FEATURE | *by Louise Parks*

Giving STEM a place in early childhood classrooms

No doubt you have seen and heard the designation *STEM* as part of a school program name, the object of grant funding, an effort of youth organizations, or a campaign of the nation's corporations. Does STEM have a place in early care and education?

What is STEM?

It's Miles building a sturdy tower with blocks, Henry weighing rocks on a balance scale, Jetta using a smartphone to record the story she's making up about an elephant and a kitten, and Josie and Jim identifying the different beans in the soup they have for lunch. STEM, while a relatively new term in education, describes what developmentally appropriate classrooms have enjoyed for years—the tools of science, technology, engineering, and math learning.

The acronym STEM was first promoted by the National Science Foundation (NSF) to describe the content and scope of science, technology, engineering, and math education. While some teachers address each area individually, the NSF's goal is to build an understanding of these integrated subject areas as essential to long-term academic success and economic well-being.

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In early care and education classrooms, STEM components are important parts of an integrated curriculum that reflects the belief that preschoolers are natural and curious scientists. Preschoolers are adept at asking the *how* and *what* questions that are the core of STEM.

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Science is a way of thinking. Science is observing and experimenting, making predictions, sharing discoveries, asking questions, and finding out how things work.

Technology is a way of doing. Technology is using tools, being inventive, identifying problems, and making things work.

Engineering is a way of doing. Engineering is solving problems, using a variety of materials, designing and creating, and building things that work.

Math is a way of measuring. Math is sequencing, patterning, and exploring shapes, volume, and size.
—Adapted from Boston Children's Museum

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In preschool classrooms, **science** consists of observations, explorations, comparisons, and investigations of common materials and processes in three general areas: physical science, life science, and earth and space science. The nasturtium growing on a windowsill is material for an investigation of the impacts of water, sunlight, containers, and food on a plant's appearance, growth rate, and flower production.

For young children, a spider on the playground is the subject of speculation, questions, and observation with a magnifying glass—"Did those hairy legs help the spider spin that web?" The spider is not a creature that ignites fear (unless the child is modeling an adult's behavior) but instead curiosity, comparisons, and discoveries.

Science is not magic: the natural world is predictable and events have explanations, even if we haven't discovered or can't fully understand them yet.

Technology can include classroom computers and keyboards but existed long before the digital age. Consider the advantages of a vegetable peeler over a knife: For the job of peeling a carrot, technology made an everyday task easier, safer, and faster. Simple machines—including pulleys, wheels, inclined planes, gears, and wedges—are evidence of technology with a deep history as well as opportunity for current and continuing exploration.

An early use of modern technology in preschool classrooms was the cassette recorder that enabled individualized instruction—identifying common sounds, recording the text of familiar books so that children could access words and pictures independently, and making access to music for movement activities easier and less fragile than a turntable and disks allowed.

In classrooms today, technology often includes digital cameras, smartphones, tablets, interactive computer games, GPS systems and maps, smart pens, smart scopes, and the wealth of accessible information via the Internet. Most of these technologies are easy enough for children to use and flexible enough to individualize application to specific children's interests and needs.

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Engineering is perhaps most visible in construction activities—those with blocks and those with permanent fasteners like nails, bolts, and screws. The activities involve planning, experimentation, design, and creativity. For example, when children fold paper back and forth in accordion pleats, they are likely to discover that the paper is stable and strong in one direction (pleats perpendicular to the table) but not in the other (pleats parallel to the table).

SCIENCE
IS NOT MAGIC.

They may extend the experiment by measuring the strength of the paper: Can it hold up a pencil, a book, a block, or a basket before it collapses? Does the size of the pleat matter? Does the thickness of the paper matter? As they answer questions like these, children plan, design, and discover properties in the natural world, often with little teacher intervention.

Math, perhaps the most familiar aspect of the STEM family, quantifies materials in the natural world. Children count, learn one-to-one correspondence, match, measure, explore patterns, and make comparisons. Too often, an adult's long-standing math anxiety interferes with conversations and problem-solving related to mathematical concepts.

Take the often-heard lament, "He has more than me." Consider the learning that can happen if, instead of offering meaningless reassurances that the amounts are the same, a teacher takes the time to build the one-to-one correspondence needed to factually verify the claim.

