

Teachers' Perspectives on Contributions of a Prairie Restoration Project to Elementary Students' Environmental Literacy

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ABSTRACT

Place-based environmental education draws on childhood experiences in nature that foster place-conscious connections to the local bioregion, and intentionally cultivate children's relationships with nature on a trajectory toward increased environmental literacy. Even though opportunities for children to bond with the local natural environment are paramount for developing responsible environmental behavior and ultimately an environmentally literate citizenry, few elementary schools prioritize such experiences. The present study focused on a place-based approach to developing environmental literacy through elementary students' participation in a prairie restoration project. The purpose of this study was to examine teachers' perspectives on how a prairie restoration project impacted elementary students' environmental literacy. Based in an interpretive paradigm, this qualitative case study involved seven teacher-participants from two schools, and drew on data collected from field trip observations, classroom observations, interviews, and artifacts over a span of one academic year. Findings indicated that teachers' fostered six components of environmental literacy through the prairie restoration project: feeling at ease in nature, appreciation and respect for nature, wonder and curiosity, awareness of ecological interdependence, sense of agency to restore nature, and responsibility and service toward environmental protection. Two or three of these empirically-derived themes corresponded with each stage of David Sobel's three-stage model for the development of place-based relationships between children and nature. The correspondence between Sobel's model and the study's six themes resulted in a promising framework to support curriculum design by providing focal points for particular dimensions of each stage of Sobel's model. Place-based approaches like the prairie restoration project can foster valuable components of children's relationships with nature on a trajectory toward increased environmental literacy.

KEYWORDS

Environmental Literacy, place-based pedagogy, elementary science, in-service elementary teachers, Nature Education

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Introduction

In 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 toward solutions that are equitable and sustainable. Fostering environmental literacy by developing environmental awareness, knowledge, skills, attitudes, values, and behaviors among the next generation of citizens is paramount for improving the Earth's prospects for environmental sustainability in the coming decades.

Experiences with nature during childhood are a vital aspect of environmental education and have been shown to contribute to the development of pro-environmental attitudes and behaviors during adulthood (Wells & Lekies, 2006; Strife & Downey, 2009; Wells, 2000; Palmer et al., 1998; Palmer, Suggate, Bajd, & Tsaliki, 1998; Chawla, 2006; Chawla, 1999; Ewert, Place, & Sibthorp, 2005). 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). Elementary school curriculum structured to provide children with meaningful experiences to connect with their local bioregion is paramount to developing an environmentally literate society.

In this era of school accountability, however, P-12 school practices are 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; Stevenson, 2007).

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, few schools prioritize such experiences (Gruenewald & Manteaw, 2007). This case study was part of a larger study that 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. The broader study explored the pedagogical value of a prairie restoration project. The present study examined teachers' perspectives about how prairie field trips and classroom activities centered on a prairie restoration project impacted third grade students' environmental literacy.

Environmental Literacy

Importance of Technology Integration into Teaching

Environmental literacy is widely regarded as a multifaceted construct that captures the principal intended outcomes of environmental education and reflects the degree to which one is ready and equipped to act responsibly toward nature. Roth (1992, p.9) offers 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. (1992, p.9)

While no universal definition of environmental literacy exists (Yavetz, Goldman, & Pe'er, 2009), many international commissions and intergovernmental summits have produced landmark reports establishing cogent visions for intended outcomes of environmental education such as the Belgrade Charter (UNESCO-UNEP, 1976) and the United Nations Conference on Environment and Development in Rio (UNCED, 1992), among others. The Tbilisi Declaration (UNESCO, 1978), for example, produced environmental education objectives divided into five categories: awareness, knowledge, affect, skills, and participation. A number of environmental literacy framework published in the 1990's (e.g. Hungerford & Volk, 1990; Roth, 1992; Simmons, 1995) built upon objectives set forth by UNESCO and other international initiatives to identify various constellations of categories defining components of environmental literacy. In 2011, the North American Association for Environmental Education (NAAEE) released a comprehensive, research-based framework informed by internationally accepted conceptions of environmental literacy (Hollweg et al., 2011). The NAAEE framework divides environmental literacy into four principal components: knowledge, dispositions, competencies, and environmentally responsible behavior. Though various conceptions of environmental literacy include different dimensions, a key tenet is that environmental literacy extends beyond conceptual knowledge to describe what is needed for healthy and responsible human relationships with nature.

