J Sci Teacher Educ (2012) 23:789–803
DOI 10.1007/s10972-011-9236-1

Use of the Outdoor Classroom and Nature-Study to Support Science and Literacy Learning: A Narrative Case Study of a Third-Grade Classroom

Charles J. Eick

Published online: 3 May 2011

Abstract A case study of an exemplary third grade teacher's use of the outdoor classroom for meeting both state science and language arts standards is described. Data from the researcher's field journal, teacher lesson plans, and teacher interviews document how this teacher used nature-study to bridge outdoor classroom experiences with the state science and language arts curriculum. This teacher's early life experiences supported her strong interest in science and nature in the outdoors and experiencing it with her children. Children interacted with the outdoor classroom throughout the day as a context for science and literacy learning. All but one child successfully met Annual Yearly Progress (AYP) goals in reading at the end of the school year.

Keywords Outdoor classroom · Nature-study · Inquiry · Language arts integration · Biography

When I run into students that I've had a long time ago, that's the one thing that they tell me. I remember when you took us to the woods. I remember when you did science with us.
— Susan

Introduction

Children today have limited understanding of the elements of nature learned through experience (Louv 2005; Malone 2007). Malone contends that having little to no outdoor play restricts children's mobility in nature and thus limits their "capacity to

C. J. Eick (✉)
Auburn University, 5040 Haley Center, Auburn, AL 36849, USA
e-mail: eickcha@auburn.edu

expand their environmental literacy" (p. 524). She maintains that modern life, over-protectiveness of parents, and heightened fears of danger have all led to this situation. In addition, there is evidence that suggests that lack of outdoor experiences in nature may also put children at a disadvantage in learning ecological concepts—the bridge between biology and the environment (McComas 2002). The learning of ecological concepts is greatly enhanced when children of all ages have prior experiences in nature on which to build this learning (Auer 2008; Dillon et al. 2006; Upadhyay and DeFranco 2008). Teachers in formal education settings can benefit from children's outdoor experiences in their teaching of ecology, and can integrate outdoor experiences into their curriculum to further assist children's learning. Upadhyay and DeFranco (2008) found that children in third grade better retained their knowledge of ecology and the environment when lessons were embedded in the context of their prior outdoor experiences. First-hand experiences of nature provide a foundation upon which environmental principles are better learned (Auer 2008).

Childhood experiences in nature when fostered by significant adults also form a critical foundation for further interest in learning about ecology and protecting the environment (Chawla and Cushing 2007). School teachers can play a significant role in this process through fostering knowledge about environmental issues and through connecting children to community-based projects. Those experiences that involve studying human impact on the environment lead to a greater ethic of caring about nature and subsequent environmental activism in children (Auer 2008; Chawla and Cushing 2007). Auer (2008) states, "This 'sensitivity' to the environment, via the external senses, appears to enable other learning objectives, including the normative and advocacy-oriented dimensions of environmental education" (p. 7). The natural world and wonderment it brings for young children can provide the context for learning about science and the natural world while also expanding children's environmental literacy (Broda 2007).

In this narrative case study, an experienced third grade teacher located in the Southeastern United States is studied in how she takes her children outdoors and into the woods to enhance their science and language literacy through awareness of nature and the environment. More specifically, the research questions were:

1. How does this teacher use the school's outdoor classroom and nature-study to connect to her science and language arts curriculum?
2. How does this teacher's nature-study approach to literacy learning impact children's state test results in reading and grammar for meeting Annual Yearly Progress (AYP)?

Such a descriptive case study of practice, along with high stakes test results, provides an evidence-based model in utilizing the outdoor classroom within the context of today's elementary schools where the focus is almost exclusively on math and language literacy (Griffith and Scharmann 2008). Also, a narrative approach adds insight into the belief-based decision-making supporting this teacher's practice that is informed by biography (Bullough 1998). Understanding both the school-classroom contexts and teacher dispositions would provide a more complete picture of this case and its potential transferability to other locations.

