# Best Practices

STEM teaching is an interdisciplinary approach to learning where students learn and apply concepts in science, technology, engineering, and mathematics. By their very nature, early childhood settings are primed to support STEM learning. Consider the definitions of each discipline:

> *Science*: The process of finding out about the world and how it works by exploring, gathering data, looking for relationships and patterns, and generating explanations and ideas using evidence.
>
> *Technology:* The tools that have been designed to meet human needs such as balance scales to compare weights, lenses to look closely at living things, and digital tools like computers and tablets.
>
> *Engineering:* The process of designing tools, systems, and structures that help humans meet their needs or solve problems.
>
> *Mathematics:* The study of quantities (how many or how much), structures (shapes), space (angles and distances), and change.

Simply watching children will confirm the fact that their play at various learning centers integrates subject matter from these disciplines every day. As they explore with their minds and with their senses, they are observing, asking questions, designing, building, testing, and solving problems.

At different times, children may engage with science, technology, engineering, and mathematics separately or in combination. For example, when a child builds a tower with blocks, he or she acts as an engineer as he or she tries to make a tall, yet stable structure. That child also takes on the disposition of a scientist when he or she explores how blocks of different materials, shapes, and textures affect the strength and stability of the tower. That child might also use mathematics and technology as he or she uses tools to measure the heights of the towers.

Today, educators will learn the best practices for teaching STEM to young children— engaging children with STEM activities at learning centers, integrating STEM vocabulary throughout the day, and guiding children to reflect on what they've experienced and learned.

## Use Learning Centers to Engage Children In STEM

Young children build their knowledge and understanding of the world by observing, asking questions, and investigating. These are natural inclinations that form the foundation for early science, technology, engineering, and math exploration. Educators can nourish these tendencies and utilize the learning environment to develop them.

- **Recognize that STEM experiences can be planned and unplanned**. Good teaching is intentional teaching, but teachable moments can happen at any time. Carefully planned activities and materials can inspire and incite children's natural desires to explore and can lead to spontaneous teaching and learning.
- **Engage children with thoughtful and intentional learning center activities** that invite them to engage in STEM. (e.g., building ramps, constructing a marble run, planting a garden, using a magnifying glass)
- **Plan activities that prompt investigation and exploration**. (e.g., rolling different kinds of objects down ramps, comparing weights of objects using a balance scale, using blocks to build structures that fit within a boundary)
- **Guide exploration with open-ended questions**. *What, why,* and *how* questions have the potential to encourage deeper thinking, thoughtful answers, and continued exploration.
- **Understand that the STEM disciplines are closely intertwined**. For instance, when a child examines a piece of fruit, he or she may taste it, classify its shape, and count its seeds, engaging in both science and math exploration.
- **Integrate skills that go beyond STEM**. Best practice in STEM education includes a focus on critical thinking, collaboration, and language and literacy. Intentional educators create purposeful opportunities for children to communicate their ideas through talking and writing—e.g., by collecting data, recording observations, and sharing their ideas with others.

### Why is STEM education an important part of the early childhood experience?

- STEM exploration happens naturally: educators can refine and further help develop these skills for children's lifelong learning.
- Children need to have opportunities to ask questions, explore, and investigate.
- Children can explore objects and materials directly, learn how to collaborate with others, and use technology in authentic ways.
- Children benefit from engaging in problem-solving, critical thinking, and discovery.

## How can the learning environment be designed to support STEM education?

- Offer activities and materials that give children opportunities to find out how things work—to observe, explore, ask questions, solve problems, design, collaborate, build, and think critically.
- Offer activities and materials that encourage children to explore with their minds and senses. Engage children in science, technology, engineering, and mathematics together or separately. For example,
    - Use the Sensory Table Center for sinking and floating investigations. Children can sort, count, and compare the characteristics of items that sank and items that floated.
    - Use the Block Center for developing children's math and engineering skills by inviting them to build structures and notice the materials, sizes, and shapes that make their structure sturdy.
- Offer activities that pique children's interests so that they will participate actively and talk about what they are thinking about and doing.
- Provide opportunities for children to explore with peers and educators, one-on-one and in small groups.
- Utilize the outdoor environment. For example, in the springtime, you might provide small shovels or spoons and encourage children to dig holes in the dirt and observe and record what they find.

## What kinds of questions and comments can educators use to support children's STEM explorations?

- Use open-ended questions to guide children's explorations. *What, why,* and *how* questions can encourage deeper thinking, thoughtful answers, and continued exploration.
- Model how to ask questions. Scientists, engineers, and mathematicians all ask questions, so encourage children to become expert question-askers by modeling your own thoughts and questions. *(Is the pencil going to roll or slide? I wonder if that rock will float or sink?)*
- Respond to children's ideas and suggestions with questions that will extend the learning. *(Interesting idea! How could we test it out?)* Responding with questions encourages further inquiry by children and develops their critical thinking skills.

### How can educators make literacy a part of STEM explorations?

- Read fiction and nonfiction picture books on STEM-related topics.
- Have children collect data by drawing or writing.
- Record ideas, opinions, estimations, and predictions on group charts.
- Encourage children to share ideas verbally with others (such as when they describe the structures they've built.)

## Integrate STEM Vocabulary

Educators help children build language skills every day when they ask questions and facilitate conversations. STEM explorations are a great context for developing children's vocabulary. As they engage in STEM activities, children do what scientists and engineers do—they observe, investigate, ask questions, measure, design, and build—as they do they can use the same vocabulary that scientists and engineers use. Educators can facilitate this language development by integrating STEM vocabulary into daily interactions with children.

