SCIENCE AND MATHEMATICS EDUCATION:

INTERNATIONAL INNOVATIONS, RESEARCH, AND PRACTICES

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3.3 PLACE-BASED ENVIRONMENTAL EDUCATION RECONSIDERED: CHALLENGES FOR K-16 EDUCATORS

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... because humanity is a biological species living in a biological environment... because, like all species, we are exquisitely adapted in everything from our behavior, to our genetics, to our physiology, to that particular environment in which we live. The Earth is our home. The rest of life is a critical part of that home. Unless we preserve the rest of life as a sacred duty, we will be endangering ourselves by destroying our home in which we evolved and on which we completely depend. (American University Radio, 2010)

The above quote is how Pulitzer Prize winning ecologist Dr. E. O. Wilson responded, when asked on public radio, how, if given only 45 seconds, he would explain the importance of preserving Earth’s biodiversity and understanding humankind’s impact on the environment. His response captures well the motivating factor behind many environmental educators. The interrelatedness of living organisms within a biological system is an important concept for students of environmental education (indeed, all citizens) to understand. Environmental educators are continually challenged to find ways of making this message clear. Yet it is difficult to foster environmental concern among people who have limited exposure to nature. In today’s modernized world of video games, supermarkets, computers, televisions, and handheld electronic devices, many Americans have very little exposure to the natural environment in which they live. Louv (2005) described today’s youth as having an awareness of the global threats to the environment, but having limited physical contact or intimacy with the very nature under threat. He juxtaposes this condition against the typical environmental awareness of children 50 years ago.

As a boy, I was unaware that my woods were ecologically connected with any other forests. Nobody in the 1950s talked about acid rain or holes in the ozone layer or global warming. But I knew my woods and my fields; I knew every bend in the creek and dip in the beaten dirt paths. I wandered those woods even in my dreams. A kid today can likely tell you about the Amazon rain forest – but not about the last time he or she explored the woods in solitude, or lay in a field listening to the wind and watching the clouds move. (Louv, pp. 1-2)

The question becomes: How do we instill a sense of connection to nature among students who rarely experience it themselves? Since the early 1990s, I have witnessed, experienced, and employed different teaching strategies in the attempt to affect this connection among students. One strategy involved physically moving the instruction to outdoor settings so that the students could intimately experience nature. Although by far the most effective way I have found to connect students to their environment and help them develop an appreciation for biodiversity, there are many reasons teachers are unable to employ this strategy (Bloom, Holden, Sawey, & Weinburgh, 2010). I have attempted to help students develop a concern for nature by requiring them to report to the class
about current environmental events found in the news and was left with the impression that the students found this less than stimulating. Showing films that demonstrated the aspects of nature which I find most remarkable, oftentimes only provided a dark environment conducive to napping. Most recently, I taught a non-majors class with a curriculum that emphasized global issues featured in mainstream news magazines. These issues included climate change, acid rain, ozone loss, mercury toxicity, pesticide bioaccumulation, impending drought conditions, nuclear meltdown, and emerging diseases—all issues which exemplify human impact on the environment and of importance to every individual in my class. This approach, although successful at connecting the science content to the students’ real lives, had a downside. Many students complained of the constant barrage of bad news of impending doom and demonstrated signs of ecophobia (Bloom & Holden, 2011). Ecophobia is a condition in which news of environmental catastrophes fosters the development of a fear which can prevent individuals from feeling capable of affecting change in the circumstances (Sobel, 2007).

Despite the challenges I have faced, I continue to look for new strategies to help accomplish the goal of quality environmental education for my students. In each class I teach, I strive to instill in my students the understanding that they can take their own individual actions to offset humankind’s impact on the environment (Bloom & Holden, 2011). I maintain that before a student can face large-scale environmental problems, they must first develop a sense of agency. The challenge for the environmental educator is to guide the student to the development of this sense of agency. Recently, a new pedagogy, place-based education, has emerged which emphasizes teaching and learning that is contextualized within the students’ local environment. Although place-based education is not designed for any specific subject, environmental educators are promoting this teaching strategy as a way to help students develop the deep understanding of their own local environment and, in the process, develop the sense of agency needed to achieve effective environmental education. This chapter describes one attempt at using a place-based approach to teaching environmental issues such as water systems and exposes concerns that environmental educators should consider when using this approach.

