STEM in Early Childhood

Teaching Young Learners to Ask Questions and Solve Problems

What is STEM?

STEM is an acronym for:

- **S**cience
- **T**echnology
- **E**ngineering
- **M**athematics

STEM has come to be associated with an approach to teaching and learning that integrates the content and skills of science, technology, engineering and math.

Why are we focused on STEM now?

- 2006: Programme for International Student Assessment (PISA) comparison of 30 developed countries:
  - American students ranked 21st in science literacy and 25th in math literacy.
- 2009: National Assessment of Educational Progress (NAEP):
  - Fourth grade students showed no signs of progress for the first time in many years and 8th grade students showed only moderate progress.
  - President Obama announced the *Educate to Innovate* initiative to improve student participation and performance in STEM education.

But STEM in Early Learning?

- Young learners are naturally curious and questioning.
- Early learners are natural scientists.
- STEM education sparks a child's interest in science, technology and math.
- Foundations of scientific learning are *inquiry* and *exploration;* both are elements of STEM.
- STEM encourages developmentally appropriate instruction as children explore the world around them.

Connecting Practice with Research

In 2010 Lilian Katz described two types of learning that occur in early childhood classrooms: academic and intellectual.

Katz, Lilian G., STEM in the Early Years, SEED Papers, Fall 2010
http://ecrp.uiuc.edu/beyond/seed/katz.html

Academic vs. Intellectual Learning

Academic Learning

- Passive
- Small discreet bits of information
- Items learned require correct answers
- Relies heavily on memorization
- Clear, i.e. the alphabet

Intellectual Learning

- Active
- Emphasizes reasoning, hypothesizing, predicting, development and analysis of ideas
- Natural
- Builds on children's interests and questions
- Promotes higher level thinking skills

Intellectual Pursuits and STEM

Katz concludes: "An appropriate curriculum in the early years is one that encourages and motivates children to seek mastery of basic academic skills *in the service of their intellectual pursuits,"* such as reasoning, hypothesizing, predicting, as well as the development and analysis of ideas.

These higher level thinking skills are the educational goals of STEM curricular projects.

How Can I Teach STEM in my Early Childhood Classroom?

The good news- you are probably already doing it!!!

- Children explore, discover, build, experiment, predict, hypothesize and integrate knowledge as they try to make sense of the world.

- You provide the stimulation, materials, and freedom to explore.

Setting the Stage

- Teach your students how to think and act like scientists. Provide many opportunities to develop inquiry skills (making observations, asking questions.)

- Pay attention to your students' interests; gather related resources to engage them in problem-solving.

- Set a tone for responding to student observations with genuine interest (model); notice and name "good listening" *between* students, as well.

- Allocate time and space for exploration.

Guiding an Investigation

1. **Determine Purpose**: Prepare (or notice) an event that suggests further exploration.

   Teacher: "Wow! That tennis ball rolled all the way across the carpet. I wonder if we can make it do that again. I wonder if this golf ball will do the same thing. What do you think? Let's try it."

Guiding an Investigation

2. **Discuss**: Guide an exchange of observations and ideas (in large or small group.) Use phrases, such as "I wonder," "What would happen if?", "I think," and "How do we know?" Encourage predictions.

   Teacher: "That was really fun rolling balls in our classroom today. Did you notice if the balls rolled the same way, or were they different? Did some roll farther than others? I wonder if we could make some of them roll even farther…what would happen if we rolled them down a ramp? What do you think?"

Guiding an Investigation

3. Experiment: Organize opportunities for testing hypotheses. (Gather materials, prepare space, allocate time.)

    Teacher: "Let's think about what might happen when we roll these two balls down this ramp; let's make a prediction. Now, who would like to test our prediction to see if we are right?"

Guiding an Investigation

4. **Document**: Record the data and observations (literacy and numeracy skills.)

    Teacher: "I noticed you two are working together. That's a good way to share ideas and learn new things. I see you put a sticker on the paper to show how far the golf ball rolled. Let's measure how far it went with these blocks. Now you can put a different sticker for the tennis ball." ("We can write our names on this sign-up list so everyone can get a turn.")

Guiding an Investigation

5. **REFLECT**: Discuss the experience and/or experiments. Interpret the data; consider extensions and applications. (This final step is critical!)

    Teacher: "Let's take a look at the pictures and words we have from our friends in the ball area. Boys, can you come up and tell us what happened when you rolled the balls down the ramp? What happened when you tried different balls? Do you think the same thing would happen if other people tried this? What might happen if we tried cars?"

The Process in Review

1. Determine Purpose
2. Discuss
3. Experiment
4. Document
5. REFLECT

Check Your Understanding

Follow the link below (from the Fred Rogers Center ELE website) to find a video clip of a teacher guiding an inquiry activity with preschool children. As you watch, look for ways the teacher follows the investigative process.

http://ele.fredrogerscenter.org/activity/a-wonderful-place?page=3

(Click "Go To Activity" after you connect the link.)

