007, p. 153). Through additional analysis, I abstracted and contextualized themes into assertions.

Table 2. Themes Derived From Data Analysis.

Number	Theme
1	At Ease with Nature
2	Appreciation and Respect
3	Wonder and Curiosity
4	Awareness and Interdependence
5	Sense of Agency
6	Responsibility and Service
7	Developmental Progression from Self to Others
8	Addressing State Science Standards
9	Developing Scientific Thinking
10	Providing Life Experience
11	Concrete Connections
12	Integration across Curricular Domains
13	Marginalization of Science and Social Studies

Figure 3 graphically represents the organization of categories into themes and resultant assertions. Figures 4 and 5 depict the convergence of themes into assertions, which are fully described in Chapters IV and V.

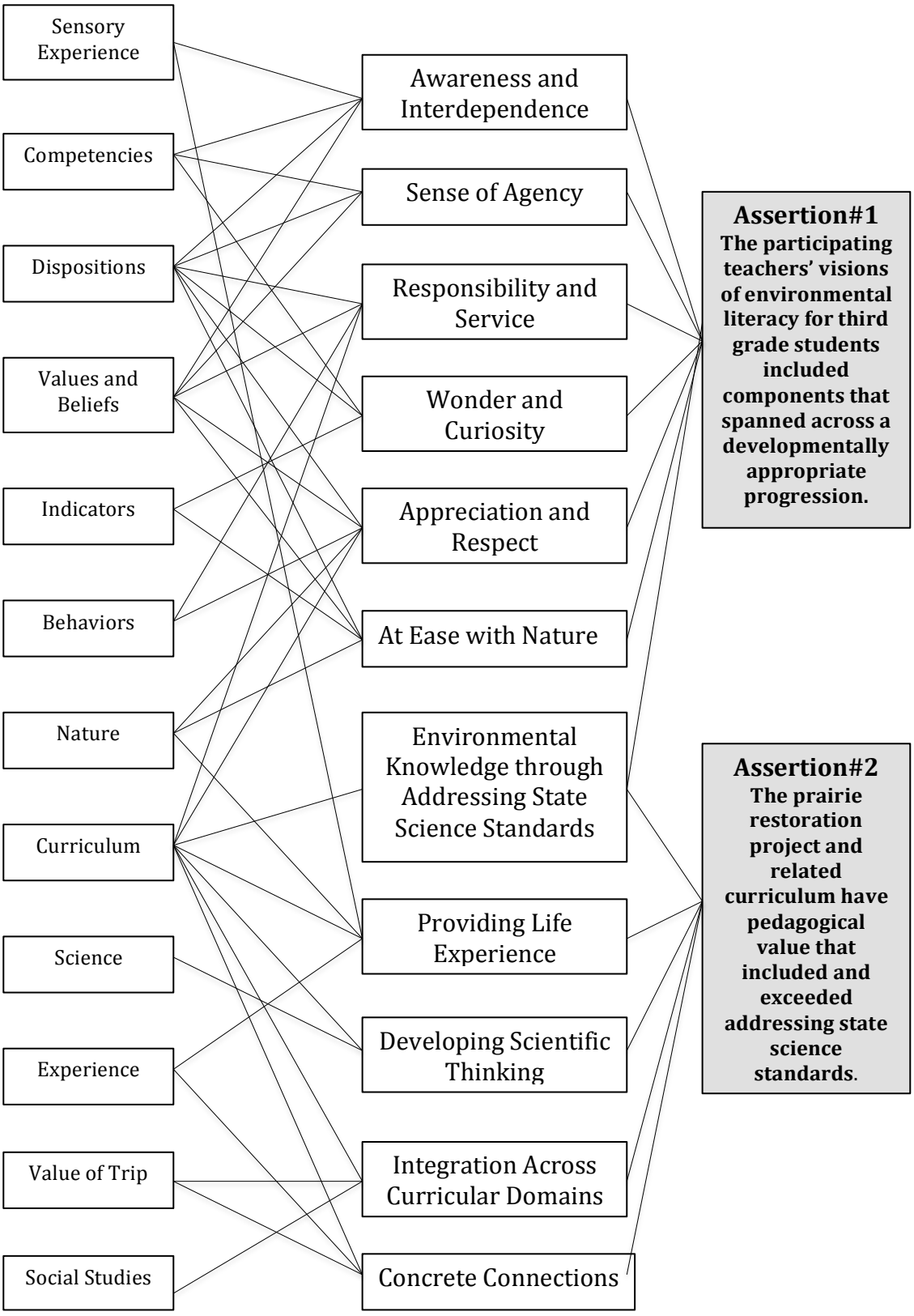


Figure 3. Data Analysis Map: Categories to Themes to Assertions #1 and #2.

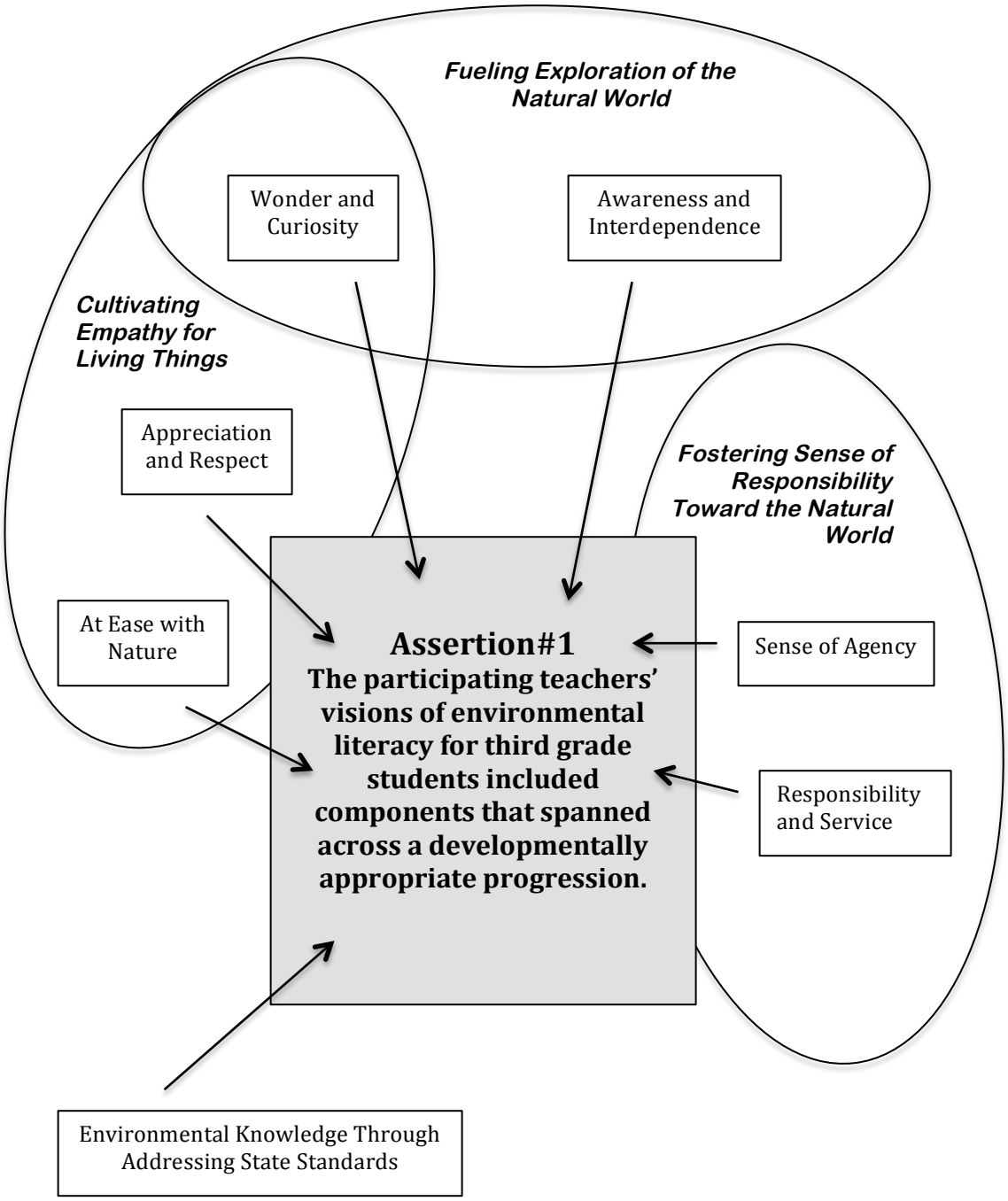


Figure 4. Data Analysis Map: Themes to Assertion #1, Showing Relationship to Sobel's Model of Stages for Children's Relationships With Nature.

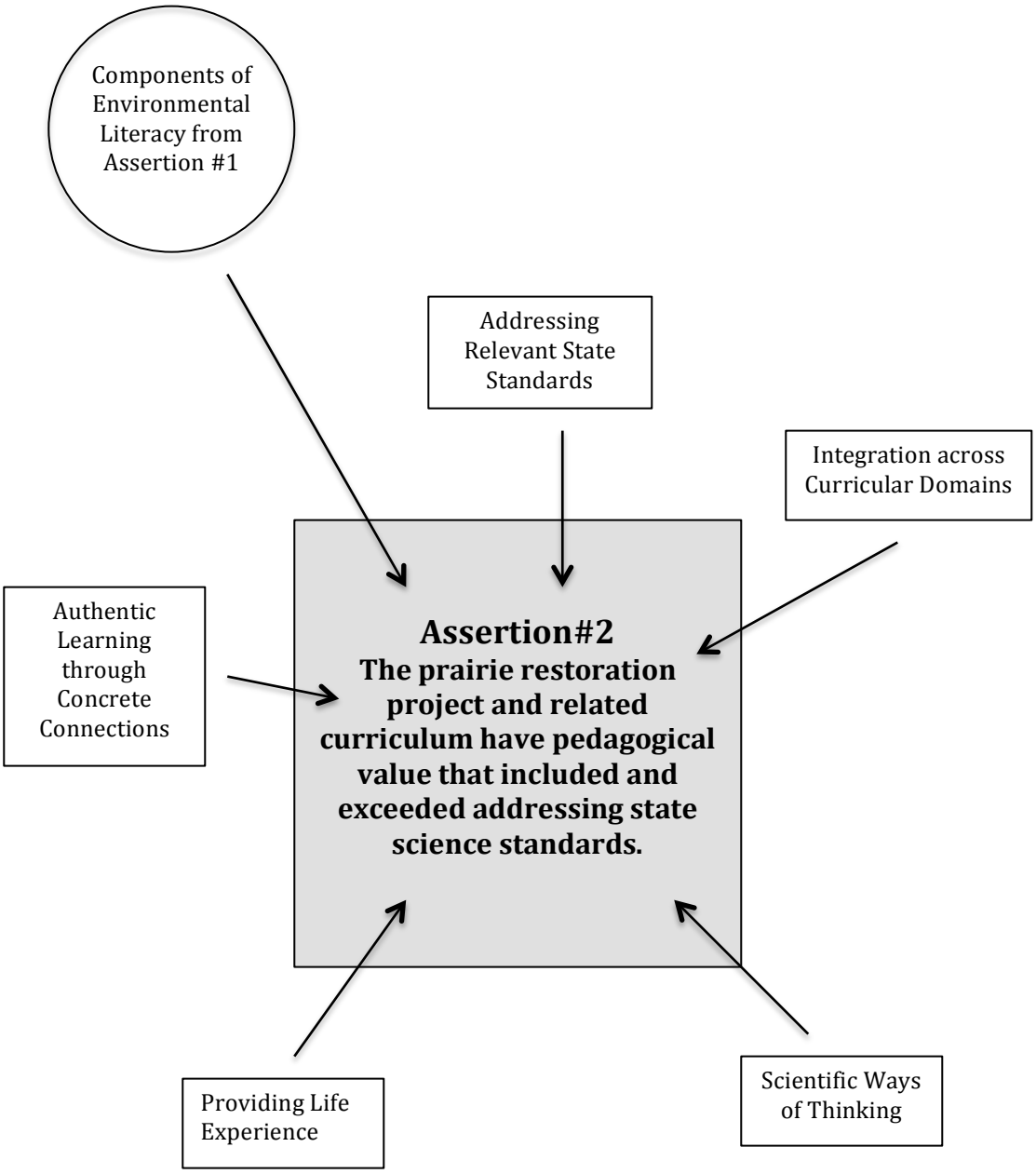


Figure 5. Data Analysis Map: Themes to Assertion #2.

Validity and Reliability

Role of Evidence

Establishing trustworthiness of qualitative research is contingent upon the presentation of credible claims supported by carefully and diligently collected evidence.

While various strategies can help to lessen threats to validity, such methods alone do not constitute validity (Maxwell, 2005). To believe that a particular set of prescribed methods could guarantee validity would be to adhere to a positivist paradigm in which irrefutable evidence could prove facts. This research study is grounded in an interpretivist paradigm and thus seeks to offer sound evidence that will compel readers to agree with the constructions of meaning presented in the findings. Even though absolute trustworthiness cannot be achieved, this study employed several strategies to reduce threats to validity.

Purposive Selection of Participants

Participants recruited for this study were selected purposively, meaning participants were sought who were highly likely to possess knowledge and experience that contributed towards answering the research questions. Only third grade teachers who participated in the prairie restoration project in 2011-12 and/or 2012-13 were invited to partake in this study.

Triangulation

This study drew upon a variety of forms of evidence, including interviews, classroom observation, field trip observations, and artifacts such as curricular materials. Evidence that emerged in one form of data collection was usually supported by another, but on occasion multiple forms of evidence yielded conflicting findings. For example, ideas expressed verbally by participants in interviews were usually congruent with classroom and field observations, but in some instances, incongruences were noted and highlighted in the findings. Further, another level of triangulation occurred through the participation of seven teachers, providing seven perspectives about the same process of

anchoring the prairie field trips in third grade standards and undertaking the prairie restoration project with third grade students.

Audit Trail

All data collected for this study were meticulously organized and stored. I audiotaped and transcribed all interviews in a timely fashion. Field notes that include observer comments were prepared during and promptly after classroom and field trip observations. Memos were used to capture researcher thoughts and insights throughout the progress of the research study. Taken all together, a diligent and careful record of all data collection and analysis procedures resulted in a credible and compelling audit trail.

Member Checking

To enhance the descriptive validity of the data, participants were provided with their interview transcripts and invited to review them for accuracy and completeness. At a later date, preliminary findings were sent to participants and their feedback was sought in order to enhance the interpretive validity of findings. Participants had the opportunity to identify any inaccuracies and to suggest any changes that would improve clarity and precision. Teacher feedback resulted in a small number of minor changes and improvements.

Memos

Throughout the course of the research project, I wrote 21 memos that captured my thoughts, reflections, concerns, and insights arising as the project unfolded. One memo, for example, described the struggle of realizing that the coding of my pilot study data was oddly incongruous with the coding of the data from the full study. Through reflection, I realized that because the pilot study had slightly different research questions, it yielded

correspondingly different codes. In the memo, I admitted the necessity of recoding all the pilot study data. Another memo discussed the restraint needed to avoid correcting minor content errors made by teachers during field trips and lesson observations because that was not appropriate to my role as researcher and would have lessened the validity of the data. For example, one teacher pointed out a 13 lined ground squirrel to her students during a field trip but misnamed it as a prairie dog, an animal that does not live in the tall grass prairie.

CHAPTER IV

FINDINGS

This chapter provides a description of key findings from the study. The aim of this chapter is to capture significant themes that emerged from the data through analysis. First, the research questions are reviewed. Next, an overview of themes that relate to the first two research questions is provided, followed by a discussion of data supporting each theme. Finally, I offer an overview of the second set of themes, those that relate to the third research question, and discuss supporting data for each of those themes.

Research Questions

The purpose of this study was to ascertain third grade teachers' conceptions of environmental literacy as related to a prairie restoration environmental education project, and to describe the prairie restoration project's impact on teachers' capacity to teach for readiness to act responsibly towards the natural environment. The questions guiding this study were:

1. What are teachers' conceptions of environmental literacy for third grade students?
2. How does the prairie restoration project contribute to teachers' capacity to teach for environmental literacy of third grade students?
3. What is the pedagogical value of the prairie restoration project?