**Place-Based Education**

Place-based education may be described as

... learning that is rooted in what is local—the unique history, environment, culture, economy, literature, and art of a particular place. The community provides the context for learning, student work focuses on community needs and interests, and community members serve as resources and partners in every aspect of teaching and learning. (Rural School and Community Trust, 2004, p. 4)

Sobel (2004) describes place-based education and its value as

... the process of using the local community and environment as a starting point to teach concepts in language arts, mathematics, social studies, science, and other subjects across the curriculum. Emphasizing hands-on, real-world learning experiences, this approach to education increases academic achievement, helps
students develop stronger ties to their community, enhances students’ appreciation for the natural world, and creates a heightened commitment to serving as active, contributing citizens. (p. 7)

Sobel (2010) maintains that using place-based education as the beginning point of instruction will encourage students to master understanding of what is already familiar to them. After they understand the familiar, they may then extend their knowledge base to things which are more abstract or distant.

**Setting**

During the summer of 2009, I was part of a team which used a place-based approach during a professional development (PD) for K-12 science teachers. The objectives of the PD were to (a) increase the teachers’ content knowledge about environmental systems and (b) increase their pedagogical skill in environmental education. In designing the curriculum for the PD, we chose to focus on water systems and to use a place-based approach. We hoped that by teaching about local water systems, the teachers might begin asking, and seek answers to, questions about global water issues. We believed that this would model how they ought to teach environmental systems in their own classrooms.

**Experiences for the Teachers**

The PD consisted of a 2-week summer academy in late July, and subsequent monthly Saturday meetings throughout the 2009-2010 academic year. It was primarily conducted on the campus of a small, private university in North Texas but also included numerous off-campus trips to more remote water systems. Our instruction included much outdoor, hands-on interaction with local water bodies where the teachers collected biotic and abiotic data using environmental equipment we provided. We hoped that this inquiry-based methodology, paired with place-based strategies, would result in lasting and meaningful learning about the teachers’ local environmental water systems. We initially explored local water bodies and then, as we progressed through the PD, extended our range to more distant water bodies that were interconnected to the Trinity River watershed, which supplies water to the region in which these teachers live.

Each outdoor experience emphasized one or more important aspects of place-based education. These aspects included: grounding the instruction in local issues, demonstrating how the content is personally relevant to the learners, presenting the content as a narrative/story, establishing an urgency/need-to-know feeling in the learners, and guiding the learners to a sense of agency for dealing with the large-scale environmental issues. With each experience, we observed varying degrees of success at motivating the teacher participants to become engaged in the content material and were challenged to carefully examine the efficacy of our curriculum and the effectiveness of place-based education in teaching environmental issues.
Starting Local

Orr (1994) emphasizes the need for environmental education to begin by focusing on what is local before extending the knowledge to unfamiliar places.

A world that takes its environment seriously must come to terms with the root of its problem, beginning with the place called home. This is not a simple-minded return to a mythical past but a patient and disciplined effort to learn, and in some ways, to relearn the arts of inhabitation. These will differ from place to place, reflecting various cultures, values, and ecologies. They will, however, share a common sense of rootedness in a particular locality. (Orr, p. 170)

Following Orr’s (1994) recommendation, the first water body we visited was located on the campus of the university where the PD was conducted. Teachers were asked to explore one portion of a creek that ran through the campus and to develop questions that they would like to have answered about the water system. We intended to provide the resources and time throughout the 2 weeks to allow them to answer their questions. This was the first outdoor experience of the PD and the teachers responded with enthusiasm. They rolled up their pant legs, waded into the water, squealed with excitement as they slipped on the muddy banks, collected specimens—both plant and animal—and used equipment we provided to collect data about the creek. We asked them to document many of the creek’s physical and chemical characteristics (i.e., pH, temperature, flow rate, nitrate/nitrite/ammonia levels, and dissolved oxygen) and to collect and/or document biotic components of the creek. We hoped that over the span of the PD they could collect similar data at multiple water bodies and through these experiences, the teachers would begin to identify patterns and relationships between the biotic and abiotic factors consistent across all water systems. Despite their enthusiasm while on-site, upon return to the classroom, we found that none had developed research questions about the creek which we could use our data to help answer. The teachers were satisfied with their experiences and felt that they knew all they needed about the campus creek. We hoped that with further experiences at other water bodies connected to the creek, their intellectual engagement would increase to match their physical engagement. But I wondered, was the creek too familiar to them to stimulate any further questions? Or maybe, because the creek wasn’t on their campus and they lacked a personal connection to it, they had no reason to want to know more. Maybe we needed to find a water body that represented their water.

