Using Screen Time to Promote Green Time

Outdoor STEM Education in OST Settings

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Addressing the myriad developmental and academic needs of young children is no "walk in the park." But what if it could be? Too many of today's children spend too much time indoors, often interacting with screens. They don't get enough physical exercise. Their learning about nature comes from books and teachers rather than from firsthand exploration of natural phenomena. These issues affect most modern American children, but they are particularly prominent among low-income children in high-need neighborhoods. Walks (and other activities) in the park, if properly designed, could go a long way toward improving children's health and developing their cognitive skills.

Many out-of-school time (OST) programs already serve low-income children; many incorporate physical activity, STEM (science, technology, engineering, and mathematics), or both. But dealing with these and other priorities while keeping children safe, aligning with school learning goals, and sometimes being held responsible for academic outcomes such as grades and test scores can overwhelm the most dedicated afterschool professionals. When and how can outdoor exploration of natural phenomena fit in, especially in urban neighborhoods?

As surprising as it may seem, technology can provide part of the answer. This article describes *PLUM LANDING*, an all-digital PBS program that helps OST programs and families get outdoors to explore nature. Findings from the program evaluation suggest lessons for OST programs that want to incorporate outdoor STEM learning, no matter what curriculum or resources they use.

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Children Need More Green Time

According to Richard Louv (2005), children today have less direct experience in nature—less green time—than previous generations had. The reasons include lack of unstructured time, worries about safety, inadequate access to outdoor space, and the lure of screens and technology. With his book *Last Child in the Woods,* Louv put a name to this phenomenon—*nature-deficit disorder*—and highlighted its perils for the social, physical, and emotional well-being of children. The resulting "No Child Left Inside" movement and other forces have sparked interest in the long-term effects of lack of green time on children's health, academic development, and care for the environment.

The effects on child health of exposure to nature are well documented. Reduced green time is associated with high rates of obesity, asthma, attention disorders, self-regulation issues, low self-esteem, anxiety, stress, and depression (Christiana, Battista, James, & Bergman, 2017; Derr & Lance, 2012; Flouri, Midouhas, & Joshi, 2014; Razani et al., 2016). Conversely, time in nature confers physical and mental health benefits (Cleland et al., 2008; Faber Taylor & Kuo, 2009, 2011) including increases in immune system functioning (Li et al., 2007; Li et al., 2009).

Lack of outdoor time means also that children miss powerful learning opportunities. In 2016, the North American Association for Environmental Education guidelines for early childhood environmental programs recommended that "particularly for very young children, environmental education should incorporate exploring woodlands, getting wet feet, climbing rocks, building with sticks, running on grass, turning over rocks, following insects, stomping in puddles, and so forth" (North American Association for Environmental Education, 2016, p. 3). Supporting this approach are studies that identify direct engagement in nature as a factor that improves student outcomes in environmental education programs (Rickinson, 2001; Stern, Powell, & Hill, 2014).

Finally, children's lack of experience in nature may portend trouble for the earth itself. In order to develop an emotional affinity with nature and to become environmental stewards, children need personal experiences in the outdoors (Chawla, 1998; Hungerford & Volk, 1990; Sobel, 2001). Studies suggest that children who spend meaningful time playing and learning in nature develop a stronger sense of environmental affinity than others (Collado, Staats, & Corraliza, 2013; Ferreira, 2012; Larson, Castleberry, & Green, 2010) and that, over time, these experiences can translate into conservation behaviors and a stewardship ethic (James, Bixler, & Vadala, 2010; Wells & Lekies, 2006). The well-being of our planet may be jeopardized if adults do not help our children develop an understanding of the natural world, a sense of wonder and love for it, and, therefore, the motivation to protect it.

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How OST Organizations Can Help

OST programs bring important assets in promoting environmental education and outdoor play. For one thing, they are often better able than schools to take children outside. For schools, increasing pressure to improve academic performance often means increased "seat time" and fewer opportunities for recess or other outdoor time, despite evidence that play and learning in nature bring developmental and academic benefits (Jarrett, 2002). OST programs can therefore fill an important gap by bringing children outdoors and connecting them to nature.

