STEM Comes to Preschool

Sally Moomaw and Jaumall A. Davis

Asia carefully turns the handle of a handheld drill that her teacher holds in place over a piece of soft wood. Soon sawdust begins to appear. “Round and round it goes,” they sing, as Asia cranks the handle. Suddenly the drill bit slips through the wood. “A hole!” exclaims Asia. “Let’s do it again.” The teacher replaces the drill bit with a smaller diameter bit. “You made a round hole with the big bit,” he says. “Do you think this new bit will make a round hole too?” Asia shrugs. “Do you think it will make a big or a little hole?” the teacher asks. Asia shrugs again. “Well, let’s find out,” he says, and Asia eagerly begins to turn the crank again.

Math and science and the related technology and engineering are natural pairings. These four disciplines form the acronym STEM (Science, Technology, Engineering, and Math) and can be readily combined into an integrated curriculum for early childhood classrooms.

Many educators believe that children learn best when disciplines are interconnected. An integrated curriculum, such as STEM, is in keeping with developmentally appropriate practice in early childhood education: “Teachers plan curriculum experiences that integrate children’s learning within and across . . . the disciplines” (Copple & Bredekamp 2009, 21). The National Council of

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Photos courtesy of the authors.

Preschool STEM activities

Although opportunities abound to integrate STEM education into preschool classrooms, teachers must help children construct learning connections among the disciplines. For example, in the opening vignette the teacher directs Asia’s attention to the shape of the hole made by the drill and creates an opportunity for her to compare the size of the drill bit to the hole it makes.

The following three activities were developed as part of a university/public school partnership to increase STEM learning in urban preschools. Pattern, pendulum, and incline activities ignited intense interest in the children.

Birds sing in patterns

Patterns are important elements of both mathematics and science. Math educators consider recognizing, describing, and extending patterns as key concepts for young children and include these in both national and state content standards (NCTM 2000; Ohio Department of Education 2004).
To help children recognize, remember, and represent melodic patterns, we introduced the standard vocal syllables from music (do, re, mi, and so on). We added corresponding hand signs, a teaching strategy called the Kodály method.

Understanding patterns helps children construct key mathematical relationships; for example, in counting, each number is one more than the previous number, but each odd or even number is two more than the previous odd or even number.

Similarly, patterns occurring throughout science can be observed by children within many contexts, such as in the recurring cycle of day and night, the forward and back motion of a swing, or the songs of birds. Understanding systems, order, and organization is a unifying concept of the National Science Education Standards (NRC 1996), and patterns are a key element in this regard.

Patterns. The concept of pattern as repeating elements can be difficult for young children to understand. Given the diversity of the children in our preschool, we decided it would be best to introduce patterning through multiple modes of learning: auditory, visual, vocal, and movement-related. We chose toy Audubon birds, realistic plush replicas of real birds, as an intriguing way to integrate natural science, technology, and mathematics. A squeeze of the birds activates a microchip that plays the authentic song of each species (as recorded by the Cornell University Lab of Ornithology).

Our preschoolers showed immediate interest in causing the birds to “sing” their birdsongs, but they could not initially name any of the birds nor identify any of their songs. Yet they quickly realized that birds sing in patterns. Some birdsongs are melodic, a short tune that repeats; other birds emit only one tone but in a pronounced, rhythmic pattern.

To help children recognize, remember, and represent melodic patterns, we introduced the standard vocal syllables from music (do, re, mi, and so on). We added corresponding hand signs, a teaching strategy—called the Kodály method—frequently used by music educators to approximate the physical placement of the tones within

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**Audubon Birds with Melodic and Rhythmic Representations**

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<tr>
<th>Audubon Bird</th>
<th>Bird &amp; Song</th>
<th>Representation</th>
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<tbody>
<tr>
<td>Black-capped Chickadee</td>
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<tr>
<td>Great Horned Owl</td>
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<tr>
<td>Northern Cardinal</td>
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<td>Blue Jay</td>
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<td>Western Meadowlark</td>
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We observed that the learning seemed to generalize to patterning in other contexts, such as extending color patterns.
structures down (pendulum) or moving objects faster and more easily (incline). Quantification and measurement were embedded in the activities.

Devries and Kohlberg (1990, 92-93) offer four important criteria to follow when designing physical knowledge activities for young children.

1. **The child should create the action that causes the phenomenon.** Being the source of the action helps demystify the response of the object and leads children toward scientific, rather than magical, thinking.

2. **The child should be able to vary his or her action.** This helps children form cause-and-effect relationships and construct physical principles.

3. **The result of the action should be observable by the child.** Children must be able to observe the effects of their actions in order to understand causality.