What Do You Think?

Which steps of the process were evident in the clip?

[A](). Determine Purpose and Discuss

[B](). Experiment

[C](). Document

[D](). Reflect

[E](). A and B above

[F](). C and D above

(Click on the letter for your response above)

Think Again

Even though the paper towels and paper scraps remained as a record of the experiment, they were not recognized as such by the teacher or students. It is important for children to understand that documenting results is an important step in developing conclusions and reporting results to others.

Perhaps because the clip was brief, we were unable to see evidence of a reflective discussion. This step is critical to bringing closure and contextual understanding to the experience. The children need to talk about why this finding is important in their world.

[Try again☺](#)

Good For You

You have learned to recognize the critical elements of the inquiry process. You're ready to move on toward developing a deeper appreciation for inquiry learning, and incorporating STEM goals in your classroom.
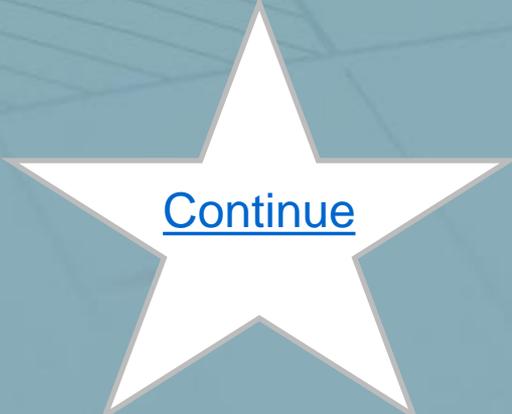
Continue

Digging Deeper

The following video clip provides a more in-depth picture of the kinds of explorations and learning that can result from an investigative approach. As you watch, consider how you might set up an exploration area outside your classroom. (This clip comes from the "TES" website in the United Kingdom; 14 minutes)

http://www.tes.co.uk/teaching-resource/Listening-and-Questioning-6083778/

Start Your Engines

- The following activities are intended to give you a start on incorporating inquiry learning and STEM objectives in your classroom.

- General activity descriptions are offered in the slideshow. Specific and detailed lesson plans are offered as separate, printable documents on this site.

A Word About Technology

- Each of the following activities incorporates technology as a tool to assist in the development of science, engineering, and mathematics skills.

- Depending on the tools you have available, you could also include the use of a data projector and interactive whiteboard to enhance the sharing of collected data.

- Digital cameras offer excellent opportunities to document the investigative process from start to finish.

How Strong Are Magnets?

General Objective: To promote curiosity about magnets; to practice the investigative process.

Exploration: Students explore the power of magnets using various magnetic and non-magnetic items.

Experiment: Students compare the strength of various magnets (in terms of numbers of papers held.)

Document: Students record data on a chart.

Reflect: Students share data chart and draw conclusions about strength of various magnets. (Classroom use of magnets/display area can be established for future use.)

Magnets (continued)

- **Prompt Student Thinking** by asking questions such as: "I wonder what kinds of things are attracted to magnets." "Are all magnets the same?" "How can we measure which magnets are stronger?" "What will happen if we try to hold this paper between the magnet and the metal surface?"

- **Curriculum Extensions:**

  – Math: counting, balancing, measuring weight, concept of number, numeral recognition

  – Writing: journals, shared writing, print awareness, alphabet knowledge, sound/letter association

- **Using Technology**: digital cameras, I-Pad

Will Plants Grow Without Light?

General Objective: To promote curiosity and understanding of the elements necessary for plant growth.

Exploration: Students observe two plants; one healthy, one struggling. Students make predictions about plant care and growth.

Experiment: Students plant seeds in two (or more) pots. Provide light for one; dark for the other.

Document: Students draw pictures in journals to show differences in plants.

Reflect: Students report (using drawings) and draw conclusions about light and plant growth.

Plant Growth (continued)

- **Prompt Student Thinking** by asking questions such as: "I wonder what will happen if we put one plant in the closet?" "How can we get the soil in the pots?" "How can we measure which plant is bigger?" "What will happen if we give this plant light now?"

- **Curriculum Extensions:**

  – Math: standard and non-standard measurement, counting, concept of number, numeral recognition

  – Writing: journals, shared writing, print awareness, sound/letter association, alphabet knowledge

- **Using Technology**: digital cameras, I-Pad, magnifying lens

Marble Runways

General Objective: To promote curiosity about marbles and gravity; to practice the investigative process.

Exploration: Students explore the properties and behavior of marbles, using various materials as runways.

Experiment: Students compare the behavior and speed of marbles as they descend various runways of different material and different positions.

Document: Students time and compare data showing speed of descent.

Reflect: Students share data chart and draw conclusions about properties that influence speed.

Marble Runways (continued)

- **Prompt Student Thinking** by asking questions such as: "I wonder what will happen if we drop a marble down this runway." "Did it move fast? "Do you think we can make it go faster?" "How can we measure the speed?" "What will happen if we change the runway?"