Overview of First Set of Themes

The first eight themes capture key components of environmental literacy for third grade students as perceived by the teachers participating in the study. Additionally, the extent to which the prairie restoration trip contributes to these components is discussed. The first eight themes address the first two research questions. Six of the eight themes include being at ease with nature, appreciation and respect, wonder and curiosity, awareness and interdependence, sense of agency, and responsibility and service. Developmental progression from self to others is another theme discussed in this section that is relevant to the first two research questions. The eighth theme, addressing state science standards, describes the environmental knowledge that teachers identified as being important for environmental literacy; because this theme also addresses the third research question, it is identified here but fully discussed in the second set of themes

First, teachers indicated that students who were environmentally literate were at ease with nature, not fearful or anxious when visiting the prairie environment. The prairie trips provided authentic experiences for children to interact directly with the natural environment; some exhibited fearful responses and others showed affinity for the prairie. Teachers noted that children's relationships to nature had evolved over the course of their careers, with children becoming generally less "outdoorsy." Some teachers indicated that they perceived children from rural settings to be more comfortable in nature than children from urban settings.

Second, developing a sense of appreciation and respect for the prairie emerged as a core component of third grade environmental literacy for all teachers in the study. In order to recognize the prairie habitat as endangered and valuable, teachers aimed to help

children become aware of the unique attributes of the prairie ecosystem that distinguish it from agricultural land, and to help children recognize the difference between prairie grasses and lawn grass. Teachers cultivated a strong sense of respect towards prairie plants and animals, and expected students to respect the integrity of the prairie ecosystem when visiting it on field trips. Most teachers pointed out connections between appreciation, caring, and respect for the natural world.

Third, wonder and curiosity were fostered by all teachers, even though teachers did not explicitly identify wonder and curiosity as components of environmental literacy. During prairie field trips, children were permitted to stop and examine discoveries. Teachers expressed enthusiasm for children's curiosity and sense of wonder during field trips and classroom lessons. Teachers also modeled curiosity and sometimes left questions open for children to ponder rather than providing an immediate answer.

Fourth, teachers sought to develop a sense of awareness about the natural environment and fostered an understanding about the value of interdependence in nature. Teachers coached their students to be observant about physical features of the prairie landscape and encouraged keen engagement in a wide variety of sensory experiences such as smelling crushed plants, listening for animal sounds, and feeling natural objects such as bison bones and the square stems of mint plants. An intriguing connection emerged between developing a sense of awareness and valuing interdependence, the notion that all things in nature are connected. By attending carefully to physical characteristics of natural objects, teachers were able to help students sharpen their lenses for contextualizing natural objects on a broader scope, not only fully recognizing natural objects for their physical presence, but also for their role in ecosystems and

interrelationships with other parts of the prairie ecosystem. For example, teachers not only helped students to experience the sights, smells, and feel of prairie plant seeds, but also helped student to understand interactions such as pollination and seed dispersal.

Fifth, a belief that children can make a difference in terms of protecting the natural environment and a sense of agency to do so emerged as another component of environmental literacy as perceived by the teachers. The process of harvesting prairie plant seeds, growing the plants in classrooms over the winter, and transplanting the seedlings in spring provided opportunities that teachers seized to foster children's sense of ability to make a positive impact. Some teachers highlighted the role and value of teamwork in children's efforts to conserve and restore the natural environment. One teacher in particular, Ms. Gogh, was especially focused on equipping her students to become critical thinkers able to pose questions, to find their own voices, and ultimately to make independent decisions about leading healthy lives congruent with environmental sustainability.

Sixth, a central component of environmental literacy as perceived by teachers was a sense of responsibility and duty to protect and preserve the natural environment. The prairie restoration process itself, teachers' expectations for environmentally responsible behavior during field trips, and efforts to promote recycling were principal avenues for fostering a sense of responsibility towards the natural environment. The service learning aspect of the prairie restoration project was another element of this theme that emerged from the data for some of the teachers.

Seventh, three of the teachers who each had over fifteen years of classroom teaching experience spontaneously commented on a developmental progression among

third grade children that they had seen unfold repeatedly over the course of a typical school year. They reported that many third grade children shifted from a focus on self towards an increased awareness of others.

Theme One: At Ease With Nature

One component of environmental literacy described by teachers was children feeling comfortable in nature, rather than fearful or anxious about being in contact with natural objects or the natural environment. When asked to describe children with healthy relationships to nature, some teachers identified an eagerness or openness to experience new things in nature as an important indicator. Ms. Hull related a story about one of her students who was at ease with nature. The daughter of a biologist, she "was the first one to touch worms" and was willing to pick up an insect when one of the teachers hesitated to do so herself. Ms. Hull went on to describe such students in general as,

> Willing to share answers, willing to touch things, willing to try things. You know, not oohing and aahing about things, but feeling like this . . . is just part of life, instead of "that's icky," "it stinks," and stuff like that.

Children who are at ease with nature possess one of the fundamental aspects of environmental literacy as conceived by teachers in this study.

During various observation visits, it was apparent that teachers contended with some children who were very uncomfortable with nature and anxious about venturing out to the prairie. Some children showed strong, fearful reactions to caterpillars, squirrels, grasshoppers, and spiders. During a prairie field trip, one girl became upset and cried for several minutes in response to a caterpillar that touched her; the teacher comforted her to help her regain her composure. On a different prairie field trip, a boy stomped on a

grasshopper for no apparent reason until it was thoroughly crushed while other children crowded around and said, “Ewww.” Indeed, one of the codes that emerged from analysis was entitled “Ick Factor” and captured incidents where teachers responded to children expressing disgust towards nature. Similarly, a code appeared for fearful or anxious reactions to nature.

Conversely, there were also many situations that arose during observations when teachers responded to children demonstrating strong affinity for nature and appearing both comfortable and enthusiastic about interacting with nature. For example, one girl excitedly and spontaneously held out a grasshopper in her outstretched hand to show me her discovery, a sharp contrast to the boy who crushed a grasshopper as described above. In contrast to the “Ick Factor” code, a code entitled “Awe/Wow Factor” drew together examples of teachers interacting with children fascinated by nature or teachers modeling fascination towards nature. A regular aspect of all prairie field trips was for children to gather around interesting finds of living things or natural objects, frequently discovered by one of the children.

Notably, most teachers expressed some concern about children spending less time playing outdoors, patterns observed over the course of their teaching careers. Teachers described how children have generally become less “outdoorsy” and more focused on indoor play, particularly “now with the video games and the electronic age.” Such changes were typically contextualized in negative terms, viewed as a loss. Ms. Wood pointed out the role of fear in the reduction of time spent outdoors during childhood. She stated,

> I think that the connection [between children and nature] isn't as close as when I was a child, when you got the fear . . . now that you don't dare send your kids out, I mean. We went bird-watching with my neighbor across the street. We'd take our little bird books and go out in the field, and go across the bypass. Now, kids aren't allowed that luxury, I think. Not because I think the world is that much scarier, it's because we're more scared. I think the media and whatever, it's too close.

When describing changes to her students' relationships to nature, Ms. Halt explained how many of her students' families appear to have shifted priorities away from recycling during these difficult economic times. She said,

> I think when we first started, our graphing data of people that recycled was higher than it is now. Just from my informal observations from my students, I don't think a lot of our families care about recycling right now. They are worried about bigger issues for them. I don't think they're necessarily caring about our environment. They are caring about their next meal and . . . different issues.

While different teachers expressed varying views on how children's relationships to nature have changed over time, none described patterns of increased contact between children and nature, and most indicated an overall erosion of connectedness between children and nature.

Interestingly, two teachers commented on differences in comfort levels with nature observed among children from rural settings as compared to those from urban settings. Both pointed towards a pattern where they perceived children from rural settings to be more attuned with and comfortable in nature.

Theme Two: Appreciation and Respect

All teachers indicated that developing a sense of appreciation and respect for the prairie was a key component of children's environmental literacy and was a desired outcome for the prairie restoration project. Teachers wanted students to recognize the prairie as a distinct ecosystem that was worth preserving, to empathize with prairie animals, and to feel a sense of caring and responsibility towards the prairie.

In order for children to appreciate the prairie, teachers realized that it was vital for children to recognize the prairie as a unique ecosystem, distinguishable from farm land or grass that makes up urban lawns. Ms. Rose explained that she hoped her students would "take away what prairie is" and she wanted her students to know that "our prairie is not just the flatland." Ms. Bright defined the concept of prairie in one of her lessons that I observed. Ms. Lake described an approach for finding out what children knew about the prairie before studying it. She said,

> I first start out with a green piece of paper and I tell [the students] to draw something you think is on the prairie. And I've had everything from skyscrapers to the buffalo, to the little log cabin of Laura Ingalls Wilder, just to kind of see what they know about it. This class actually knew a lot about the prairie, but in the past there have been classes - some of them don't know anything about what it would be.

Indeed, a misconception that arose during field trips was for some children to indicate that wheat was one of the grasses they expected to find at the prairie. Ms. Hull had samples of prairie grasses on display in her classroom to help students become familiar

with common prairie grasses and to distinguish them from grass commonly found in city lawns. Ms. Hull said,

> And part of it is, I just want them to get in their head a better picture of what a prairie is. Because most of them, at this time of year [fall], when they come to school, . . . they don't have a clue what a prairie is. I mean, they've heard the word. And maybe "Little House on the Prairie." They have no idea. So just being able to broaden that concept of prairie, and that animals live here and that it's important, because animals do live here and it's not just a bunch of "dumb grass." [laughs] Is what they look at it, you know. [laughs] So they see that. And I think they are really amazed how many animals make their home on a prairie.

Helping children to develop a conception of the tall grass prairie as a distinct ecosystem with inherent value was a theme that emerged in the data for every teacher to varying degrees.

Beyond recognizing the prairie as a unique entity, most teachers sought to convey to students the idea that the prairie is endangered and is worth preserving. Ms. Halt explained that many of her students believe that prairie lands are still abundant, but that she wanted them to understand "that whole idea that [the prairie] is rare, and then the idea that we have to take care of it and what we can do to take care of it." Another example can be found in the type of transition between PowerPoint slides that Ms. Hull selected for a slide show about bison that she created. Ms. Hull chose the transition effect called "diffuse" so that an image of the prairie with the caption, "The prairie habitat has changed," appeared to be mowed down, scattered as confetti, and replaced by an image

of a farm field. The implicit message was that the prairie is endangered because much of it has been lost to agricultural lands.

In addition to grasping the inherent value of the endangered prairie, teachers also sought to cultivate a strong sense of respect towards the prairie and nature in general, another component of environmental literacy among third grade children. Codes that stemmed from teachers' expectations for children to act respectfully towards the prairie appeared for all teachers. During the prairie field trips, children were reminded repeatedly by teachers to leave the prairie grasses intact, and not to take things from the prairie such as galls or berries. Also, teachers consistently required children to clean up any garbage from snack or lunch. Ms. Bright, for example, indicated that a child who was ready to act responsibly towards the natural environment would neither pull seeds from grasses nor interfere with prairie animals such as the snake her class had recently seen.

Most teachers regarded the prairie trips as pivotal for developing a combination of appreciation, caring, and respect for the prairie. In response to describing what would be lost if the prairie trips were eliminated, Ms. Halt explained, "I think that overall appreciation for what it is. . . . If you don't appreciate something you're not really going to respect it, care for it, and conserve it."

Theme Three: Wonder and Curiosity

The third theme that emerged from data analysis highlighted the role of a sense of wonder and a sense of curiosity as building blocks for environmental literacy among third grade children. Teachers fostered children's sense of wonder towards discoveries of natural objects and living things by encouraging children to pay full attention to prairie plants and to observe carefully when examining evidence left by animals such as an ant

hill, bird nests, or leaves devoured by caterpillars. Ms. Halt described how children had the "really neat experience" of seeing deer bones left from a coyote kill in fall and again the following spring. Indeed, during one of the prairie field trips, I observed a student excitedly discover a jaw bone from that very pile of deer bones, remains that the naturalists from the science center had left undisturbed so that many children have had the chance to "discover" those same bones over the span of recent years.

Similar to children's sense of wonder, children's sense of curiosity was also cultivated through the prairie trip experiences as well as during classroom lessons. When children became curious about something they noticed while walking through the prairie, the class was often permitted to stop and take a closer look. During prairie field trips, I saw classes stop to examine goldenrod galls, snakes, frogs, beetles, decomposed logs, various plants, swallow nests, mounds made by pocket gophers, holes made by snakes, and even a piece of hardened tree sap. Often these points of interest were identified by a naturalist or a teacher, but children's questions and observations frequently initiated the stop to examine the object of interest more closely. While opportunities for fascination with nature were abundant and easily accessible on field trips where children encountered an array of engaging natural finds, it was pivotal that the adults made space for children to express their excitement and encouraged them to share their discoveries.

It should be noted that not all opportunities for asides stemming from children's questions were pursued. Sometimes, the class forged ahead and children's questions or comments were pushed aside for the time being. On one field trip in particular, a male student's questions were brushed aside by the teacher or the naturalist on five separate

occasions throughout the day. I do not know why this well behaved student's astute questions were dismissed, and I was disappointed by the missed opportunities.

In addition to responding to children's observations, teachers and naturalists, as well as many parent volunteers, encouraged children's sense of fascination by modeling interest, curiosity, and sometimes amazement. For example, because the fall of 2012 was unusually dry, an enormous rock with a spot polished to a smooth sheen by wallowing bison became accessible in an area that was usually too boggy to enter. Naturalists and teachers made a point of ensuring children understood that this was an exceptionally rare and special opportunity, and expressed their own enthusiasm about touching the spot worn smooth by generations of bison from the past. Similarly, during classroom observations and prairie field trips, teachers sometimes modeled curiosity by posing "I wonder" questions or raising a question without providing an immediate answer, such as when Ms. Lake wondered aloud about some of the class' discoveries during their spring field trip, including a tent caterpillar nest, shelf fungus on a tree, and the possible entrances to a large ant hill.

Of note is that while no teacher identified curiosity as an indicator of children's environmental literacy when interviewed, it was clear from the field trip and classroom observations that all the teachers valued and honored children's curiosity regarding the prairie. Indeed codes for valuing curiosity emerged during data analysis for every teacher participant. Teachers and naturalists cultivated children's sense of wonder and curiosity by permitting the class to stop and observe discoveries more closely, by showing enthusiasm and interest for children's finds, by modeling curiosity and wonder, and by occasionally not providing immediate answers to some questions.

Theme Four: Awareness and Interdependence

A theme that I did not anticipate was the teachers' expectation for children to develop a strong sense of awareness about their immediate surroundings. Children were encouraged to be observant, to be in the moment, to pay attention to details and notice particularities about the prairie. For example, Ms. Rose commented about wanting her students to recognize seasonal changes on the prairie that differentiated the fall trip from the spring trip. Similarly, Ms. Wood indicated she talked with her class about how unusually short the plants of the tall grass prairie were going to be in fall due to extremely dry summertime conditions. Further, a regular component of the spring field trips was for students to walk through a section of forest silently and pay careful attention for any signs of animals. Also, the role of sensory experiences for children emerged repeatedly as a code in the data for all teachers. From smelling crushed plants on the prairie and in the classroom, to listening for the difference between the call of a chipmunk and a tree frog, to touching the fur on a bison hide, the prairie restoration project brought a wide array of sensory experiences to which children were encouraged to pay full attention.

For Ms. Gogh, Ms. Wood, and Ms. Hull in particular, the importance of fostering a sense of awareness seemed to stem from the developmentally appropriate idea that being observant is a necessary precursor to developing a sense of appreciation and respect for nature. Ms. Wood explained,

> [My students] love snow, but I don't know that they have taken the time, a lot of them, to slow down and enjoy, you know, like a rainy day or the crisp feel of the

> air. Some of them, maybe. But to truly appreciate nature, I think they are on their way maybe. And the prairie is a good thing for that.

Similarly, Ms. Hull explained,

> You would hope that they would become more respectful. Or maybe not even that level, just more observant of nature. . . . That they find that nature is…interesting and they observe it and they can look at it and there's more detail there than they might think about, than that first look. . . . A lot of times they are not observant at all, they are not paying attention, to notice the details, ask questions about why does this grow like that and why does this animal live under the ground? And things like that. Just being more observant.

