Facilitator's Guide

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Stream from http://resourcesforearlylearning.org/educators_pd/
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Introduction

This professional development training module is designed to help you lead educators in using best practices to teach science, technology, engineering, and math (STEM) to young children. It is one of several modules developed for early childhood educators by the Department of Early Education and Care of the Commonwealth of Massachusetts.

This training meets the guidelines for Continuing Education Units (CEUs) as outlined by the Massachusetts Association for the Education of Young Children (MassAEYC).

For more information about this professional development training module, visit http://resourcesforearlylearning.org/educators_pd/.

About this Guide

This Facilitator's Guide provides instructions and narrative for delivering a video-based training for early childhood educators. You'll find an agenda, learning goals, preparation suggestions, talking points, activities, and handouts. You'll also find general tips and resources to help you facilitate the training. Use these materials with the accompanying videos to lead family child care and center- and school-based educators in an engaging, content-rich training.

Note: **To view the videos referenced in this guide, go to http://resourcesforearlylearning.org/educators_pd/. Select *"Engaging Children in STEM."* Be sure you have access to the videos prior to and while leading this training.**

Learning Goals

After participating in this training, educators will be able to:

- Summarize the best practices for engaging children in science, technology, engineering, and math (STEM).
- Recognize and design activities that invite children to observe, explore, investigate, problem-solve, experiment, and design.
- Plan ways to integrate STEM language throughout the day to help children think and act like scientists.
- Identify strategies for helping children reflect on new understandings.
- Apply new knowledge to current practices.

Agenda

Introduction	15 minutes
Engaging Children in STEM (Overview)	5 minutes
Use Learning Centers to Engage Children in STEM	15–20 minutes
Integrate STEM Vocabulary	15–20 minutes
BREAK (optional)	5–10 minutes
Guide Children to Reflect on New Understandings	15–20 minutes
Try It	15–20 minutes
Wrap Up	5–10 minutes
Total Time	**90–120 minutes**

Preparation

Before leading this training, you should:

- Watch the videos and get to know the best practices.
- Read through the training module. Become familiar with the talking points so that you can share them in a natural, conversational way.
- Obtain and test the technology you need to share the videos with participants and make sure you have a reliable Internet connection during the training.
- Gather any props or materials needed for the Try It activity.
- Rehearse and fine-tune your presentation to "make it your own." Time yourself to make sure you are within the allotted time.
- Create a handout packet with copies of the following for each participant:
    - Self-Assessment
    - Learning Log
    - Try It
    - Best Practices
    - Learning Guidelines and Standards
    - Resources for Further Learning
    - Training Evaluation
- Consider working with a partner the first time you lead this training. You can learn from and support each other when preparing, practicing, and facilitating. After the training, you can reflect on participants' evaluations together.

Facilitation Tips

Whether you're a new or experienced facilitator, these tips can help your training run smoothly.

- Arrive early to prepare the training room for optimal learning.
    - Place handout packets where participants check in.
    - Have pens or pencils and paper on every table.
    - Check your technology setup to make sure the videos play without problems.
- Create a space that is inviting and comfortable.
    - Play soft music as people arrive.
    - Greet participants with a smile and a handshake. A personal introduction helps set the stage for collaboration and learning.
- Invite partner or small group discussion.
    - Before the training begins, invite educators to identify a partner. People learn best when they have a chance to talk about what they are learning or thinking.
    - Allow a few minutes for partners to introduce themselves to each other.
    - During the training, provide opportunities for partner interaction.
- Keep participants engaged.
    - Follow the "ten-two rule" as you present the training: Speak for no longer than ten minutes at a time and then provide participants at least two minutes of interaction or activity.
    - Avoid simply reading the talking points that have been provided. Become familiar with each point so that you can keep the training engaging, fluid, and conversational.

Icebreaker Ideas

When working with a group of educators who may or may not know each other, it's a good idea to provide a few moments to "break the ice." This allows people to relax, laugh, move, and get to know each other (and you). Below are just a few ideas you can use to begin a training session.