- **Curriculum Extensions:**

  – Math: time measurement, counting, numeral recognition, concept of number

  – Writing: journals, print awareness, shared writing, alphabet knowledge, sound/letter correspondence

- **Using Technology**: digital cameras, I-Pad, timers

Balls and Ramps

<u>General Objective</u>: To promote curiosity about balls and gravity; to practice the investigative process.

<u>Exploration</u>: Students explore the properties and behavior of balls, using various materials as ramps.

<u>Experiment</u>: Students compare the behavior and distance traveled by balls as they descend various ramps of different material and different positions.

<u>Document</u>: Students compare data showing the distance balls travel beyond the ramps.

<u>Reflect</u>: Students share data chart and draw conclusions about properties that influence distance traveled.

Balls and Ramps (continued)

- **Prompt Student Thinking** by asking questions such as: "I wonder what will happen if we roll these two balls across the carpet." "How do you think we might make them roll farther?" "What do you think will happen if we roll a ball down this ramp?" "What will happen if we change the ramp?"

- **Curriculum Extensions:**

  - Math: measurement using non-standard units, counting, numeral recognition, concept of number

  - Writing: journals, print awareness, shared writing, alphabet knowledge, sound/letter correspondence

- **Using Technology**: digital cameras, I-Pad

Block Structures

General Objective: To promote curiosity about building with blocks; exploring shapes, foundations and gravity.

Exploration: Students explore the properties of structures built from blocks, using various configurations.

Experiment: Students compare various structures to see which can withstand wind.

Document: Students record data showing the number of blocks and design used to resist increasing amounts of wind.

Reflect: Students share data chart and draw conclusions about properties that influence structure sturdiness.

Block Structures (continued)

- **Prompt Student Thinking** by asking questions such as: "I wonder how we might build a house that would stand up to the wolf (in the <u>Three Little Pigs</u>)." "How do you think we might make a strong house?" "What do you think will happen if we blow on these blocks?" "What will happen if we use this fan to make more wind?"

- **Curriculum Extensions:**

  – Math: properties of shapes, spatial relationships, counting, numeral recognition, concept of number

  – Writing: journals, print awareness, shared writing, alphabet knowledge, sound/letter correspondence

- **Using Technology**: digital cameras, I-Pad, electric fan

Sand Castles

General Objective: To promote understanding of the properties of sand and changes that occur when water is added.

Exploration: Students build sand castles, adding water to dry sand to observe changes in density of castles.

Experiment: Students compare sand structures formed with varying amounts of water.

Document: Students measure the height of sand castles and draw pictures to document the effects of water.

Reflect: Students share their pictures and discuss their findings.

Sand Castles (continued)

- **Prompt Student Thinking** by asking questions such as: "How can we make the best castle?" "How can we measure the castles?" "What will happen if we add a *lot* of water to the sand?"

- **Curriculum Extensions**:

  – Math: standard and non-standard measurement, counting, number recognition, concept of number

  – Writing*:* journals, recording data, shared writing, print awareness, alphabet and phonological knowledge

- **Using Technology:** digital camera, video camera, I-pad, computer

Shapes, Shapes, Everywhere

General Purpose: To promote awareness of shapes in the environment; to introduce data collection and analysis through graphing.

Exploration: Students explore solid shapes, their importance in everyday life, and how they can be used to build new structures.

Experiment: Students collect and compare solid shapes; build structures, and create representational graphs.

Document: Students place objects on a large floor graph, draw pictures of structures they create, and survey peers for favorite shapes.

Reflect: Students will discuss the graph, share their pictures and/or structures, and share observations of shapes they find in their environment.

Shapes (continued)

- **Prompt Student Thinking** by asking questions such as: "Have you ever seen something shaped like this in your house?" "What can you do with this?" "Can we put these shapes together to create something new?" "I wonder if we have more [spheres] or [cylinders]? How can we find out?"

- **Curriculum Extensions**:

  - Math: data analysis, graphing, comparing quantities

  - Writing: journals, shared writing, print awareness

- **Using Technology**: digital camera, video camera, computer, I-Pad, flashlight

Make It Happen

You will find a "Customized Action Plan" PDF document on our website to help you formulate a plan for implementing STEM projects in your classroom. You can select your favorite activity from the initial drop box menu, and then complete the remaining items based on your individual situation. You can then print your action plan, and move forward with your students.

Summary

- The key to effective instruction and learning is engagement.

- STEM investigations are about problem-solving and inquiry; not fact-finding.

- Today's children need to develop the skills to ask questions, collect evidence, and make decisions.

Resources

- Detailed lesson plans for each of the suggested activities are located on our site: www.edsolutionsllc.info .

- Lists of popular stories to accompany the activities are also available for printing.

- Websites offering additional video clips of children and teachers practicing explorations are also listed on this site.