Planting Deeper

Outdoor experiences challenge children's misconceptions about the needs of plants.

By Ana Maria Caballero and Nermeen Dashoush

The teacher points to the picture of the plant while the children sit in front of her on the rug. She asks, "Is a plant a living thing?" A chorus of children confirm that it is. Then she poses the question, "What do plants need to survive?" A child raises his hand and offers sun and water as answers. The teacher confirms and says there is one more thing that plants need. She points to the collective group for input and they all respond "AIR."

This is a scene that plays out across many early childhood classrooms. While the words may be different, sometimes even mentioning nutrients from the soil, the essence of the discussion is still ultimately the same: There are things that plants need and the children are going to identify them. The children rattle off information that might have been picked up through read-alouds or class activities. Often it seems that lessons are designed to veer them toward this response—garden baggies with and without water, plants placed in closets devoid of sunlight, and other experiments and experiences that tick off the checklist of plant needs.

While these lessons and experiences are beneficial for establishing foundational concepts about plant survival, the goal is now to break away from a "checklist mindset" and allow children to develop a more complex understanding of the diverse needs of different types of plants. While plants do indeed need light, air, water, and nutrients to survive, the various ways they meet these needs, along with how these needs manifest themselves, form the basis for understanding biodiversity.

Research has shown that young children develop many common misconceptions about plants (Anderson, Ellis, and Jones 2014; Barman et al. 2006). For example, some young children believe trees, grass, and weeds are not plants, and that plants need things provided by people, or that sunlight is helpful because it keeps the plant warm. Outdoor experiences are the perfect avenue for challenging children's ideas about plant parts and plant needs that often arise when they give plants human characteristics and have only classroom understanding of plant diversity.

The Arnold Arboretum Field Study Program provides outdoor experiences for children in order to develop authentic firsthand knowledge of life sciences. The Arboretum welcomes approximately 3,200 children (preK–5) from greater Boston annually. During the program called Explorations with Head Start participants, the children visit three times throughout the school year to observe seasonal change. The program's mission is to provide depth over breadth by encouraging hands-on exploration of seasonal phenomena and thoughtful conversations with students about the plants they encounter.

Outdoor spaces, such as the Arnold Arboretum, allow children to gather their own evidence of plant biodiversity. Unlike most states, Massachusetts has science standards for preK children as part of the Massachusetts Science Technology and Engineering (STE) Framework. The Massachusetts STE are an adaptation of the *Next Generation Science Standards* (*NGSS*). The educational framework at the Arboretum adheres to their state's framework for teaching life science to children, which reads: Using evidence from the local environment, explain how familiar plants and animals meet their needs where they live (PreK-LS2-2). The following practices described here have been identified as key for moving past the listing of what plants need, aligning more with standards such as emphasizing scientific practice and requiring children to look for evidence. Furthermore, through these practices, children begin to see variety within plants, which will help rectify misconceptions. Although all of the following recommended practices were originally used by an Arboretum educator, they are intended to give teachers tools to explore any outdoor setting. Always wear closed-toe shoes and tall socks over long pants as protection against ticks when in the field. Also wear layers against the weather, and bring water. Teachers should always carry a basic first aid kit and bring children's personal medications if necessary.

Observation Skills: Exposure to Plants at Different Stages

One of the first things we do at the Arboretum with young children is bring them to an area where seedlings from maples, oaks, or horse-chestnuts can be found growing. Be aware of nut and other allergies before handling tree fruit. Check observation areas for hazards such as poison ivy, litter, or fire ants. After discussing what the leaves look like and showing children how to use probes, in the form of 6-inch wooden plant markers, to gently

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Digging for acorns (left) and observing a tree sapling up close (right).