Furthermore, OST programs are uniquely equipped to supplement classroom STEM learning. To build their understanding of environmental science, children need multiple opportunities both to learn the explicit skills and knowledge that formal science education can provide *and* to build a body of informal, experiential knowledge through direct exploration in nature. OST activities can provide this direct experience, which has been shown to be critical to children's persistence and engagement with formal science learning and, over time, with scientific exploration more broadly (National Research Council, 2009). For instance, children can develop their understanding of weather by observing clouds; investigate water flow by following the path of rainwater from the sidewalk to a storm drain; and learn about animal behaviors by watching squirrels, pigeons, and insects.

OST programs also have a unique opportunity because they tend to serve the most vulnerable populations. They therefore can bring outdoor STEM learning to children, particularly those in urban areas, who may not have other opportunities to explore nature. City children often lack opportunities to explore science outdoors, in part because educators feel that they do not have access to appropriate outdoor spaces or that the outdoor spaces they can access, such as city parks, don't represent "nature" (Bruyere, 2012; Simmons, 1998). Guidance can help urban educators more clearly see and take advantage of the learning opportunities all around them (Flouri et al., 2014).

Once an OST program decides to build in outdoor exploration, how can educators and administrators actually make it happen, without adding to staff workloads? After all, informal education programs are already tasked with a lot. Besides being expected to offer fun programming, they are under increasing pressure to include academics, especially STEM, and physical fitness in their programming (Hynes & Sanders, 2010; Wiecha, Hall, Gannett, & Roth, 2012). An OST organization may specialize in one of these priorities, but achieving multiple priorities is difficult. Incorporating outdoor exploration and environmental science can add another layer of challenge, especially for urban programs that may not recognize local opportunities to explore environmental science or feel prepared to take advantage of them.

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Launching Outdoor Exploration in OST Settings

To overcome these challenges, urban programs need ideas and structure for outdoor exploration, particularly for programming that balances physical activity with learning and enjoyment of the outdoors (Goldstein, Famularo, & Kynn, 2018). Training and guidance have been shown to contribute to successful experiences (Rosenberg, Wilkes, & Harris, 2014).

Perhaps surprisingly, electronic media may provide part of the answer. Though some see technology as a contributor to reduced green time, digital media can be a tool for learning in nature. It can help to deepen children's engagement with nature, set the stage for learning, and equip families to integrate outdoor exploration into their everyday lives (Anggarendra & Brereton, 2016; Goldstein, Famularo, Kynn, & Pierson, 2018).

One program designed to accomplish these purposes is *PLUM LANDING* (WGBH Educational Foundation, 2017b), a PBS KIDS all-digital environmental science project. Designed to bring active science exploration to children ages 6 to 9 and their families, the project strives to lay a foundation for lifelong commitment to the environment. It features Plum, a curious, nature-loving alien, and her five earthling friends as they embark on epic explorations of Planet Earth. Animated stories, live-action videos, online games, hands-on activities, and apps offer kids opportunities to wonder and explore, observe and create, and play and discover their way across diverse ecosystems.

Guidance for informal educators provides support in using these materials to foster real-life exploration in children's own neighborhoods. The *PLUM LANDING Explore Outdoors Toolkit* (WGBH Educational Foundation, 2017a) helps OST educators implement programming for their participants and families, addressing common challenges along the way. Funded by a three-year grant from the National Science Foundation, media producers at WGBH and researchers at Education Development Center worked with partner OST programs throughout the U.S. to iteratively create, test, and refine the toolkit. In 2018–2019, Concord Evaluation Group conducted an independent summative evaluation of the toolkit. This research forms the basis for the suggestions offered in this article.

Methodology

The multimethod evaluation of the toolkit and of its potential to foster science exploration studied three common outdoor education models: afterschool programs that work with children, informal programs that provide facilitated programming for families, and programs that encourage families to explore on their own. Participant observations in this article come from surveys and interviews conducted for these three studies.