- **Provide a label for children's actions**. Point out when children make observations, predictions, collaborate, discuss, design, plan, investigate, construct, explain, use their senses, problem-solve, and communicate. For example, *Josh, I noticed that you are carefully* watching *and* observing *how the ball rolls down the ramp.* Or, *Emily has* designed *a wide ramp. Let's* notice *what happens when the ball rolls down the ramp*.
- **Integrate STEM vocabulary before, during and after activities**. The more often children hear a word, the better they will understand what it means and be able to use it themselves.

### Why is it important for adults to integrate STEM vocabulary throughout the day?

- Vocabulary is a crucial aspect of language, communication, and learning. When young children understand and use words such as *compare, predict, plan, investigate, design,* and *observe*, it helps them engage more fully in STEM learning and it increases their overall vocabulary development.
- Young children should hear and use mathematical language (e.g., *longer, shorter, higher, more, fewer, follow, add, construct,* etc.). When children engage in STEM activities, they encounter these words often.
- Children learn words gradually over time and as they hear and use words in different contexts. They continually deepen their understanding of words in parallel with related

concepts. (e.g., they learn what the verb *sink* means in tandem with learning what the action of *sinking* is)

### How can educators encourage children to use STEM vocabulary?

- Model the use of STEM vocabulary. *(Let's test it out; Let's do an experiment; Everybody observe what Nicole is doing; You predicted that the flashlight would slide.)*
- Label children's actions. Point out when children observe, predict, collaborate, discuss, design, plan, investigate, construct, explain, use their senses, problem-solve, and communicate. *(Claudio is going to put a leaf in the water. Do you* predict *it will sink or float? Let's* notice *what happens*.)
- Integrate STEM vocabulary before, during, and after activities. The more children hear a word, the better they will understand what it means, and be able to use it themselves.

## Guide Children to Reflect on New Understandings

As children engage in STEM activities, they test out their own ideas and have opportunities to develop new ones. In order to develop new ideas, children need to reflect on their explorations and observations. They need time and support to rethink old ideas in light of new experiences. After any STEM exploration, educators should provide opportunities for reflection.

- **Include time for children to discuss, describe, and summarize** what they've experienced.
- **Prompt children to reflect**. Children could:
    - Look back at a prediction and compare it to what actually happened. *(I predicted the ball would roll down the ramp. The ball did roll down the ramp.)*
    - Review experiences and observations and generate new conclusions and explanations. *(Why do I think that happened?)*
    - Compare related experiences and make connections. *(How do balls roll the same indoors and outdoors?)*

### Why is it important for children to reflect on new understandings?

- Young children need time and space to think about what their observations and experiences mean and how new discoveries might alter their previous ideas. For example, if children observe that a wooden block floats, does that mean that all wood floats? Or that all blocks float?

## In what ways can children reflect on what they've learned?

- By looking back at a prediction and comparing it to what happened. *(What did you predict about how the flashlight would move down the ramp? How did it move?)*
- By reviewing their experiences and observations and coming to a conclusion or generating an explanation. (Children might conclude that some things slide and some things roll down ramps; that some balls go faster than others; and that the sun melts the ice.)
- By looking at related experiences and making connections to their own. (Children might watch a video about children painting with ice and compare what they see to what they experienced during the same activity.)

## How can educators help children reflect on what they have learned?

- Allow time for children to reflect, ask questions, and deepen their understanding.
- Ask open-ended questions to help children describe and share their observations and experiences.
- Invite partners to "turn and talk," rather than calling on one child at a time, so that all children can share their thinking and new understandings. Listen in to determine what children are learning and thinking.
- Provide opportunities for children to record their thinking using graphs, charts, drawings, or labeled diagrams.

## How do open-ended questions help children think reflectively?

- Open-ended questions have many possible responses. They encourage children to articulate their own observations and ideas rather than give "correct" answers. They may begin with words like *how, what, what if,* and *why do you think. (What do you think of the kiwi? What don't you like about the cucumber? Why do you think the ice is melting?)*
- Open-ended questions help develop children's abilities to observe, describe, and explain their observations and ideas, and extend their investigations. They encourage children to think like scientists by reasoning and by developing their ideas based on evidence from their observations. (*What did you notice about things that roll? How might you test which balls will roll the fastest?)*

## Glossary

**academic language:** words about specific topics and subjects that children must learn in order to be successful in school

**engineering**: the process of designing tools, systems, and structures that help humans meet their needs or solve problems

**mathematics:** the study of quantities (how many or how much), structures (shapes), space (angles and distances), and change

**open-ended questions**: questions that require critical thinking, invite opinion or explanation, and result in more than a one-word answer

**science:** the process of finding out about the world and how it works by exploring, gathering data, looking for relationships and patterns, and generating explanations and ideas using evidence

**STEM:** an interdisciplinary approach to learning where students learn and apply concepts in science, technology, engineering, and mathematics

**STEM vocabulary:** words that relate to the processes of science, technology, engineering, and math (e.g., *categorize, change, classify, collaborate, communicate, compare, construct, count, describe, design, discover, discuss, draw, experiment, explain, graph, identify, investigate, listen, measure, notice, observe, plan, predict, problem-solve, question, record, share, sort, use senses, watch*)

**technology:** the tools that have been designed to meet human needs, such as balance scales to compare weights, lenses to look closely at living things, and digital tools like computers and tablets

View the self-paced video workshop at http://resourcesforearlylearning.org/educators.

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