Role of Nature Experiences During Formative Years

Several research studies have illuminated the vital role of childhood nature experiences in the development of a trajectory toward increased environmental literacy. Wells and Lekies (2006) proposed a conceptual model for childhood participation with nature, and adult environmental attitudes and behaviors based on their finding from interviews with over 2000 American adults. 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. Palmer, Suggate, Bajd, & Tsaliki (1998) undertook an ambitious international study that collected data from multiple sources on the formative life experiences of environmental educators from nine countries spanning six continents. Palmer's research team 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 (p.434).

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 nature experience in the development of pro-environmental attitudes and behaviors.

Similarly, some studies have found impacts of experiences not only during childhood, often defined as 11 years and younger, but also adolescent years, often defined as 12-18 years. Chawla (1999) interviewed 30 environmentalists in Kentucky and 26 in Norway, and identified a cluster of key life experiences common to these groups. Experiences in nature during childhood and adolescence emerged as a potent element with over 75% of the participants citing it as a critical reason behind their commitment to environmental causes. Ewert, Place & Sibthorp (2005) surveyed over 500 university undergraduates on environmental beliefs and experiences in nature before age 18. They found appreciative outdoor activities and consumptive outdoor activities to be among the statistically significant predictors of environmental beliefs. Similar to research studies that found childhood experiences to be pivotal, these studies identified both childhood and adolescent experiences as potent precursors to pro-environmental beliefs and attitudes in adulthood.

Place-Based Experiences in Nature

When considering the role of childhood experiences in nature for developing environmental literacy, it is important to examine the characteristics, context and underlying purposes of children's experiences in nature. Some environmental education learning experiences aim to convey messages about the critical urgency of environmental tragedies, but childhood experiences in nature can engender nature-protective behaviors without being framed with shock and crisis about environmental calamities. For example, Finger (1993) found increased environmental behaviors among adults who had engaged in direct experiences in the outdoors and learned about local environmental activism compared to those who had learned about environmental tragedies primarily through the media. The study concluded, "Environmental behavior is less the result of learning and knowledge and more the result of particular environmental experiences" (p.18). Similarly, long-term impacts of a fourth grade field trip to Great Smokey Mountains National Park, "a site devoted to preserving biodiversity" (p. 34) included retention of knowledge and pro-environmental attitudes (Farmer, Knapp, & Benton, 2007).

Several descriptive names have been used to identify environmental education that aims to develop a sense of place in a local region rather than focusing on abstract, global-scale, "doom and gloom" environmental crises. According to Knapp (2008, p.6), some of the terms that have been used to describe various forms of place-based education include: *community-based learning, service-learning, environment as an integrating concept, environment-based education, outdoor education, bioregional education, ecological education, sustainable-development education, and nature studies*. Gruenewald and Smith's

(2008, p.xvi) definition has been adopted for the purpose of the present study, “Place-based or place-conscious education introduces children and youth to the skills and dispositions needed to regenerate and sustain communities.” Fostering children’s relationships with the local bioregion by drawing on direct experiences in nature is a powerful avenue toward increased environmental literacy.

Children’s Place-Based Relationships with Nature

David Sobel (1996) developed a model describing three stages that form a generalizable pattern for the evolution of children’s place-based relationships with nature during childhood and into adolescence on a trajectory toward environmentally responsible adult behaviors. Sobel’s model is comprised of three stages: developing empathy for living things, discovery and exploration in nature, and social action to protect the natural world. Sobel’s model is unique but corresponds with Hungerford’s (1996) concept that pro-environmental behaviors are developed sequentially by progressing through entry-level variables, ownership variables, finally empowerment variables.