That's Me!

Read a statement aloud to the group. Ask participants to stand up, raise a hand in the air, and shout *That's me!* if the statement applies to them. It's fun to see which statements apply to all participants and which do not apply to any. Statements might include:

- *I teach at a family child care.*
- *I have worked with children for five years or more.*
- *I was born in Massachusetts.*
- *I write down the funny things that kids say.*
- *I laugh out loud at least once a day.*
- *I check Pinterest at least once a week.*
- *I have no idea what Pinterest is.*
- *I believe that there is no problem that good chocolate can't solve.*

You can come up with your own statements or invite a few participants to come up with statements. When they say their statement aloud, others (including you) can reply, *That's me!*

Weave a Web

Holding onto a ball of yarn, share your name and an interesting fact about yourself with participants. Keep the end piece as you toss the ball of yarn to a participant. Ask the participant to share his or her name and a personal fact, and hold onto the yarn as they toss the ball to another participant. Continue until everyone has had a turn and the "web" is complete.

Two Truths and a Lie

Ask participants to jot down two truths and one lie about themselves or their work with children. For example:

- *I speak Japanese.*
- *I am related to Davy Crockett.*
- *I have three sets of twins in my program this year.*

Form participants into small groups of three or four people. Have each person in the group read their statements aloud and ask the rest of the group to guess which statement is not true.

Four Corners

Post a word from a set of four related words in each corner of the room, such as:

- *lion, bear, eagle, deer*
- *desert, beach, mountain, city*
- *sushi, salad, enchilada, pizza*
- *hybrid, convertible, truck, Mustang*

Ask participants, *Are you a hybrid, convertible, truck, or Mustang?* Direct participants to move to the corner of the room with which they most identify. Ask participants, now in small groups in their corners, to share with one another why they chose that corner and how it represents their interests, so that they can discover common attributes they may share. Have each small group pick one person to share the group's common attributes with the larger group. Repeat the process with another set of four words as many times as you like.

People Bingo

Photocopy and distribute the "bingo card" below. Invite participants to find people who match a fact listed on the card and have them sign off on that fact. Each person can sign off on only one fact. Explain that when a participant has obtained five signatures in a row (horizontally, vertically, or diagonally), he or she should shout *Bingo!* and introduce the people who signed his or her card to the rest of the group.

People Bingo				
Has traveled outside the U.S.	**Likes pineapple on pizza**	**Has lived in MA for more than 10 years**	**Knows how to juggle**	**Has never been on a plane**
Can speak a foreign language	**Has 3 or more brothers**	**Likes to camp**	**Has been scuba diving**	**Reads the Sunday paper**
Likes to scrapbook	**Has a summer birthday**	**F R E E S P A C E**	**Likes to garden**	**Can say the alphabet backwards**
Likes math	**Does crossword puzzles**	**Owns a cat**	**Has been to Alaska**	**Likes to run**
Likes thunderstorms	**Has watched a meteor shower**	**Is afraid of snakes**	**Knows how to sew**	**Can play basketball**

Training

Introduction (15 minutes)

Welcome Participants to the Training

- Introduce yourself and share your background and experience.
- Announce the length of the training (1½–2 hours) and note other logistics, such as break times, restroom location, and so on.
- Review the agenda and explain the structure of the training.
    - Participants will watch an overview video and then three short videos that explore best practices in creating a learning environment.
    - After each video, participants will briefly discuss the main points and reflect on what they have learned.
    - Participants will also have the opportunity to share and reflect on their own practices.
- Share the learning goals and objectives. Participants will:
    - Explore the best practices for engaging children in science, technology, engineering, and math (STEM).
    - Learn how to plan activities that invite children to observe, explore, investigate, problem-solve, experiment, and design.
    - Explore ways to integrate STEM language throughout the day to help children think and act like scientists.
    - Examine strategies to help children reflect on new understandings.
    - Apply new knowledge to current practices.
- Introduce the Learning Log.
    - The Learning Log includes questions to help participants identify best practices and distill the important points made in each video. The *viewing questions* reinforce ideas from the videos. The *reflection questions* help educators draw connections to their own experiences.
    - The Learning Log can also be used to jot down notes, questions, and ideas.
- Consider doing an icebreaker activity to get participants "warmed up" and ready to learn and interact. (See Icebreakers Ideas for suggestions.)

