Sample school-age active STEM learning experiences

Facilitator notes: As you introduce and guide the suggested science, math, and engineering-based experiences, the following strategies can increase the amount of STEM learning that occurs and STEM skills that are used:

1. Ask the children to make predictions before carrying out steps in the experiment: "I think _____ because _____."

2. As children play, create, and discover, circulate among the groups and ask what they notice. Encourage them to measure, document, or photograph observations and discoveries.

3. Encourage children to vary a few things and see how it impacts the outcomes. Ask questions like "I wonder what would happen if….." or "What else would be interesting to try?"

4. Revisit the predictions after the experiment is over to see if they were correct.

5. Celebrate the fun—share with peers, take pictures, digitally record experiments in process, make displays, and report discoveries to family members at pick-up time. Funders and administrators may also be very interested in reviewing displays of STEM learning.

Facilitators should:

- Allow for ample time to explore variations of the original experience. (Children may want to explore them several afternoons in a row. The best active learning experiences are not completed in one short time period but are investigations that children return to, wonder about, and experiment with over time.)
- Expect varied outcomes.
- Invite additional ideas and questions to be investigated in the future.
- Plan for time at the end of the experience to reflect on discoveries or designs and to share excitement and accomplishments.

Sample STEM experience suggestions to inspire you

Inquiry suggestions below are listed within specific STEM categories, but they often involve two or more components of STEM. Review the descriptions and consider how they each include characteristics of active learning—such as allowing movement, noise, hands-on engagement, exploration of materials, child-choice, and variation on a general question—with open-ended and varied results. These are just a few of the thousands of possibilities of messy, open-ended explorations that invite school-age children and teens to be creative and curious—starting points from which children and staff can explore for weeks.

Which of these suggestions might move your program to a higher degree of active engagement than currently? Match your program's children's interests and knowledge, your preferences and expertise to these subject areas as a starting place. Staff can check out the resource books and websites for additional ideas from this small potpourri of suggestions. Better yet, ask the children what they would like to investigate next: "We're putting plans together for next week. What's something else you would like to try out?"

Chemistry explorations

Make Glurch

Explore material concepts like fluidity, elasticity, viscidity. Children can experiment with this recipe by adding more or less powder.

Ingredients:

2 teaspoons Borax powder

1 cup warm water

2 cups white glue

1-1/2 cups cool water

2 bowls

Spoon

Procedure:

Measure 2 teaspoons of the Borax into a bowl. Measure 1 cup of warm water and pour it into the Borax powder. Stir until dissolved. Set aside. Measure 2 cups of glue into another bowl. Measure 1-1/2 cups of cool water and pour it in with the glue – mix well. Pour the Borax and water mixture into the glue. Mix with your hands or a spoon.

Make Oobleck

Oobleck is a colloid that moves from a solid to a liquid and back again.

Ingredients:

1 cup water

1-1/2 cups cornstarch

Mixing bowl

Spoon

Procedure:

Pour 1 cup water into a mixing bowl. Measure 1-1/2 cups cornstarch. Add 1 tablespoon cornstarch to the water, and mix it in. Keep adding cornstarch and mixing it in. When your solution gets very difficult to stir, you have Oobleck. Scoop some up with your hand, and watch how it oozes back into the bowl. Use your fist to punch the ooze, and observe what happens.

Make scented, tinted play dough

Ingredients:

1-1/2 cup flour

¼ cup salt

1 pack unsweetened drink mix

2 tablespoons oil

½ cup hot water (warm tap water works)

Procedure:

Mix all dry ingredients together. Add oil and hot water. Mix until blended. If mix is too sticky add a bit more flour. If too dry, add a bit more oil. Store in an airtight container.

Biology explorations

Outdoor walk

Choose partners. Each pair gets a basket or bag to collect natural items that are interesting or beautiful to them. If possible have magnifiers available. This simple opportunity awakens a child's senses, including his sense of wonder. Once back inside, children can sort, categorize, investigate, dissect, create collages, photograph, display, or even use the items as building or painting tools.

Spontaneous nature observations

Magnifiers, containers, and digital cameras are helpful tools to support this active investigation. For example, stop other activity and call a group huddle to look at an amazing spider web that a child in the program discovered. Watch the spider work. For interested children, research the type of spider that it might be; create webs with natural materials.

Ecology explorations

Set up a rain gauge, thermometer, or other weather tracking equipment in an outdoor area near the program. Indoor barometers are also interesting, inexpensive indicators to have in the classroom that help predict weather changes. After a weather event or on a daily basis, ask children to record readings from the equipment. Compare them to readings reported on the local weather website or to the posted weather forecast. Encourage children to create their own study ideas around weather tracking. Some weather tracking equipment can be built by children. Children may want to place similar equipment at their homes and compare results.

Physics explorations

Balloons aloft

One way to explore air movement is through balloon play. Going outdoors makes it extra challenging and fun.

