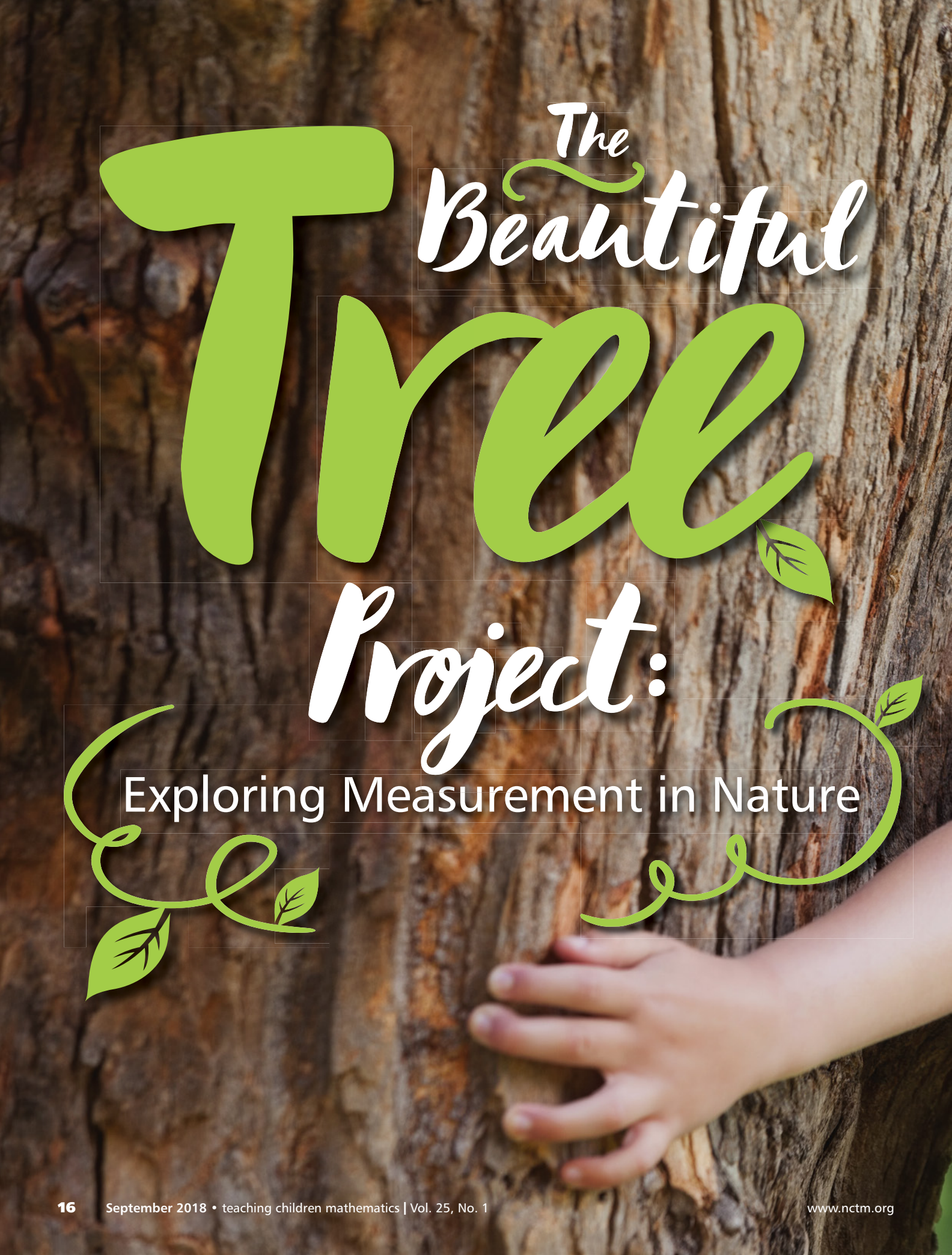

The Beautiful Tree Project:

Exploring Measurement in Nature

The outdoors offers children a rich space for learning and inspires authentic mathematical opportunities.

Deanna Pecaski McLennan

My kindergartners are gathered around a large oak tree in late spring. They have spent days observing and representing their understandings in different ways, including sketching and building models using loose parts. Today their conversation drifts toward wondering about the tree's size.

"This is such a big tree, even though I want to hug it, I can't put my arms around it."

"It's so tall I have to squint my eyes when I look at the top because it's too sunny."