A "collection box" of various natural items (left). Students compare leaf size, shape, and color (right).

unearth the seedlings, we allow children to wander the area in search of a seedling of their own. "I found one Ms. C!" shouts a four-year-old. "Tell me what you see," prompts one of our field study guides. "It has reddish leaves with five points, just like the one you showed us." Field study guides are trained volunteers who lead small groups of children in their explorations of the landscape. Often, in the case of oaks and horse-chestnuts, the seed is still visible: a cracked shell with one white, protruding root and one thin, solid stem bearing miniature leaves. "What plant parts can you see?" Almost choruslike, the children chant "roots, stem, and leaves!" A short discussion ensues, where the children are encouraged to use their hand lenses to observe close up and fingers to feel the texture of each plant part. They use as much vocabulary as possible to describe what they notice. Then, they are challenged to find the "parent tree." Through careful observations of leaf shape, color, and texture, children seek out nearby trees, comparing and contrasting what they have in their hands to what they see. "How do you know this seedling came from that tree? Talk to your field partner about that." Such questions prompt children to use the evidence in their hands to defend their claim. It is always a revelation when a child makes the connection that the small seedling they are holding will become a large and beautiful tree, with a hard trunk, thousands of leaves, and an extensive root system that can be evidenced by a few protruding, moss-covered root tops. All of a sudden, that life-cycle-of-a-tree poster inside the classroom has come to life. Chances are, in an outdoor setting, there will be broken branches and tree logs lying nearby. This is yet another opportunity to discuss living and nonliving things and examine the decomposition process of plants.

Many three-and four-year-olds, having only grown grass, bean, or sunflower seeds indoors, have a difficult time understanding that a tree is a plant. This makes sense when you consider that many urban children have limited exposure to natural outdoor spaces. Furthermore, the seeds planted are herbaceous, whereas trees are woody plants. That is, woody plants have cambium cells responsible for adding girth to a stem and thereby producing wood. Herbaceous plants have flexible stems and die back every year. If children are only exposed to planting garden seeds in order to learn about plant needs, they may develop the misconception that all plants require the same needs in the same amounts and that trees are not plants. They may even begin to think that plants need people to water them, plants make flowers for people to enjoy, or that sunlight helps plants by keeping them warm.

Asking Productive Questions: Experiences That Promote Investigation

Sometimes the question is not "what are the needs of a plant?" but "how much _____ does a plant need?" (insert water, light, or nutrients). Just like there are many different cake recipes that rely on the same basic ingredients, there are many different trees that rely on the same basic plant needs. Biodiversity comes from the myriad ways in which plants take in those ingredients and the various locations and climates that surround the plants. Teachers can help young children understand this through carefully planned outdoor experiences that begin with asking productive questions. We must stop and listen carefully, searching for the thread of logic in their answers.

Find a shady spot outside. Engage all the senses when discovering this spot—how does the soil and air feel on the skin? What do you hear when you close your eyes? What can you smell? What plants do you see growing here? Touch the plants—how do they feel? Can you use your body to show me how that tree is shaped? Typically, five-year-olds will say that the air feels cold, the soil is wet and dirty, and leaves feel bumpy, smooth, or soft. There is variation in how the environment makes them feel, from scared and spooky to happy and excited. Ask the children to name what a plant

needs to grow, and invariably one answer will be "the Sun!" Now, in your shady spot, ask children whether they feel the Sun. Point to a young tree growing in the shade of taller ones, and ask how is it that the tree can grow without the Sun? Common answers include "the Sun comes out later," "maybe it will stay little," or "it is still light here, not like at night." Each of these answers hint at many truths—it is not necessary for young children to have a "right answer." It is important, however, that they have the chance to consider challenging questions that can be explained with evidence from their surroundings.

Next, pass out clipboards, a recording sheet, and pencils to pairs of students. Invite them to search their surroundings to draw and label examples of plants that are growing in full sun, part sun, and shade. With the help of an adult, they can take a photo or, if allowed, clip and tape a small sample of the plant to their sheets. Perhaps they can find plants growing at the edge of the woods, in the woods, next to a sidewalk, and in a pond.

