Teachers Connecting Urban Students to Their Environment*

Sherri L. Brown, Nikki L. Votaw, and Thomas R. Tretter

"Why do environmentalists ignore a third of the U.S. population?" Oladipo, a local environmentalist, asked in an *Orion* article titled *Global Warming is Colorblind.* In her 2 years of volunteering and working at an urban nature preserve, Oladipo had "never seen another face like [hers] come through our doors. At least, I've not seen another black woman come for a morning hike or native-wildlife program" (Oladipo 2007, p. 11). She elaborated on her observations by stating

> nobody benefits from the perception that enjoying and caring for the environment is an exclusively white lifestyle. The truth is that brown, yellow, red, and black people like to go backpacking, too. Those of us with the means are buying organic, local, and hybrid. If environmentalism continues to appear mostly white and well-off, it will continue to be mostly white and well-off, even as racial and economic demographics change. The environmental movement will continue to overlook the nuances, found in diversity of experience, that reveal multiple facets of environmental problems - and their solutions. (p. 11)

As a science education community preparing science teachers, we must ask ourselves if we are meeting the needs of preservice and inservice science teachers in presenting experiences that provide a foundation to teach all learners. And if not, what are we doing to address this deficit? It has been widely reported from science achievement scores on national and state standardized exams that minority students perform lower than white students. The 2005 National Report Card showed that minority students had lower scores than their white counterparts at all grade levels, despite the fact that at fourth and eighth grades the gap had lessened slightly since 1995 (National Assessment of Educational Programs [NAEP] 2005). Not only do minority students have lower scores on standardized tests, but they also tend to lose interest in science and develop negative attitudes toward science through middle school (e.g., Atwater et al. 1995; Hill et al. 1995). One reason for this may be that

S.L. Brown (✉) and T.R. Tretter
University of Louisville, College of Education and Human Development, 2301 S. Third Street, KY 40292, Louisville, USA
e-mail: s.brown@louisville.edu

N.L. Votaw
Johnson Bible College, Teacher Education, 7900 Johnson Drive, Knoxville, TN 37998, USA
e-mail: nvotaw@jbc.edu

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the urban school environment often tends to have few resources, large enrollments, little equipment, and less experienced teachers. Because urban schools often tend to have larger percentages of minority students than nonurban schools, the potential disconnect of urban students with science would disproportionately impact minority students. For the purposes of this chapter, references to urban students imply a relatively large percentage of nonwhite students included in this population.

To impact urban students' attitudes and understandings of science, school science needs to connect to the real world. Educators must emphasize the relevance of science to the lives of all students, not just the white-middle class experiences that are typical to school science (Atwater 1996). This requires that science teachers be informed about processes of "knowing, doing, and communicating science that are not mirrored in traditional school science" (Barton 1998, p. 528). Research in the field of science education suggests three underlying ideas that need to be considered when encouraging students to connect science to their own lives. First, students must be exposed to culturally relevant teaching; hence, school science should value the ways of knowing that are reflective of the students (Atwater 1996). Second, science must be a social practice (O'Neill and Barton 2005). Learning takes place in a social environment and the content learned cannot be separated from the context in which it was learned (Rahm 2001). Third, students must have ownership over their learning (O'Neill and Barton 2005).

Thus, the purpose of designing the graduate course, *Science Beyond the Classroom (SBC)*, was to provide preservice and inservice K-12 science teachers content and pedagogical experiences with multiple authentic opportunities that engage high achieving, low socioeconomic status (SES), urban students in connecting science to their community. The science teachers and urban students learn concurrently about scientific concepts that are applied in nonschool settings from actual visits to community sites (e.g., sewage treatment plant, water treatment facility, forest and arboretum, power plant, etc.). The course outcomes provide evidence for supporting the collective interaction of all of these groups (e.g., urban students, teachers, and site visit guides) to create a positive sociocultural context of this course. This chapter summarizes the relevant literature and theoretical framework underlying the course, the implementation and expectations of the course, and the content and pedagogical outcomes from the teachers who participated in the course. Readers interested in student outcomes should see Votaw (2008) or Brown, Votaw, and Tretter (2009).