While all teachers encouraged the students to observe carefully and to pay attention to details, some teachers viewed such awareness as contributing to developing a sense of appreciation for the prairie.

The second facet of this theme is the teachers' focus on interdependence, the idea that nature is comprised of complex webs of life and that people and nature are connected together in deep and powerful ways. Ms. Wood said she hoped the prairie trips would help her students to understand "how everything affects something else in nature." During classroom lessons, Ms. Bright explained how the rotting log that students observed on the prairie trip functions as food for insects, and she directed children's attention to the exchange of pollen and nectar between plants and animals. Ms. Gogh told her class a story about how bees are disappearing all over the world and she explained the connection to pollination and food production. She wrapped up by stating, "The bees are suffering. We are all connected. If the bees suffer, we suffer. We are all connected."

Not all teachers expressed a vision of interdependence that included humans as part of nature. Ms. Lake viewed the prairie as a place humans visited, but that people were distinctly separate from the prairie. She said,

> When were out there [on the prairie], we're part of their community now, and of the prairie community. . . . This is their habitat, it's not ours. We need to respect that, so kind of a respect of what's yours, what's your community, what's your place.

This perspective was still steeped in a sense of respect for nature, but regarded humans as separate from nature and downplayed human reliance on nature.

The two facets of this theme, awareness and interdependence, were related; helping students to become more observant of nature strengthened their awareness of interdependence within the webs of life found on the prairie, and also contributed to students' understandings of human-nature interactions. With support and direction from the teachers and naturalists, children were encouraged to become fully present to the physical characteristics and the interdependent relationships of a particularly large rotting log, a regular stop on the spring prairie trip. It would have been easy for students to simply walk by the rotting log without noticing how the soft wood shreds looked, felt, or smelled, or without recognizing the significance of a rotting log within an ecosystem. A quote from Ms. Hull reveals the relationship between awareness and interdependence. She said,

> One thing that we talk about is a rotting log. You might just see it as a big chunk of wood, but it's also future soil. . . . It's food for animals. . . . What we talk about is . . . just being respectful. [Students] see the value in it, see some connections

> between plants and animals. . . . The plants kind of help the animals, and the animals kind of help the plants, some of those connections. So between people and animals, between people and nature. We rely on it for food and those kind of things. Connections I guess between plants, animals, people-especially when we're studying Native Americans. Between people, food, homes, and how we get products from nature.

Thus, being observant of natural objects and living organisms helped students to sharpen their lenses for noticing physical characteristics, changes over time, and interrelationships involving the focal points of their observations.

Theme Five: Sense of Agency

All teachers indicated a desire to foster a sense of agency among their students, to empower their students with a message that kids could make a difference with regards to protecting the natural world. The prairie restoration project provided a opportune experience to convey that message to students. Corresponding codes appeared in the data for all teachers. Ms. Lake, for example, described how her students had a duty to restore the prairie and held "the power and ability to help restore [the prairie] and put it back." Ms. Rose, in turn, explained that one indicator of environmental literacy was when students had "a sense that they are a piece to this whole puzzle of preservation [of prairie habitat.]"

When asked to explain three things she hoped students would gain from the prairie restoration project, the first element Ms. Hull listed was, "just feeling that they're part of restoring the prairie, planting plants, that they're doing something that's going to help the prairie and they see that as worthwhile." Ms. Hull has been involved in the

restoration of several plots over a span of fifteen years and reported that she showed her students “parts of the prairie that have been restored by third graders in the past, so it becomes more of a service learning thing.” When I accompanied Ms. Hull on her class’ spring trip to the prairie, she showed me the established plots of restored prairie from 2001 to 2007. Helping her students to feel actively engaged in restoring the prairie and to recognize the impact of previous classes’ restoration efforts were ways that Ms. Hull fostered a sense of agency among her students.

Similarly, Ms. Halt indicated that she truly valued the opportunity to confer a sense of agency among her students. She said, “That's my favorite part of the prairie trip, that they get to see it, that what they're doing is making a difference and they get to see that. It's my favorite part of it.” Helping her students to feel empowered to restore the endangered prairie was an important element of Ms. Halt’s approach to the prairie restoration project.

Some teachers recognized that the challenges many of their students faced in daily life were obstacles to developing a sense of agency in their students. Ms. Halt, for example, set a modest target to help one of her students feel a sense of empowerment within the scope of actions accessible to him during their prairie visit. She said,

> I keep having one little boy in my mind. He's having a really hard couple of days and I just know there's stuff going on, and he's crying and he's late. But he's still working and strong, and won't tell you what's going on. And I think what about him? What about him when we go to the prairie, what do we want him to do? What do I want him to achieve? Not to throw his garbage on the ground, to know that's his ability to take care of that.

Even though the goal Ms. Halt set was limited in scope, she sought out a path for this particular student to feel some sense of agency and power to positively affect the natural environment during the prairie trip.

Another dimension of developing a sense of agency that emerged from the data of some teachers was the power of teamwork. Ms. Gogh and Ms. Wood, in particular, expressed a desire to convey to students that working as a team to take care of the natural environment could have more impact than working alone. Ms. Gogh explained how this principle carried over to her classroom routines when, for example, she pointed out to students how quickly and effectively the class was able to clean the classroom when working together as a unit.

Ms. Gogh was particularly focused on explicitly developing a sense of agency among her students. She sought to endow her students with the tools they needed to learn independently. She encouraged students to pose questions, to be open to new experiences, and to express their opinions publicly in the classroom. She sought to equip students to make responsible and healthy environmental decisions without directing them explicitly to do so. Ms. Gogh stated, "I don't want them to be cranked up and say, 'Oh! [Ms. Gogh] said I have to turn the water off when I brush my teeth.'" Instead, Ms. Gogh hoped that students would come to that conclusion on their own, and would independently choose to turn off the tap when brushing. After extensively describing her vision of "eco-mindedness," Ms. Gogh wrapped up one of her interviews with the following,

> I don't teach third grade curriculum, I teach students. And no matter what I give them, I want them to be thoughtful about what they do

> with the information I give them. And so I think that's the overriding piece of this. I want to give them everything they need to do the right thing, even though I don't want to tell them what the right thing is. I want them to figure it out, hoping they'll agree with me.

During interviews, classroom observations and field trip observations, Ms. Gogh consistently avoided positioning her environmental beliefs as dogma and instead coached her students to find their own voices and their own paths towards positively impacting the natural environment.

Theme Six: Responsibility and Service

Beyond teaching children to value and appreciate the prairie, and beyond empowering children with a sense of agency to effect positive change, teachers sought to foster a sense of responsibility and a sense of duty towards service among their students. A recurrent set of codes that emerged to varying degrees in data for all teachers was the importance of cultivating a sense of responsibility towards restoring the prairie, a sense of stewardship for protecting the prairie, and involvement in service learning.

The undertaking of restoring prairie offered an important avenue for fostering a sense of responsibility toward the natural environment. Ms. Lake described the importance of helping students to recognize that they had the capacity to fix or restore something and that they had a subsequent responsibility to do so. She said,

> [Students] have the ability to repair something or restore something that's not there, like the prairies are disappearing so it's our job to go collect the seeds and go plant them. We have the ability to stop something and repair it or restore it.

Similarly, Ms. Hull pointed out that she hoped students would recognize preserving the prairie as a valuable undertaking. She explained,

> I think also with the project, the restoration, that they have a little sense that they can make a difference and that there's a reason to make a difference-for animal homes and all that. That we want to . . . keep the prairie because a lot of animals live there and it's part of the world that we live in.

Teachers recognized that the harvesting of prairie seeds, followed by growing seedlings in classrooms over the winter, and finally transplanting the new plants at the science center formed a process underpinned by a sense of stewardship to restore and preserve prairie lands that were regarded as special and inherently valuable.

Another facet of the prairie restoration project was its connection to service learning. Ms. Rose explained how she regularly engaged in service learning with her students "where we're actually going out on-site and working with an organization." She then identified the prairie restoration project as a form of service learning, and pointed out that one of the naturalists had indicated the seeds harvested by the children would actually cost several thousand dollars if the science center was required to purchase them. Codes relating the prairie restoration project to service learning appeared in data for five of the seven teacher participants to varying degrees.

Beyond the process of prairie restoration, the prairie trips and associated curriculum provided additional opportunities for teachers to strengthen their students' sense of responsibility and service toward the natural environment. Students were expected to take care of the prairie by cleaning up garbage, by not picking seeds from unripe prairie plants, by leaving natural objects on the prairie rather than collecting them

(other than harvesting seeds when directed), and by being careful not to disturb prairie animals or their homes. During one of the field trips to the prairie, Ms. Gogh said to a small group of students who had excitedly discovered some frogs in the grass,

> Be nice to the frogs. This is their house. When someone comes to your house, you would be gentle. If you came to my house, you would be gentle. Now you're in the frog's house, so be gentle. You can do this. I believe in you.

Teachers expected children to act responsibly toward the prairie in ways that extended beyond the prairie restoration process.

Another approach to fostering a sense of responsibility toward the natural environment stemmed from recycling. Six of the seven teachers described class projects and routines focused on recycling. Ms. Hull described how her unit on recycling helped students to feel a sense of duty toward preserving natural resources. She explained,

> I bring in a bunch of things that have been recycled, and talk about the cost of making new products and how we're using natural resources, and kind of make a big deal about when you throw things in the garbage, you are really throwing natural resources away. And I'll even say to them [laughs], "What are you throwing those trees away for?" Just to help them realize that these products didn't just come from nowhere, that they came from somewhere . . . and that if we save the product, we save using that natural resource. That's one of the big ideas I try to get through to them.

Most teachers had recycling boxes prominently displayed in their classroom and expected students to use them. Some teachers described extensive past efforts to teach the value of recycling through guest speakers, field trips to the recycling plant and establishing

systems for third grade students to be responsible for collecting recycled paper school-wide. The changes in the science standards, however, resulted in the loss of the recycling standards from third grade and thus recycling has been reduced as a curricular focus for almost all the teachers. Nonetheless, it was clear that most teachers maintained an expectation for children to recycle and hoped children would gain a sense of duty toward recycling.

Theme Seven: Developmental Progression From Self to Others

The seventh theme highlighted some teachers' comments about the developmental progress of third grade students moving from focus on self toward an increased awareness of others in the world. These comments arose spontaneously from three teachers, each with over fifteen years of classroom teaching experience. Ms. Lake said,

> [Students] kind of just have a deeper understanding that there's more than just me. I think third grade is a time when kids realize that there is more than just me. Kindergarten and first grade - it's all about me, but then [in] third grade they start to realize that there's a little bit more out there. It's not just them. There are others.

Similarly, when asked to create a chart that captured what she hoped her students would learn about relating to the natural environment after being a student in her classroom for an academic year, Ms. Gogh's diagram prominently included a progression from self, to others, to world. She explained that "they're developmentally at third grade, sometimes they only can think about themselves." Then she went on to state, "The ultimate piece is that they open up and see that their actions are important to the whole world." Without being asked directly about development progressions during interviews, Ms. Lake, Ms.

Gogh, as well as Ms. Rose pointed out that their third grade students typically progressed from focusing on themselves toward becoming more aware of others in the world.

Overview of Second Set of Themes

The remaining six themes relate to the third research question by identifying key ways that the prairie restoration project offers pedagogical value beyond directly contributing to components of children's environmental literacy discussed above. These six themes include addressing state science standards, developing scientific thinking, providing life experience, concrete connections, integration across curricular domains, and marginalization of science and social studies.

Theme eight captured how the prairie-related curriculum contributed to meeting state science standards, perhaps the most obvious way the prairie restoration project offered pedagogical value outside of its direct relationship to fostering the aforementioned components of environmental literacy. Teachers connected the prairie learning experiences to a variety of current science standards, especially ones relating to plants and animals. Other science standards, including ones stemming from topics such as light, shadows, daily changes of the sun, and engineering design, were also targeted by some teachers. Participants indicated the curricular shift within the prairie-related curriculum due to the recent revision of state science standards was minor in scope and the prairie trips remained solidly anchored in a robust set of science standards.

Theme nine showed how learning activities associated with the prairie restoration project offered multiple opportunities for teachers to foster scientific ways of thinking among students. Teachers encouraged students to make careful observations and to draw logical inferences based on evidence, and were present when naturalists also did so

during prairie trips. Some teachers also invited children to take on the identity of scientist. Interestingly, while all teachers were cognizant of the new nature-of-engineering strand that had been recently added to state standards, none explicitly identified standards from the nature-of-science strand when asked to describe which standards were addressed by prairie-related learning experiences, even though classroom and field trip observations revealed a connection.

Theme ten explained that teachers regarded the prairie trips as enormously valuable for providing important life experience to children. Participants indicated that visiting the prairie ecosystem offered opportunities to expand children's worldviews and to expose them to an increasingly endangered natural habitat. Some teachers pointed out that broadening life experience through exposure to the prairie was especially valuable for children from families of lower socio-economic status.

Theme eleven highlighted the wide array of concrete connections that facilitated student learning. Teachers intentionally fostered connections between classroom instruction, prairie field trips, and students' lived experiences. Not only did teachers recognize the pedagogical value of facilitating connections to increase concreteness of abstract ideas, to improve transfer of concepts across contexts, and to deepen student learning, but a plethora of multifarious connections also appeared in practice.

Theme twelve characterized the integration of a variety of curricular domains into the prairie experiences, including science, social studies, language arts, and to a limited extent mathematics. Because the relationship between the prairie restoration project and the academic science standards was discussed previously, this theme focused on connections to social studies, language arts, and mathematics. The prairie trips also

served as a thread or scaffolding that anchored learning experiences across the academic year and thus increased curricular cohesion.

Theme thirteen pointed out that all four teachers at one school described the marginalization of science and social studies curriculum without being asked about this topic during interviews.

Theme Eight: Addressing State Science Standards

Perhaps the most conspicuous way that the prairie restoration project offered pedagogical value outside of directly supporting teachers' capacity to teach for components of children's environmental literacy previously described was its contribution to addressing state science standards. Teachers identified several science standards with which the prairie restoration project resonated. Further, teachers reported relatively minor changes between the previous state science standards, approved in 2003, and the current ones, which were revised in 2009, put into rule in 2010, and required to be implemented state-wide by 2011-2012.

Though this study focused primarily on the integration of science standards into the prairie experiences, a number of codes emerged in the data that reflected multiple connections to the state social studies standards as well, due to the integrated nature of elementary education. Theme eight captures relationships to the previous and current state science standards, while the connections to the social studies standards are discussed briefly in theme twelve, integration across curricular domains.

When asked how the prairie trips related to the current state science standards, all teachers' responses included topics centering on plants such as life cycles and seed dispersal, and topics centering on animals such as animal characteristics and adaptations.

Indeed, concepts about plants and animals were very prominent in nearly all observations of classroom lessons and prairie field trips. For example, plant and animal adaptations, including both structural and behavioral adaptations for animals, were a major topic of study during many classroom lessons and prairie visits, as were various forms of seed dispersal and pollination in plants.

At one of the schools, the two teachers who had the most extensive amount of teaching experience at the third grade level described their efforts to integrate as many science standards as they could into the prairie-related curriculum. Between them, they identified key topics in the new science standards including light, shadows, daily changes of the sun, sound, space, and engineering design. Sound and space were regarded as poor candidates for the prairie-related curriculum, but light, shadows, daily changes of the sun, and engineering design were deemed suitable. Indeed, one teacher had already begun to have students analyze the direction of the sun's light and resulting shadows at various points during one of the prairie field trips. Further, these teachers had plans to have students apply engineering design principles to plan and build bug traps that would then be set up for the day at the prairie during future field trips.

Teachers alluded to the messiness and complexity of launching new science curriculum stemming from recently-adopted science standards. The district had purchased new elementary science curriculum materials in response to the revision of state science standards and most teachers described the process of curricular change in science as fluid and ongoing. Ms. Halt said, "The first year is kind of messy, trying to figure out how to mesh everything together, seeing how the big picture can be." Multiple teachers expressed appreciation for the school district's commitment to hire an education

consultant who "unpacked" the new science standards and matched the district's newly adopted science curriculum materials to the revised science standards.