Nature-Study and Science Education

Nature-study as science content and teaching approach was most prominent in schools in the United States in the late nineteenth and early twentieth centuries (McComas 2008). The science content was "virtually everything found in the natural world" (p. 24). Indeed many of the elements and processes of nature made up the body of the studied curriculum, including plants, animals, rocks, weather, and astronomy; and all investigated through first-hand experiences in the outdoors. Individual proponents of nature study like Anna Botsford Comstock were prolific writers of science content connected to the natural world. She also wrote on pedagogy that included observation of natural objects and seeking answers to emergent questions, a pre-cursor to today's inquiry approach (McComas 2008). Soon, more formalized school curriculum replaced nature-study, but the remnants of nature-study re-emerged with the conservation movement and later with the environmental movement. Today, its influence is seen in the modern science of ecology, the inter-relationships between the living and non-living world, with environmental science being an application of these principles to societal impacts on nature (McComas 2002). Much nature-based curriculum currently exists in science in schools in the United States today, and particularly informs life science (ecology) and environmental science studies.

As a teaching approach, nature-study parallels the current approach to teaching science advocated by the National Science Education Standards (National Research Council (NRC) 1996) where inquiry investigation and questioning form the theoretical framework for learning science: "As students focus on the processes of doing investigations, they develop the ability to ask scientific questions, investigate aspects of the world around them, and use their observations to construct reasonable explanations for the questions posed" (p. 6). In nature-study students' own sense of wonderment and curiosity about the natural world was a motivational tenet for the inquiries or explorations into learning that ensued. These explorations required the application of science process skills, or the tools of inquiry, to carry out. These process skills for investigating nature included observation, measurement, drawing, classification, prediction, and inference, among others. These are the same tools of inquiry required for learning science through inquiry today (NRC 2007).

As a form of learning in context, the nature-study approach is also supported by current brain-based research on how students learn science (NRC 2000). Students learn science best when abstract ideas (principles and concepts) are tied to students' prior knowledge and concrete experiences within familiar contexts, further developed, and then later applied to related contexts. Nature and the outdoors form the basis of this context in which past and ongoing experiences are further developed into understandings of science through ecological principles and environmental practices (Auer 2008; Dillon et al. 2006; Upadhyay and DeFranco 2008).

Context

An exemplary third-grade teacher of science, Susan (pseudonym), and her students agreed to participate in a study of their daily curriculum and practice in using the

school's outdoor classroom and a nature-study approach. Susan, who has taught for 19 years, had a long-standing reputation in this rural school district within proximity to a major university for her strength as a teacher of science. She began college as a science major in biology. This case was "selected for its uniqueness, for what it [could] reveal about a phenomenon" (Merriam 1998, p. 33); in this case, how Susan utilized the outdoor classroom in her teaching within a school context that emphasized language and mathematics literacy. The researcher conducted this study as a participant-observer and co-teacher in the classroom for 3 days each week during the Fall 2009 semester.

As a co-teacher assisting Susan (Villa et al. 2004), the researcher regularly taught small groups of children during morning rotations during language arts time and assisted during math time. Also, the researcher, as a former science teacher, occasionally helped in co-planning and modeling science and outdoor lessons to the children (Kenney et al. 2003). The class of 22 children roughly mirrored the demographics of the school's entire third-grade: 59% Caucasian, 27% African American, and 14% Asian/Latino. The school's percentage of third-grade children on free-and-reduced lunch, a measure of poverty, was 31%. The school system's total third-grade population on free-and-reduced lunch was 27%. These children would take the state's high stakes testing regime for determining Annual Yearly Progress (APY) in math and reading for the first time at the end of the third grade. Science testing would not occur until fifth grade and was not part of the AYP formula.

Due in large part to Susan's efforts and her principal's support, her elementary school (grades 1–5) had an outdoor classroom under development that consisted of multiple nature trails through the surrounding woods, including one down to the local stream, a butterfly garden, a vegetable garden, and a bird-feeding station. She recruited local resources through the university, governmental agencies, and wildlife organizations to help develop these features of the outdoor classroom, and even had architectural plans along with promises of free labor to build an outdoor pavilion. She also had plans to add an outdoor weather station, sundial, and geology study area.

As an experienced teacher leader in her school, Susan also worked closely with her colleagues in encouraging the use of the outdoor classroom. She wanted to see outdoor connections made across grade levels and across the curriculum. She saw how learning utilizing the outdoor classroom could connect from year to year and spiral to deeper learning across disciplines. For example, in second grade children study the *life cycle* of butterflies that connected with the third grade study of butterfly *plants*. In third grade children study native plants that connected with fourth grade state history and the study of pioneer and Native American gardens. Susan was also instrumental in planning the fourth grade overnight field trip to 4-H Camp. In this way, the children at her school could continue their outdoor learning experiences.