Relevant Literature

Although numerous studies have focused on student learning during outdoor and place-based environments, there has been limited research examining the impact of site visits on teachers' content knowledge and pedagogical practices. Limited research exists in spite of the fact that there are over 180,000 teachers nationwide who participate in professional development events provided by informal science education institutions each year (Association of Science-Technology Centers 1996). This number of participating teachers suggests that teachers find these experiences valuable. The National Science Teachers Association (1998) highlighted the importance of informal science institutions in a position statement on informal science education where they stated that "informal science learning experiences offer teachers a powerful means to enhance both professional and personal development in science content knowledge and accessibility to unique resources" (p. 17). Research on teachers' experiences from informal learning environments involving professional development workshops or programs are discussed within three domains: content and pedagogy, confidence and enjoyment, and creating learning opportunities.

Content and Pedagogy

Although the research to support these claims is limited, there are several studies which suggest that informal learning environments positively affect teacher content knowledge and pedagogical skills (Boykie 1986; Melber and Cox-Peterson 2005; Neathery et al. 1998). After using Star Lab™ and participating in hands-on experiences, teachers displayed an increased understanding of basic astronomy principles (Boykie 1986). After a museum workshop, teachers stated that the "hands-on activities and interactions with museum artifacts and specimens" were the most valuable components of the workshop and they were able to apply the content and instructional strategies into their science lessons (Melber and Cox-Peterson 2005, p. 111). Following a professional development at either a science center, wildlife refuge, or zoo, teachers said they had greatly enhanced their content knowledge and understanding (Neathery et al. 1998).

Confidence and Enjoyment

Informal learning experiences develop enjoyment and increased confidence in teaching science as well as content and pedagogical benefits (Kyle et al. 1990; Seidman 1989; Sukow 1990). After a museum-based inservice program, teachers reported feeling less anxious and had increased confidence and competence about teaching science (Seidman). Reporting similar findings with teachers who participated in physical science workshops in a science museum, Sukow found that teachers had an increased confidence in understanding science and in using inquiry-based science instruction. In addition to confidence in teaching science, Kyle et al. found that teachers in their informal learning program now thought of science as fun and interesting, and they displayed an excitement for teaching science.

Creating Learning Opportunities

In providing teachers experiences to increase their science content knowledge, pedagogy, confidence, and enjoyment, Freeman et al. (2004) also noted necessary factors for creating effective learning opportunities for teachers. First, teachers must be engaged in hands-on experiences similar to what they will be providing for their students. Second, the learning opportunity must provide teachers opportunities to work with experts in the field. Third, teachers must have leadership opportunities. Lastly, the learning opportunity must provide teachers practical applications and then create occasions for follow-up discussions of these applications in the K-12 school setting. Informal learning institutions are ideal learning environments to offer all of these experiences to teachers. Grinell (1988) summarized that science museums are well positioned to address the needs of teachers as museums have the resources, skilled staff, and knowledge that would benefit teachers and schools, in turn benefiting the students.

Summary

Despite the recognition that informal learning institutions are providing professional development resources for teachers, a review of the relevant research literature points to few studies that have been conducted to determine the impact of site visits on teaching content knowledge and pedagogical methods. The *SBC* course is unique in that it allows teachers to experience six site visits in a 10-day time span, and does so with course participants in the role of teacher to middle school students, closely simulating their professional responsibilities in the classroom rather than situating them exclusively in the role of a learner. Rather than repeated experiences with the same site as recommended by Falk (1983), this multiple-site structure offers opportunities for the teacher to have myriad experiences that may have a cumulative effect as recommended in the NARST policy statement of the Informal Science Education Committee (Dierking et al. 2003).

Theoretical Framework

The underlying theoretical basis for the *SBC* course aligns with the Informal Science Education Ad Hoc Committee's policy statement (Dierking et al. 2003) that states

> learning rarely if ever occurs and develops from a single experience. Rather, learning in general and science learning in particular, is cumulative, emerging over time through myriad human experiences. … The experiences children and adults have in various situations dynamically interact to influence the ways individuals construct scientific knowledge, attitudes, behaviors, and understanding. (p. 109)

Within the *SBC* course experience, environmental education (EE) content learning occurred within a community of practice (Lave and Wenger 1991) among teachers, urban middle school students, course instructors, and experts in the field. This community's shared domain of interest included the observing and learning of science practices within authentic contexts (i.e. site visits to nearby community venues). All community members engaged in similar experiences, which required relationships in which they learned from one another. These shared experiences and use of tools included the tour of facilities, reflections on experiences, completion of supplemental learning activities, and components of the digital narrative (e.g., taking pictures, interviewing experts, etc.). All members of this community of practice were involved in some aspect of the shared experiences and use of tools.