Most teachers described the changes between the previous and the new third grade science standards as relatively minor in scope. Ms. Rose said, "We kind of just tweaked from what we were doing before to fit the new standards. I think that was done easily enough." Standards related to plants and animals remained the primary anchors for prairie-related science curriculum after the revision of science standards. For example, Ms. Wood and others explained that whereas the previous standards had resulted in a focus on ecological habitats with regards to the prairie-related curriculum, the revised standards had shifted toward plant and animal adaptations. Indeed, a previous third grade standard about habitat was, "The student will know that changes in a habitat can be beneficial or harmful to organisms," (Minnesota Department of Education, 2003, p. 4) whereas a current one about adaptations was, "Give examples of differences among individuals that can sometimes give an individual an advantage in survival and reproduction" (Minnesota Department of Education, 2009, p. 10).

Recycling and water were topics that found footing in the previous standards, but had shifted into other grade levels in the revised standards. While some teachers lamented the loss of these beloved topics from the third grade standards, it was apparent that different teachers had previously integrated the topics of recycling and water into the prairie trips to varying extents. This contrast was visible, for example between the approaches of Ms. Gogh and Ms. Lake. Ms. Gogh viewed recycling as a topic that she integrated easily with teaching about the prairie. She stated, "You go to the prairie and you drop a plastic bottle on the ground, how long is that bottle going to stay there? So

[recycling] was a really easy connection before." Ms. Lake, in contrast, described a field trip to a local recycling plant and other learning activities previously associated with her recycling unit without mentioning the prairie or related curriculum at any point. Recycling and water were topics that some, but not all, teachers previously integrated into prairie trips.

Overall, most teachers described the minor curricular shifts occurring in response to the change in third grade science standards as having a modest positive impact or no consequential impact on correlation between the standards and the prairie trip. When describing the impact of the changes in the science standards on the prairie trips, Ms. Halt said, "I think it's made it better. I think it's given us a little bit more to work with, to add a bit more to it." Ms. Hull commented that while naturalists at the science center "all do a great job," they "do a little better job out there of fitting in adaptations than they do habitat." Ms. Gogh indicated that while there was a small drop in the number of related science standards, the prairie trips remained valuable for addressing an array of standards. She said,

> We do have less standards that connect to the trip. Just in that fact, it makes the standards that we do have more intense. . . . It still does really cover a lot of our standards, it's just not quite as many as in the past. I still look at that trip is a very valuable trip to learning and to show mastery.

Teachers reported that the revision to the state science standards resulted in a shift that had little substantial impact on the strong correlation between the prairie trips and state science standards.

Theme Nine: Scientific Ways of Thinking

The ninth theme described how the prairie-related curriculum contributed to teachers' opportunities to develop scientific ways of thinking among children. During classroom observations and field trips, learning activities were implemented that fostered the development of various science process skills as well as rational and deductive thinking. Further, students were invited to assume a scientific frame of reference to explore the natural world. These skills, while present in the state standards on the nature of science, were not explicitly identified by any teachers as an avenue through which the prairie experiences were correlated with the state science standards, except for one passing comment by a single teacher.

Repeated patterns of codes emerged in the data regarding the use of science process skills, especially observation and inference. Naturalists and teachers regularly asked students to make careful observations of plants and signs of animals during prairie field trips, and teachers also did so during some classroom lessons. When Ms. Halt wrapped up a classroom lesson that reviewed steps of scientific investigations, she told students, "When we go to the prairie, you are going to make lots of observations." She went on to describe some of the natural objects and living things they might observe at the prairie. Additionally, naturalists and teachers asked students to draw inferences based on observational evidence, such as realizing that holes in leaves inferred insect activity and beaver teeth markings inferred the presence of beavers. In certain episodes, these skills were explicitly identified by name and sometimes even associated with scientific work, whereas in other episodes the skills were called upon for use without prompting students to associate the skills with scientific endeavors. For example, during one prairie

trip, students concluded that particular gopher mounds were likely formed relatively recently because they noticed the dirt was loose. The teacher did not, however, point out that students had formulated an inference based on an observation.

Beyond inviting students to utilize evidence-based rational thinking and science process skills, teachers sometimes encouraged students to employ a scientific frame of reference or even to embrace the identity of scientist. For example, Ms. Hull told her students, "You guys are pronghorn investigators" when she assigned a group of students to create a list of pronghorn adaptations based on a text and images during a classroom lesson. In addition to offering comments to individual students such as, "You are such a scientist!" Ms. Gogh told her class during a classroom lesson, "I'm thinking someone in this room might be a scientist to find out why bees are getting sick and how we'll pollinate our plants in the future." Ms. Wood commented that she hoped her students would become more aware of potential careers in science.

Interestingly, even though a number of teachers raised the matter of nature-of-engineering standards being added to the revised state science standards, none pointed out the correlation between the nature-of-science strand in the science standards and the incorporation of science process skills and scientific ways of knowing the natural world into the prairie experiences. The only explicit reference to the nature-of-science strand in the state standards occurred in the following passage from one of Ms. Gogh's interviews,

> I want [students] to ask questions. And I want them to be open to new learning. *So that actually is a standard, to be able to have questions*. So I want to give them to tools to learn as I did. I don't need to have them learn what I learned. [Emphasis added]

While teachers invited students to make observations and inferences and were present when naturalists also did so, teachers did not explicitly identify a relationship between the prairie-related curriculum and the state standards about the nature of science.

Theme Ten: Providing Life Experience

The next theme that captured pedagogical value of the prairie restoration project beyond a direct link to components of environmental literacy previously described was providing life experience that exposed children to the world beyond their neighborhoods. Teachers pointed out that the prairie trips brought valuable opportunities to broaden children's life experiences and to expose children to a unique natural environment. Some teachers indicated that such exposure was especially valuable and important for children from families of lower socio-economic status.

Ms. Bright described how the prairie trip brought a chance for students to encounter a relatively undisturbed natural environment that could not be replicated in a classroom setting. She said, "I think it's just a really good experience to open up the kids to learning outside of the classroom, outside of the textbook to get a real life experience of the prairie and the life you see out there." Similarly, Ms. Hull explained that the prairie trips brought some children into direct contact with nature, an experience that some of her students would likely not encounter within their families. She stated,

> I think that trip really . . . helps [students] connect with nature a lot more than they were before. Because for a lot of the students, they've never been, I would say maybe half haven't been on a nature trip before. It's just because . . . it's not something that their families do. So for them to take a mile hike in the nature, for some of those, it might be the first time for a long time that they're really aware

that this is a possibility as an activity. Or that "I like this" or some of them might say "I don't like it." So I think it's just one more experience, that puts it in front of them.

Ms. Bright and Ms. Hull regarded the prairie restoration project as a potential source of engaging life experiences with the natural world.

During an interview, Ms. Rose created a chart (Appendix E) that depicted a web describing what she hoped students would gain with regards to relating to the natural environment after being a student in her classroom over the span of an academic year. She placed a card listing “prairie” in the center and then surrounded it with other cards that captured her key intended outcomes. She positioned a card stating “exposure to nature” at a prominent location at the top of her chart. Ms. Rose explained how she valued the trip for its opportunity to provide exposure to nature and hoped that children would “not take [the prairie trip] for granted, . . . because so many kids do not have those opportunities, ever, to be out in a huge open area like that, like our prairie.” Like Ms. Hull, she indicated while she hoped the experience would foster a sense of appreciation for the prairie, she wanted it to fundamentally provide an experience of exposure, valuable even if some children did not like their visits to the prairie.

Ms. Lake positioned the prairie trips alongside cultural events that her students attended through school field trips, including the art museum and the symphony. She explained the value of exposing children to experiences that expanded their frames of reference. She said,

> I think [students] need to be exposed and made aware of that stuff and there are other things out there than going home and doing video games or playing outside. That there are "things beyond my door that I don't know about."

She indicated that "a lot of the kids in the school do not get the experiences that say kids at another school would get in their home," pointing out that her classes regularly include children from families of lower socio-economic status. At Ms. Lake's school, 41% of the students were eligible for free and reduced lunch, above the state average of 36%.

Similarly, Ms. Halt described how several of her students had a very limited worldview based on minimal life experiences, and that the prairie trip offered a way to expand their worldviews. She stated,

> First and foremost it's not an academic per se experience that I'm looking for. It's a life experience. So many of our kids . . . even talking about what should we write about. "Let's come up with brainstorming ideas about what you want to write your story about. Have you ever been anywhere? Have you ever done anything?' Many of these kids have not. Their life is [name of the school] and [name of a low income neighborhood]. That's their frame of reference, that's their world. So to get them out of school and out into the wilderness . . . that nature experience is new to them. They might never get that. So to me it's a life experience I want them to get out of that.

Interestingly, she went on to chastise herself for indicating that her top-priority intended outcome for the prairie trips was to enhance students' life experience rather than a myriad of possible academic goals. She said, "but really I want their life experience, isn't that terrible? Of all those academics that I can say."

Theme Eleven: Concrete Connections

Related yet distinct from the tenth theme of providing life experience, the eleventh theme highlighted the prairie restoration project's capacity to foster concrete connections and thus render learning more authentic. Within the data for all teachers, codes appeared revealing that teachers regarded the prairie restoration trip as a source of authentic connections that enhanced student learning. In addition to teachers describing the value of concrete connections, the data were rife with examples of connections occurring between the classrooms and the trips, and between the classrooms or trips and the students' daily lives. Indeed, one of the elements of the notes Ms. Gogh took during her spring field trip was a running list of trip to classroom connections that she planned to exploit during lesson planning after the trip.

Classroom-to-trip connections occurred frequently across a wide array of topics. During a classroom lesson, Ms. Bright asked students to recall specific examples of pollinators observed during the prairie visit. She said, "Boys and girls, what I want you to talk about is what you saw [on the prairie trip]. I know you know bees pollinate plants, but did you see any out there? What animals did we see pollinating plants?" She directed students to the idea that gnats and ants were pollinators encountered on the prairie field trip. Ms. Gogh's class carefully observed a variety of plants during a classroom lesson on seed dispersal, including an echinacea plant brought in by a student. At the end of the lesson, Ms. Gogh commented that she anticipated students would see echinacea plants on their upcoming field trip, and indeed they did. I observed Ms. Halt teach a classroom lesson about light and shadows and then saw her students predict where their shadows would fall when exiting the woods and hiking out into the open prairie on a field trip.

Indeed, even a bus trip out the science center provided an opportunity for Ms. Gogh to connect a child's observation that the dividing lines on the highway appeared to get bigger as they got closer to the bus to a third grade astronomy standard about the apparent size of stars.

So many occurrences of classroom-to-trip connections arose for teaching the concepts of structural and behavioral adaptations that these examples merited separate data codes. Teaching about facets of animal adaptations such as camouflage, defense, acquiring food, and evading predator, together with specific examples of adaptations for animals such as bison, pocket gophers, badgers, skunks, porcupines, caterpillars, woodpeckers, and frogs crossed back and forth between learning experiences in classrooms and on prairie trips. Ms. Hull's class, for example, studied images of pocket gopher and badger adaptations in class and then discussed several of these same adaptations while physically examining pocket gopher and badger pelts on a prairie field trip.

Beyond connections between classroom and prairie trip experiences, an array of trip-to-life connections arose from most teachers' data during analysis. Some trip-to-life connections were fairly minor, such as pointing out that the sage crushed and smelled by children during prairie visits was also an herb used for cooking, and the pollen from a jack-in-the-pulpit prairie plant looked very similar to pollen from poinsettia plants that were familiar to some students. Other classroom-to-life connections were more substantial, including relationships between the river observed during the fall and spring trips, and the extensive flooding that periodically dominates the landscape and lives of regional residents.

In addition to trip-to-life connections, several occurrences of classroom-to-life connections unfolded during classroom observations. For example, a video showed by all teachers at one school elicited a spontaneous comment from a student who compared her own mother locking the family's door at night to a mouse protecting her babies overnight by concealing the nest entrance with grass. Also, Ms. Wood showed her students images that contrasted the long roots of prairie grasses and the short roots of typical lawn grass and then related root length to plant survival during the recent exceptionally dry summer.

Clearly, the prairie restoration project offered a myriad of opportunities for a variety of connections between classroom experiences, prairie field trips, and students' own personal experiences. All teachers not only fostered such connections but also discussed the pedagogical value of them. Some teachers indicated that such connections made abstract concepts more concrete and accessible to children. Ms. Wood, for example, highlighted the role of sensory experiences in making learning concrete when she stated,

> This [prairie learning experience] can be down to earth, this can be something you can touch and feel and smell and all the rest of it, when you're doing the prairie, so that's a hands-on activity which is real to the kids.

Ms. Bright expressed the value of concrete, hands-on experiences embedded in the prairie trip that are impossible to replicate in the classroom when she said,

> [Students] can see this wide open space where humans really haven't had a lot of impact. I mean we were walking in that field with plants up to our waists. What a neat experience–you can't get that in the classroom. You don't see that in pictures–it's not the same connection that they can make. It's just that open land.

> This is how animals live and this is how the whole cycle works, of plants. I just feel like that connection, and going there – it really makes a difference and the kids can really see that hands-on versus just in-the-classroom approach.

Ms. Bright went on to describe the value of the prairie trips this way, "I think it does allow for so much more discussion, and so much understanding of what we're teaching when we can have it hands-on."

While some teachers highlighted the value of making abstract ideas more concrete through hands-on experiences, other teachers pointed out that making concrete connections facilitated transfer of knowledge from one context to another. Ms. Lake explained,

> When they go on vacations or do other things, some of the things with the habitats and the landforms we're learning about transfers over into their own life, so that they can see that in something other than the book or on TV. . . . When we go back to the prairie this spring, we'll see erosion from the river, and so they can see that and make the transfer from the book to their life, and what we're doing.

Further, some teachers discussed how the prairie trips deepened student understanding about key concepts. Ms. Wood questioned whether students could develop a "true understanding" of ecosystems without visiting one. In response to describing what could be maintained and what would be lost if the prairie trips were dropped, Ms. Wood said,

> You're going to do lots of experiments and the kids love doing them. And you can teach terminology until the cows come home. And you can probably- most kids can understand an ecosystem by studying. But to have the true understanding, I'm not sure, if you don't go there.

Facilitating transfer of knowledge and deepening understanding emerged as ways that teachers regarded the prairie trips as vehicles for enhancing student learning.

Theme Twelve: Integration Across Curricular Domains

The twelfth theme distilled from data analysis was the integration of learning experiences across curricular domains. All the teachers took advantage of opportunities to weave a variety of curriculum areas into the prairie restoration project, especially science and social studies, as well as language arts and mathematics. Indeed, most teachers reported that the prairie restoration trip functioned as a thread, anchor, or culminating experience that tied together instruction across the academic year. The interconnectedness between the prairie restoration project and the academic science standards was extensive and has been discussed in a previous theme, thus the focus in this theme is the integration of social studies, language arts, and mathematics.

Alongside science, social studies was the other discipline in which the prairie trips were most firmly anchored. As a discipline of study, social studies is typically divided into four principal strands: citizenship and government, economics, geography, and history. Patterns of repeated codes emerged from the data for all teachers indicating the incorporation of social studies concepts and skills, primarily from two strands of social studies: history, especially the topics of prairie settlers and Native Americans, and geography, especially the topics of landforms and mapping skills. For example, historical uses of medicinal plants such as purple cone flower, scouring rush, and bloodroot were commonly discussed on prairie field trips, as were Native American uses of bison. All teachers identified landforms as a social studies topic integrated with the prairie trips and teachers incorporated cardinal directions and other mapping concepts to varying extents.

The state had recently adopted newly revised social studies standards, scheduled to be implemented within two academic years. Most teachers expressed uncertainty about the forthcoming new social studies standards, indicating they had yet to study them to determine the fit with the prairie restoration project, but were hopeful to find a level of congruence sufficient to justify continued implementation of the prairie restoration project. Teachers were pragmatic about this matter, however, and appeared ready to examine the new social studies carefully in order to make a considered determination regarding the level of fit between the upcoming social studies standards and the prairie trips.