Susan, like the other third grade teachers, followed a daily routine where children studied disciplines based on a time schedule. Her class began the day with their morning calendar before traveling to physical education. Upon return, they spent the rest of the morning in language arts, whole group reading and skill rotations, before

having lunch—almost 2.5 h later. After lunch the children had recess time outside before returning to their math lessons. The last 30 min of the day was spent on either science or social studies, often alternating these disciplines based on unit length. The school system itself was a participant in a science reform initiative that utilized kit-based resources such as STC® and FOSS® for teaching science in grades K-8, so having science time was a requirement for teachers.

Methods

The researcher chose a narrative approach to understanding the data generated in this case study (Clandinin and Connelly 2000). A narrative approach was chosen because of the many life stories that the teacher shared as a window into understanding her professional decisions in the classroom (Bullough 1998). Narrative is a way of understanding experience and life history that shapes teachers' professional lives (Clandinin and Connelly 2000). The researcher chronicled his experiences in the classroom through keeping a daily field journal of events and activities. Documentation of Susan's perspective on her classroom came from two audio-taped interviews, daily lesson plans, and related documents. These documents were predominantly presentation notes and grant proposals detailing her work in the development of the outdoor classroom and its related curriculum. The first semi-structured interview took place before the study began and focused on Susan's science and nature-study curriculum and her development and use of the outdoor classroom (see "Appendix"). This interview oriented the researcher to Susan's approach in her classroom and provided initial data for further observation and inquiry while a co-teacher in her classroom. The second semi-structured interview took place at the end of the study and focused more on emergent issues during the study including the integration of the outdoor classroom and science with literacy learning, and how Susan perceived the outdoor experiences as impacting her children's awareness of nature, attitudes, and learning.

In answering the first research question, interview data were transcribed and coded on emergent topics related to curriculum, practice, the use of the outdoor classroom, and perceptions of impact on children. These codes (e.g., use of rotation time, motivation to write) were placed in a matrix with supporting data lifted from the transcripts of both interviews (Miles and Huberman 1994). Examples of classroom activity supporting interview data were lifted from the researcher's daily journals and also placed in this matrix. Teacher documents and lesson plans were used to triangulate interview and journal data sources in supporting the account of the researcher's experience in this teacher's classroom (Patton 2002).

In answering the second research question, state test results that determine annual yearly progress (AYP) for reading, which included grammar, were charted for 16 of the 22 children who took the test in spring 2010. These 16 children remained at this school the following year, and thus, these test data were available to the teacher and the researcher. AYP is a measure of the school's performance and compliance with state administered, federally-mandated, No Child Left Behind legislation. The AYP test in reading in this state included multiple-choice and open-ended test questions.

In open-ended questions children must write their response along with reasons, explanations, or a rationale for it. Schools must continue to show an increase in scores and subgroup scores regardless of proficiency level in order to continue to meet AYP. These children's test scores from this study were compared to the scores of the other third grade children at this same school, across the system, and the state. Results of this high stakes test for each child are shared as four proficiency levels: Level IV—Exceeds academic content standards, Level III—Meets academic content standards, Level II—Partially meets academic content standards, and Level I—Does not meet academic content standards. Levels III and IV are considered acceptable or passing on this test. Schools receive full credit for passing scores toward their AYP. Schools receive partial credit toward AYP for Level II scores and no credit for Level I scores.

Results

The Outdoors as a Context for Science

Susan taught science on a daily basis during the designated science time at the end of the day. She regularly utilized the outdoor classroom to help teach science through many nature-study connections to her state course of study and existing science curriculum (see Table 1). She brought children outside during lessons as the real-world context for children's ongoing science studies. This was the situation in her unit on the life cycle of plants. At the beginning of the unit while studying seeds, children went outside on the nature trail to find different seed types, learning about how they were dispersed. Later in the unit, they added flowering plants to the butterfly garden while also studying flowers and bee pollination as part of the existing curriculum. Another unit of study was monarch migration where children used their prior knowledge of animal and plant life cycles, the butterfly garden, and surrounding skies to look for and document migrating monarch butterflies. Another unit of study involved the use of the on-site stream to find and classify macroinvertebrates in order to rate stream quality. Children also studied local impacts and development on the stream, including erosion from nearby construction. In this way children met two important state science standards on animal classification and habitat protection. In many of these instances, Susan used the outdoor classroom and study of nature as an application for the scientific principles the children were learning through their science curriculum in the classroom. She integrated these experiences with existing classroom curriculum when and where provided, such as STC® and FOSS® kits. The outdoor classroom experiences were explicitly tied to her instruction in the classroom, and not used as a positive escape or change from the mandated curriculum.