Afterschool Study

The first part of the evaluation consisted of an implementation study that compared outcomes among afterschool programs that used the toolkit and those that did not, using a randomized block design. Interested programs were randomly assigned to an intervention group that used the toolkit or a comparison group that did not. A total of 12 afterschool programs participated in the study: six from urban locations in Massachusetts; three from urban areas in South Carolina, New York, and Texas; one suburban location in Maine; and rural locations in Georgia and Kentucky. In the urban and rural programs, participants were predominantly low-income families. The final sample included 12 afterschool educators and 77 students. Students ranged in age from six to 12 years, with an average of 9.8 years. Although the toolkit materials were developed for educators working with six- to nine-year-old children, the evaluators found in pilot testing that many of the younger participants were unable to complete the study surveys. They therefore encouraged programs to try out the materials with kids on the upper end of the target age spectrum.

Participants in all programs were surveyed upon enrollment in the study and again at the end of the study. After the pre-test survey, programs in the intervention group were given the toolkit and related materials; comparison group programs got the materials after the post-test survey. Researchers also conducted observations in three Boston-area programs.

Facilitated Family Study

The second component of the evaluation was a qualitative study that included data from six one-day facilitated events at five nature-based family education programs. The five programs, based in Alabama, Georgia, Massachusetts, Utah, and California, all served primarily low-income families; three were in urban locations. Programs in the study received *PLUM LANDING* toolkits and were asked to collect post-participation surveys from children and parents or caregivers. Informal educators were also surveyed at the end of the program. The final sample included 10 educators (five from one location, two from another, and one from each of the other three), 27 parents, and 22 children, who completed surveys either alone or with help from their parents. Kids ranged in age from five to 12 years, with an average of 7.6 years.

Self-Facilitated Family Study

The third part of the evaluation was conducted with families who used the toolkit on their own. Researchers conducted Skype interviews with nine families. Three of these had participated in the facilitated family program. The other six families were recruited from the evaluation firm's national research panel to try out toolkit activities at home and provide feedback. These six families were located in diverse settings (urban, rural, and suburban). All classified themselves as low income, and all had children ages 6 to 9.

Materials

The *PLUM LANDING Explore Outdoors Toolkit* included materials focusing on four urban ecology themes: water, weather, plants, and animals. The toolkit was designed to be modular, so that programs could pick and choose the components that would work best for their audiences, the weather, and the available time and outdoor space. The toolkit featured:

1. An introductory video and guide for program directors.
2. Instructions for hands-on activities designed to blend fun, science learning, and physical fitness: eight activities for afterschool programs, eight for facilitated family programs, and 10 for families exploring on their own. Family activities were available in English and Spanish.
3. Twelve animated webisodes, featuring Plum and her friends, that are intended to get kids excited about the science concepts in the hands-on activities.
4. An online game that complements and extends the science learning from the webisodes and hands-on activities.
5. Seven videos, hosted by a veteran outdoor educator, intended to guide OST educators in leading outdoor activities in urban settings.
6. A free app that helps families build the habit of fun, active outdoor exploration.
7. An online site where children can document their completion of real-life outdoor missions to receive digital badges.
8. Eight parent videos, in English and Spanish, that offer tips and inspiration to help parents get the most out of their time outside with their kids.
9. Nineteen "learning pathways" for OST educators: suggestions for combining the activities and digital

media into programming blocks suited to the program's audiences and time constraints.

Lessons Learned

The evaluation of the toolkit identified important principles that OST programs may want to consider when implementing nature-based programming:

1. Science learning can happen anywhere.
2. Home connections can reinforce learning.
3. Science learning doesn't have to be complicated.
4. Games make science less intimidating.
5. Technology can promote engagement with nature.
6. Physical activity can motivate outdoor science exploration.
7. Digital exploration and outdoor play can enhance science learning.

Science Learning Can Happen Anywhere

Our findings demonstrated that urban dwellers don't have to travel far to find suitable locations for science games and activities. Researchers observed educators and families conducting activities on sidewalks, in school playgrounds paved with concrete, and in an abandoned parking lot. Children and families blew bubbles and tracked where the wind took them, investigated animal habitats, collected plant seeds, and experimented to see how quickly water evaporates in sun versus shade—all within their local neighborhoods.

Parents in the study shared details about their experiences. One reported, "My child learned about the diversity we can experience in even a very small area, and how teeming with life even a small patch of grass can be." Another said, "My child learned how to hear the hidden animals." Still another told us, "[I was surprised to learn] what is around us in our town."