In addition to science and social studies, language arts and math were also integrated into curriculum associated with the prairie restoration project. Literacy skills were consistently embedded in classroom science lessons observed, and appeared regularly in prairie field trips as well. For example, during classroom lessons, Ms. Halt modeled strategies of effective reading such as having students annotate steps of the scientific method in the student workbook, and Ms. Rose described to students what she anticipated bolding of text in the textbook to signify. Also, Ms. Wood pointed out connections to students between a story from a classroom lesson and a plant observed and dissected during a field trip. While literacy skills were integrated extensively, mathematical thinking appeared less often during observed prairie-related science lessons and field trips. Examples of math integration included Ms. Halt encouraging students to use fractions to describe the Earth's self shadow during a classroom lesson, and students calculating the perimeter of planting squares while transplanting seedlings at the science center.

Most teachers described how the prairie trips served as an agent for curricular coherence throughout the academic year. A pattern appeared indicating that the notion of regarding the prairie trips as a thread or anchor was more common among teachers in one school compared to the other, though the pattern was present in teachers from both schools. Ms. Halt stated, "The prairie trip serves as the introduction to it all, and a place for us to go back and keep anchoring that learning to," and she expressed the value of a "full circle experience" provided by a pair of trips that occur near the beginning and the end of the academic year. Ms. Gogh described how the prairie experience "becomes a thread that the kids connect to all the way through the school year." Ms. Wood described how she wove the prairie experiences into her curriculum across the entire academic year. She said,

> I love having the focus of the prairie. It gets you started. It gets you into something. You can refer back to it. You can look forward to it again, in that you get to go two times. So it does drive a lot of my curriculum. So I appreciate having it.

The prairie experiences served as a valuable scaffold to which a variety of learning experiences were tied throughout the course of the school year.

Theme Thirteen: Marginalization of Science and Social Studies

The final theme captured the marginalization of science and social studies in the third grade curriculum at one of the schools. Ms. Wood spontaneously explained that it was very difficult to fit all required science and social studies topics into the third grade curriculum because science and social studies together were allocated a total of only thirty minutes in the daily classroom schedule, in order to accommodate the school's

commitment to ninety minutes of reading, sixty minutes of writing, and ninety minutes of math every day. Ms. Hull echoed this concern when she stated,

> You probably understand that often science and social studies are some of the first things that get squeezed out. Because at our level, they're not tested. I mean they will be, but they're not right here so our focus is on getting kids to read, write, and be mathematical thinkers. And that's our first priority, whether scientists like it or not. [laughs] That's the reality of it.

The two other teachers at Ms. Wood and Ms. Hull's school also introduced the issue of marginalization of science and social studies in the third grade curriculum without being asked directly about this topic during interviews. It may be useful to note that the school at which these teachers worked had recently undergone substantial reorganization as a punitive measure in response to failing to meet Adequate Yearly Progress for multiple years under the parameters of No Child Left Behind legislation.

Summary of Themes

In Chapter IV, I provided a description of themes that emerged from data collection and analysis. I found the key components of environmental literacy for third grade students as perceived by the teachers participating in the study encompassed being at ease with nature, appreciation and respect, wonder and curiosity, awareness and interdependence, sense of agency, and responsibility and service. Further, prairie-related curriculum offered pedagogical value beyond directly contributing to teachers' capacity to teach for aforementioned components of environmental literacy in several ways, including addressing state science standards, developing scientific thinking, providing life experience, concrete connections, and integration across curricular domains. Two

minor themes were teachers' ideas about developmental progression among third grade students from self to others, and marginalization of science and social studies.

In Chapter V, I will present and discuss two assertions stemming from data analysis. Further, I will present implications for teacher education, limitations of the study, and recommendations for further research.

CHAPTER V

DISCUSSION

The purpose of this study was to describe elementary teachers' conceptions of environmental literacy in relationship to a prairie restoration project and to explore ways in which the prairie restoration project contributed to enhancing educational learning experiences. The research questions driving this study were:

1. What are teachers' conceptions of environmental literacy for third grade students?
2. How does the prairie restoration trip contribute to teachers' capacity to teach for environmental literacy of third grade students?
3. What is the pedagogical value of the prairie restoration project?

The theoretical frameworks unpinning this study were David Sobel's (1996) model for developmental progression in children's relationships with nature, and NAAEE's framework for environmental literacy (Hollweg et al., 2011). The NAAEE framework for environmental literacy (Hollweg et al., 2011) was used in the formation of "bin" codes during the analysis process but does not figure strongly in the discussion in Chapter V.

The themes that emerged from data analysis were clustered into two groups. The first set captured key elements of environmental literacy as perceived by the participating teachers, in particular: being at ease in the natural environment, appreciation and respect, wonder and curiosity, awareness and interdependence, sense of agency, and

responsibility and service. The second set of themes identified ways that the prairie restoration project offered pedagogical value, including addressing state science standards, integrating subject areas, developing scientific thinking, providing life experience, and forming concrete connections. The eighth theme, addressing state science standards, was relevant to both sets of themes because it highlighted the environmental knowledge that teachers considered important to environmental literacy and also described a fundamental way that the prairie restoration project offered potent pedagogical value; theme eight, however, was only discussed in the second set of themes for the sake of clarity.

In this chapter, I state and discuss two assertions derived from further data analysis and contextualization of the themes within Sobel's theoretical model as well as relevant research literature. This chapter also includes recommendations for practice in teacher education, limitations of the study, and directions for future research.

Assertion One

The first assertion derived from thematic data analysis was, "The participating teachers' visions of environmental literacy for third grade students included components that spanned across a developmentally appropriate progression from cultivating empathy for living things, to fueling discovery of nature, to fostering a sense of responsibility toward the natural world." As presented in Table 3, the six themes that captured key elements of teachers' visions of environmental literacy resonated with the stages of Sobel's (1996) developmental model serving as a theoretical framework for this research project.

It is important to note that Sobel does not regard the three stages as mutually

exclusive. He points out, “In real life there will always be a complex interplay of empathy, exploration, and social action. Empathy doesn’t stop when exploration starts and social action does have a place in early childhood” (1996, p .35). Nonetheless, the fundamental tenor of environmental education activities evolves through the stages and each stage is anchored in a different lens on the natural world.

Table 3. Relationship Between Sobel’s Model and the Study’s Themes.

Stages in Sobel’s Model	Related Themes
Cultivating Empathy for Living Things	#1 At Ease With Nature #2 Appreciation and Respect #3 Wonder and Curiosity
Fueling Exploration of the Natural World	#3 Wonder and Curiosity #4 Awareness and Interdependence
Fostering a Sense of Responsibility Toward the Natural World	#5 Sense of Agency #6 Responsibility and Service

Empathy for Living Things

The first stage of Sobel’s model for fostering developmentally appropriate relationships between children and nature is cultivating empathy for living things. This stage targets children between the ages of four and seven years, and aims to help children develop a sense of caring, compassion, and empathy for living things in the natural world. For this stage, Sobel recommends “cultivating relationships with animals, both real and imagined” (1996, p. 13) and fostering a sense of connectedness with living things as “an emotional foundation for the more abstract ecological concept that everything is connected to everything else” (1996, p. 13). The first three themes from this

research project's findings were feeling at ease with nature, appreciation and respect, and wonder and curiosity. These themes were congruent with developing a sense of empathy toward living things, the first stage of Sobel's model.

The first theme derived from data analysis highlighted the participant teachers' views about the importance of helping children to feel at ease with nature, not fearful or anxious while visiting the prairie. Feeling comfortable in nature was a logical precursor necessary for developing an empathetic connection with prairie plants and animals. For example, there was a sharp contrast between the girl who cradled a grasshopper in her hand and eagerly held it out for me to see, and the boy who demonstrated an egregious lack of empathy by stomping on a grasshopper in front of other children. Indeed, one of the indicators identified by teachers to denote a healthy relationship with nature among children was a sense of eagerness or openness to try new experiences. The first theme, feeling at ease with nature, resonated with Sobel's first stage because being comfortable in nature and being open to try new experiences in nature were prerequisite to fostering a sense of connection and empathy with living things.

The second theme to bubble up through data analysis was the development of a sense of appreciation and respect for nature. A particularly salient aspect of this theme was the teachers' desire for children to recognize the prairie as a unique ecosystem, home to distinctive prairie grasses and array of specialized plants and animals. Such a desire fit well with Sobel's first stage of developing empathy toward living things because teachers wanted children to recognize the inherent value of the prairie ecosystem and to feel a sense of caring and empathy toward it.

The third theme emerging from data analysis was the role of wonder and curiosity

in building environmental literacy among third grade children. In his model, Sobel highlighted the importance of "fostering Rachel Carson's 'sense of wonder'"(1996, p. 13) among young children. Rachel Carson's poetic perspective on fanning the embers of wonder in young children was aptly captured in this excerpt from her seminal book, *The Sense of Wonder*:

> A child's world is fresh and new and beautiful, full of wonder and excitement. It is our misfortune that for most of us that clear-eyed vision, that true instinct for what is beautiful and awe-inspiring, is dimmed and even lost before we reach adulthood. If I had influence with the good fairy who is supposed to preside over the christening of all children I should ask that her gift to each child in the world be a sense of wonder so indestructible that it would last throughout life, as an unfailing antidote against the boredom and disenchantments of later years, the sterile preoccupation with things artificial, the alienation from the sources of our strength. If a child is to keep alive his inborn sense of wonder without any such gift from the fairies, 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. (1956/1998, p. 54-55)

The third theme, cultivating children's sense of wonder and curiosity, resonated deeply with Sobel's first stage of developing a sense of empathy toward living things because wonder is a powerful avenue through which to foster empathy for nature.

Exploration of the Natural World

The second stage of Sobel's model for fostering developmentally appropriate relationships between children and nature is fueling discovery and exploration of the

natural world. Sobel (1996) states, “Exploring the nearby world and knowing your place should be a primary objective for the bonding with the earth stage, from ages seven to eleven” (p. 19). This second stage is characterized by expanding geographic boundaries as children extend their “home territory” from the confines of their neighborhood and school yard to encompass other ecosystems in the local bioregion, such as the tall grass prairie. Sobel’s second stage encompasses exploration of the natural world that results in bonding with the earth, a personal connection to the interdependence of life and Earth’s systems. The third and fourth themes from the research project were wonder and curiosity, and awareness and interdependence. These two themes resonated strongly with exploration of the natural world, the second stage of Sobel’s model.

The study’s third theme, wonder and curiosity, highlighted the role of curiosity and fascination in fostering environmental literacy among third graders. During prairie visits, children’s curiosity was honored when classes were permitted to stop and take a closer look at discoveries such as pocket gopher mounds, goldenrod galls, and foliage ravaged by thousands of tent caterpillars. The theme of wonder and curiosity in the study was closely connected to Sobel’s second stage because children’s exploration of the natural world was largely fueled by their curiosity.

The fourth theme reported in the findings of this study captured the teachers’ efforts to cultivate children’s sense of awareness about their immediate surroundings in the local bioregion. For example, children’s sense of awareness about a rotting log was augmented by the sensory experiences of how the soft wood shreds looked, felt, and smelled. Students’ sense of awareness about the rotting log was further extended by pointing out the role of the rotting log as an interdependent component of an ecosystem.

Increased awareness of natural surroundings and the commensurate ability to recognize interdependence in nature, the study's fourth theme, resonated deeply with Sobel's ideas about exploration of the natural world. He stated that bonding with the natural world entailed becoming fully present to it and embracing one's own role in the interdependence inherent in the web of life. When describing an example to illustrate the second stage of his model, Sobel described how children came to deeply understand the water cycle through ongoing exploration of their nearby watershed. He wrapped up by quipping, "Wet sneakers and muddy clothes are prerequisites for understanding the water cycle" (1996, p. 27). In both the example of the rotting log from this study and Sobel's example of exploring the water cycle, sensory experiences amplified personal connections to the natural world.

Another dimension of the relationship between this study's fourth theme and Sobel's second stage revolves around the importance of bonding with the local bioregion. When explaining that many elementary classrooms study the tropical rainforest instead of plants and animals living in local ecosystems, Sobel observed, "Children are disconnected from the world outside their doors and connected with endangered animals and ecosystems around the globe through electronic media" (1996, p. 4). The prairie restoration project connects children with an ecosystem native to their local bioregion, the tall grass prairie. The prairie experiences increase children's awareness of the components, relationships, and properties of an ecological system "outside their doors" (Sobel, 1996, p. 4).

Social Action to Protect the Natural World

The third stage of Sobel's model for cultivating developmentally appropriate

relationships between children and nature is social action. Sobel explains that youth, aged twelve to fifteen, can engage in actions to protect and conserve the natural environment with support from adults. Sobel cautions against the introduction of multifaceted environmental tragedies too early because children who have not attained formal operational thinking tend to view complex social issues in simplistic, dichotomous terms. Issues that are local in scope and manageable in scale are most appropriate, such as organizing recycling efforts or working to shape town ordinances. The fifth and sixth themes from the study's findings were fostering a sense of agency, and cultivating a sense of responsibility and service toward caring for nature. These themes corresponded soundly with undertaking local and manageable social actions to protect the environment, the third stage of Sobel's model.

The fifth theme to emerge from this study's data analysis was sense of agency, a belief that children's actions can make a positive difference to protect the natural world. Teachers hoped that students would feel fulfilled and empowered by their contribution to restoring an endangered habitat. Some teachers pointed out the role of teamwork in striving to protect and preserve the natural environment. Fostering a sense of agency was a vital component of engaging in social action, the final stage of Sobel's model. Believing that children can make a difference to protect the prairie was inherent in the prairie restoration project; some teachers made that connection explicit to their students, such as when Ms. Hull proudly showed the plots of previously restored prairie from years past. Further, the kinds of social actions Sobel described were collective in nature, such as setting up a local recycling program for batteries, and thus resonated with valuing teamwork related to a sense of agency to protect nature, as expressed by two teachers in

the study.

The sixth theme from the study's findings was fostering a sense of responsibility and commitment to service among students. Teachers sought to develop a sense of duty toward restoring the prairie and a sense of stewardship for protecting the prairie. An element of this theme was the value of service learning as a means to foster responsibility as community members, which was highly congruent with Sobel's third stage, social action. Indeed, the prairie restoration project demonstrated many of characteristics that Sobel identified as suitable for social action in the third stage of his model. In particular, the prairie restoration project was a local undertaking, rather than one that was highly abstract or unrelated to the children's immediate bioregion, such as ocean pollution or rainforest destruction. Also, the scope of the underlying issue was manageable; while the loss of endangered prairie could be an emotional issue for some, its scale was less overwhelming than planetary issues such as climate destabilization due to global warming or the mass extinction of biodiversity on Earth. In sum, the study's theme of responsibility and service toward protecting the natural world aptly matched Sobel's third stage of social action.

Developmental Progression From Self to World

The seventh theme revealed that unsolicited comments from three of the most experienced teachers participating in the study recognized a developmental progression in third grade children from focusing on self, to others, to the world. Data from these teachers indicated that whereas teachers perceived many children to think only of themselves oftentimes in the beginning of third grade, teachers saw a progression toward children showing more regard for others and becoming more open to the world. Indeed,

this progression from self, to other, to world was an intentional and explicit component of Ms. Gogh's approach to fostering "eco-mindedness" among her students.

The developmental progression among third grade students described by these teachers mirrored Sobel's model. Sobel's first stage, development of empathy for living things, tends to occur on a personal level with the child interacting directly with living things in concrete ways. Sobel's empathy stage resonates with the teachers' ideas about children focusing on self. Indeed, in describing the first stage of his model, Sobel states, "Early childhood is characterized by a lack of differentiation between the self and the other" (p. 13). The second stage of Sobel's model involves children expanding their geographic boundaries to explore and discover special places in nature, reflecting the notion of shifting focus from self to others as described by teachers. Finally, Sobel's third stage, social action, is congruent with opening one's focus and interests to the world-at-large. Even though unsolicited comments about developmental progressions of third grade students arose in only three teachers' data, ideas from these three teachers mirrored the three stages of Sobel's model.

Another important component of environmental literacy described by participating teachers was knowledge about key concepts captured in relevant state standards, especially science and social studies standards. The discussion of environmental knowledge embedded in state standards is folded into the discussion below about the second assertion drawn from thematic analysis.