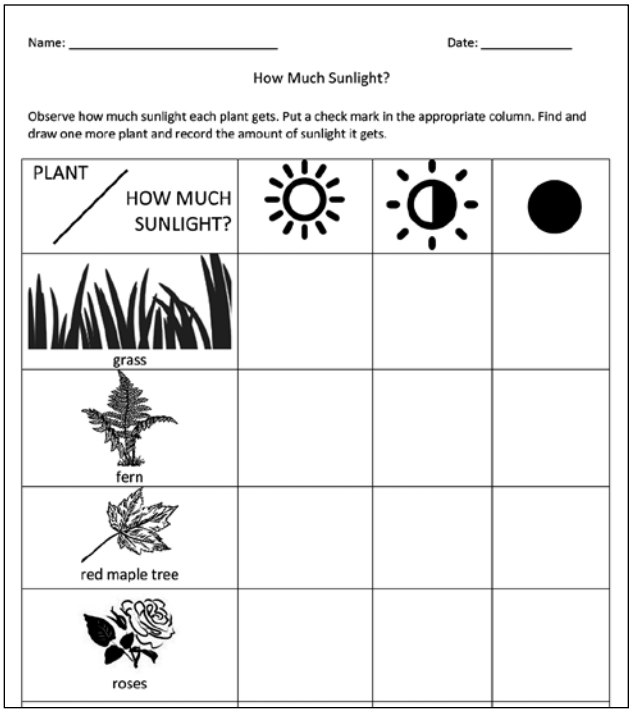
At the Arboretum, Field Study Guides often take children from a woodland habitat to the open meadow near the ponds. Children lie down on tarps and put on blindfolds. They are guided through careful questioning to understand the "feeling" of this new habitat. When children open their eyes, they can see that there are many more colorful flowers, more space between trees, and lots of grass.

Through these experiences, teachers can help young children engage in science talk, using evidence from their explorations to discuss why roses might need more water than a water lily, why there is grass on the field, but none under the oak trees, or what might happen to saplings as they grow in shade. These discussions, and observations on recording sheets, provide rich material for formative assessments. Teachers with an inquiry mindset, rather than a giver of scientific knowledge, can help propel young children toward constructing a more comprehensive understanding of plant needs and biodiversity.

Making observational drawings from a collection box (above). A sunlight data sheet (right).

Gathering Data: Making a Plant Collection

While exploring the landscape in small groups, children ages 3–6 are encouraged during each visit to collect found material—leaves, fruit, seed pods, broken bits of bark—to put into a collection box. Adults also use clippers to cut samples of plant material to illustrate a particular concept. For example, to demonstrate variation within a species, children handle leaves from a red oak and a white oak and are encouraged to describe what they notice; namely, that the lobes of a red oak are pointy whereas those of the white oak are rounded. Children then become "squirrels" searching for acorns underneath those trees—and lo and behold, the acorns also differ in color, shape, and size! Into the collection box go all these discoveries. Next, children observe that the soil can be damp and shady under all those oak trees, and little sunlight penetrates the thick canopy of leaves. Specific questions, such as *"Why is the soil damp?" "What might happen to an acorn buried in this soil?" "Is damp soil helpful to the growing seedling?" "How can plants grow underneath the oaks if there is little sun-*


Name: _____ Date: _____

How Much Sunlight?

Observe how much sunlight each plant gets. Put a check mark in the appropriate column. Find and draw one more plant and record the amount of sunlight it gets.

PLANT / HOW MUCH SUNLIGHT?			
grass			
fern			
red maple tree			
roses			

light?" and *"Where does the water it needs come from?"* can help widen children's understanding of plant needs.

The collection box grows with samples of children's finds gathered from different habitats. We use this collection to help even very young children make observational drawings. Together, drawings and natural artifacts can be used by the students to present newly formed ideas and be used as evidence in science argumentation. For example, a teacher can ask, "How are the plants we saw today the same, and how are they different?" or "Explain how these plants get what they need to survive." Generally, young children can use the sentence frame "I used to think_____, but now I know_____." When conducted in small groups, teachers can record student answers and prompt for more clarification through the use of talk moves. Such talk can be used as summative assessments of children's beginning understanding of the disciplinary core idea "Use observations to describe patterns of what plants and animals (including humans) need to survive."

Nature in Fictional Readings: Comparing Depictions With Reality

In one kindergarten classroom, prior to going outside for a science exploration, the teacher instructs all children to "find a perfect leaf." As they search among all the fallen leaves, and through the ones still holding on to branches, one can hear cries of dismay and frustration, or excitement at the many shades of green, yellow, and reds on display. Once each child has collected a leaf, the group engages in sharing and analyzing the "perfect" leaf as compared with what is usually depicted in books. Children will quickly see that each leaf may have a hole, a black edge, be ripped, scratched, be irregularly shaped, or have variations in color. Why would this be? Guiding children to question what they observe and develop explanations using evidence will go a long way toward teaching young children about diversity and variation in nature.