Educators who worked with children and families also reported that they used the materials to explore science in their local neighborhoods. One said, "Although we live in a suburban setting, there is still so much to learn about the creatures, plants, and environment in general." Another said that the project "made me more aware of my environment, and [now] I pay closer attention to details around us."

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Home Connections Can Reinforce Learning

For OST programs, take-home activities enabled parents to participate with their children in continued learning connected to OST experiences. Even for families who participated together in facilitated activities at nature centers or community learning programs, take-home activities encouraged them to continue exploring on their own. All take-home activities in the toolkit were available in English and Spanish. The self-guided, hands-on activities enabled families to do science anywhere, anytime, and to involve siblings or extended family members. The handouts prepared caregivers to answer children's "how" and "why" questions, gave them ideas on spending more time outdoors, and provided instructions for easy science experiments.

Study families who tried the activities at home provided positive feedback. For example, one parent said, "It involves activities [my child] can do in the classroom and [we can do] at home. I learned a lot!" Other parents and educators reported that the activities helped them connect indoor learning with outdoor exploration. For example, one mom said at pre-test that she did "indoor science" with her son, but that she "shied away from messy science" activities outdoors. After trying the toolkit activities, she reported that "seeing how much fun he had and how easy they were (and not messy)," she realized that "we can do this kind of thing more often, and we should do it more often."

Science Learning Doesn't Have to Be Complicated

Designed for programs with limited budgets and minimal storage space, the *PLUM LANDING* activities required only everyday supplies that are lightweight, easy to carry, and affordable, such as jump ropes, toothpicks, and yarn. This approach not only eased the burden on educators to find and purchase supplies, but also helped children understand that science is a part of their lives. One educator reported, "*PLUM* was a great experience for kids for almost no cost." Another reported, "The lessons were inexpensive to execute."

All toolkit activities were designed to enable children to become more familiar with environmental science concepts and to practice foundational science skills, such as making predictions or observing and comparing results. Even simple activities, like closely examining insect life in a patch of grass, comparing how water flows on different surfaces, or observing clouds to predict the weather, offered valuable lessons in environmental science. For example, one afterschool educator said, "I enjoyed seeing the kids' interactions and their curiosity to learn new things." Another reported having "learned some new stuff" alongside the participants.

OST leaders and parents of all experience levels reported that the simplicity of the activities helped them feel more capable of introducing the activities into their regular outdoor programming or outdoor playtime at home. During a pre-test interview, one mom reported that she was uncomfortable doing science-related activities because her daughter "was still too young." During the post-test interview, this mother said that she was "pleasantly surprised" by the toolkit activities:

> Before this, if I was with her at the park, she wouldn't be wanting to look about nature or learn about [science]. She would want to play with her friends, go on the swings, the slide. So it was definitely a good experience because we never, ever have learning experiences at the park. So this was a first.

One study dad was initially hesitant about because he expected to need a high level of science knowledge to "manage" toolkit activities with his son. After using the toolkit, he said that he was quite relaxed now and realized that he could "do these kinds of things with [his son] outside without any special academic preparation."

Games Make Science Less Intimidating

Many adults reported at the beginning of the study that they were uncomfortable or only somewhat comfortable leading science learning and teaching science concepts. Some felt unprepared due to their own lack of knowledge or worried that they wouldn't be able to communicate complex ideas effectively. However, the *PLUM LANDING* approach, which incorporated science learning into outdoor games, helped educators and parents feel more confident. For instance, one game helped children learn about the ways in which animals move through their habitats by trying to match their own skills to those of their animal neighbors. Could they jump 20 times their body length, as a grasshopper can? Or flap their arms 3,000 times in 60 seconds, as hummingbirds do with their wings? A version of hide-and-seek helped children see how camouflage helps animals stay hidden from predators, and a version of Red Rover demonstrated how water moves through permeable and impermeable surfaces.

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To help OST staff feel confident leading these games to explore science concepts, the toolkit provided step-by-step instructions. In fact, all six of the afterschool educators who responded to the post-test survey reported that the toolkit gave them ideas for exploring nature with program participants and helped them become more comfortable in doing so. One educator reported, "I loved the rhymes and the games that went along with the unit in helping to remember signs of rain and air pressure."

Children also reported in post-participation surveys that the games made learning fun for them:

- "[The games were] fun and I got to meet new kids."
- "I liked the coyote and rabbit game."
- "Running games were fun."
- "Games like bee and pollen [were fun]."