Assertion Two

The second assertion stemming from thematic data analysis was, "The prairie restoration project and related curriculum have pedagogical value that included and

exceeded addressing state science standards." The curriculum related to the prairie restoration project targeted a robust set of state science standards, especially ones centering on concepts related to plants and animals but including other standards as well. In this era of school accountability, teachers are beholden to state standards, especially ones upon which state assessments measurements are designed. Facets of curriculum in American schooling, however, extend beyond what can be captured by measures of academic success grounded in state standards. Similarly, the second set of themes from this study provided a snapshot of some of the ways that the prairie restoration project exemplified pedagogical value beyond state standards and outside of the themes related to environmental literacy already discussed. In addition to addressing state science standards identified by teachers, the curriculum related to the prairie restoration project offered other forms of pedagogical value, including serving as a platform upon which to integrate a variety of subject areas, developing scientific ways of thinking, providing life experience for children, and fostering authentic learning experiences through concrete connections.

State Science Standards and Integration Across Curricular Domains

Certainly, an obvious way that the curriculum associated with the prairie restoration project contributed pedagogical value to students' education was its relationship to addressing a robust set of state science standards, even after revised state science standards were adopted and put into effect. Participating teachers reported that the prairie-related curriculum matched with a number of science standards centering on plant and animal life, including structural and behavior adaptations, as well as plant pollination

and seed dispersal. Especially at one of the schools, teachers were developing the integration of many other science standards into the context of the prairie learning experiences, such as ones relating to light and shadows, and engineering design. As described in the theme on curricular integration, the prairie restoration project also offered a significant contribution to meeting state social studies standards, along with relationships to standards in other subject areas as well. The prairie restoration project served as a curricular scaffolding to which a variety of state standards were tied.

Even though schools are typically bound to address state standards because of state legislative requirements, many schools have marginalized science and social studies curriculum in order to make additional room for subject areas that are measured by state assessments, particularly English language arts and mathematics (McMurrer, 2007). The marginalization of science and social studies was a phenomenon that appeared in the findings of this study as well. All the participating teachers at one school expressed some consternation about the reduction of teaching time dedicated to science and social studies in response to a school-wide directive that increased teaching time for reading, writing, and mathematics. The prairie restoration project provided an effective platform for showcasing key concepts from a relevant set of state science standards, especially important in the current political landscape where the value of science education is not consistently recognized. The prairie restoration project also provided an avenue for integrating curriculum from a variety of subject areas, thus tightening the efficiency of the overall classroom curriculum.

Scientific Ways of Thinking

One of the ways that the prairie-related learning experiences offered pedagogical value beyond the state science standards identified by participating teachers was to develop scientific ways of thinking among students. During classroom lessons and prairie field trips, various learning activities provided opportunities for students to practice making observations and inferences, as well as to assume a scientific frame of reference by thinking rationally and deductively, and sometimes by taking on an identity of scientist.

The skills related to the nature of science embedded in the prairie-related curriculum contributed to an essential aspect of students' science education, even though teacher participants did not appear to identify it as such. A core component of scientific literacy as defined by national science standards is "knowledge of the way science works" with an emphasis on "the scientific world view, scientific methods of inquiry, and the nature of the scientific enterprise" (AAAS, 1989, p. 1). Further, the state standards to which the teachers in the study were responsible also included a progression of standards about the nature of science, including ones at the third grade level. In essence, it is vital for citizens to possess sufficient understanding of key characteristics of science in order to make sense of scientific issues that produce ever-increasing implications for personal and societal matters. Indeed, the National Research Council's (2007) seminal report on reforming K-8 science education*, Taking Science to School*, stresses the importance of fostering children's nature-of-science knowledge and skills within the practical context of inquiry learning. The nature of science is an essential component of effective science education (NRC, 2007), but is often neglected in elementary classrooms (Fulp, 2002).

The matter of embedding the nature of science into elementary curriculum raises thorny questions about cultural responsiveness. Some scholars such as James Trefoil (2008) claim that the scientific world view congruent with E. D. Hirsch's vision of cultural literacy (2002) is sufficient to address matters of multiculturalism, even though such a perspective considers the scientific world view originating from Western thought as the only legitimate form of knowing the world scientifically. Such a view regards citizens essentially as passive consumers of scientific findings produced by expert scientists entrusted with social responsibility for the enterprise of science. Aikenhead (1996, 2006), Coburn (2000), and Roth and Calabrese Barton (2004), along with others have challenged the monolithic nature of a Western-science-only approach to the nature of science. These scholars call for recognition of multiple methods for studying the natural world that honor cultural and personal ways of knowing and that are grounded in active, participatory approaches to undertaking scientific study. While the findings from this study regarding nature-of-science instruction were not exhaustive, the codes that did emerge pointed toward congruence with a traditionally oriented approach to nature-of-science, one that resonated with Western thought rather than any alternate scientific worldviews.

Providing Life Experience

Another way the prairie restoration project offered learning opportunities beyond addressing academic standards identified by participating teachers was by exposing children to experiences with nature that they may not have encountered without participation in the prairie restoration project. Teachers reported that most of their students had little to no personal experience with tall grass prairie environments, and that

some were uncomfortable and anxious about visiting the prairie because it was unknown to them. Further, many teachers expressed some concern about reductions to time children spent playing in the outdoors, a pattern most teachers had noticed in general over the span of their careers. Some teachers indicated that life experiences that exposed children to a novel natural environment were especially valuable for children from families of lower socio-economic status.

Several research studies have illuminated the vital role of childhood nature experiences in the development of a trajectory toward adult environmentalism. Wells and Lekies (2006) proposed a conceptual model connecting involvement with nature during childhood to adult environmental attitudes and behaviors based on their finding from interviews with over 2000 adults from the United States. They found that experiences in wild settings such hiking and camping had a stronger positive association than domesticated natural activities such as planting seeds or harvesting garden produce. Strife and Downy's (2009) and Wells' (2000) studies investigated access to green space for children in poor urban environments and concluded that experiences with nature were highly significant for their life-long well-being and cognitive functioning. A large network of researchers undertook an ambitious international study (Palmer et al., 1998; Palmer, Suggate, Bajd, & Tsaliki, 1998) in which they collected data from multiple sources on the formative life experiences of environmental educators' from nine countries spanning six continents. Palmer's research team (Palmer, Suggate, Bajd, & Tsaliki, 1998, p. 434) concluded that:

> The data . . . emphasize without a doubt the importance of providing the young with opportunities for positive experiences of nature and the countryside; those in-

the-environment experiences that nurture attitudes of appreciation, care and concern for the world that will endure the passing of years.

While these studies identified a plethora of life experiences that influenced adults' commitment to environmental activism and environmental education, a consistent element identified throughout these studies was the pivotal role of childhood experiences in nature.

Teachers reported that the prairie restoration project presented opportunities for children to make concrete, personal connections with a local ecosystem, to experience it during different seasons, and to develop a bond with it by caring for it and contributing to its restoration. While determining the impact of the prairie restoration project directly on children's perceptions of nature was beyond the scope of this research study, it seems plausible that exposure to the prairie through the restoration project will positively impact children's relationships with nature and influence their commitment to responsible environmental behavior as adults.

Concrete Connections

The final way this study found the prairie restoration strengthened learning experiences beyond addressing academic standards targeted by participating teachers was by rendering learning more authentic through concrete connections between the prairie trips and classroom lessons, between the prairie trips and children's lives, and between the classroom lessons and children's lives. Teachers not only actively fostered a myriad of connections, but also recognized the pedagogical value of concrete examples to make abstract concepts more accessible, to facilitate the transfer of concepts across contexts, and to deepen student understanding of important ideas.

The multifarious connections between classroom lessons, prairie field trips, and students' daily lives were valuable for enhancing and deepening student learning. When describing how learner-centered environments assist in the formation of connections for learning, the National Research Council's landmark report, *How People Learn*, included this statement,

> Learner-centered environments attempt to help students make connections between their previous knowledge and their current academic tasks. Parents are especially good at helping their children make connections. Teachers have a harder time because they do not share the life experiences of each of their children. (2000, p. 153)

The prairie restoration project provided an array of experiences shared between students and teachers, and yielded multiple opportunities for teachers to guide student thinking toward contextualizing key concepts by weaving together concrete connections across contexts. The report also stated,

> The context in which one learns is also important for promoting transfer. Knowledge that is taught in only a single context is less likely to support flexible transfer than knowledge taught in multiple contexts. With multiple contexts, students are more likely to abstract relevant features of concepts and develop a more flexible representation of knowledge (2000, p. 78).

Learning experiences with concepts both in the classroom and during prairie field trips offered valuable opportunities to students to develop more sophisticated representation of knowledge. For example, Ms. Hull's students encountered concepts associated with the

structural and behavioral adaptations of pocket gophers and badgers both through visual images in the classroom and tactile experiences with pelts during a field trip.

It should be noted, however, that meta-analysis of research literature has shown that the stages of cognitive development originally described by Piaget appear to be less discrete and more subject to change through instructional supports than originally posited (NRC, 2007). Thus the notion that children's learning is bound to concrete experiences has been called into question by contemporary cognitive development psychologists (NRC, 2007). Such findings may temper the value and import of concrete connections in the learning processes of children. Nonetheless, participating teachers highlighted the potency of fostering concrete connection. For example, when asked to name three things she hoped students would gain from participating in the prairie trips, Ms. Gogh replied, "Connections, connections, connections . . . I want third grade to connect to everything that they learn about."

Recommendations for Teacher Education

First, the themes resonating with Sobel's (1996) model for a progression of stages in children's development of relationships with nature offer a lens on Sobel's model that could function as a useful tool for curriculum design in science and environmental education at elementary levels. When planning vertical and horizontal articulation between learning experiences in a curriculum aimed at fostering environmental literacy, educators may find that intentionally attending to the progression of themes that led to Assertion #1 may yield a curriculum particularly well designed to enhance children's environmental literacy. For example, an educator who intends to foster a sense of empathy toward living things in a curriculum designed for children aged four to seven

years might focus deliberately on helping children feel at ease with nature, developing a sense of appreciation and respect for the natural environment, and cultivating wonder and curiosity about the natural world. Similarly, explicitly designing learning experiences that enhance wonder and curiosity and target sensory awareness as well as an understanding of ecological interdependence might be particularly fruitful components of curriculum aiming to provide discovery experiences for children aged eight to eleven years. Last, attending to youth's sense of agency, responsibility, and service might strengthen curriculum focused on environmental social action for youth aged 12 to 15 years.

When planning vertical articulation of curriculum, educators may find it useful to consider the developmental progression of the stages and the possible need to adjust learning activities to accommodate students whose prior experiences lack depth in one or more stages. It is important to recognize that the stages are not mutually exclusive or tied inextricably to particular age ranges. The data analysis map for Assertion #1 that appears in Figure 4 on page 55, as well as Table 3 on page 104 showing the relationship between Sobel's model and the study's themes could function as a useful tool for curriculum planning and design.

Second, because science education is often marginalized in elementary education settings (Fulp, 2002), it is particularly important to prepare teachers to integrate curriculum across subject areas so that science concepts can be inserted into class time designated for other content areas, and so that the overall efficiency of curriculum delivery is increased thus leaving time for science instruction. The prairie restoration project aptly provided an effective framework upon which to scaffold various learning experiences targeting an array of state standards across different subject areas. It is

important for teacher education programs to ensure that teachers recognize the capacity of environmental education projects to serve this function as an tool for curricular integration, and that teachers are equipped to make use of them in this way.

Third, the prairie restoration project was not simply a platform upon which to integrate curriculum but was comprised of a pair of meaningful outdoor experiences that served as an agent for curriculum coherence. Taking children out to the prairie in fall and again in spring permitted students to experience seasonal changes occurring in the prairie. Planting seeds that were collected in fall and cultivating them during the winter also contributed significantly to weaving curricular cohesion over the course of the school year. Instead of a "stand alone" field trip, the prairie restoration project offers a model for employing paired outdoor experiences as "bookends" for an entire school year, as well as a unifying strand that can be threaded throughout the curriculum over the course of the year.

Fourth, teachers reported that the prairie restoration project provided powerful life experiences for children and noted that the school trips to the prairie may have been the only opportunities that some children had to experience the prairie habitat. Stephen J. Gould, noted evolutionary biologist, famously wrote, "I also appreciate that we cannot win this battle to save species and environments without forging an emotional bond between ourselves and nature as well – for we will not fight to save what we do not love" (1991, p. 10). It is imperative that new teachers feel this emotional connection themselves, and that they grasp the value of fostering bonds between children and the remaining remnants of the tall grass prairie, an endangered, local ecosystem in need of conservation. Consequently, teacher education programs should incorporate extended

nature experiences where teachers connect emotionally with the local bioregion, and come to recognize the value of doing so.

Fifth, because developing a strong, personal relationship with nature is a lifelong endeavor, continued experiences to reflect on connecting with nature should be made available to teachers beyond their initial preparation. At one of the schools in the study, there were two teachers who remained in third grade for several years and mentored others as they moved into and out of third grade teaching assignments. Schools would do well to invest in resources of time and money directed at mentorship of experienced and inexperienced teachers who are new to embracing environmental education projects.

Sixth, teachers in the study did not appear to recognize the relationship between the state standards about the nature of science and the prairie-related learning experiences. While I caution against generalizing findings based on the experiences of seven teachers, this study seems to point toward a need for ongoing professional development that makes explicit the nature of science embedded in elementary classroom environments, as well as strategies to enhance teachers' preparedness to weave nature-of-science knowledge and skills into elementary curriculum. In order to do so effectively, elementary teachers need and deserve sufficient preparation in science coursework during their initial teacher preparation, as well as ongoing professional development regarding both science content and the nature of science.

Seventh, given the thorny nature of questions regarding the nexus between Western canonical science and traditional cultural beliefs, it is particularly important to prepare teachers to be culturally responsive with regards to diverse ways of knowing the natural world. While such questions are invariably complex and cannot be reduced to a

simplistic dichotomy, it is important for teacher education courses to delve into this knotty domain. Developing a strong understanding of the nature of Western science is not enough; new teachers need to formulate sophisticated understandings of humanistic science, an "everyday-life approach that animates students' self-identities, their future contributions to society as citizens, and their interest in making personal utilitarian meaning of scientific and technological knowledge" (Aikenhead, 2006, p. 2). Such approaches dig into the realms of citizen science, indigenous science, and science-technology-society-environment connections.

The eighth and perhaps most important recommendation stemming from the study's findings is for teacher educators to support and guide the evolution of teachers' understandings about the value of service-oriented environmental education projects that connect children with the local bioregion in meaningful ways that contribute to environmental literacy. According to the seven teachers, the prairie restoration project contributed enormous pedagogical value to the education of third grade students. Participant teachers recognized most of the themes that emerged in the study, but even these experienced teachers did not appear to identify all the ways the project contributed, including the role of curiosity in fostering environmental literacy and the connection between nature-of-science standards and prairie-related learning activities. Further, participant teachers identified ways the prairie restoration project contributed pedagogical value both within and beyond the realm of the state standards. The importance of providing life experiences to children, for example, was pronounced among the teachers' views but is not captured in any state standard document. Teacher education programs have a powerful opportunity and a solemn duty to ensure that teachers are fully equipped

to both recognize and implement the kinds of pedagogical outcomes offered by environmental education projects like the prairie restoration project, outcomes that address and extend beyond the state standards. We need to prepare new teachers to meet state standards, but also to understand that the standards alone do not capture all the worth of education.

Limitations of the Study

First, this study focused only on the perceptions and experiences of seven third-grade classroom teachers. I did not seek to include data from others who may have been able to offer insights about the endeavor of the prairie restoration project, such as parent volunteers, the science center naturalists, or building principals. In particular, even though pre- and post-summaries of work samples and interviews with children would surely have brought a deeper dimension to the findings, collecting data about children was not part of this study.

Second, classroom observations took place only during prairie-related science lessons. I did not observe lessons from the full complement of subject areas taught in the third grade. There may have been times, for example, when teachers integrated prairie-related concepts into language arts or math lessons, but my observations would not have captured those instances. The study's findings discuss the integration of subject areas into the prairie restoration project, but not the integration of the prairie restoration project into all aspects of the third grade curriculum.

Last, I caution against generalizing the study's findings. As with any qualitative research project, the aim was to develop a thick, rich understanding of participants' views and experiences in a particular context. The study was based on data collected about the

perceptions and experiences of seven teachers undertaking their work within the scope of an environmental education project with a service learning orientation. It is important to recognize that while findings from the study may transfer sufficiently to illuminate the work of other practitioners and researchers, findings from qualitative research on a modest scale are not intended to be generalized to a broad scope.