- Ask each participant to identify a partner to work with during the training and encourage them to share ideas. (You can offer small group discussions if you prefer.)

Complete the Self-Assessment

Educators grow and hone their skills by continually identifying their own strengths and training needs and reflecting on their own practices.

- Invite participants to complete the first half of the Self-Assessment to help them discover the skills they already possess and to identify those they would like to work on.
- Explain that toward the end of the training, participants will complete the second half of the Self-Assessment to measure their growth and learning.

Engaging Children in STEM (5 minutes)

Introduce the Topic

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.

Introduce and View the Video

Introduce the overview video featuring Eleonora Villegas-Reimers, Associate Professor of Education at Wheelock College. Use this brief video to set the stage for a discussion of best practices in teaching STEM to young children.

"Engaging Children in STEM" (approx. 2 min)

Use Learning Centers to Engage Children In STEM (15–20 minutes)

Introduce the Best Practice

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.

Introduce and View the Video

Tell participants they will watch a video featuring center-based and family child care educators as they thoughtfully and intentionally plan activities that engage children in exploration, observation, and inquiry.

"Use Learning Centers to Engage Children in STEM" (approx. 4 min)

Ask participants to look for effective strategies used by the educators in the video. Use these questions to guide their viewing:

- *How does the learning environment support STEM explorations?*
- *What questions and comments do educators use to support children's STEM explorations?*
- *How do educators integrate literacy to deepen children's explorations and understanding?*

Partner/Small Group Share

After viewing the video, get participants thinking, talking, and learning together.

- Invite participants to share with each other, in pairs or small groups, what they noticed as they watched. Challenge them to use the language stem *I noticed…* rather than *I liked…*
- Suggest that participants jot down notes, ideas, or questions in their Learning Log.

Review

Share and expand on key points covered in the video. Use the following questions and talking points in your discussion. Ask participants to offer examples from the video as well as to draw upon their own experiences.

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.)

View Again (optional)

Emphasize the key messages by showing the video a second time, if possible. Seeing the video again will give participants an opportunity to notice things they may have missed and to expand their learning.

Reflect

Help participants make the connection between what they have learned and what they do in their own programs. Ask them to answer the *reflection questions* in the Learning Log.

Integrate STEM Vocabulary (15–20 minutes)

Introduce the Best Practice

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.

Introduce and View the Video

Tell participants they will see educators model for children how to use STEM vocabulary before, during and after an activity. They will also see how the educators encourage children to learn and use these words.

"Integrate STEM Vocabulary" (approx. 2 min)

Ask participants to look for effective strategies used by the educators in the video. Use these questions to guide their viewing:

- *How do educators model STEM vocabulary?*
- *How do educators prompt children to use STEM vocabulary to express their ideas?*

Partner/Small Group Share

After viewing the video, get participants thinking, talking, and learning together.

- Invite participants to share with each other, in pairs or small groups, what they noticed as they watched. Challenge them to use the language stem *I noticed…* rather than *I liked…*
- Suggest that participants jot down notes, ideas, or questions in their Learning Log.

Review

Share and expand on key points covered in the video. Use the following questions and talking points in your discussion. Ask participants to offer examples from the video as well as to draw upon their own experiences.

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.

View Again (optional)

Emphasize the key messages by showing the video a second time, if possible. Seeing the video again will give participants an opportunity to notice things they may have missed and to expand their learning.

Reflect

Help participants make the connection between what they have learned and what they do in their own programs. Ask them to answer the *reflection questions* in the Learning Log.