4. **The reaction of the object should be immediate.** This allows children to accurately pair the two events (action/reaction).

**Pendulums.** Our pendulum consisted of a 1½-inch-diameter hard rubber ball suspended from a wooden frame (16 in. high and 12 in. wide) mounted on a baseboard. For easy access, we placed the frame on either the floor of the block area or a bench where children could try to knock over blocks, a popular childhood activity (which also fit DeVries and Kohlberg’s first criterion). We read *Bam, Bam, Bam,* by Eve Merriam, to connect the activity to real-life engineering projects.

Children could vary the placement of the blocks, change the direction of the pendulum, and alter the force they used to swing it (criterion 2). They could immediately tell whether they had hit any blocks (criterion 3) and see the reaction of the blocks (criterion 4). Thus, all four criteria of a good physical knowledge activity were met.

**Outcomes.** Predictably, many children placed the blocks too far away from the pendulum. Swinging the ball harder proved ineffective, as the tethered ball only wrapped around the frame. One very inventive child placed a block on top of the frame, realizing that when the pendulum wrapped around, it would hit his block. “I got it!” he proudly exclaimed as his block crashed down.

Some children began to examine the ball and cord more carefully. “It won’t reach,” one child correctly concluded and promptly moved her blocks closer. For children who seemed too frustrated to continue, like the child who insisted the pendulum was “broke,” the teacher intervened with leading questions, such as “How can the cord reach the blocks?” and modeled lining up the cord with the blocks. As children altered the block placement, they began to experience success.

Some children counted the blocks they knocked down, while others continued to swing the pendulum until no blocks were left standing. Their persistence paid off. “They all fell down!” one child proudly announced. “Let’s do it again” was a popular request.

**Reflection.** In their eagerness to knock over the blocks, children explored key concepts related to both physics and geometry. Some children arranged blocks in a horizontal row and discovered that the pendulum changes direction and can reach more blocks if it keeps swinging. One child demonstrated a sophisticated understanding of the pendulum’s movement. “I’ll try it here,” Andre said, placing a block...
off to one side of the pendulum. Much to the teacher’s surprise, he then swung the pendulum on a diagonal several times until he struck the block. Although Andre didn’t use a geometric term such as diagonal, he clearly understood trajectory and adjusted his aim accordingly. This scenario shows that children like Andre, who are nonverbal or have limited language, may display higher-level thinking in physical knowledge experiences than traditional assessment methods can reveal.

The teacher’s car always loses

A second physics activity, suitable for outdoors or indoors, involved a variable-slope ramp.

Inclines. Children set up a simple ladder frame and arranged two lightweight boards (4 feet long, 1 foot wide, and ¼ inch thick) at various heights on the frame. They chose identical cars to race down the ramp. The children quickly discovered that the steeper the slope of the ramp, the faster and farther a car traveled. Whenever the teacher was asked to participate in the car races, the children assigned him a low ramp, thus guaranteeing that his car would always lose!

Outcomes. The teacher was particularly gratified by the children’s verbal exchanges as they manipulated the cars and inclines. For example, Michael, who had significant speech delays, suggested to his friend Joey, “Let’s play this again. You help me.” Michael connected two ramps, with the lower ramp overlapping the other, thus creating

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a bump. The boys then rolled their cars down the ramp. "He jump off!!" exclaimed Joey, as his car hit the bump and flew off the side of the ramp. The boys repeated the experiment again and again, each time delighted when the car jumped the ramp.

It was evident that all the children were drawing from past experiences as they experimented. For example, even if they had been absent from school for several days, each remembered that the steeper the ramp, the faster the speed of the car. Children who could not verbalize this relationship would adjust the ramp or point to a higher position for the ramp they intended to use.

**Reflection.** The large, lightweight materials allowed children with physical impairments to participate actively in the experimentation process, a primary goal in an inclusive classroom. Many children who had never before built ramps created their own ramps in the block area.

After about two weeks, when the initial excitement had abated somewhat, the teacher added measurement to extend the children's interest in the experiment. Measurement is an important content area in mathematics (NCTM 2000) and a key element in scientific inquiry (NRC 1996). Children used chalk to mark the stopping points of their cars. In trying to make their cars go farther, they discovered that if the ramp was too steep, the car would bang the ground and not travel far.

**Conclusion**

These experiences confirmed for us that, regardless of ability, young children are ready, willing, and able to engage in STEM activities. In this preschool classroom, children constructed important scientific and mathematical relationships. They explored materials that piqued their scientific curiosity and math discovery. They can build upon these foundational concepts in future educational experiences. Most important, they learned that math and science can be exciting areas to explore.

**References**