One of Susan's goals was to "get the children outside and on the trail as often as I can." She stated that she felt this way because of her own childhood experiences in the outdoors:

Table 1 The state course of study for science and connections made to nature-study

	Nature-study connection
State course of study standards—3rd grade	
Life science	
Identify structures and functions of the muscular and skeletal systems of the human body [FOSS, human body]	Owl pellet dissection and study
Describe the life cycle of plants, including seed, seed germination, growth, and reproduction [STC, plant growth and development]	Seed collection on trail hike Butterfly garden plantings and flowers Visit by Apiculturist
Identify how organisms are classified in the Animalia and Plantae kingdoms	Macroinvertebrate sampling Leaf collection and tree identification Field guides (birds, reptiles, insects)
Determine habitat conditions that support plant growth and survival	Flora inventory in outdoor classroom Growth of potted plants
Earth and space science	
Describe earth's layers, including inner and outer core, mantle and crust; classifying rocks and minerals [FOSS, earth materials]	Rocks and minerals collection on trail Field trip to local caverns
Identify conditions that result in specific weather phenomena, including thunderstorms, tornado, and hurricanes	Outdoor weather observations, instruments
Describe ways to sustain natural resources, including recycling, reusing, conserving, and protecting the environment; impact of society on the environment	Vegetable garden and composting Water quality monitoring in stream Stream walk survey Field trip to local Environmental Center
State Course of Study Standards—2nd Grade	
Life science	
Identify characteristics of animals including behavior, size, and body covering; identifying migration and hibernation as survival strategies	Monarch migration observations Butterfly garden visits

> I grew up on a farm. And my grandmother was a big environmentalist. I lived in the woods basically. I don't remember a time when I wasn't outside; in the summer, every day of my life outside doing something. And she taught me the names of the trees, wildflowers, plants, all that kind of thing…. I played in a creek every day in the summer time…. And so, I mean it was just one of those natural things that we absolutely loved science…. So, and you want to bring that back to the kids. *[Second teacher interview]*

In this regard, she also used the outdoor classroom as a regular laboratory for ongoing study. One example of this was the children's study of weather and going outside to regularly observe and record weather data, as well as going outside for the migrating monarch study.

Using the Outdoor Classroom Throughout the Day

Susan took advantage of every opportunity to continue to teach science and make connections to nature-study outside of the scheduled 30 min of science time. The language arts rotation time during the morning often incorporated a science station to continue or introduce new science studies. For example, during the investigations of plants and how plants are classified, the researcher continued a lesson on tree identification and leaf color change, incorporating content area reading with a hands-on chromatography activity using leaves already collected from the trail. And, before going to the stream to collect macroinvertebrates for classification, the researcher led a card game that helped the children identify and classify images of what they would find in the stream, and how to calculate a biotic index of stream health:

> Rotations—I brought the [card] game to do. It went great in doing the simulation with cards and later showing the vials of bugs from the case. Kids really liked looking at the bugs. We are setting kids up for [a] trip to [the] stream on Thursday morning to do macrinvertebrate sampling. Susan did a reading for them already in the early morning on macroinvertebrates and the four categories for steam pollution. *[Journal entry, November 3]*

Susan scheduled the field trip to the stream during the morning language arts block of time, which was the only time of the day when her children would have enough time needed to do it. Occasional longer outings in the outdoor classroom like this one were done during this block of time.