Camp and Course Background

The *SBC* course provides teaching and learning experiences for preservice and inservice science teachers and urban youth concurrently during a *Hands-on, Minds-on Summer Science Camp* experience.

Hands-On, Minds-On Summer Science Camp

Conducted each summer since 2006, the *Hands-on, Minds-on Summer Science Camp* has received funding support for camp participants' recruitment, travel, food, tickets, cameras, and instructional supplies from General Electric and E.ON U.S. Foundations. Recruiting for the camp participants was done in collaboration with the Lincoln Foundation (n.d.), which is a "premier nontraditional educational programs provider for disadvantaged youth" (p. 1). The camp participants are Lincoln Foundation's "Whitney M. YOUNG (Youth Organized to Understand New Goals) Scholars (WYS) program members who are academically talented, economically disadvantaged seventh grade students" (Whitney M. Young Scholars, n.d., p. 1). The rationale for recruiting the *WYS* was that those students from low socioeconomic backgrounds often lack opportunities to participate in educational programs outside of school and are often not exposed to scientific careers in the community. These same students also frequently belong to underrepresented groups in science and technological professions.

The 10-day *Camp* focused on site visits to community-based venues where environmental science issues were addressed on a daily basis. The community sites (e.g. local cave system, water treatment facility, sewage treatment facility, zoo, forest and arboretum, and power plant) were purposefully selected because environmental science concepts such as conservation and recycling were routinely practiced. For example, during the visit to the power plant, participants learned about the plant's conservational efforts: (a) scrubbers were used in the stacks to remove sulfur dioxide gases; (b) fly ash was a by-product recycled for use in gypsum board and concrete; and (c) water from the cooling towers was tested daily before returning to the river to avoid thermal or chemical pollution to the river. The participants later observed the use of the fly ash product at the forest and arboretum visitor center (the first LEED™ Platinum building in the state); the visitor center's concrete floor was constructed from recycled fly ash.

The selected sites were also very applicable and relevant to the lives of the urban students as personal daily consumers of electricity, water, and natural resources. Participants examined their personal conversational efforts at each site, such as preserving electricity by turning off the lights, preserving water by using less (i.e., taking shorter showers, turning off water while brushing teeth), and reducing amount of waste water (i.e., urban runoff from car washing, lawn care). From each site visit, the participants were able to weave the conservation content together. For example, the conservation of water was addressed through multiple examples during the site visits. The participants designed a town based on limited water supply at the water treatment plant and interacted with a city model to show runoff activity to storm drains at the waste treatment facility. In addition, they toured the visitor center at the forest and arboretum to learn about specific building constructions that allow for reuse of rain water for toilet flushing and parking lot purification methods that funnel run-off water through a peat-based treatment. All site visits included elements to promote awareness of environmental issues, personal consumption habits, and appreciation of natural settings (e.g., forest and arboretum and cave system).

They also completed activities on the university campus that underscored the environmental science concepts they observed during the site visits (see Table 1). Examples of the camp activities included the design and construction of (a) a filter from various materials (sand, pebbles, cotton, screen, etc.) to "clean" a sample of "dirty" water; (b) a karst model from gypsum board and leaf litter to simulate acid rain (vinegar) effects on limestone rock (gypsum board); and (c) a food web model based on Kentucky animals from the All Wild about Kentucky's Environment (n.d.) to visually demonstrate the interconnectedness of all life. To assess impact of these camp experiences and activities on the student participants' environmental science learning and attitudes, each participant completed a pre- and postcontent assessment and modified environmental attitude survey (Wojtowicz 1995).

A detailed account of the sewage treatment facility visit and previsit supplemental activities is as follows. Prior to the site visit, camp participants completed a homework assignment to investigate the inner-workings of their own bathroom toilet (see Appendix 1; Tretter 2004). The following day, the teachers guided the students in completing a demonstration using "mock toilet" toilet stations, which display the physical science concepts used in flushing toilets (see Fig. 1).