"My mom said that tall trees are old trees."

"I bet this tree is older than me."

"I bet this tree is older than Mrs. McLennan!"

"I think this tree is at least one hundred years old."

I teach a full-day kindergarten class in Ontario, Canada, that is greatly inspired by nature. As part of our inquiry-based, integrated approach, we spend many hours outdoors each day, exploring our vast play yard and engaging in play-based activities typically done inside a classroom. I have been rewarded to see the depths of the children's wonderings about the natural space and the beauty and intricacy of the changing seasons. My students are fascinated by the living things that they find in our ecosystem, and they spend much time wondering, researching, and representing their ideas in the form of projects. They notice, classify, and sort the changing colors of leaves in fall; count and compare the types of footprints they discover in winter; and identify and represent the natural patterns they find in spring. According to Wein (2008), educators who embrace emergent learning are attuned to children's—

> interests and concerns, and curriculum expands into genuine inquiry, as [they] together become participatory co-learners who attempt to understand some aspect of real life. (p. 1)

When educators honor the interests of children, embedding obligatory standards and assessment strategies into authentic moments of learning becomes easy and effective, making outdoor play mathematically meaningful and engaging.

In her work, Boaler (2015) encourages us to rethink our relationships with math. When we consider the role and importance it will play in children's future lives, helping them cultivate a positive mathematical mindset is essential. We want children to feel confident in their abilities to participate in complex situations and see how relevant these are to the world around them. For these reasons, I embrace moments of math learning outdoors (see **fig. 1**) and support children in projects that incorporate intricate problem solving and communication of their ideas into the community and beyond. The Beautiful Tree project became a highlight in our mathematical journey, helping to articulate our vision for the necessity of outdoor play and the rich possibilities of child-centered math explorations.

FIGURE 1

The children spend hours outdoors, exploring and wondering.

FIGURE 2

The loose parts on the light table included "gems" and branches.

The beautiful tree

The trees in our yard are strong and tall, and I refer to my students as *little acorns* because of the beauty and diversity of life in our yard. During one of our many outdoor play times, I noticed that children were drawn to one tree in particular. This tree towers over the others and has brilliant green leaves. When one stands under it, one feels enveloped in a safe place where one can appreciate the streaming rays shining through the foliage and can forget about

the world around. And although many other places in the yard are fun to visit, the children always seem to return to this particular tree.

Wanting to bridge our experiences between the indoors and outdoors, I placed some interesting loose parts on the light table (see **fig. 2**) along with a favorite book to read aloud (Salas 2012). I hoped it would prompt students to think deeply about the tree's physical structure and beauty. The loose parts included round and irregularly shaped "gems" and natural branches of varying lengths. I anticipated that as children used the parts to create interesting pictures and designs, the materials would spark a continued exploration of the tree during indoor play that would ready and heighten their learning the next time we went outdoors. Many children reflected on their past experiences and were quite eager to manipulate the materials and represent their interpretations in diverse ways, creating their own "trees" by using the gems and branches. They read the story and referenced photos they had taken of the tree on the class iPad®. Throughout their play, I noticed and named numerous math concepts as they emerged, including *sorting* as the children grouped the loose parts, *symmetry* as they created multiple representations of the tree by using gems and sticks, and *length* as the children compared their "trees" and wondered whose was the tallest.

Using art to support math

In emergent learning, teachers are guides who help make connections and heighten explorations in support of children's wonderings.

When the class headed outdoors the next day, I invited the children to revisit the large tree and engage in some mindful observation and drawing (see **fig. 3**). As a teacher inspired by Reggio Emilia, I believe that children use hundreds of languages, including the arts, to represent their growing understanding to others (Edwards, Gandini, and Forman 2012). Students often use drawings to communicate their ideas and theories about life and the world around them. Sketching the tree (see **fig. 4**) inspired many of the kindergartners to consider just how big it was and sparked additional questions about how old it might be. The children quietly chatted as they drew, and as I entered their conversations to help them infuse depth and perspective into their drawings, I asked them to consider how tall and wide they thought the tree was. How many branches did they estimate were on the tree? How many leaves should they include on each branch? Were their drawings effective in helping someone else appreciate how large and beautiful our tree was? I reminded students of their earlier work, and I prompted them to consider those observations in their sketching.

FIGURE 3

The children chatted quietly as they sketched the tree.

FIGURE 4

The teacher asked questions to help them infuse depth and perspective into their drawings.