Another time during the school day when Susan continued her use of the outdoor classroom for science and nature-study was during recess time. Children had an allotted 30 min of time for recess outside each day after eating lunch. During this time, most of the children played on the playground equipment, but a substantial minority of them regularly explored the natural surroundings, particularly looking for insects, spiders, lizards, or other small animals; or helped with the gardens. Garden help involved planting, mulching, pruning, harvesting, and weeding of the butterfly and vegetable gardens. Susan viewed children's behavior during the time outdoors in recess as a natural extension of what children were learning indoors. However, she had another purpose for encouraging children to interact with the outdoor classroom and nature during recess that related to her personal interests:

> Now, everybody will come over and take a look at the migrating monarchs. But there are certain children that when we head over there towards the garden, they are there. They're ready to go; they are wanting to do it…. And I remember when I was a little kid…, I didn't always fit in with some of the other activities that were available. This would have been my choice of activity. So, I guess it's selfish on my part that we can go play, too. *[Second teacher interview]*

Reading and Writing About Nature

Susan viewed her students' science and nature studies as the content upon which they learned to better read and write, and in turn, how reading and writing helped

them learn the science content. She often shared how she "…really [could] not separate the science from the language arts." This science content was connected to the context of the outdoor classroom and the children's direct experiences with nature and the outdoors. Susan shared one way that she saw this work among her students:

> …what usually happens is we go and we find something outside. Well immediately when they go on their next trip to the media center, they're checking out books on those topics. And then when they're writing a story, all of a sudden those types of things start to come into play. So, it's just a… it's a spiral of wonderful building and spiraling interest that helps with their educational motivation. *[First teacher interview]*

Reading for fluency and comprehension was one of the most important skill-sets that was taught each day, and also heavily tested in the third grade at Susan's school. Susan applied her state's reading strategies to passages that she chose that fit her current nature studies. These passages replaced her standard 'toolkit' readings and basal readers:

> Or for instance, when we did the trees, in the toolkit there were poems about other things that we're not studying. So, I turned around and, since we were studying trees at the time, I found examples of poetry about trees that would fit with the various same types of poetry…. And so, it was with weather. *[Second teacher interview]*

She applied this same technique of teaching reading for comprehension to selected content passages that she located on the Internet about butterfly gardens and macroinvertebrates.

Susan believed that utilizing reading passages based in the context of what students were currently learning and doing motivated them in their application of the reading skills that she had to teach them—this was considered 'best practice'. However, Susan and her third grade colleague, Alice, who taught similarly, were not always secure in what they were doing, and their emphasis on science and use of the outdoor classroom, because of the external pressures to increase reading test scores. This also implied using more of the prescribed reading program. I perceived these pressures as I wrote in one journal entry: "Susan shared how their elementary meeting yesterday was not good because [student] scores are not high enough. Teachers are pressured to focus more on reading and math." *[Journal entry, November 4]*

Writing was almost as big an emphasis in Susan's class as reading. She helped her students' expository, narrative, descriptive, and persuasive writing. As with reading, she applied the teaching of writing skills to children's experiences in the outdoor classroom. Susan viewed these forms of writing as ways for her children to process their learning and make more sense of it. Children wrote stories about their experiences finding seeds on the trail, preparing their butterfly garden, and being a water droplet in the water cycle, among others.

One example of an expository writing assignment was to help teach 'author's purpose' where the children wrote about their experience at the stream in collecting macroinvertebrates and the associated facts about why they had gone to the stream

and what they found out. Susan always first modeled how to begin and write each assignment through use of writing prompts and graphic organizers. In talking with Susan about her perceived success of this approach in both learning science and writing, she shared:

> But, if they can take that, take their information that they gleaned from their trip to the stream and turn it around into an expository piece that explains their purpose for doing it and what they found and the results from going in there—their actual analysis of the stream's condition—I think they really learned something…. *[Second teacher interview]*

Susan felt strongly that science and language arts connected to the outdoor classroom was especially a big motivator for her lower achieving children, whose self-esteem was boosted through outdoor experiences: "This is an area where they [lower achieving children] can shine, and have positive experiences." Susan was particularly excited about more than one child's writing about their trip to the stream, and how it motivated them to write more and more coherently than ever before. She particularly pointed out Carl's [pseudonym] work:

> When we went to write the macroinvertebrate piece, Carl is usually one of those that I can maybe get one or two words out of… well, he might write a sentence…. But when he started writing about macroinvertebrates, he had two pages! And this was during rotation time, when I was over here teaching reading and he was at his desk writing independently. He wrote two pages and it was connected and it was meaningful and he did a good job, and he had pictures. *[Second teacher interview]*