Before arriving at the treatment facility, the camp participants predicted in their notebooks what they thought occurred at a sewage treatment facility and what they expected to see. At the sewage treatment facility, the tour guides provided a brief overview and displayed a short video to explain the inner workings and design of their facility. This particular sewage treatment plant was purposefully selected

Table 1 Description of sites visited and supporting camp activities

Site	Science content	Supporting camp activities
Large cave system	Formation of caves	Karst model
Power plant	Energy transfer Recycling	Building a motor Steam engine demonstration Pollution control (thermal and air)
Water company	Water filtration and conservation	Building a water filter Calculating daily water usage Designing a "mock" town
Zoo	Interdependence of living things Carrying capacity Animal classification Endangered species conservation	Physical food web *Oh Deer*[a] Animal identification
Sewage treatment facility	Cleaning of sewage water	Run-off activity How a toilet works[b]
Local forest and arboretum	Stream restoration Recycling, green building techniques	Discussion of connections to all sites visited

[a] Council for Environmental Education 2002
[b] Tretter 2004

Fig. 1 Camp participants completing activity at "mock toilet" station

because it was architecturally designed to use the natural landscape of the land (i.e. utilizing gravity) and minimally impact the natural landscape. The students were divided into two groups: one group toured the entire facility (see Fig. 2), while the other group completed a waste water runoff activity (see Fig. 3).

Fig. 2 Sewer treatment facility tour

Fig. 3 City model run-off activity

Then, the groups alternated roles so that all experienced each event. After returning to campus, the student participants reflected on their learning by using their notebooks and instructional worksheets about the sewer treatment process. After the students had witnessed the process of cleaning sewage water, they were able to apply EE water conservational efforts to the inner workings of the "mock toilet". They were able to discuss strategies such as purchasing a high-efficiency toilet (HET), installing an adjustable flush flapper valve, or adding an object to the toilet tank (brick, etc.). They were also able to discuss strategies to reduce city wastewater run-off.

During the camp for all site visits and activities, participants documented their experiences using a science notebook, which included pre- and postsite reflections to engage students in synthesizing their understandings. Groups were assigned a particular site to showcase their learning and each student in the group received a disposable camera to document his/her assigned site visit. Under the guidance of their group teacher, each group prepared and presented a digital narrative of a site visit during a culminating event in a public forum to their parents, university faculty, and staff, Lincoln Foundation personnel, and community members. To construct this narrative, camp participants revisited their notebooks to ensure accurate site visit details, wrote a storyboard (i.e. the narration) about their learning, and then selected specific digital photographs to support their narration. They utilized Windows Moviemaker™ software at a university campus computer lab and microphone headsets to construct their digital narratives. This digital narrative process was an authentic learning task for the camp participants because it showcased their learning in a story context rather than a traditional test-type of assessment.

Science Beyond the Classroom (SBC) Course

The *SBC* course addressed multiple course goals by providing the teachers methods (pedagogical strategies) that engaged and connected urban adolescent learners with "real-life" environmental science applications in the community. The course provided teachers the opportunities to address the disconnect adolescent urban students may have between school science and real science. It is common for science teachers to address student queries such as "why am I learning this?" and "when will I ever use this again?" Learning about scientific concepts that are applied in nonschool settings (e.g., power plants, water treatment facilities, etc.) was an important goal.

Specifically, the *SBC* course addressed the following seven major goals: (1) help teachers increase their awareness of environmental science learning opportunities within everyday contexts and learn how to plan and coordinate the use of informal learning centers in teaching K-12 science; (2) nurture positive attitudes of urban students toward environmental science learning by increasing awareness of science in the community; (3) plan student-centered instructional activities/lessons that support science learning for all students regardless of race, gender, socioeconomic status; (4) enhance science instruction with integrated technology; (5) evaluate and reflect on instructional choices, classroom management techniques, and diverse student needs; (6) integrate physical, earth/space, and life science with other academic disciplines; and (7) foster collaborative relationships with colleagues and community resource personnel.

Course population. The target population for the *SBC* course included preservice and inservice science teachers who wanted to experience multiple authentic opportunities that engage high achieving, low socioeconomic status, urban students in connecting science to their community. The 23 "teachers" (5 males; 18 females) who completed the course had various years of teaching experience (0–25), certification levels (six elementary; three high school, six middle school; one special education; two primary/K; five none/preservice) and subject area expertise (e.g., physics, mathematics, biology, anatomy, chemistry, English language learner, environmental).

Course structure and rationale. To address the course goals, the teachers were provided opportunities to enhance their own teaching skills during the community site visits by teaching the camp participants within informal learning contexts. Each teacher worked closely with a small group (four to five) of low-socioeconomic status middle school urban youth (camp participants) for a 10-day *Hands-on, Minds-on Summer Science Camp*. The teachers prepared supplemental activities for site visits, instructed small groups of camp participants during each site visit, guided assessment reflections (i.e. notebook entries) of camp participants, and directed the digital narrative process.