Sobel (1996) posits that the focus in children’s affective relationships with nature during early childhood centers on developing empathy for living things. Young children, approximately four to seven years old, need opportunities to connect with animals, plants, and other living things in order to develop an ethic of care, empathy, and compassion. For this stage, Sobel recommends “cultivating relationships with animals, both real and imagined” (1996, p. 13) and fostering a sense of connectedness with living organisms as “an emotional foundation for the more abstract ecological concept that everything is connected to everything else” (1996, p. 13). Congruously, Hinds and Sparks (2008) demonstrated that affective connections to nature predicted intention to engage with the natural environment. Also, Cheng and Monroe (2012) examined affective dimensions of children’s connectedness to nature and identified empathy for creatures as a core element. Other studies have similarly shown that empathy (Geller, 1995; Schultz, 2000) and sympathy (Allen and Ferrand, 1999) are valuable for predicting pro-environmental behaviors.

According to Sobel’s model, middle childhood is characterized by discovery, a time for children aged approximately eight to eleven years to explore and bond with the natural environments near their homes. Sobel (1996, p.19) 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.” This second stage is characterized by expanding geographic boundaries as children extend their “home territory” from the confines of their neighborhood and schoolyard to encompass other ecosystems in the local bioregion, such as the tall grass prairie in the case of the present study. 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 within Earth’s systems. Concordantly, Kals, Schumacher, and Montada (1999) found that nature-protective behaviors in adulthood were correlated to a sense of affinity for nature, which was traced back to past and present experiences in nature. Other studies have identified direct experiences with nature during childhood to be pivotal for establishing substantial positive bonds with the natural world (Chawla, 2002; Bunting & Cousins, 1985; Horwitz, 1996; Kellert, 2002).

Finally, Sobel's model reserves social action for 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 who can engage in actions to protect and conserve the natural environment with support from adults. Congruously, Cheng and Monroe (2012) found that sense of responsibility to protect nature was a core component of children affective attitudes toward nature and was positively correlated with children's interest to participate in nature-based activities. When describing the model's third stage, 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 protecting local water resources, organizing recycling efforts, or working to shape town ordinances.

It is also important to note that Sobel does not regard the three stages of this model 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 purposeful orientation toward the natural world.

Purpose of Study

Childhood experiences in nature have been shown to be important for developing various aspects of environmental literacy. Place-based approaches, such as David Sobel's work, target childhood experiences in nature that foster place-conscious connections to the local bioregion, and intentionally cultivate children's relationships with nature on a trajectory toward increased environmental literacy. The present study focused on a place-based approach to developing environmental literacy through elementary students' participation in a prairie restoration project. The purpose of this study was to examine teachers' perspectives on how a prairie restoration project impacted elementary students' environmental literacy.

Methodology and Research Design

The research methodology for 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). Like Charmaz (2006), who acknowledges that her grounded research methodology cannot produce an exact picture of the world but rather an "interpretive portrayal," this study's qualitative research methodology embraces the subjectivities of building meaning, and resonates with symbolic interactionism as described in the works of George Herbert Mead, Max Weber, and especially Herbert Blumer. Snow (2001, p. 367) aptly decants Blumer's visions of symbolic interactionism to its essence with these three points:

1. People act toward things, including each other, on the basis of the meanings they have for them.
2. These meanings are derived through social interaction with others.

3. These meanings are managed and transformed through an interpretive process that people use to make sense of and handle the objects that constitute their social worlds.