Technology Can Promote Engagement with Nature

Rather than keeping kids glued to their screens, technology can actually contribute to *increased* engagement with nature, according to our findings. The *PLUM LANDING* animated videos sparked children's interest and appeared to motivate them for outdoor learning. Playing games online helped to reinforce the learning from hands-on outdoor activities. During observations, we noted that children spent only a few minutes at the beginning of each session watching the videos. Most of the time during each session was spent running around, exploring, and observing nature outside.

Educators also appreciated the role of the videos in introducing science concepts and setting the stage for outdoor learning. One educator said, "It was easy and exciting for our educators to be supported by the videos and simple experiments." During outdoor exploration time, we repeatedly observed educators reminding the children about concepts covered in the media.

Parents reported that the technology made it easier for them to engage with the activities outside, so they didn't have to, as one put it, "carry around a bunch of handouts" while they were exploring. One mom reported that the toolkit changed her view of how "outdoorsy" she and her son truly were:

> I felt like he and I are such outdoorsy people … until we started, like, going through the activities and actually trying to apply them to our environment. Now, I am, like, "Wow, I don't feel like we're as 'nature-y' as we thought we were." We need to do more of this kind of thing all the time!

Physical Activity Can Motivate Outdoor Science Exploration

The toolkit included media and hands-on activities to promote physical fitness—a common goal for many OST programs. The evaluation found that, in addition to increasing physical movement, activities such as racing, balancing, mimicking animal movements, and completing scavenger hunts made the science activities appealing and drove children's engagement with science concepts.

The most common responses to a question about the children's favorite part of the project related to being outside and playing in nature:

- "Going out."
- "I like that we got to exercise."
- "I liked the movement."
- "Nature."

Parents also appreciated the connection to physical fitness. Two parents reported that their favorite parts of the project were related to children's outdoor physical activity. One parent enjoyed "watching my kids run around and be excited about God's beautiful creation." Another reported that her favorite part of the project was the chance for child to "play outside."

Using the toolkit seemed to expand families' repertoire of physically active outdoor activities to include such science explorations as nature walks, collecting rocks, and looking for bugs. Before using the toolkit, families were most likely to report that children's favorite outdoor activities were sports-related or physical activities. In the self-facilitated family study, half of the families provided examples of science-related nature activities they had done with children before engaging with the toolkit, but sports or other physical activities still predominated in children's time outside. For the other half of the children, parents did not mention engaging in science or nature exploration before using the toolkit. After using the toolkit, all the children still reported enjoying the same outdoor activities they reported in the pre-test, but four of the six children reported enthusiastically that they wanted to add science-related nature activities to the things they regularly did outside.

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Digital Exploration and Outdoor Play Can Enhance Science Learning

Our study found that digital exploration and active outdoor play need not supplant science learning. Rather, adding technology and physical activity actually enhanced children's engagement with science.

For example, nearly all (26 of 27) of the parents in the facilitated family study reported that their children were more motivated to learn about science and nature after using the toolkit. Children's responses supported the parents' perceptions: The majority reported that they wanted to learn more about science and spend more time exploring nature. Every one of the afterschool educators in the study said that the toolkit motivated them to explore science and nature with program participants.

The majority of children—100 percent in the facilitated family study and 63 percent in the afterschool study—reported that they learned something from *PLUM LANDING* that they hadn't known before. All of the OST educators reported that the toolkit helped the children in their programs to learn about science and nature.

In fact, when children were asked what they liked most about the toolkit programming, they often pointed specifically to the fact that it was educational, for example:

- “It was really fun, and I like that we learned about animals.”
- “Exploring and making a flower was fun.”
- “The game outside [when] we learned about plants [was a favorite part].”

Taking It Outside

Whether or not an OST organization uses the *PLUM LANDING Explore Outdoors Toolkit* or a similar program, research-driven, ready-to-use programs offer exciting new learning resources and options. Convenient, proven, and effective, such programs can expand and enrich science learning in OST settings while helping OST educators meet an ever-growing list of priorities. OST programs can use such resources to bring active, outdoor science learning opportunities into the lives of urban children, providing them with more green time and thus helping them to grow and thrive.

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