Sarama and Clements (2009) remind us that taking a child's perspective helps deepen one's understanding about what is happening in the play and how to better support the learning. After quietly observing the children, I entered their conversation eager to capitalize on their math interests and support the questions they had. The children were curious about the tree's age and knew that they should measure the distance around the trunk to find out. With teacher prompting, they made connections to past measurement experiences and suggested tools that they could use. One child wanted to use a standard measuring tape. Another child was not confident it would be long enough and suggested first wrapping the tree in masking tape (see **fig. 5**) and then removing and measuring the tape to see how long it was. A third student hoped to use connecting links (see **fig. 6**) because he knew we had a large quantity of them and would have enough to wrap the tree. A fourth thought we could measure the tree's trunk by gathering in a circle and holding hands around it (see **fig. 7**).

FIGURE 5

Doubtful that a measuring tape would be long enough, a student suggested wrapping the trunk with masking tape.

FIGURE 6

For tools to measure the tree, students made connections to their past measurement experiences.

Measuring outdoors

After gathering the necessary materials (paper, pencils, clipboards, masking tape, connecting links, measuring tape, iPads), the children proceeded to measure the tree trunk. They remembered that to get as accurate a measurement as possible, they would need to start at the very end of their tool—or what would be considered zero—and work upward. As they worked, I noticed how their measurement schema helped them problem solve when the tools did not work the way they had originally envisioned. Children who wrapped the tree in masking tape wanted to standardize their tool and quantify it, so they wrote ordinal numbers on the tape in permanent marker. A child began writing ordinal numbers starting from zero and moving in rough increments along the length of the tape. Those working with connecting links realized that they had to hold them tightly around the trunk without slack to get an accurate nonstandard measurement. When one measuring tape was not long enough, students solved the problem by taping two together. Each team of kindergartners used a different tool to measure, yet students engaged in supportive, ongoing conversations with one another throughout the task. Motivated by a common question, they worked confidently and persistently until everyone had arrived at a conclusion.

According to Boaler (2015), giving children the time and freedom to experiment with math situations before introducing a standardized term or algorithm is important because authentic math opportunities evoke a growth mindset and engage children emotionally in the task. My students were more motivated to measure the tree's trunk than they might have been if asked

to work on such a task at a contrived measuring center or on an activity sheet.

After the outdoor play, I invited students to share their experiences during our whole-group consolidation circle in the classroom. The majority of kindergartners were highly engaged participants in the conversation as they discussed the different strategies they had used to measure the tree and the advantages and disadvantages of each. They thought the masking tape was a good choice because it was very long and stuck to the tree, but they were unsure whether the increments used to depict the markings were spaced evenly enough. They agreed that the connecting links were easy to use and attach to one another, ensuring a snug fit against the trunk. The measuring tapes made them feel like real mathematicians because they were tools they had observed their parents using, but one was not long enough. The children wondered if the results of each tool were equal, even if the numbers did not appear to match (e.g., the number of links used was not the same number marked on the masking tape or the measuring tape). We discussed that the masking tape that wrapped around the tree measured from end to end to the child-written number 122. Children who used connecting links shared that a total of 115 were used to wrap the tree. Those who had taped two measuring tapes together knew that they had used both fully, but they were unsure how to double the number to arrive at a total. They knew the number 2, representing the number of tapes altogether, seemed like a small number when compared to the masking tape and links, but they had difficulty articulating how else to represent this measurement.

We placed the tools in the center of the carpet and shared our observations. This led to a very robust discussion about standard versus nonstandard units of measurement, how two things can be equal even if they appear to be different, and the meaning of the term *circumference*. We also observed documentation from outdoor time together (e.g., photos, videos, sketches) and discussed what we noticed. The children realized that even though each tool represented a different number, they were all of equal lengths when placed next to one another on the floor. The number 122 on the masking tape was of equal length to the 115 links as well as to the two attached measuring tapes. This was a huge realization by the children: Regardless of which tool was used, they all equally represented the circumference of the tree. This conversation evoked additional questions about the trees in the yard, and the kindergartners wondered if they could locate a tree with a bigger circumference than the one we had already measured.

FIGURE 7

The kindergartners suggested multiple ways to measure the tree.