Break (optional) (5–10 minutes)

Guide Children to Reflect on New Understandings (15–20 minutes)

Introduce the Best Practice

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?)*

- **Use open-ended questions to challenge children to "go deeper"** as they express their own observations and ideas. For instance, *Why did the ice melt?* rather than, *Did the sun melt the ice?*
- **Help children record their observations, questions, findings, and thinking**. (Children can draw a picture or simple diagram, dictate their thoughts or observations, for an adult to record, or write a simple caption for a photograph)

Introduce and View the Video

Tell participants they will watch educators guide children in discussing, describing, and reflecting on what they have learned. They will see the educators use questions, videos clips, and charts as vehicles to support reflective thinking.

"Guide Children to Reflect on New Understandings" (approx. 3 min)

Ask participants to look for effective strategies used by the educators in the video. Use these questions to guide their viewing:

- *How do educators help children reflect on what they have done or observed?*
- *In what different do children reflect on their experiences?*

Partner/Small Group Share

After viewing the video, get participants thinking, talking, and learning together.

- Invite participants to share with each other, in pairs or small groups, what they noticed as they watched. Challenge them to use the language stem *I noticed…* rather than *I liked…*
- Suggest that participants jot down notes, ideas, or questions in their Learning Log.

Review

Share and expand on key points covered in the video. Use the following questions and talking points in your discussion. Ask participants to offer examples from the video as well as to draw upon their own experiences.

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?)*

View Again (optional)

Emphasize the key messages by showing the video a second time, if possible. Seeing the video again will give participants an opportunity to notice things they may have missed and to expand their learning.

Reflect

Help participants make the connection between what they have learned and what they do in their own program. Ask them to answer the reflection questions in the Learning Log.

Try It (15–20 minutes)

The Try It activity helps educators plan how to apply new ideas to their own early childhood program. Ask participants to work with a partner and direct their attention to the Try It handout in their packets.

STEM Savvy

Participants will design a STEM-rich learning center.

- Have partners identify a new or existing learning center that is in each of their programs.
- Invite them to design an activity for the center that encompasses a combination of science, technology, engineering, and math skills.
- Ask pairs to describe the activity and materials at the learning center.
- Together, have them list the STEM concepts they want children to learn from the experience.
- Then, have them list key STEM vocabulary they will integrate into the exploration.
- Next, have pairs think of two or three open-ended questions they would ask while working with children.
- Finally, ask pairs to think about how they will engage children in reflection and record their thinking.

Wrap Up (5–10 minutes)

- Invite participants to complete the second half of the "Self-Assessment" and then measure their growth and learning.
- Ask participants to look over their notes from the training and jot down three things that they want to remember from today in their Learning Log.
- Invite partners or small groups to meet and share their three "keepers." Then ask a few participants to share their "keepers" with the larger group.

- Thank participants for attending. Remind them to revisit the video or get activity ideas at Resources for Early Learning: http://resourcesforearlylearning.org/
- Encourage them to fill out and return the Training Evaluation.

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

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Self-Assessment

Name: _____ **Date:** _____

Before the training: Place a ✓ in the box that best represents your current comfort level.
After the training: Place a ✓ in the box that best represents your new comfort level.

1 = Very uncomfortable 2 = Uncomfortable 3 = Neutral 4 = Comfortable 5 = Very comfortable

	Before					After				
	1	2	3	4	5	1	2	3	4	5
General **I am comfortable with my ability to . . .**										
Understand what STEM education is.										
Recognize opportunities for STEM exploration that already exist in my early childhood program.										
Engage children in all aspects of STEM.										
Use Learning Centers to Engage Children in STEM **I am comfortable with my ability to . . .**										
Use existing learning centers to engage children in collaborating, planning, investigating, designing, and problem-solving.										
Plan for and create additional learning centers that invite children to use STEM.										
Use learning centers to integrate skills that go beyond STEM (e.g., critical thinking, communicating, and collaborating.)										
Ask open-ended questions that prompt children to think deeply and integrate STEM language.										
Integrate STEM Vocabulary **I am comfortable with my ability to . . .**										
Label children's actions. (Point out when they *observe, predict, investigate, compare, design, build,* etc.)										
View almost every activity as an opportunity to model the language that scientists use. (e.g., *experiment, predict, explore, compare, describe, record*)										
Guide Children to Reflect on New Understandings **I am comfortable with my ability to . . .**										
Prompt children to reflect upon and summarize their learning by looking back at a prediction and comparing it to what happened.										
Prompt children to reflect upon and summarize their learning by reviewing their experiences and observations and coming to a conclusion or explanation.										
Prompt children to reflect upon and summarize their learning by looking at related experiences and making connections to their own.										