Children Meeting AYP in Reading

Children's state test scores for reading (and grammar) at the end of third grade showed that 15 of the 16 children met academic content standards in reading, attaining a Level III score or better. Twelve of these 15 children attained the highest Level IV score that meant they exceeded academic content standards. Only one child scored at Level II meaning partial achievement of standards. These test scores and passing rate of 94% were 1% higher than the third grade as a whole at this school but equal to the third grade in the entire school system (see Table 2). This pass rate came with more of Susan's school's third-graders on free-and-reduced

Table 2 Third grade reading scores and percent pass rate for spring 2010

Proficiency level	Susan's children	School's children	System's children
IV and III (passing)	15	90	449
II (partial passing)	1	7	27
I (not passing)	0	0	0
Total students	16	97	476
Percent passing (%)	94	93	94

lunch (31%) than the school system's entire third grade (27%). These pass rates were above the state-wide passing rate for third graders in spring 2010 which was 87%.

Discussion

Going Outside to Learn Science

The teacher is this narrative case study seamlessly integrated her use of the outdoor classroom and nature-study approach with her mandated science curriculum. Susan easily used outdoor experiences in nature as the *meaningful context* to help her children connect to the science learning (NRC 2000). For advocates of nature-study, this approach made sense due to the similarities of topics of study between historic nature-study and science curriculum today (McComas 2008). This approach was supported by the teacher's strong bent for her children to learn science through outdoor experiences. She cited her own childhood experiences on a farm, in the woods, and in the local stream as the source for her own interest in science. These prior life experiences in nature have likely helped to form her beliefs and interests about the need to take children outside (Chawla and Cushing 2007):

> …nature activities in childhood and youth, as well as examples of parents, teachers and other role models who show an interest in nature, are key 'entry-level variables' that predispose people to take an interest in nature themselves and later work for its protection. (p. 440).

Understanding Susan's life narrative was important in understanding why she and others like her value nature and the outdoors, and persist in integrating it into their classrooms. She had the support of her principal for her science program, but the need to increase reading scores at her school was a growing pressure that called into question her interdisciplinary approach. Her strength of belief based in her past personal experience in science, science teaching, and life stories in nature likely supported her persistence in what she did, even with increasing pressure to teach differently. Her belief was self-reinforcing in how her children responded to their experiences in nature through motivating them to further study through reading and writing, and in their meeting and mostly exceeding academic content standards for reading (and grammar) at a comparable level to other classrooms. Teacher beliefs are strong determinants of persistent action in the classroom (Pajares 1992). Without these strong beliefs informed by past and present personal life experience it would be harder to carry out the interdisciplinary approach with an emphasis on science and the outdoors that Susan implemented.

In his work on place-based education for elementary age children, Sobel (1997) argues that children can bond and connect with the natural world if given the opportunity at an early age. This bonding forms the foundation for interest, caring, and potential social action to protect and preserve nature (Chawla and Cushing 2007). Susan's approach to nature-study, much as she experienced as a child, was to foster this interest in the children at all grade levels through the many walks in the

woods to explore their own sense of place. Her approach also provided the context and concrete experiences upon which meaningful science and literacy learning took place (Auer 2008; NRC 2000).

Susan did not view her use of the outdoor classroom and nature-study lessons as separate or additional to her teaching of science and literacy skills, but fundamentally linked her children's outside learning with their inside learning. These links are critical for supporting greater cognitive learning in science from outdoor experiences (Dillon et al. 2006; Upadhyay and DeFranco 2008). The failure of outdoor (informal) science experiences in supporting formal schooling is often due to disconnect between the learning in the two environments, and short duration of the integrated learning experience (NRC 2010). Susan's daily persistence in how she used the outdoor classroom to teach school science may be unique to her personal life experiences and school context. However, her purposeful use of outdoor learning experiences to support indoor learning can be replicated elsewhere to bolster students' science achievement (Auer 2008; Dillon et al. 2006; Upadhyay and DeFranco 2008).