Inspiring more math with fiction

As the responsive educator in the space, I wanted to heighten the explorations by building on the children's prior knowledge and applying and extending their ideas in a more robust experience. So, to continue to spark engagement, I introduced a fictional book during a subsequent whole-group time. In *Stella, Fairy of the Forest* (Gay 2002), the characters explore a treed area near their house and discuss all the wonderful things that might live there, including fairies. On one page in particular, Stella points out how big and old the trees in the forest are. At this point in our read-aloud book, I asked the class to reflect on the similarities between Stella's forest and our yard. The children made the connection that our trees are big and that must mean they are all old. I reminded them of previous conversations and wondered if they were still interested in finding the biggest (and maybe oldest) tree. Students readily agreed and suggested using the chain of links from the previous activity to find out. "If we wrap it around another tree and it's too small, that means the tree is bigger than our tree," one insightful child reflected.

During the next outdoor play time, many of the kindergartners were eager to bring the links with them and measure every tree in our yard. We started at one end and moved from

tree to tree, holding up the links and comparing whether the chain was larger or smaller than the original. The children knew that when the ends of the chain overlapped, it meant the tree was smaller, and if a gap remained, it was larger. This was a rich opportunity, full of math language and connection, as the children physically compared each tree's size and worked together to manipulate the long chain in an efficient way. Some even drew a map of the yard, marking each tree's location and crossing off those that had been measured, to keep a record of the activity. After persisting for more than an hour, the children eventually located two trees that were much larger than our original beautiful tree! We marked these on our maps. Walking back to the classroom, I overheard an interesting exchange occur between two children.

"The new tree is bigger, but I wonder just how old it is."

"We could cut it down. If you look inside a tree, you can see how old it is."

"How?"

"Count the number of circles."

"But then the tree will be dead. If it's dead, no one can see it again. It won't be in our yard anymore."

"I don't know how to figure it out then."

Connecting with the community

During the next consolidation circle, I asked the children to share their ideas with the group. Most were interested in knowing each tree's age but agreed that cutting them down was not an option. They did not know how to proceed. I suggested that we contact the city arborist, who was responsible for caring for all the trees in our parks. A key foundation of the Reggio Emilia approach is that the school community and beyond can be supportive of children's learning and can share in the endeavor of guiding them forward (Edwards, Gandini, and Forman 2012). Associating with a city arborist would help us connect our Beautiful Tree project and corresponding math questions with a field expert who could enhance our work and form a relationship with the school, moving our project beyond the metaphorical walls of the school and into the greater community.

The children were quite excited to welcome the arborist. Before heading into the yard, they reviewed with him the documentation they had collected up to that point. To communicate their questions and how they hoped to proceed in this project, they shared an informed, confident understanding of measurement (Tarr 2010). The arborist was amazed; he had never been asked to visit with such a young group of children and was impressed with the depths of their commitment to the task. The children gathered recording tools—iPads, sketchbooks, clipboards, and the measurements tools they had used previously. And as the arborist led us on a nature walk, the kindergarten students peppered him eagerly with questions and documented the experience with their tools. What kinds of trees were in the yard? Why did some leaves have black markings? What kinds of insects lived inside the bark? Which tree was really the oldest? The arborist answered each question, sharing his experience and knowledge and demonstrating the different tools and resources he uses in his everyday job.

The arborist helped us locate the oldest trees (which turned out to not be the largest because of the fast rate at which they grew) and, more important, he left the children with a new problem to explore. As he examined our yard, he noted that the lawn service employees had been cutting too close to the trees. As a result, the equipment had been cutting the tree trunks, which were slowly dying. Students were horrified. They realized the gravity of this situation and upon walking back to the school began crafting their next plan of action. They wanted to write letters to the lawn service people and our school principal, create posters to share around the school, and ask their families for help. They brainstormed about how they could water the trees more regularly and what materials they could place at their base to help the trees retain moisture.

The most effective inquiries are the real-life problems that impassion learners; the children were touched by this new problem and were driven to action. As I participated in the flurry of planning and discussion that happened during the next outdoor play, I knew that the children would be motivated to explore this new problem with the same drive and enthusiasm that had sparked it in the first place: wondering about the beauty of the outdoor space and motivating them to participate in solving a problem in the world around them.

The outdoor world is rich with mathematical possibility! Educators who are attuned to children's wonderings can reflectively help support authentic, meaningful math in developmentally appropriate and engaging ways.

SHTONADO/THINKSTOCK (VINE, LEAF)

Common Core Connections

K.MD.A.1
K.MD.A.2

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