Directions for Future Research

This study was predicated on a need to fill a pronounced gap in the research literature, one that seeks to capture teachers' voices about conceptualizing environmental literacy in the context of their own work, rather than comparing teachers' conceptions to predetermined ideas set forth by researchers. This study, an effort to describe elementary classroom teachers' conceptions of environmental literacy as it pertained to a prairie restoration environmental education project's impact on their students' readiness to act responsibly toward the natural environment, offers a valuable and important start to this nascent field of educational research.

The study opened several vistas for future research, including ones that focus on students, on teachers, and on students and teachers together. First, it would be fascinating to ask students to share their perceptions about the prairie restoration project and its potential connections to their relationships with nature. Following children who participated in the prairie restoration project for an extended period of several years, or visiting with students from different grades who participated in the project in third grade would potentially yield compelling findings about the project's long term impacts on children's relationships with nature. Because the prairie restoration project has been underway for approximately two decades, over two thousand students have participated

and the oldest ones are now approaching their thirties. During one of the prairie field trips, a parent volunteer commented that her tenth grade daughter fondly reminisced about prairie restoration memories to the parent volunteer's third grade daughter.

In addition to seeking out past and present student participants, another potentially fruitful direction for research is to inquire about the relationship between teachers' own relationships with nature and their approaches to teaching within the prairie restoration project. For example, do teachers with more eco-minded attitudes toward nature emphasize different content standards or different components of environmental literacy among their students? How might teachers' own childhood experiences in nature impact their vision for what the prairie restoration project can offer their students in terms of developing healthy relationships with nature? Though I collected some data about teachers' orientations toward nature by asking each to describe his or her own relationship with nature, much potential remains untapped in this regard.

Another direction for future research lies in questions centering on the impact of digital technology on children's relationship with the prairie. During prairie field trips, some participating teachers commented on the evolution in the types of technology that children brought with them on prairie trips to take photos over the years, from digital cameras, to cell phones, to Nintendo DS game players, to iPod touches. In what ways do digital technologies facilitate and/or hamper children's interactions with the prairie? What aspects of visiting the tall grass prairie would children most choose to capture using digital technology and for what intended purposes? How might children's digital images reflect their conceptions of what constitutes the prairie ecosystem?

Last, questions surfaced in the findings of the study regarding the nature of science, another potentially productive direction for additional research. What types of professional development experiences might help teachers to explicitly recognize nature-of-science connections to the prairie-related curriculum? How do different demographic groups of students rate their comfort level about trying on identities of scientists? To what extent does prairie-related curriculum require some students to undertake Aikenhead's (1996, 2006) "border crossings" between canonical Western science and traditional cultural beliefs, or to delve into the tensions Coburn describes in his world view theory (Coburn, 1991, 2000)? Though the field of science education research centered on the nature of science from a Western canonical science perspective is well established (e.g., McComas, Clough, Scott, Smith, & Lederman, 2000; McComas, 1998), these questions could illuminate intriguing insights pertaining to vital aspects of scientific literacy for all.

Concluding Comments

Comprised of crucial constellations of dispositions, competencies, knowledge, and behaviors, environmental literacy looks different at various stages of human development. Teachers reported that the prairie restoration project offered compelling opportunities to develop positive relationships between children and nature, and to prepare children to act responsibly toward the natural environment. Further, the prairie restoration project wove together a rich array of pedagogical outcomes that not only addressed state standards, but also expanded beyond them. While state standards target valuable and fundamental purposes for schooling, they capture only academic components of visions for education, leaving many layers untapped. Fostering

environmental literacy embedded in rich elementary educational experiences, such as the prairie restoration project, is vital to developing a citizenry equipped to make complex personal and social decisions that will determine sustainability of human life on Earth in the coming pivotal decades.

APPENDICES

Appendix A
Consent Form

Informed Consent

Researcher: Teresa Shume
Contact: Teresa.Shume@my.und.edu (218) 287-4972
Department: Teaching & Learning (PhD Candidate)

Purpose of the Study and Invitation to Participate
You are being asked to participate in a research project based on your 3rd grade class' participation in a prairie restoration project. The purpose of this study is to explore teachers' views on the impacts of the prairie restoration project on children's readiness to act responsibly towards the environment. As a participant, you will be asked to set a time and location for 2 interviews with the researcher. It is estimated that interviews will last 30-45 minutes. If you are willing, the interview will be taped for the purpose of review and transcription. The researcher will also arrange times with you in advance for up to 6 observation visits of field trips and/or classroom lessons associated with the prairie curriculum. You will be asked to permit the researcher to borrow sample curricular materials related to the observations (such as blank student worksheets) in order to make copies. It is anticipated that 8-10 teachers will participate in this study.

Risks and Confidentiality
Any information that is obtained in this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Your real name will not be used at any time and the recording and transcription of any and all parts of your interviews will be coded with a pseudonym for the purpose of review and in the final report. In addition, to make sure that the information shared in the final report is correct, you will be offered a summary of interview and observation comments in order to check for accuracy.

There are no foreseeable risks to participating in this study. However, if you feel uncomfortable you may ask to stop or choose not to answer a particular question. Your participation is voluntary and your decision to not participate or to discontinue your participation at any time will not affect your current or future relations with the University of North Dakota.

Benefits
An in-depth description of 3rd grade teachers' views on the impacts of the prairie restoration project has the potential to increase understanding about the role of local environmental education projects in developing children's sense of responsibility towards the environment. Another important benefit provides a close up view of how science educators interpret and implement state science standards for elementary-age learners.

Statement of Research
The researcher conducting this study is Teresa Shume**.** You may ask any questions you have now. If you have questions, concerns, or complaints about the research please contact Teresa Shume at the information above. If you have questions regarding your rights as a research subject, or if you have any concerns or complaints about the research, you may contact the University of North Dakota Institutional Review Board at (701) 777-4279. Please call this number if you cannot reach the researcher, or you wish to talk with someone else.

Your signature indicates that this research study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a copy of this form.

Participant's Name _____

_____ _____
Signature of Participant Date

_____ _____
Signature of Researcher (Teresa Shume) Date

Appendix B
Consent Form for Teacher From Pilot Study

Informed Consent
(Includes Consent for Prior Interviews and Observation Visits)

Researcher: Teresa Shume
Contact: Teresa.Shume@my.und.edu (218) 287-4972
Department: Teaching & Learning (PhD Candidate)

Purpose of the Study and Invitation to Participate
You are being asked to participate in a research project based on your 3rd grade class' participation in a prairie restoration project. The purpose of this study is to explore teachers' views on the impacts of the prairie restoration project on children's readiness to act responsibly towards the environment. As a participant, you will be asked to set a time and location for 1 interview with the researcher. It is estimated that the interview will last 30-45 minutes. If you are willing, the interview will be taped for the purpose of review and transcription. The researcher will also arrange times with you in advance for up to 4 observation visits of field trips and/or classroom lessons associated with the prairie curriculum. You will be asked to permit the researcher to borrow sample curricular materials related to the observations (such as blank student worksheets) in order to make copies. It is anticipated that 8-10 teachers will participate in this study.

Use of Prior Interview Transcripts and Observations
You are being asked to consent for this study to include information that was collected in 2 previous interviews (November, 2011) and 2 previous observation visits (September, 2011) for a small UND course project in fall of 2011.

Risks and Confidentiality
Any information that is obtained in this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Your real name will not be used at any time and the recording and transcription of any and all parts of your interviews will be coded with a pseudonym for the purpose of review and in the final report. In addition, to make sure that the information shared in the final report is correct, you will be offered a summary of interview and observation comments in order to check for accuracy.

There are no foreseeable risks to participating in this study. However, if you feel uncomfortable you may ask to stop or choose not to answer a particular question. Your participation is voluntary and your decision to not participate or to discontinue your participation at any time will not affect your current or future relations with the University of North Dakota.

Benefits
An in-depth description of 3rd grade teachers' views on the impacts of the prairie restoration project has the potential to increase understanding about the role of local environmental education projects in developing children's sense of responsibility towards the environment. Another important benefit provides a close up view of how science educators interpret and implement state science standards for elementary-age learners.

Statement of Research
The researcher conducting this study is Teresa Shume**.** You may ask any questions you have now. If you have questions, concerns, or complaints about the research please contact Teresa Shume at the information above. If you have questions regarding your rights as a research subject, or if you have any concerns or complaints about the research, you may contact the University of North Dakota Institutional Review Board at (701) 777-4279. Please call this number if you cannot reach the researcher, or you wish to talk with someone else.

Your signature indicates that this research study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a copy of this form.

Participant's Name _____

_____ _____
Signature of Participant Date

_____ _____
Signature of Researcher (Teresa Shume) Date

Appendix C
Interview Protocol

Interview Protocol
Elementary Teachers' Perceptions of Environmental Literacy

Interview Code: _____

I. Digital recorder tested and spare batteries available.

II. Verify consent form has been signed.

III. Review purpose of the interview:
[The purpose of this study is to explore 3rd grade teachers' views of the prairie trips and curriculum's impact on their students' readiness to act responsibly towards the environment. It is estimated that interviews will 30-45 minutes. If you are willing, this interview will be tape recorded (without your name or any identification) for the purpose of review and transcription.]

IV. About this interview:
Date:_____ Time:_____ Location: _____

V. (First interview only) This participant teacher's number of years:
Classroom teaching:_____
Teaching 3rd grade: _____
Participating in prairie project: _____

VI. Interview Questions

1 – When did you become involved in the prairie restoration project?

2 - What is your role in this project?

3 - Tell me about the fall and spring prairie trips and how they were integrated into 3rd grade curriculum before the new science standards were released and implemented.

4 - Tell me about the fall and spring prairie trips and how they are integrated into 3rd grade curriculum now that the new science standards have been released and implemented.

5 - Has the change in standards impacted what 3rd grade students gain from the prairie trips? If yes, how?

6 - Please describe the process by which curricular decisions about the prairie trips were made when the new science standards came into effect.

7 - How would you describe your own relationship to the natural environment? What experiences or factors have shaped your relationship to the natural environment? Which of these have been most influential on your teaching?

8 - Stepping back and looking at the prairie visits as a whole, what are 3 things that you hope children take away from participating in the prairie restoration project?

9 - What do you hope students will gain from the prairie trips with regards to relating to the natural environment?

10 - Beyond the prairie trips, have you incorporated other environmental education projects into your teaching? If yes, tell me about that. In what ways are the prairie trips similar or different?

11 - What do you hope students will gain with regards to relating to the natural environment from being a student in your classroom over the course of the academic year? Will you please write down a list of key points. [Participant will be asked to create a written list.]

12 – Next, I'm going to ask you to write some of the key words from your answer to the previous question onto index cards. Are there any categories or patterns you see among the cards? [Participant will be asked to select key words and write them on index cards. After the participant arranged the cards as he/she sees fit, the cards will be taped to a large sheet of paper. Participant will be asked to label categories or relationships between cards.]

13 - What tells you when a third grade student has a healthy relationship with the natural environment? What about an adult?

14 - Previously you made and organized some cards that captured some of your key ideas about what you hope students will gain with regards to relating to the natural environment from being a student in your classroom over the course of the academic year. Let's review that together. [Diagram is made available for review.] Is there anything you want to add or change?

15 – Are there places on your diagram where the prairie visits contribute. If yes, please tell me about those places.

16 – Are there any places on your diagram where the prairie visits' contributions are not just helpful but are pivotal for students to make gains in that area? If yes, please tell me about those places.

17 - Are there places on your diagram where impacts from the change in 3rd grade science standards (and resulting changes to the prairie trips) can be seen? If yes, please tell me about those places.

Sample Probing Questions

- You mentioned…
- Help me understand more about…
- Can you say a little more about…
- What's your thinking behind…
- Walk me through…

VII. Close interview:

- Thank participant.
- Assure him/her of confidentiality.
- Remind about member-checking.
- Ask if he/she has any questions.

Appendix D
Interview Protocol for Teacher From Pilot Study

Interview Protocol for Participant with Two Prior Interviews
Elementary Teachers' Perceptions of Environmental Literacy

Interview Code: _____

I. Digital recorder tested and spare batteries available.

II. Verify consent form has been signed.

III. Review purpose of the interview:
[The purpose of this study is to explore 3rd grade teachers' views of the prairie trips and curriculum's impact on their students' readiness to act responsibly towards the environment. It is estimated that interviews will last 30-45 minutes. If you are willing, this interview will be tape recorded (without your name or any identification) for the purpose of review and transcription.]

IV. About this interview:
Date:_____ Time:_____ Location: _____

V. This participant teacher's number of years:
Classroom teaching:_____
Teaching 3rd grade:_____
Participating in prairie project _____

VI. Interview Questions

A. First Interview (Pilot Study)
1 - How did you get involved in the prairie restoration project?

2 - What is your role in this project?

3 - Has your role changed over time?

4 – Can you talk a little bit about the learning activities that take place in the classroom in preparation for the fall field trip and as a follow-up afterwards? Activities related to the prairie during the school year? Before and after the spring field trip?

5 - What are 3 things that you hope children take away from participating in the prairie visits?

6 - As a teacher, have you incorporated other environmental education projects into your teaching? If yes, tell me about that.

7 – How have the new science standards impacted your efforts to weave environmental education projects into your teaching?

8 - I noticed during the Science Center visit that you were concerned about how your students treated the prairie plants. What are your expectations for how children treat plants?

B. Second Interview (Pilot Study)

The purpose of this second interview is to discuss factors that have contributed to your commitment to incorporating environmental education, such as the Prairie Restoration project, into your teaching. These factors might be life experiences, professional experiences, interactions with certain people, or anything else that contributed to your commitment to environmental education.

1 - Let's begin by having you list and describe some of these factors. [This is very open-ended, and I will add prompts to encourage the participant to expand as appropriate. e.g. Can you say a little more about that? Why was that an important experience for you?]

2 - Are there any other factors you'd like to add?

3 - Now that you've established a list of factors, I'm going to ask you to organize and prioritize them best you can. Which ones do you think were the most influential on your commitment to environmental education?

4 - How would you describe a person who is eco-minded? What does a third grader look like who's eco-minded and what does an adult look like who's eco-minded?

5 - Are there any other influences beyond what you have indicated on your list that have contributed to your willingness to cultivate a sense of eco-mindedness among your students?

6 - Is there anything else that you want to add in terms of why you have chosen to make a space for eco-mindedness in the scope of your teaching?

C. Third Interview
1 - What do you hope students will gain from the prairie trips with regards to relating to the natural environment?

2 - Beyond the prairie trips, have you incorporated other environmental education projects into your teaching? If yes, tell me about that. In what ways are the prairie trips similar or different?

3 – What do you hope students will gain with regards to relating to the natural environment from being a student in your classroom over the course of the academic

year? Please write down a list of key points. [Participant will be asked to prepare a written list.]

4 –Next, I'm going to ask you to write some of the key words from your answer to the previous question onto index cards. Are there any categories or patterns you see among the cards? [Participant will be asked to select key words and write them on index cards. After the participant arranged the cards as he/she sees fit, the cards will be taped to a large sheet of paper. Participant will be asked to label categories or relationships between cards.]

5 - Let's review the diagram together. [Diagram is made available for review.] Is there anything you want to add or change?

6 – Are there places on your diagram where the prairie visits contribute. If yes, please tell me about those places.

7 – Are there any places on your diagram where the prairie visits' contributions are not just helpful but are pivotal for students to make gains in that area? If yes, please tell me about those places.

8 – Are there places on your diagram where impacts from the change in 3rd grade science standards (and resulting changes to the prairie trips) can be seen? If yes, please tell me about those places.