Regularly going outdoors, or even focusing on science and nature, in the context of her school's schedule and emphasis on skill-based literacy over content literacy was difficult. Many elementary schools and teachers devote little time to science due to the constraints of NCLB (Griffith and Scharmann 2008). Susan was able to extend her use of the outdoor classroom through periodically scheduled morning outings during her language arts block of time and her regular use of recess time. During these times, her children had the opportunity to continue to interact with nature and further their understanding of it (Thomson 2007). Many of the discoveries and observations that children made with nature during these times, such as observing their first monarch butterfly and finding 'bugs' in the stream, were particularly exciting and impressionable for many children. These experiences of nature and their affect on children's attitudes and interest in natural science are not typically measured by schools and high-stakes testing which emphasize formal academic achievement. However, these types of ongoing informal experiences with science and nature can lead to further interest in science, persistence in learning it, and potential environmental science related careers (Chawla and Cushing 2007; NRC 2010). Susan often shared stories of her past students and one in particular who returned in the past year to tell her that she was majoring in environmental biology because of her experiences with Susan "down at the creek."

Literacy Across the Curriculum

As much as this teacher emphasized science learning and interest, she emphasized children's literacy skills in reading and writing even more. In using the outdoor classroom, Susan witnessed a heightened motivation to read, write, and draw in those children who struggled most with engaging in literacy activities. Susan used her science curriculum and nature-study as the content for children's reading, and

their inquiry-based experiences in nature as the content for their writing (Cervetti et al. 2006). Children were learning to apply the strategies for reading for comprehension to science content passages under study. These process skills used in reading mirrored the same skills used in nature-study and inquiry as children went outside with a purpose to make observations, infer meaning, and classify organisms found in nature before summarizing their findings (Miller 2006; Padilla et al. 1991). In a study of 315 fourth grade children, Wigfield et al. (2008) found that concept-oriented reading instruction in science on an ecological theme led to significantly higher scores in reading comprehension, reading strategies, and reading engagement than similar strategy-based approaches using only basal readers.

In Susan's class, children read about what they were learning, such as butterfly gardens and macroinvertebrates, and then connected this information to active experiences in science and the outdoor classroom to write narratives on their personal learning. Susan emphasized writing in her children's learning of science because she saw how it helped them reflect on and further process their learning from experiences in science. This comprehensive literacy approach was very evident in each science unit, and created a synergy where learning in one subject area supported learning in the other. It also mirrored the research process of reading, outdoor inquiry, and writing conducted by scientists and naturalists. This case study of Susan adds further support to recent research on cognitive learning that states that children's learning must be situated in meaningful and familiar contexts, based on concrete (real-world) experiences, and motivate engagement in reflective thinking on learning (NRC 2000).

Summary

The outdoor classroom provided a real-world context for children's learning in science through use of nature-study, the link between outdoor experiences in nature and a state's mandated science curriculum. The teacher in this case study was supported in her work by strong beliefs based on personal narrative and life experiences that all children need to explore and study in the outdoors. Children's structured experiences in nature and natural discoveries occurred at different times during a school day, including science, the language arts block, and recess. The outdoor classroom in this case study also provided the context for reading and writing about science and nature from experience. Literacy was broadly conceived to include science and language arts skills that worked in concert to mirror the scientific research process of reading, inquiry, and writing on scientific learning in nature. High-stakes test results affirmed this approach through comparable high reading scores to other third grade classrooms. This case study is a strong narrative example of how the outdoor classroom and science education can be integrated in today's elementary schools under high stakes testing pressures where contexts are favorable because science is still valued. More importantly, through narrative inquiry it highlights the dispositions (life experiences and beliefs) that are also needed to support a teacher in doing it.

Appendix

First Teacher Interview

1. How does the environment integrate into your teaching of science? How does it integrate into your use of the outdoors and outdoor classroom? What specific connections do you make with your science units?
2. What community connections have you made in building and supporting you in your use of the outdoor classroom? Fellow teacher connections?
3. What items are currently in place in the outdoor classroom?
4. What strengths do you perceive for your teaching in using the outdoor classroom and what difficulties do you encounter? What special skills do you find teachers need in using the outdoor classroom?
5. How do you see your use of the outdoor classroom impacting your special needs population of students?
6. How do you use the outdoor classroom across the curriculum?
7. How does you use of the outdoor classroom and related activities build classroom community among your students?
8. Is there anything else that you want to share with me that would be important to know about your classroom, students, curriculum, and use of the outdoor classroom?

References

Auer, M. R. (2008). Sensory perception, rationalism and outdoor environmental education. *International Research in Geographical and Environmental Education, 17*(1), 6–12.