Making It Personal

Melaville, Berg, and Blank (2006) emphasize the importance of guiding students to an understanding of local issues and helping them to acquire the skills to act upon issues that concern their own community. In an attempt to get them involved in understanding their own water system, and hopefully, in time, to recognize the connection between their water and the campus creek, we began asking questions about the local municipal water system such as, Where does your tap water come from? What happens to the water that drains from your toilets and bathtubs? While some were able
to identify that the water’s source was the Trinity River, none were able to trace the pathway of the water from the river to the sink in our classroom. Most knew that toilet and tub water was sent to a wastewater treatment plant, but had little knowledge of what happened to it once it arrived there or where it went after being treated. We hoped that once the teachers recognized this content deficiency, they would develop a need to know attitude and would begin asking questions.

We had a representative from the area water treatment plant come and tell the story of how the river water ended up flowing from our taps. His description included many details about the many processes the water must be put through in order to be safe for human consumption. The teachers were highly engaged in the lecture and asked many questions. Later, we took a trip to the local wastewater treatment plant and were provided a guided tour through the facility. Again, the teachers asked many questions, took copious notes, and photographed and videotaped almost all portions of the plant. Now the teachers had been presented with the cycle of their own municipal water—from the local river, to the water treatment plant, to their tap, down their drain (perhaps after moving through their own body), to the wastewater treatment plant, and back to the river where it could, once again, be taken up to the water treatment plant to be pumped back out to residential taps. We hoped that by recognizing this interrelationship between water in so many different locations, the teachers might begin widening their referential to more distant water sources and begin recognizing how, they too, are interconnected to a much larger global water cycle. However, when asked, the teachers only reacted as if they had learned more than they knew, but did not provide any questions that indicated they felt the need to know more. I was beginning to feel as if our attempt at place-based environmental education was not going to be successful.

**Telling a Story/Providing Some History**

Egan (1997) recommends designing educational curriculum that supports and develops the “rich imagistic and emotional mental activity” (p. 62) of learners and describes storytelling as an appropriate model to accomplish this goal. To this end, at the next sampling site, the teachers were provided some historical context behind how the municipal water supply system was developed in their water district. The site we visited was Benbrook Lake which is located on the Eastern fork of the Trinity River. This fork, north of the city, is one of four forks which converge to form the Trinity River proper. This lake is a reservoir which provides water to the City of Fort Worth during drought conditions. A representative from the Corps of Engineers discussed how the dam operated and provided statistics on how often water had to be released to keep up with City of Fort Worth demands and told stories of past emergency water conditions when water levels of the lake dropped dramatically. The most evocative story told, however, described why Benbrook Lake—actually a reservoir—was built. The teachers were told about how, in 1949, heavy flood rains fell on the Clear Fork’s watershed. Over the span of 9 hours, 11 inches of water fell leaving much of the city underwater. Archived photos (available at [http://www.fortwortharchitecture.com/oldftw/oldftw.htm#disaster](http://www.fortwortharchitecture.com/oldftw/oldftw.htm#disaster)) depict major architectural landmarks, such as the historic Montgomery Ward building, under more than 20 feet of water and nearby homes almost completely submerged. One particularly striking image shows a horse standing on the barely visible roof of a home.
hidden beneath the flood waters. The flood resulted in millions of dollars of damage and the loss of 10 lives. As a result, the Corps of Engineers chose to undertake two major construction projects to prevent further flooding. The Trinity River was channeled to help control its flow rate and the Benbrook Lake dam was later built. To this day, Benbrook Lake is useful in containing flood waters delivered by heavy rains and its dam is opened or closed to control the rate of water flowing down the Clear Fork of the Trinity River.

The teachers, familiar with the landmarks, streets, and buildings described in the story, listened in rapt attention. It was clear that the tall-tale sound of this very real, historical story was engaging to the learners. By engaging the teachers with such dramatic stories, they were eager to learn about the Trinity River watershed, the various tributaries of the river, the effect of urban development on the capacity of the watershed, and the reasoning behind the development of reservoirs such as Benbrook Lake.