Often, much of what children know about nature comes from books and all manner of media depictions. Without exposure to nature in all its complexity, children can develop wrong impressions about what plants should look like and what plants need. For example, characters are often drawn holding a watering can while standing above a flower plant; this leads many children into thinking that plants take in water through their leaves. According to Rice (2002), "The trade books we examined communicated misinformation about science concepts in a variety of ways, in text as well as in drawings and artwork." Trundle, Troland, and Pritchard (2008) suggest that the best way to counter misconceptions is to provide experiences that challenge these misconceptions.

An experience that complements read-alouds used at the Arnold Arboretum is the "Story Walk." Developed by Anne Ferguson in Vermont, this literacy technique uses laminated pages from a children's book attached to wooden stakes and installed along an outdoor path. Children and adults enjoy reading the story, one page at a time, as they walk along enjoying nature.

Dot and Jabber and the Great Acorn Mystery by Ellen Stohl Walsh (2001) is the story of two mice detectives who want to find out why an oak seedling is growing where it is, far away from an oak tree. By placing the pages of the book along a path surrounded by oaks and fallen acorns, children are immersed in the real landscape of the story. Children can then compare and contrast what they see in a book with what nature has to offer. Depending on the scientific accuracy of a story and its pictures, children can be challenged to consider what is real and what came from the imagination of the author/illustrator. Questions such as, *"What do we know about how roots grow? How is that the same or different from this picture?" "Do all leaves look the same on this tree?* (point to a real tree) and *"Why would the illustrator draw them this way in her book?"* can guide children to closer observation. Sometimes, a simple matching game where children find real leaves or acorns to match the pictures in a book is enough to jumpstart a conversation about variation in nature. Armed with evidence from the outdoors, children can then construct explanations to defend their growing understanding of plant needs and biodiversity.

Repeated experiences with the outdoors will, over time, help children move beyond their checklist of plant needs to a broader, more complex understanding of plant survival and biodiversity. These experiences can also help clarify misconceptions about plants, plant parts, plant functions, and plant needs. Along the way, preschool children engage in authentic and purposeful practices of science that develop an inquiry mindset and lay the foundation for later learning in K–12 classrooms. ■

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Resources

MA STE 2016. *Massachusetts Science and Technology/Engineering Curriculum Framework*. Massachusetts Department of Elementary and Secondary Education

Walsh, E.S. 2001. *Dot & Jabber and the great acorn mystery*. Boston: Houghton Mifflin Harcourt.

StoryWalk
www.kellogghubbard.org/storywalk

Connecting to the *Next Generation Science Standards* (NGSS Lead States 2013):

K-LS1 From Molecules to Organisms: Structure and Processes
www.nextgenscience.org/pe/k-ls1-1-molecules-organisms-structures-and-processes

1-LS3 Heredity: Inheritance and Variation of Traits
www.nextgenscience.org/pe/1-ls3-1-heredity-inheritance-and-variation-traits

The materials/lessons/activities outlined in this article are intended for use in preK classrooms. Science experiences in preK by their nature are foundational and relate to early elements in learning progressions that facilitate later learning in K–12 classrooms. As the *NGSS* performance expectations are for K–12, we have not included specific performance expectations but have identified the disciplinary core ideas that are addressed to show the link between these foundational experiences and students' later learning.

Science and Engineering Practices	**Connections to Outdoor Activity** *Students:*
Analyzing and Interpreting Data Constructing Explanations Engaging in Argument From Evidence	• make a collection box with plant artifacts and use this to engage in science talk. • discover and explain connections between seedlings and mature trees. • evaluate differences between media depictions of natural phenomenon and actual landscape.
Disciplinary Core Ideas	
LS1.C : Organization for Matter and Energy Flow in Organisms • All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.	• compare light requirements between plants growing in shade and sun. • name plant parts of a seedling and describe how those plants parts provide for a plant's needs.
LS3.B : Variation of Traits • Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.	• describe differences and similarities in leaves of the same species and between related species.
Crosscutting Concept	
Patterns	• use evidence from the collection box to explain that different plants need different amounts of light and water according to where they live, or that there is variation within plants of the same species, and between habitats.