Broda, H. W. (2007). *Schoolyard-enhanced learning: Using the outdoors as an instructional tool, K–8*. Portland, ME: Stenhouse Publishers.

Bullough, R. V. (1998). Musings on life writing: Biography and case studies in teacher education. In C. Kridel (Ed.), *Writing educational biography: Explorations in qualitative research* (pp. 19–32). New York: Garland Publishing, Inc.

Cervetti, G. N., Pearson, P. D., Bravo, M. A., & Barber, J. (2006). Reading and writing in the service of inquiry-based science. In R. Douglas, M. P. Klentschy, & K. Worth (Eds.), *Linking science and literacy in the K–8 classroom* (pp. 221–244). Arlington, VA: NSTA Press.

Chawla, L., & Cushing, D. F. (2007). Education for strategic environmental behavior. *Environmental Education Research, 13*(4), 437–452.

Clandinin, D. J., & Connelly, F. M. (2000). *Narrative inquiry: Experience and story in qualitative research*. San Francisco: Jossey-Bass Publishers.

Dillon, J., Rickinson, M., Teamey, K., Morris, M., Choi, M. Y., Sanders, D., et al. (2006). The value of outdoor learning: Evidence from research in the UK and elsewhere. *School Science Review, 87*, 107–111.

Griffith, G., & Scharmann, L. (2008). Initial impacts of no child left behind on elementary science education. *Journal of Elementary Science Education, 20*(3), 35–48.

Kenney, J. L., Militana, H. P., & Donohue, M. H. (2003). Helping teachers to use their school's backyard as an outdoor classroom: A report on the watershed learning center program. *The Journal of Environmental Education, 35*(1), 18–26.

Louv, R. (2005). *Last child in the woods: Saving our children from nature-deficit disorder*. Chapel Hill, NC: Algonquin Books.

Malone, K. (2007). The bubble-wrap generation: Children growing up in walled gardens. *Environmental Education Research, 13*(4), 513–527.

McComas, W. F. (2002). The ideal environmental science curriculum: I. History, rationales, misconceptions, and standards. *The American Biology Teacher, 64*(9), 665–672.

McComas, W. F. (2008). Back to the future? Reconsidering the role of 19th century nature-study in 21st century science teaching. *The Science Teacher, 75*(2), 24–28.

Merriam, S. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass Publishers.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Thousand Oaks, CA: Sage Publications.

Miller, R. G. (2006). Unlocking reading comprehension with key science inquiry skills. *Science Scope, 30*(1), 30–33.

National Research Council (NRC). (1996). *National science education standards*. Washington, DC: National Academies Press.

National Research Council (NRC). (2000). *How people learn: Brain, mind, experience, and school*. Washington, DC: National Academies Press.

National Research Council (NRC). (2007). *Taking science to school: Learning and teaching science in grades K–8*. Washington, DC: National Academies Press.

National Research Council (NRC). (2010). *Surrounded by science: Learning science in informal environments*. Washington, DC: National Academies Press.

Padilla, M. J., Muth, K. D., & Padilla, R. K. (1991). Science and reading: Many process skills in common? In C. M. Santa & D. E. Alvermann (Eds.), *Science learning: Processes and applications* (pp. 14–19). Newark, DE: International Reading Association.

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research, 62*, 307–332.

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Sobel, D. (1997). Sense of place education for the elementary years. *Proceedings of the 1997 Forum* (pp. 32–39). (ERIC Document Reproduction Service No. ED 421 312).

Thomson, S. (2007). Do's and don'ts: Children's experiences of the primary school playground. *Environmental Education Research, 13*(4), 487–500.

Upadhyay, B., & DeFranco, C. (2008). Elementary students' retention of environmental science knowledge: Connected science instruction versus direct instruction. *Journal of Elementary Science Education, 20*(2), 23–37.

Villa, R. A., Thousand, J. S., & Nevin, A. I. (2004). *A guide to co-teaching: Practical tips for facilitating student learning*. Thousand Oaks, CA: Corwin Press.

Wigfield, A., Guthrie, J., Perencevich, K., Taboada, A., Klauda, S., McRae, A., et al. (2008). Role of reading engagement in mediating effects of reading comprehension instruction on reading outcomes. *Psychology in the Schools, 45*(5), 432–445.