To underscore that the informal learning site visits should not be isolated occurrences but interwoven into the classroom learning context, the *SBC* course instructors encouraged the use of specific pre- and postsite visit supplemental activities during the camp. To collaborate on the design of these supportive activities, the teachers convened on the university campus for 2–3 days prior to the camp. They developed or modified the existing environmental science content-based lessons from Project WILD (Council for Environmental Education 2002), Project Learning Tree (American Forest Foundation 2007), Pure Tap Water Adventures in Water Curriculum (Dearing-Smith 2002), etc. to supplement each site visit (see Table 1). The teachers also constructed a water filter, built a motor, and constructed a digital narrative prior to camp participants' arrival. In doing so, they were able to assist the camp participants in meaningful ways to troubleshoot any problems and address any content misunderstandings.

Although the *SBC* course included multiple applications to "real-world" contexts, it cannot adequately address all the opportunities that may be available to teachers (i.e., science centers, museums, aquariums, laboratories, etc.). Therefore, the ability to continue learning about informal learning contexts and how to connect this real-world application to students' lives was an invaluable goal for the course. To provide teachers the skills and confidence in using informal venues for students' science learning, course instructors introduced them to several site-specific personnel whom they would be able to contact for planning future site visits. Not only did teachers receive personal contact information, but they also received instructional materials for use in their classroom (e.g., recyclable fly ash samples from power plant, curriculum book from water company, etc.). The teachers had direct learning experiences in facilitating site visits to various venues in diverse conditions (outside/inside, hot/cold, rainy/sunny) and they developed a logistical awareness of how to prepare student groups for a site visit. The teachers were highly involved in the daily organization of each camp participant's experience and his/her materials used during site visits; they were actively engaged in all activities at the site visits. Even though the site visits were led by tour guides, the teachers were not peripheral participants because they needed to encourage and facilitate students' questions, model appropriate behavior, model appropriate science notebook use, etc. They monitored group logistical issues (e.g., attendance, participation, restroom visits, arrival, and departure) and students' materials (e.g., clipboards, cameras, science notebooks, water bottles, pens, sunscreen, bug spray, coats, etc.).

To address science teachers' abilities to connect fundamental science principles and concepts to applications in everyday life, the *SBC* course engaged teachers in the teaching and learning of environmental, physical, earth, and life science content knowledge. Prior to, during, and after each site visit, teachers facilitated camp participants in making connections among the science content, community professions, and conservational efforts. The teachers experienced the learning of science content in a variety of ways, which included inquiry-based learning, team planning, team teaching, individual content reflections, large and small group discussions, demonstrations, and the tours during the site visits. These experiences provided multiple approaches to enhance the teachers' own content knowledge as well as their approaches to teaching the content to their future students.

To prepare the teachers in guiding camp participants in using technology to demonstrate science conceptual understanding, the *SBC* course provided teachers a meaningful context to implement the use of disposable and digital cameras, Windows Movie Maker™ software, and various audio files in guiding camp participants to communicate their understandings from their community site visits. Rather than learning *about* technology applications in an abstract context, students and their teacher learned *with technology* by grounding the application in the completion of a culminating student product, a digital narrative.

To determine content knowledge and pedagogical methods gained from the course, the teachers maintained a science notebook throughout the entire course and camp experience in which they wrote about various aspects from each site visit (i.e., pedagogical ideas from tour provider, site visit connections). From their notes, diagrams, and handouts, the teachers wrote specific content and pedagogical reflections regarding their impressions of the camp and the camp participants' learning that occurred. To provide information regarding the use of content and pedagogical knowledge gained from the course in the teachers' classroom, the course instructors interviewed teachers at the end of the upcoming school year (approximately 9 months after the completion of the course).

Impact of Course Experiences on Teachers

The results of reflections and interviews with teachers revealed ways in which this course impacted them in their content knowledge and pedagogical methods. In spite of a substantial time span (9 months after participation) between course experiences and interviews, each teacher remembered his/her experiences and could speak to the impact that those experiences had on him/her. This suggests that the impacts reported from teachers are most likely to be enduring rather than transient.

Cultural Awareness

Samantha became aware of the different background experiences of people of different cultures. She was surprised that

> A lot of kids were scared of the cave, but even when we were walking around [the forest] just in the woods, they acted freaked out. For me, it wasn't that big a deal because I grew up around that stuff.