In other words, instead of accepting the behaviorist notion of stimulus-response, symbolic interactionism recognizes that human interpretation mediates between stimulus and response, and thus is an ineluctable component of making sense of the world. The subjectivity of human interpretation is key to the research question that drove this study; rather than verifying the presence of certain environmental literacy dispositions pre-selected by the researcher, this study sought to identify and describe the environmental literacy dispositions that were targeted in intention and in action by the teachers themselves. A case study research design was selected because of its suitability for research that seeks to build and analyze contextual portraits in order to develop a deep understanding of an associated phenomenon or occurrence (Yin, 2009).

Participants and Location

Participants in this study were seven third grade elementary classroom teachers from an Upper Midwestern school district whose classes participated in a prairie restoration project for one academic year. In fall, the third grade classes were bussed to a 300-acre regional science center approximately 15 miles away where they explored the tall grass prairie and collected ripe seeds from native plants while accompanied by teachers, naturalists, and parent volunteers. During the winter months, students planted some of the collected seeds in their classrooms and engaged in prairie-related learning activities, primarily during science and social studies lessons. Toward the end of the school year, the classes returned to the science center for another set of learning activities that included planting their seedlings and sowing additional seeds that were collected in the fall. Though this ongoing project is primarily educational in focus, thousands of third graders have been involved in the restoration of approximately ten acres of tall grass prairie since 1994.

As shown in Table 1, the seven teacher-participants' classroom teaching experience ranged from eight to 21 years. Length of experience teaching third grade paralleled length of experience participating in the prairie restoration project, ranging from one to 15 years. All participants were Caucasian and all but one was female. In order ensure the protection of the identity of the lone male participant, the title "Ms." was used in all pseudonyms.

Data Collection

Congruent with Yin (2009), case study data were collected from a variety of sources, including field trip observations, classroom observations, interviews, and artifacts. Observations of teacher-participants took place during day-long field trips to the prairie at the science center in fall and spring, as well as related classroom science lessons. Following recommendations of Roulston (2010), draft interview questions were revised in response to a pilot study and observations in order to design a purposeful interview protocol, which included teacher-participants constructing charts using three by five inch cards listing terms generated in response to some interview questions. Through member checking, participants were consulted about the accuracy and completeness of interview transcripts. Artifacts collected for this study included copies of the relevant

sections of the student textbook produced by a publishing company, copies of worksheets and 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.

Data Analysis

Following Maxwell (2005), data were initially categorized using an open coding process. Segments of data related to broad areas associated with environmental literacy were identified and named with short descriptive labels. These labels became the organizational codes that

served as “bins” to broadly sort data. Next, a deeper level of coding resulted in classifying data segments labeled with organizational codes into subgroups that emerged from multiple readings of the interview transcripts, field trip observation notes, classroom lesson observation notes, and curricular artifacts. These subgroups were named with short descriptive labels that became the more specific substantive codes, hereafter referred to simply as “codes.” Each teacher-participant’s data were coded in a different color. When all the occurrences of a code were aggregated across all data sources, the distribution of colors revealed the distribution of that code across participants. Ultimately, the use of a color scheme during coding made it possible to assure that findings were truly representative of overall patterns, and made any particularities or exceptions immediately evident.

Once the data were “fractured” through open coding (Maxwell, 2005, p.96), the next phase of analysis was to search for patterns of relationships among codes. Related codes were organized into categories. For example, codes that were assembled into a category for sensory experiences, defined as instances when children were invited to use their senses other than sight, included: smell, touch/feel/tactile, hear/quiet to listen, and taste. Comparable lists, ranging from two to 13 codes, were the basis for each category. In the next step, searching for relationships among categories resulted in the emergence of themes. Figure 1 depicts a data analysis map indicating how categories contributed themes. For example, the category of sensory experiences contributed to the themes of awareness of ecological interdependence, as well as wonder and curiosity. Preliminary findings were sent to participants and their feedback was sought in order to increase validity through member checking.