Creating Urgency and Agency

Bloom and Holden (2011) emphasize that when teaching about environmental issues, it is important to both establish a sense of urgency about the environmental problems as well as foster a sense of agency in the students so they will be better able to face them. To help the teachers fully appreciate the importance of understanding our local water systems, we took them to several sampling locations that clearly represented the impact of human behavior on the aquatic environments upon which we depend for drinking water. Leaper Lake is a shallow, constructed lake which is bisected by a narrow land bridge used as a roadway. The water body is habitat to numerous migratory birds and is lush with aquatic vegetation. One half of the lake receives runoff from a nearby golf course while the other does not. With only a visual observation, the impact can be noticed. The color of the water on either side of the land bridge indicates high algae growth on the side receiving golf course runoff. A local environmental educator told us more about how the lake has been impacted since the construction of the golf course and nearby casino. Furthermore, the teachers were able to visit the underground springs which feed the lakes and were told of how the increased water consumption, used by the golf course and the casino, had significantly reduced their flow rate. Later discussion revealed that the teachers were beginning to appreciate the importance of understanding human behavior on water systems. To provide them a more optimistic perspective and to help them develop a sense of agency, we took them to another sampling site, this time a couple of hours south of the city. We wanted them to witness an example of how environmental remediation could result in positive environmental impact. The Lake Waco Wetlands (www.LakeWacoWetlands.com) extend over 180 acres and were constructed in 2001 by a partnership between the City of Waco, Texas; the U.S. Army Corps of Engineers; and Baylor University. The wetlands, located about 90 miles south of Fort Worth, are home to numerous species of aquatic wildlife and have developed into an active research and education site. The wetlands were built as a mitigation project to offset habitat loss from the 2000 decision to raise the level of Lake Waco by 7 feet. The lake level was raised to compensate for the urban development in the area and the resulting increased water demands of the growing population. This site visit, including in-depth lectures and a guided tour, provided the teachers clear descriptions of how lakes
and reservoirs are used in urban areas and how water consumption by citizens can directly result in environmental impact and habitat loss. This experience provided teachers both a sense of responsibility (i.e., my actions have an effect) and a sense of agency (i.e., my actions can have a positive impact).

Despite the variable successes of each of these approaches at the various sampling sites, we were not satisfied that the teachers were demonstrating the desired interest in global water issues—the goal of the PD. In other words, we sensed that each attempt was successful at getting the teachers superficially engaged in the content, but lasting interest was never achieved. It was as if the teachers would drink in new knowledge when it was provided to them in an interesting way, but they were not developing a thirst for deeper understanding. With the 2-week summer portion of the PD almost completed, we wanted to end with an example of how to bring this content into the classroom so as to foster a long-term inquiry into the underlying concepts of water systems. We chose to create a native-Texas aquarium in our classroom to achieve this goal.

**Bringing It All Into the Classroom**

Having always been a believer that living materials can infuse a science classroom with engaging examples in ways that photos and textual descriptions cannot, I had previously installed a 75-gallon aquarium in the science teaching classroom of our building. The tank was home to a variety of freshwater, tropical fish with the most notable being a 9-inch clown knife fish (*Chitala ornate*) with large black eye-spots on his silver feather-shaped body, a 6-inch African featherfin catfish (*Synodontis eupterus*) who sported black polka dots and long lacy fins; several 8-10 inch long, pencil-thin carnivores known as needle fish (*Xenentodon cancila*) with mouths extending approximately 20% the length of their bodies; and two brilliant orange 5-7 inch Blood Parrot Cichlids (*Cichlasoma citrinellum* x *Cichlasoma synspilum*). Despite the popularity of the tank among the faculty and students of the university, we chose to convert the tank into a native Texas tank by stocking it with fish and vegetation from the sampling sites that we visited. Before stocking the tank, the resident fish were removed and the tank was tested to see how closely the water conditions matched those of the water bodies we had sampled. Once we had manipulated the tank conditions sufficiently to satisfy the teachers that collected specimen would survive in the tank, we began looking for new inhabitants. Plants were collected from the university creek, fish from the Lake Waco Wetlands, and invertebrates from Leaper Lake. The fish included several small sunfishes (*Lepomis sp.*), less than 3 inches long, a mosquito fish (*Gambusia sp.*), a small minnow (*Pimephales sp.*), and a 2½ inch blue catfish (*Ictalurus sp.*). Macroinvertebrates were also represented in the tank by a few aquatic snails, a diving water bug, and a few aquatic beetles. The end result was, indeed, a miniature model of a Texas lake. The teachers were anxious to see how the new inhabitants would fare and even posed questions to be answered over the course of the academic year follow-up sessions such as, Would the fish survive and grow? If so, how fast and how large? Would they cohabitate or would some prey upon others? Would the plants have sufficient sunlight to survive in the tank? How many snails would there be in 6 months? These were all good questions and we felt, perhaps, we had begun to foster the thirst for knowledge we had hoped for.
As the follow-up Saturday sessions took place, however, their interest in the tank dropped. In fact, as the plant life began to bloom and algae began to coat the rocks and wood of the tank, the teachers began to find the tank less-than-interesting. More dramatic, was the distaste observed among the university faculty and students. Where they once sat and watched exotic fish swim or, if lucky, feast on hapless goldfish, they now saw only a dirty, algae-ridden tank containing nothing of interest. Nobody observed the filamentous algae as it gradually extended over almost all the smooth surfaces of the tank. None appreciated the tiny hydrozoans which could only be seen if you stared at the glass with the patience of an aquatic biologist. Nor did they notice the accumulation of oxygen in the web of plant material or question from where it came. Strangely, more visible and diverse biological activity was occurring in the tank than ever before, yet to most it appeared to be a neglected tank ready only to be drained and made right again.