This awareness helped Samantha learn about "how to work with kids from other cultures and what it is like for them to experience something that is normal for [her], but not for them." Samantha taught at a school with a diverse population of students; however, seeing a diverse group in an environment other than school brought about an awareness of the different experiences that they have outside of school.

Based on her limited experience with middle-grade students, Erica expressed skepticism both in verbal conservations and in reflective writings about what urban kids would enjoy at a forest and arboretum. She stated

> When Dr. Brown told us that a [silent walk] would be a great part of the trip, I was doubtful. How much can these kids get out of walking around silently in the forest? I was proven wrong. I think the students gained much from the experience. Some of them were a bit frustrated with silent communication, but otherwise they participated extraordinarily willingly. They were joyful, relaxed, contemplative, and some actually became withdrawn. I think it was a shock to the system of some students. I think students learned something about themselves and how they can experience things without verbal communication.

Erica expressed dismay that urban students were "extraordinarily willing" and seemingly "joyful, relaxed, contemplative, and withdrawn" while participating in a silent walk in the forest.

Erica's reflection regarding previously held assumptions to what actually occurred allowed her to experience an increased awareness of previously held biases about urban students to surface. Erica's main goal for enrolling in the *SBC* course was to gain experience in working with urban middle school students. Again, similar to Samantha's experience, Erica was able to observe and interact with a diverse group of students in an environment other than school, and in doing so she had an increased awareness of her own personal biases.

Increased Environmental Awareness and Action Implementation

Through the course experiences, several teachers elaborated on how they utilized the newly learned content knowledge in their own classroom or home settings.

After visiting the power plant and observing the steps that were taken to protect the environment (i.e. using by-products to create new materials in gypsum board and concrete), Caroline created an activity in which her own classroom students had to apply that concept to another product. Her students used something that was a "left-over" and applied it in a different way. For example, her elementary students brought various left-over items from home (e.g., metal objects, aluminum cans, etc.), which they decorated and arranged to construct a wind chime. In doing this, Caroline helped her students experience how "leftovers" can be recycled and used to make new things.

Another teacher, Ashley, became more aware of ways that she could conserve energy and water. Her awareness led her to action. She said that she attempted to "use less water and I've gotten energy efficient light bulbs throughout the house. I try to keep the thermostat down or off when I don't need it." Similar to Ashley, Emily said that her family "doesn't buy bottled water and they recycle more." Another teacher stated that she "had no idea how electricity really worked at a power plant and the different things that they had to do to get power to my own house and how to get water to my house." This awareness provided her with background knowledge, which she used in teaching her own children at home. Since her family lives near the power plant, she discussed it with her own children, discussions such as "what the smoke was [that was] coming out of the smoke stacks."

Robert said he included the concepts from the course to teach his students about the cyclical nature of water. He specifically referred to the sewage treatment facility and recent problems the facility was having due to flooding. He connected the flooding event to the student families' water bill by making students aware that their water bill includes sewage and drainage. He stated "you pay more to treat the water than you do for the water itself." He referred to this in class when they discussed the cost of running a household and how that connects to science. Yet another teacher noted "I'd been to the forest and arboretum, but didn't realize all of the environmental ways that they had designed it, the welcome center and everything to help out the environment. I didn't realize that even though I had been there before." Another teacher had no idea that the "forest and arboretum existed. It opened my eyes that there are ecologically sensitive places that I need to seek out and use as examples for my kids. It made me more sensitive that there are more options out there."

Roger's increased awareness of what occurred at the water and sewage treatment companies prompted him to create a rain garden to conserve water and drink more tap water. After visiting the power plant, he implemented "the air condition saving device thing" [agreeing to have the compressor to his air conditioner remotely turned off by the power company for brief periods during peak demand hours] that helped reduce the amount of energy used by the air conditioner. Sarah reported that the site visits made her more personally aware of small things that she could do to help conservation efforts. To promote energy efficiency, she "changed all of the light bulbs in the house" and she uses "cold water to do laundry because we now know how much energy the hot water takes." Along with energy efficiency, she also tried to conserve through recycling and drinking tap water. She said that she never really felt like she overused resources, but now is "more conscious of it."