Ask *what* questions

Build STEM into everyday activities that build conceptual foundations from children's natural curiosity. Observe—really notice and reflect on—what children are doing. For example, many preschool classrooms have magnets, magnetized wands, and metal boards in the discovery area. It's not developmentally appropriate to expect a preschooler to explain why magnets work the way they do (requiring the vocabulary and understanding of poles, attraction, metals, iron, and magnetic fields), and indeed, most teachers can't either. Instead of abandoning the magnet sets, help children focus on what they see and how their manipulations of objects can change outcomes.

Ask open-ended questions that start with *what*.

- What do you notice?
- What are you trying to do?
- What do you think will happen?
- What have you seen the other children do?
- What did you try?
- What happened?
- What do you think would happen if _____ ?

In contrast, asking a *why* question suggests that there is only one correct answer. For preschoolers, the *why* question encourages haphazard and inconsistent guesses, minimizes scientific observation, and implies that you already know the answer and that their response is unimportant.

Nonetheless, children themselves will ask *why* questions, notably the perennial "Why is the sky blue?" Explaining the cause of the blueness can begin with experiments with a prism to separate light into its colors. "What happens when sunlight shines through the prism onto white paper?" As children advance in the study of science in school, they will learn about the Earth's atmosphere and molecules that scatter the sun's light waves (with the blue waves scattered the most because they are the shortest). For now, it may be enough to respond with more *what* questions, such as "What color is the sky at night?" "What color is it at sundown?" "What color is the sky when it's raining?"

Plan authentic experiences

Because children build learning skills from sensory exploration toward symbolic thought and concept manipulation, help them build STEM competence in real-world, day-to-day contexts. Real materials that are familiar and available are the foundation of learning. Exotic and unique materials don't help children build meaningful background knowledge and suggest that STEM experiences are somehow special and not the grit of daily life.

Work to help children understand the differences between fantasy and reality: Beans don't really grow to the sky overnight as the fairy tale suggests, but they do grow from seeds (not golden ones) and become sturdy food-producing plants in the school's vegetable plot.

Review curriculum goals, individual lesson plans, and your knowledge of the interests and needs of specific children—simply, what do you want the children to learn? It's likely that you already include basic STEM experiences in your classroom activities but it's also likely that you can improve the content delivery and build greater background knowledge with a bit more focus and deliberate skill-building conversations.

For example, are your daily (and too routine) large-group calendar activities a standard repetition of the days of the week and a weather check? Or, in contrast, could you use the rudimentary data collected from an outdoor weather station to compile a diary or chart of temperatures, rainfall, and amount of cloud cover? What do you really want children to know about the weather? How can you make this information meaningful and relevant to young lives?

Integrated STEM experiences

Indoor cooking activities naturally integrate all STEM components and can result in tasty, healthful products. Ideally, the activity is sparked by children's conversations about food—likes and dislikes, at-home kitchen experiences, quantities, and tools.

The activity could be prompted by a book (*Stone*

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Cooking activity concepts			
S	**T**	**E**	**M**
Temperatures	Timers	Process plan	Quantity
Property changes	Cutting tools and simple machines	Heat sources	Size and shape
Color	Farm to market	Food production	Estimates
Nutrition	Internet recipe	Safe storage	Measuring tools
Teeth	Soap	Food labels	Fractions of the whole
Food sources	Sharing blog	Containers	Graphing preferences
Hunger and digestion	Photo and sound documentation	Running water for cleanup	Distribution of ingredients

Soup by Marcia Brown or *Growing Vegetable Soup* by Lois Ehlert), a story a child shares ("My Gran let me help make carrot muffins—I grated"), or even a TV ad (breakfast sandwiches).

Some integrated cooking activity concepts are included in the table above.

Remember to ask *what* questions as you explore and to listen to (and possibly record) children's responses. Use current knowledge to build future experiences. Soap bubbles, sand, earthworms, soil, and wheel toys are examples of materials that can bring the STEM classroom outdoors for experimentation, observation, and data collection.

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As is best practice, determine what children already know from your observations, reflect on what they need to know next and the best ways to scaffold that learning, and carefully prepare the environment to maximize the impact of any new learning experience.

Resources

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