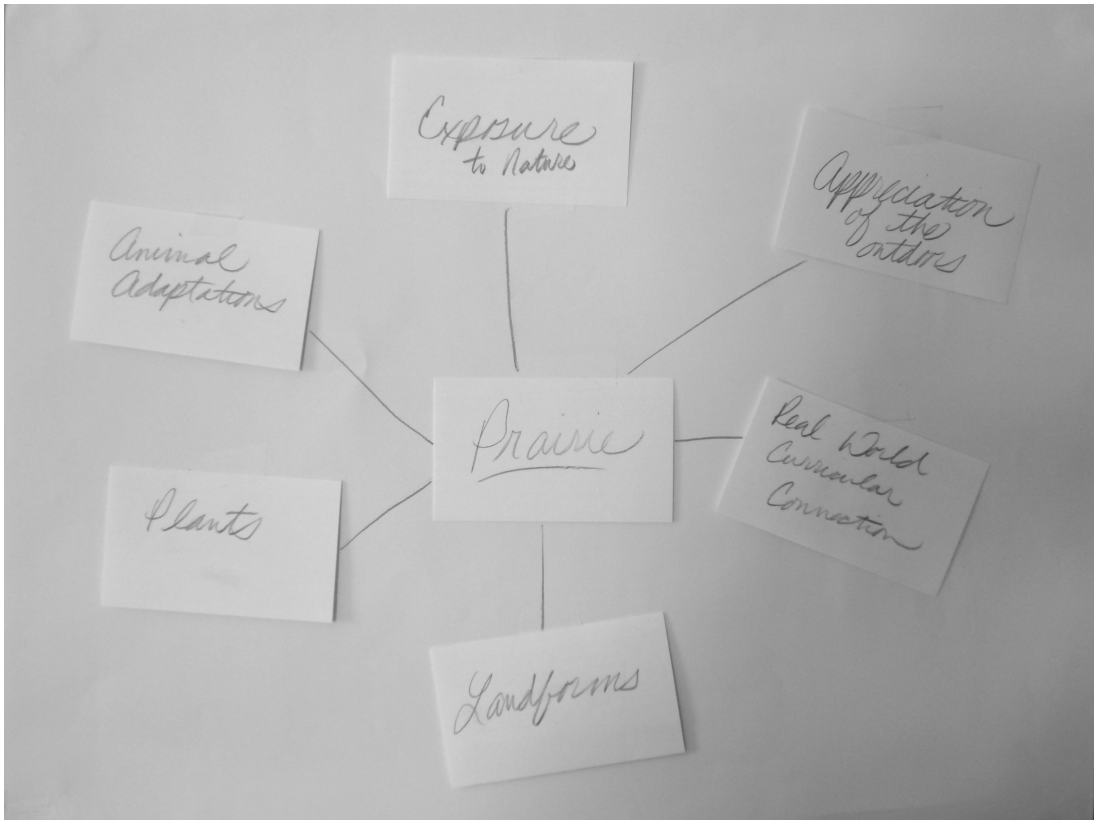
Sample Probing Questions

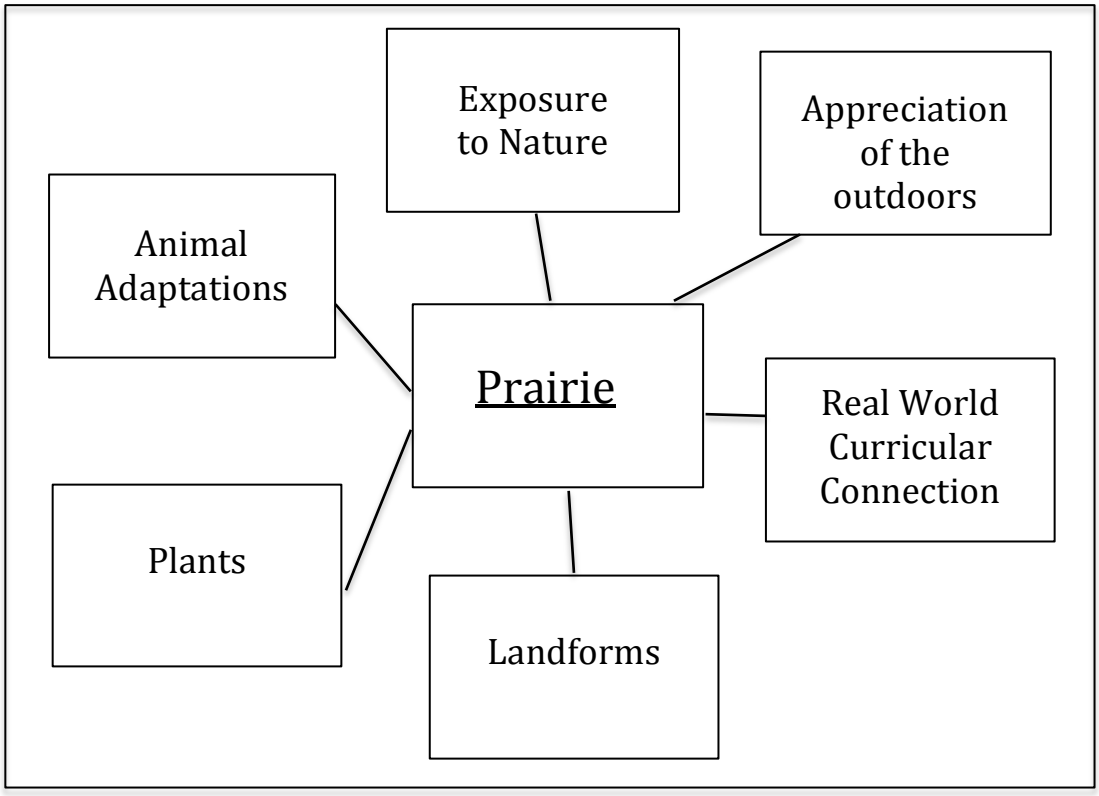
- You mentioned…
- Help me understand more about…
- Can you say a little more about…
- What's your thinking behind…
- Walk me through…

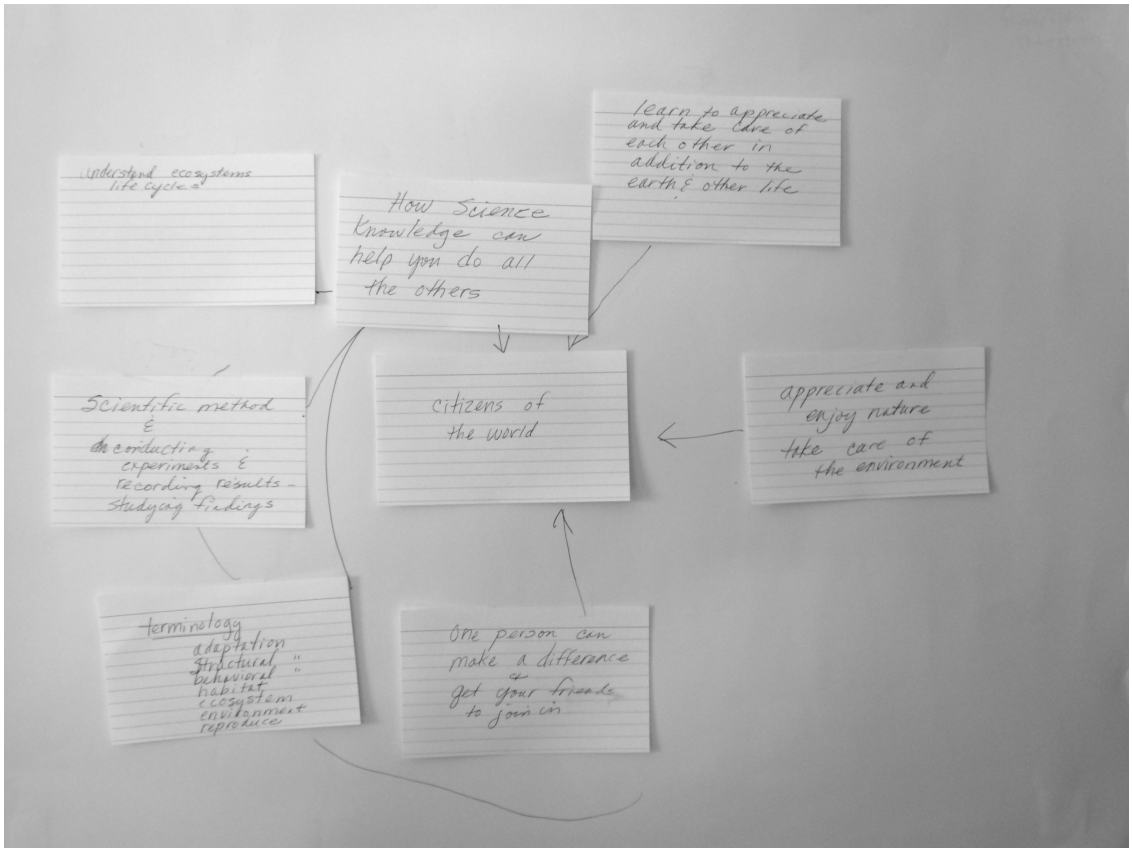
VII. Close interview:

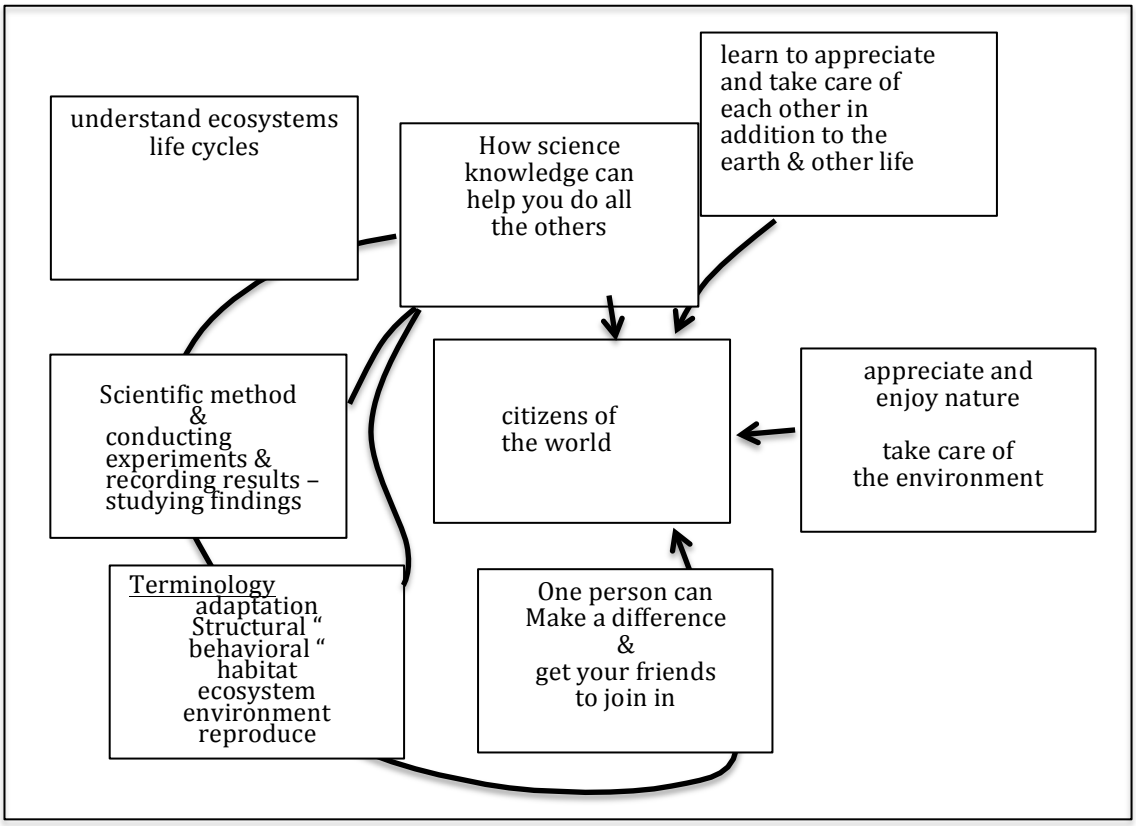
- Thank participant.
- Assure him/her of confidentiality.
- Remind about member-checking.
- Ask if he/she has any questions.

Appendix E
Sample Charts Constructed During Interviews






understand ecosystems life cycles
How Science knowledge can help you do all the others
learn to appreciate and take care of each other in addition to the earth & other life
Scientific method & conducting experiments & recording results - studying findings
citizens of the world
appreciate and enjoy nature
take care of the environment
terminology
adaptation
Structural "
behavioral "
habitat
ecosystem
environment
reproduce
One person can make a difference & get your friends to join in


understand ecosystems life cycles
How science knowledge can help you do all the others
learn to appreciate and take care of each other in addition to the earth & other life
Scientific method & conducting experiments & recording results – studying findings
citizens of the world
appreciate and enjoy nature
take care of the environment
Terminology
adaptation
Structural "
behavioral "
habitat
ecosystem
environment
reproduce
One person can Make a difference & get your friends to join in

Appendix F
Categories and Codes

Category: Dispositions
Definition: *Orientations, attitudes, personal characteristics that reflect degrees of environmental sensitivity.*
Relevant Codes:

- Awe/wow factor
- Ick factor
- Comfortable in nature
- Uncomfortable in nature
- Fearful of nature
- Open minded
- Curiosity
- Curiosity pushed aside
- Awareness
- Sense of agency
- Respectful
- Responsible for prairie/nature
- Sense of service

Category: Values and Beliefs
Definition: *Ideals and convictions that are congruent or incongruent with environmental commitments.*
Relevant Codes:

- Enjoys outdoors
- Appreciates prairie/nature
- Cares for prairie/earth
- Respect for prairie/nature
- Interdependence is important
- Sense of place is important
- Conserve/restore prairie
- Recycling is important

Category: Nature
Definition: *Elements that describe or reveal teachers' perceptions of children's relationships with nature.*
Relevant Codes:

- Nature is fun/enjoyable
- Changes seen in children
- Fearful/uncomfortable

- Rural vs. urban
- Children's ideas of what prairie is
- Immigrants fish on river
- Lack of knowledge and experience

Category: Behaviors
Definition: *Observable behaviors that demonstrate some aspect of commitment or non-commitment to environmental actions.*
Relevant Codes:

- Not picking/taking from prairie
- Not littering/cleaning up
- Showing respect for prairie
- Taking responsibility for prairie
- Recycling

Category: Indicators
Definition: *Flags or markers that teachers identified as indicators of healthy relationships with nature or readiness to act responsibly toward the natural environment.*
Relevant Codes:

- among children
- among adults

Category: Curriculum
Definition: *Elements where standards are translated into content and instruction. Special attention given to curricular connections between classroom, trips, and students' daily lives.*
Relevant Codes:

- Animals
- Changes related to new standards
- Decomposers
- Defining concept of "prairie"
- Ecosystems
- Engineering design
- Habitat
- Life cycles and seed dispersal
- Curriculum materials
- Plants and plant identification
- Prairie ecology
- Service learning
- Teaching about adaptations
- Trip to life connections

- Classroom to life connections
- Classroom to trip connections
- Connections are valuable
- Connections for adaptations

Category: Competencies
Definition: *Skills or abilities that demonstrate some aspect of readiness to act responsibly toward the natural environment.*
Relevant Codes:

- Observant, fully present
- Working as a team
- Public speaking

Category: Science Standards
Definition: *Teachers' comments and ideas relating to state science standards, or changes in state science standards.*
Relevant Codes:

- Better now
- Not better now
- Changes are small
- New or current topics
- Old topics
- Process of change

Category: Science
Definition: *Application of science process skills or scientific procedures. Relates to the nature of science.*
Relevant Codes:

- Observations ("implicit" indicates students performed the skill without it being explicitly identified as such)
- Inferences ("implicit" indicates students performed the skill without it being explicitly identified as such)
- Taking on identity of scientist
- Using scientific thinking
- Scientists uses investigative processes

Category: Experience
Definition: *Evidence that points to the value of providing life experience for students or for contextualizing classroom learning in authentic experiences.*
Relevant Codes:

- Experiences going to a prairie
- Contextualizing classroom experience in daily life

- Making personal connections
- Kids lack experience with prairie
- Prairie experiences are valuable
- Especially important for students of low socio-economic status

Category: Social Studies
Definition: *Relates to social studies standards or curriculum.*

- Anticipating new standards
- History connections
- Landforms
- Maps
- Native Americans
- More social studies connections

Category: Value of Trip
Definition: *Teachers' perceptions about the value of the prairie field trips.*

- Culminating experience
- Two trips
- Makes learning concrete
- Contributes to appreciation/caring for prairie

Category: Sensory Experiences
Definition: *Instances when children used their senses, especially smell, touch, and hearing.*

- Smell
- Touch/feel/tactile
- Hear/quiet to listen
- Taste

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