Summary

Results of teachers' reflections and interviews emerged around two themes that repeatedly became evident from the teachers' data. The particulars of these themes varied, in part due to the unique personal context for each teacher. First, the different aspects of the course and camp experiences brought about new areas of awareness for the teachers. From this awareness, teachers developed knowledge, attitudes, and skills to imbed EE tenets within their current school curriculum. Therefore, they gained additional resources and possibilities for their students. Additionally, teachers became more aware of the impact that they can have on the environment and they used their newly acquired knowledge to discuss some of the concepts from these community sites in their classrooms with their students. The data supported that the teachers moved along the EE goal continuum (UNESCO/UNEP 1978) from "awareness and sensitivity to the total environment" to "knowledge gained via experiences" (i.e. supporting learning of camp participants before and after through community tours). The teachers developed "attitudes" and "skills" necessary to identify and ameliorate environmental problems as indicated by personal changes within their own practices.

Implications

Results from the *SBC* course implementation support the effective learning opportunities elucidated by Freeman et al. (2004) in that teachers must (a) be engaged in hands-on experiences similar to what they will provide for their students, (b) have opportunities to work with experts in the field, and (c) make practical applications to the K-12 school setting. Results from the *SBC* course also demonstrated the impact that teaching urban students in multiple informal learning environments can have on K-12 science teachers. Teacher learning from this experience occurred in multiple intersecting dimensions: learning about middle school students' lack of connection to environmental concerns; enhancing their own personal learning of related content and interconnections; and coming to understand the power of the site-based pedagogy and how that can impact students. One of the main factors that affected all of these dimensions of learning was sensory interactions with the environment. Ideally, the best way for teachers or students to learn is to be directly engaged in the site themselves. Teachers need the direct experience both for their own learning and for strengthening their abilities to assist students in making a personal connection to the environment. Pragmatically, teachers will not be able to visit every site with all of their own students during the school year, but providing teachers themselves with at least one of these site-based experiences would be beneficial to their own learning and would provide them with a perspective (and possibly physical artifacts such as photos or samples) to share with their students.

Teachers expressed a growing awareness that urban middle school students may not fully understand the interconnections between the natural environment and their urban infrastructure. This enhanced awareness coupled with a strengthened understanding themselves of the interconnectedness of science with their lives both motivated and enabled teachers to enact pedagogical change in their own classrooms the year following the *SBC* course. Each teacher used his/her experiences at these sites in unique ways within his/her classrooms. These personal experiences at the site provided a context which teachers can use to enhance their instruction.

Through these direct connections, teachers showed examples of how these facilities are relevant to students' own lives. The feedback also demonstrated that teachers change their habits and personal choices when they have an increased understanding in how their actions affect the environment. Through the use of local environmental facilities, teachers can connect the products and resources that they use everyday to science. When teachers assist students' connections of these facilities to their daily lives, their students can relate their lives to their environmental impact. The EE implications include both the acquisition of resources (e.g., power plant, water treatment plant) and the disposal of waste (e.g., sewage, urban runoff, power plant refuse). Most importantly, these sites are venues that directly deal with their houses, communities, schools (not some generic power plant somewhere else) and are places where they could feel empowered to understand the underlying science. This understanding removes the mysterious, magical quality of household items used daily, such as clean water from a faucet, or electricity from a switch, or toilets flushing water "away." After students make these connections to their own lives (i.e. increased awareness), they need to be provided with opportunities to share their knowledge with others (i.e. knowledge to action). This can be done through formal presentations to parents and the community. Students can create a school display in the school hallway or media center to convey important environmental information learned to the rest of the school. Another effective outlet could be a student-created web page posting information that they learned from sites visited. The goal for the teachers is to provide experiences for their students to learn how science and the environment connects to their lives and in turn share that new knowledge with others.

Appendix 1: Toilet Homework

1. Clean toilet thoroughly after checking with your parents about how to do so safely and thoroughly.
2. Pour one cup (approximately 250 mL) of water into the toilet bowl and carefully observe the results. Record your observations on a piece of paper.
3. Pour ten cups of water, one at a time, into the toilet bowl and carefully observe and record the results.
4. Pour a large container of water (approximately 4–8 L) slowly into the toilet bowl, pouring a stream of water no thicker than about your thumb until the container is empty. Observe and record the results.

5. Pour the same large container of water quickly into the toilet bowl, emptying the container all at once. Observe and record the results.
6. Write down any questions that arise during your investigation to share with the class.

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*Pseudonyms are used to preserve teachers' anonymity.

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