Results

Six interrelated themes, listed in Table 2, emerged from data analysis describing teachers’ perspectives on how the prairie restoration project impacted elementary students’ environmental literacy: (a) At Ease with Nature, (b) Appreciation and Respect, (c) Wonder and Curiosity, (d) Awareness of Ecological Interdependence, (e) Sense of Agency, and (f) Responsibility and Service. Themes are distinguishable from each other because each offers a unique dimension of environmental literacy targeted by the teacher-participants. Boundaries between themes, however, overlap to some extent because some of the dimensions of environmental literacy are inherently related to each other and because some codes and categories contributed to multiple themes. For example, a sense of agency refers to a belief that one *can* make a difference, while a sense of

responsibility and service refers to a belief that one *has a duty* to make a difference. These two themes are distinct but closely related.

Theme One: At Ease with Nature

Teaching One component of environmental literacy that teachers indicated as having been impacted by the prairie restoration project 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 within the scope of the prairie restoration project, 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 identified 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 toward nature. Similarly, codes appeared for fearful or anxious reactions to nature, and for demonstrating a sense of uneasiness or discomfort in nature. Teachers regarded these negative dispositions as obstacles to overcome in order to increase environmental literacy.

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 toward 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.

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. 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 farmland or grass that makes up urban lawns. 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]...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." In addition to grasping the inherent value of the endangered prairie, teachers also sought to cultivate a strong sense of respect toward 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 toward the prairie appeared in all teachers' data. During the prairie field trips, children were reminded repeatedly by teachers to leave the prairie grasses intact, not to take things from the prairie such as galls or berries, and to clean up any garbage from snack or lunch. 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

Another 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 cultivated children's sense of wonder and curiosity during field trips and classroom lessons 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. When a child or adult became curious about something while walking through the prairie, classes often stopped to take a closer look. During prairie field trips, classes stopped to examine goldenrod galls, snakes, frogs, beetles, decomposed logs, various plants, swallow

nests, mounds made by pocket gophers, holes made by snakes, deer bones left from a coyote's kill, and even a piece of hardened tree sap. 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. Teachers fostered children's sense of wonder and curiosity toward discoveries of natural objects and living things by modeling 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.

Theme Four: Awareness of Ecological Interdependence

Another theme centered on the teachers' expectations for children to develop a strong sense of awareness about their immediate surroundings, and to use these careful observations to make inferences about interdependence in ecosystems. Children were encouraged to be observant, to be in the moment, to pay attention to details and notice particularities about the prairie. For example, a regular component of the spring field trips was for students to walk through a section of forest in silence and pay careful attention for any visual or auditory signs of animals. 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.

Teachers then used such careful observations of natural objects and living organisms to help students to grasp the concept of ecological 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. For example, a regular stop on the spring field trip was a particularly large rotting log where teachers encouraged students to become fully present to how the soft wood shred looked, felt, and smelled. Subsequently, classes discussed the role of the rotting log in several ecological relationships, both on site and back in the classroom. A quote from Ms. Hull reveals the relationship between awareness of nature and understanding the concept of ecological 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. . . . [Students] 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. . . . Between people, food, homes, and how we get products from nature.

Teachers helped students sharpen their lenses for noticing physical characteristics in nature, and subsequently used such observations as springboard to develop students' understanding of ecological interdependence.

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 an 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.]” 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.

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 toward agency to positively impact the natural environment.

Theme Six: Responsibility and Service

Beyond empowering children with a sense of agency to effect positive change, teachers sought to foster a sense of responsibility and duty toward the natural environment among their students. A recurrent set of codes that emerged to varying degrees in data for all teachers centered on the importance of cultivating a sense of responsibility toward restoring the prairie, a sense of stewardship for protecting the prairie, and involvement in service learning. Ms. Lake 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.

Teachers explained 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. Teachers expected children to act responsibly toward the prairie in ways that also extended beyond the prairie restoration process; 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. Another facet of the prairie restoration project was its connection to service learning. Codes relating the prairie restoration project to service learning emerged in data for five of the seven teacher-participants to varying degrees. 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 a naturalist had indicated the seeds harvested by the children would actually cost several thousand dollars if the science center had been required to purchase them.