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WGBH

Department of Early Education and Care

Learning Log

Use Learning Centers to Engage Children in STEM

View

In the video:

- *How does the learning environment support STEM explorations?*

- *What questions and comments do educators use to support children's STEM explorations?*

- *How do educators integrate literacy to deepen children's explorations and understanding?*

Reflect

In your program:

- *How do you use your existing learning centers to engage children in STEM?*

- *What did you learn that you will put into practice in your learning environment?*

Notes

Integrate STEM Vocabulary

View

In the video:

- *How do educators model STEM vocabulary?*

- *How do educators prompt children to use STEM vocabulary to express their ideas?*

Reflect

In your program:

- *What strategies do you use to model and integrate the language and vocabulary of STEM?*

- *What did you learn that you will put into practice in your learning environment?*

Notes

Guide Children to Reflect on New Understandings

View

In the video:

- *How do educators help children reflect on what they have done or observed?*

- *In what different do children reflect on their experiences?*

Reflect

In your program:

- *How do you guide children to reflect on what they have learned?*

- *What did you learn that you will put into practice in your learning environment?*

Notes

Produced by WGBH for the Massachusetts Department of Early Education and Care with federal funds from The Race to the Top – Early Learning Challenge Grant.

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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Try It

STEM Savvy

Design a STEM-rich learning center.

1. Identify a new or existing learning center in your program.
2. Design an activity for the center that encompasses a combination of science, technology, engineering, and math skills.
3. Describe the activity and materials.

What STEM concepts do you want children to learn at this center?

What STEM vocabulary will you integrate into the exploration?

What open-ended questions will you ask children as they are exploring?

How will you ask children to reflect? How will you or the children record the findings?

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Learning Guidelines and Standards

This professional development training module is aligned to Massachusetts standards and guidelines.

Massachusetts Quality Rating and Improvement System (QRIS)

Center and School Based:

- **Curriculum and Learning 1B: Teacher-Child Relationships and Interactions: Level 3** Staff engage children in meaningful conversations, use open-ended questions and provide opportunities throughout the day to scaffold their development of more complex receptive and expressive language, support children's use of language to share ideas, problem solve and have positive peer interactions.
- **Curriculum and Learning 1B: Teacher-Child Relationships and Interactions: Level 4** Staff utilizes teaching strategies that ensure a positive classroom environment, engage children in learning and promote critical thinking skills.

Family Child Care:

- **Curriculum and Learning 1B: Teacher-Child Relationships and Interactions: Level 4** Educators engage children in meaningful conversations, as age and developmentally appropriate, use open- ended questions and provide opportunities throughout the day to scaffold their language to support the development of more complex receptive and expressive language, support children's use of language to share ideas, problem solve and have positive peer interactions; Educators utilize teaching strategies that ensure a positive learning environment, engage children in learning and promote critical thinking skills.

National Association for the Education of Young Children (NAEYC)

Guidelines for Developmentally Appropriate Practice:

- **2) Teaching to enhance development and learning D** Teachers plan for learning experiences that effectively implement a comprehensive curriculum so that children attain key goals across the domains (physical, social, emotional, cognitive) and across

the disciplines (language literacy, including English acquisition, mathematics, social studies, science, art, music, physical education, and health).