Discussion

When I try to reflect upon my past and how my interest in biology was cultivated, I remember stories of adventure in the jungles of faraway places. Stories such as these are recounted in books such as Strange Animals I Have Known (Ditmars, 1931), a book I found when looking to my bookshelves for revelation of my own inspiration. Ditmars’ description of fish in the East Indies who climb in trees (p. 35) and Moroccan snake charmers (p. 130) ignited an interest in me when I read them as a child. That interest persisted throughout my schooling and continues today. I remember watching the popular television series Ripley’s Believe It or Not! and being exposed to the hairiest human, the longest finger nails, the tallest and shortest people on Earth—accounts which first introduced me to human physiology and genetic abnormalities. These unusual cases of human extremes were later explained in high school and college courses as I learned about heritable traits, genetic diseases, and pathophysiology. I recently found a reissue of Ripley’s (2004) original 1929 print volume and confirmed such contents as “The Boy Who Died of Old Age Before He Was 7 Years Old” (p. 15); strange motherhood including “The Nine-Year-Old Mother” (p. 61), “The Ninety-Year-Old Mother” (p. 63), and “The Mother of 69 Children” (p. 66); “The Fish That Climb Trees” (p. 89); “The Half Woman” (p. 98); and “The Hen That Became A Rooster” (p. 149). While all of these have valid scientific explanations—progeria, precocious puberty, delayed menopause, extreme fertility, lung-breathing fish, mutagenic drugs, and sequential hermaphroditism—they also represent nature in its most extreme or unusual, not at all local or familiar. I, and many other young budding scientists in the past, delighted in these stories of the strange and bizarre. Wilson (1984) describes this interest well.

From infancy we concentrate happily on ourselves and other organisms. We learn to distinguish life from the inanimate and move toward it like moths to a porch light. Novelty and diversity are particularly esteemed; the mere mention of the word extraterrestrial evokes reveries about still unexplored life, displacing the old and once potent exotic that drew earlier generations to remote islands and jungled interiors. (Wilson, p. 1)
This idea of exciting the learner in the exotic and unfamiliar brings forth important questions to consider about using a place-based approach with environmental education. How did my love of the exotic which inspired me as a young boy transform into an appreciation for what I observe in my own local environment which sustains my interest today? How could I view the native tank we created as filled with interesting life while others found it an eyesore? How do we keep place-based content engaging and exciting when it is as familiar as one’s own backyard?

Bridging the Gap Between Love-of-Exotic and Love-of-Local

My child-like interest in all things exotic and strange has not been left behind. Rather, I have found that my interest was sparked by my exposure to strange and unfamiliar phenomena, and then, later in life, found that what I learned about those phenomena was applicable and useful in understanding phenomena that were familiar and ordinary as well. In a way this allowed me to see the exotic-ness of what was local. My interest in childhood tales of Cyclops (chromosomal disorder), werewolves (hirsutism), and vampirism (porphyria) led me to an elementary understanding of genetics which was the scaffold on which I hung new knowledge gained in formal genetics courses when learning about much more mundane genetic traits such as widow’s peak hairlines, blue or brown eyes, and attached ear lobes. Were it not for my initial understanding, fueled by my childhood readings, I might have become bored with Punnett squares and probabilities when solving problems such as how likely a breeding cross would produce smooth-coated guinea pigs or wild-type fruit flies.