Discussion

The six themes that captured key aspects of teachers’ perspectives on the impact of the prairie restoration project on students’ environmental literacy resonated with Gruenewald and Smith’s (2008) conception of place-based education. The themes were grounded in an orientation that sought to develop a sense of place, to foster place-consciousness, and to equip students to “regenerate and sustain” (p. xvi) the tall grass prairie. It is notable that, congruent with Mueller (2008), none of the teacher-participants advocated for a “doom and gloom” approach that played on students’ fears or guilt in order to compel them to feel a sense of responsibility and stewardship toward the tall grass prairie. Indeed, across the year-long data collection period that included multiple field trips observations, classroom lessons observations, interviews, and artifacts, there was a remarkable absence of codes, categories, or themes that emerged related to environmental crisis or intention to shock students about the fragmented state of the tall grass prairie or the distressed ecological state of our planet.

Rather, teacher-participants’ words and actions sought to honor children’s cognitive, emotional, and social developmental readiness by fostering children’s relationships with the prairie and providing a manageable and concrete method to help restore it, rather than burdening them with them with the adult responsibility of grappling with the large-scale near-disappearance of an entire biome in the lower 48 states of the United States. Threats to the integrity and resilience of the tall grass prairie were not denied or ignored, but a deficit view of the state of the prairie was not dominant in the teachers’ discourse or the learning activities selected and implemented by the teachers. Congruent with studies that have demonstrated a positive relationship between experiences in nature during formative years and pro-environmental attitudes and behaviors (Wells & Lekies, 2006; Strife & Downey, 2009; Wells, 2000; Palmer et al., 1998; Palmer, Suggate, Bajd, & Tsaliki, 1998; Chawla, 2006; Chawla, 1999; Ewert, Place, & Sibthorp, 2005), the teacher-participants allowed the prairie restoration project to function as an investment in the elementary students’ childhood experiences in nature, rather than a bellwether of wider environmental crisis.

The teacher-participants’ place-based approach respected the developmental growth of elementary children in a manner congruent with David Sobel’s (1996) three-stage model for the evolution of children’s relationships with nature on a

trajectory toward increased environmental literacy. The recognition of this congruence is notable because the teacher-educators' did not draw on Sobel's work in their practice, and Sobel's model was not part of the initial research study design. After the study's themes emerged through data analysis, Sobel's model was then identified as a theoretical construct that could be used to show relevant relationships between the themes. As shown in Table 3, either two or three of the themes resonated with each of the three stages of Sobel's model. As noted earlier, though Sobel's model captures a general developmental pattern from early childhood to adolescence, the stages are not rigidly bound nor are they not mutually exclusive.

Empathy for Living Things

The study's first three themes were congruent with the initial stage of Sobel's model, developing a sense of empathy toward living things. The first theme, feeling at ease with nature, resonated with Sobel's first stage because being comfortable in nature and being open to trying new experiences in nature are prerequisite to fostering a sense of connection and empathy with living things. For example, there was a sharp contrast during a prairie field trip between a girl who cradled a grasshopper in her hand and eagerly held it out to show others, and a 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 study's second theme 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 highlighted an important dimension of 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. Finally, the third theme, cultivating children's sense of wonder and curiosity, also resonated with Sobel's first stage because wonder can engender empathy when children are engrossed by fascination for natural marvels such as the grasshopper example described above.

Exploration of the Natural World

The study's third theme, wonder and curiosity, was closely connected to Sobel's second stage because children's exploration of the natural world was largely fueled by their curiosity. Indeed, Eberbach and Crowley (2009, p.59) point out, "objects – be they beetles, flowers or dinosaurs – are powerful sources of inspiration for observation and the desire to know more."