- **(2) Teaching to enhance development and learning E** Teachers plan the environment, schedule, and daily activities to promote each child's learning and development.
- **(2) Teaching to enhance development and learning E.1** Teachers arrange firsthand, meaningful experiences that are intellectually and creatively stimulating, invite exploration and investigation, and engage children's active, sustained involvement. They do this by providing a rich variety of materials, challenges, and ideas that are worthy of children's attention.
- **(2) Teaching to enhance development and learning E.2** Teachers present children with opportunities to make meaningful choices, especially in child-choice activity periods. They assist and guide children who are not yet able to enjoy and make good use of such periods.
- **(2) Teaching to enhance development and learning E.3** Teachers organize the daily and weekly schedule to provide children with extended blocks of time in which to engage in sustained play, investigation, exploration, and interaction (with adults and peers).
- **(2) Teaching to enhance development and learning E.4** Teachers provide experiences, materials, and interactions to enable children to engage in play that allows them to stretch their boundaries to the fullest in their imagination, language, interaction, and self-regulation as well as to practice their newly acquired skills.
- **(2) Teaching to enhance development and learning F** Teachers possess an extensive repertoire of skills and strategies they are able to draw on, and they know how and when to choose among them, to effectively promote each child's learning and development at that moment. Those skills include the ability to adapt curriculum, activities, and materials to ensure full participation of all children. Those strategies include, but are not limited to, acknowledging, encouraging, giving specific feedback, modeling, demonstrating, adding challenge, giving cues or other assistance, providing information, and giving directions.
- **(2) Teaching to enhance development and learning F.2** To stimulate children's thinking and extend their learning, teachers pose problems, ask questions, and make comments and suggestions.
- **(2) Teaching to enhance development and learning F.3** To extend the range of children's interests and the scope of their thought, teachers present novel experiences and introduce stimulating ideas, problems, experiences, or hypotheses.

- **(2) Teaching to enhance development and learning F.6** To enhance children's conceptual understanding, teachers use various strategies, including intensive interview and conversation, that encourage children to reflect on and "revisit" their experiences.
- **(2) Teaching to enhance development and learning H** Teachers know how and when to use the various learning formats/contexts most strategically.
- **(2) Teaching to enhance development and learning H.2** Teachers think carefully about which learning format is best for helping children achieve a desired goal, given the children's ages, development, abilities, temperaments, etc.
- **(2) Teaching to enhance development and learning J.1** Teachers incorporate a wide variety of experiences, materials and equipment, and teaching strategies to accommodate the range of children's individual differences in development, skills and abilities, prior experiences, needs, and interests.
- **(3) Planning curriculum to achieve important goals A** Desired goals that are important in young children's learning and development have been identified and clearly articulated.
- **(3) Planning curriculum to achieve important goals A.1** Teachers consider what children should know, understand, and be able to do across the domains of physical, social, emotional, and cognitive development and across the disciplines, including language, literacy, mathematics, social studies, science, art, music, physical education, and health.
- **(3) Planning curriculum to achieve important goals C.1** Teachers are familiar with the understandings and skills key for that age group in each domain (physical, social, emotional, cognitive), including how learning and development in one domain impact the other domains.
- **(3) Planning curriculum to achieve important goals D** Teachers make meaningful connections a priority in the learning experiences they provide children, to reflect that all learners, and certainly young children, learn best when the concepts, language, and skills they encounter are related to something they know and care about, and when the new learnings are themselves interconnected in meaningful, coherent ways.
- **(3) Planning curriculum to achieve important goals D.2** Teachers plan curriculum experiences to draw on children's own interests and introduce children to things likely to interest them, in recognition that developing and extending children's interests is particularly important during the pre- school years, when children's ability to focus their attention is in its early stages.

Training Evaluation

Thank you for your participation. Please indicate your impressions of the training below.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The training met my expectations.					
I will be able to apply what I have learned.					
The trainer was knowledgeable.					
The training was organized and easy to follow.					
Participation and interaction was encouraged.					
The handouts were pertinent and useful.					

1. How would you rate this training overall?

Excellent *Good* *Average* *Poor*

2. What was most beneficial to you in this training?

3. What suggestions do you have to improve this training?

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