More importantly, however, is that I have acquired the skill of recognizing the wonderful among what a casual observer would deem ordinary. This is a skill that environmental educators must help foster in their students. Without this ability, how can a common snail darter be seen as such an important member of a community that their protection is deemed necessary even at the expense of electrical power plant construction? How can a common spotted owl be seen as more important than a logging company and all the jobs it creates? How can the promise of vast amounts of oil and natural gas be valued less than the health of coastal wetlands, pelicans, fish, and other ocean life and the ways of life that have been supported by them for generations?

We cannot make the faulty assumption that because content is grounded in the place in which a learner lives that s/he will become engaged in learning. Instead, we must realize that because the content is embedded in the learner’s place, it may more easily be viewed as boring and mundane—the same-old, same-old syndrome. To this end, we must ensure that we keep the place-based content engaging and exciting through historical context, story-telling, creating urgency and agency, and by making the familiar strange.

Making the Familiar Strange

The qualitative difference between traditional textbook science and the science content of Ripley’s Believe It or Not! and the Guinness Book of Records is that the latter type of content has what Egan (1997) describes as a romantic nature. He goes on to describe this content as mega-ergon, the telling of the “...great and marvelous things that have been done...” (p. 83). He tells us that this content is so much more engaging for a
young learner because "...such facts are more romantic: they tell about the wonders of the world, the most extreme experiences, the limits of reality, the greatest achievements, the most exotic forms of life, the most amazing events" (p. 84). von Hardenberg (1772-1801) precisely described the essence of romanticism as making the familiar strange and the strange familiar (Chandler, 2002). This powerful phrase is an important tool for environmental educators, especially those who strive to ground their instruction with a place-based approach. As I think back on how I was taught about my environment throughout my life, I find many examples of how effective environmental educators engaged me in learning about local flora and fauna using just this trick.

I recall a tour of a nature center when I was in grade school and vividly remember the guide plucking flower petals off of yucca plants growing along the trail and quickly popping them into her mouth and eating them. This was the first time I made the connection that eating flower petals was not altogether different from eating the leaves of a lettuce plant. My concept of flowers changed that day and I remember it still today.

I remember a college-level entomology class when the professor told us the story about how the all-too-familiar tree cricket possessed a remarkable ability. If one was to count the number of chirps made by the cricket in 7 seconds and then add 46 to this number, one would have calculated the temperature in degrees Fahrenheit.

Only recently was I introduced to the remarkable hidden secrets of the Cochineal (Dactylopius coccus), a common scale insect found on many native plants in the region in which I have lived my entire life. These tiny homopterans attach themselves to plants—I most-often see them on prickly pear cactus—and appear as white, fuzzy clusters on the green leaves of the plant. For decades I have ignored these familiar and mundane creatures as nothing more than ordinary until I had the privilege of learning from an environmental educator with a very strong sense of place. He paused and collected a small sample of cochineal from a cactus blade and allowed the class a look. Then, with the swiftness of a magician, he smeared the poor creatures across his palm revealing their hidden nature; scarlet red covered his hand! The insects are laced with carminic acid to deter predation; this same carmine acid has been used for centuries to create dyes for textiles, food coloring, and even cosmetics.

Each of these examples demonstrates how a knowledgeable environmental educator can take even the most mundane and common local phenomena and make them romantic, exciting, and engaging to a young (or old) learner. This skill, however, requires a deep knowledge of one’s content and one’s place. Too often, teachers are presented a strategy for teaching in a way that leaves them thinking it is the only way to teach and that all it requires is following a simple formula. However, we must remember that to be successful in this profession we call teaching, we must possess strong teaching skills; content knowledge alone, does not prepare a teacher. Teachers must develop pedagogical content knowledge—knowing when to use any of the myriad strategies that are available for teaching—as well as develop a deep understanding of the subject matter. Teachers must form a relationship with their students in order to know how each learns and recognize when learning has been achieved or when more teaching, or different teaching, is needed. Place-based education can be a valuable and effective approach to teaching environmental issues, but it must be used by teachers who have developed the necessary skills to accomplish the learning objectives for individual students with varying degrees
of engagement. My desire is that this chapter will prove informative to those who attempt to use a place-based approach for environmental instruction.

References