Of note is that though it was evident that all the teacher-participants valued students' curiosity in practice, none of them identified curiosity as an indicator of children's environmental literacy when interviewed. During prairie visits, for example, children's curiosity was honored when classes paused to take a closer look at discoveries such as pocket gopher mounds, goldenrod galls, and foliage ravaged by thousands of tent caterpillars. 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 and wonder

emerged during open coding for every teacher participant's data. One possibility could be that the teachers regarded fostering children's curiosity as simply too obvious, too germane, too assumed to bother mentioning. This hanging thread might be woven into a future research project.

The study's fourth theme, increasing awareness of natural surroundings to foster a commensurate ability to recognize ecological interdependence, related to Sobel's stage about exploration of the natural world. 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.

Social Action to Protect the Natural World

The fifth theme was sense of agency, a belief that one's actions can make a positive difference to protect the natural world. This theme corresponded with the third stage of Sobel's model, undertaking local and manageable social actions to protect the environment. Helping students to feel empowered to make a difference by protecting 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 her current students the plots of previously restored prairie from years past. Like Sobel's third stage, the teachers' efforts to foster students' sense of agency was consistent with Bandura's self-efficacy theory (1982) that someone who believes in his or her capacity to successfully accomplish a task is more likely to engage in that task.

The study's sixth theme of responsibility and service toward protecting the natural world was also congruent with Sobel's third stage of social action. Teachers sought to develop a sense of duty toward restoring the prairie and a sense of stewardship for protecting the prairie. 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 tropical rainforest destruction. Also, the scope of the underlying issue was manageable; while the loss of endangered prairie can 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.

A Promising Curriculum Design Framework

Figure 2 depicts relationships between the study's six themes and Sobel's (1996) three-stage model for the development of children's place-based relationships with nature on a trajectory toward increased environmental literacy. This framework offers the potential to support curriculum design that seeks to develop environmental literacy through place-based education. Sobel's three stages, resonant with Hungerford's sequential configurations (1996), form a solid basis for curriculum design on large or small scales. The three stages might be addressed across the span of an entire K-12 school experience as recommended

by Sobel, or within the scope of a single academic year as occurred in the prairie restoration project that was the subject of this study.

Within the framework, the study's themes can serve as focal points highlighting particular, empirically-supported dimensions of each stage in Sobel's model. For example, when establishing curriculum goals and objectives related to cultivating empathy for living things, educators could pay particular attention to targeting outcomes related to the study's three themes of assuring students feel at ease with nature, cultivating appreciation and respect for nature, and fostering a sense of wonder and curiosity. Similarly, curriculum goals and objectives related to Sobel's exploration stage could intentionally aim to cultivate a sense of wonder and curiosity, and to connect careful observations based on sensory experiences with developing a cognitive understanding of ecological interdependence. Finally, developing a sense of agency, and a sense of duty toward protecting nature could serve as focal points for learning outcomes targeting Sobel's third stage. In this way, the study's empirical evidence supports particular dimensions of each of Sobel's stages as they are implemented through curriculum.

Conclusion

The study's purpose was to examine teachers' perspectives on how a place-based prairie restoration project impacted elementary students' environmental literacy. Findings indicated that teachers' fostered six components of environmental literacy through the prairie restoration project: feeling at ease in nature, appreciation and respect for nature, wonder and curiosity, awareness of ecological interdependence, sense of agency to restore nature, and responsibility and service toward environmental protection. These six empirically-supported components of environmental literacy correspond with David Sobel's three-stage model for place-based relationships between children and nature. The resulting framework can serve to support curriculum design by providing focal points for particular dimensions of each stage in Sobel's model. Placed-based approaches like the prairie restoration project can foster valuable components of children's relationships with nature on a trajectory toward increased environmental literacy, ultimately improving our world's prospects for ecological sustainability.

Disclosure statement

No potential conflict of interest was reported by the authors.

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