Materials needed:

Package of balloons, enough for extras

Drinking straw

Open space so children can move

Procedure:

Inflate balloons. Challenge children to keep them aloft by blowing through the straws. Natural air movement and other children's body movements may add extra challenges. Encourage children to use variations that they come up with: teams of children keeping one balloon afloat, trying to direct a balloon to a designated goal, testing balloons with different inflation levels. "Can you make the balloon go back and forth between you and Emma?" (Moomaw)

Pendulum art

Supplies needed:

Plastic bottle with a pull-top (like a water bottle or dish detergent squeeze bottle)

Yarn Scissors Tempera paint Large sheets of paper

Procedure:

Cut the bottom of the squeeze bottle off and poke four holes evenly around the opening, just below the cut edge of the container. Thread long pieces of yarn through the holes and tie. Hang this container (nozzle end down) from a suspended position (for example a crossbar on playground equipment, horizontal tree branch, or the brace of a step ladder). Place large sheets of paper beneath the plastic bottle. Make sure the bottle nozzle is closed. Fill the bottle half-way with slightly thinned tempera paint. Open the nozzle, give the paint pendulum a push, and observe the paint patterns that are created as it swings.
Try variations: thinner paint, several colors of paint, different style of push, etc. (Mama Scout)

Engineering explorations

The marshmallow-spaghetti tower challenge

This team building exercise, now famous in corporate circles, is a great way to engage children and youth in using their creativity and engineering skills.

Basic supplies include:

20 pieces of regular thickness, uncooked spaghetti

One yard of masking tape

One yard of string

One standard sized marshmallow

The challenge is to see how tall a tower the team can build in a limited amount of time. For specific facilitation instructions go to http://marshmallowchallenge.com/Instructions.html

Let's have a ball

What makes a bowling ball good at knocking down pins or a basketball bounce? Youth work in small groups to design a ball appropriate for an assigned task. Children may be assigned a quality like "rolls the farthest," "strongest/knocks over the most," "biggest bounce," "easiest to catch," etc. Children will design both the ball and the test for the ball's quality. Have available a variety of household supplies like rubber bands, play dough/clay/model magic, masking tape, newspaper, balloons, yarn, foil, felt, empty water bottles/containers, etc. Explore questions like "How does the rolling change when I change the shape in this way?", "How can I make it heavier?", "What happens if I make it heavier?", and "What happens if I put holes in it?" Record trial runs and analyze the data. (McCreedy and Zemsky 2002)

Computer/Phone/Camera technology explorations

Take photos

Encourage children to take photos on a walk in the neighborhood, during a field trip, or on a "design" exploration inside the program facility to capture architecture design that they want to replicate in their block or sculpture creations.

Geo-caching

Use geo-caching or a similar GPS-based adventure at a local park. Check online for ideas.

Time-lapse photography of a nature subject

For a given period of time (a week, a month, nine months) allow children to take regular photos of something in their natural world. Study the photos and document and discuss the changes observed. Make predictions about anticipated changes or growth. Create displays of the nature observation project. As an alternative, tune in to a live stream on a website of a bird's nest, a bear's den, a forest feeding site, or other nature site. Regularly check in and discuss the changes taking place.

Explore macro and micro technology

Children explore their world, and take photographs of familiar items. Then they use the zoom feature on the camera or photo-display software to isolate an interesting portion of the photo and create a guessing game for use with their peers. Children can use cropping tools, color printing, and other actions in creating the guessing cards. Extend this exploration by exploring http://apod.nasa.gov/apod/ap120312.html

Math explorations

Child-led, staff-guided elections and sales

Incorporate many math and planning skills as children decide to offer bake sales, art sales, field trip selections, and snack selections, among other possibilities. Children can cost-out the expenses, choose items, fix pricing, advertise, conduct sales, plan and create ballots for elections, and more.

Any food preparation, baking, or cooking experience involves math, use of tools, and exploration of ingredients. Some also involve chemical changes. An easy fruit tart recipe can be found at cookingmatters.org/recipes/

Estimation station

Establish an area that has an "estimation" question on an on-going basis. Enlist child volunteers to bring in items for the rest of the group to estimate. Children write their name and their guess on a chart. Guesses can be graphed. Either immediately or at a later time, children can check their estimate against the actual answer. Encourage them to answer questions like "Was my guess too small? Too large? Close to the actual number?" Possible estimation items might be: How many seeds are in this apple? How many sheets of paper are in this tablet? How much water will be created when this quart of snow melts? How many kernels are on this ear of field corn? The children are responsible for quantifying the results. (eHow.com)

Geometry explorations

Paper folding and paper cutting explorations like snowflakes, origami, and fortune tellers are great ways to actively engage with geometry and spatial relations, patterning, and design.

STEM experiences requiring little or no equipment

Science at your fingertips

Needed: 2 people 1 chair

Ask for one child to come forward to partner with an adult volunteer/staff member. Have the adult sit in the chair and have the child stand in front of the chair at arm's length from the adult. Ask the group to suggest ways for the child to keep the adult seated in the chair. Test some of the suggested ideas (that are doable). When the children have run out of suggestions, ask the adult to sit straight against the back of the chair with feet together. Ask the child standing in front to place an index finger on the adult's forehead. Ask the adult in the chair to try to stand up. Once the demonstration has finished, allow other children to experiment among themselves or invite other adults to sit in the chair.

The science of this activity: The fingertip prevents the adult or partner from leaning forward. Without the fingertip, the partner would be able to lean forward, which moves the center of balance forward, and allows the adult to stand. (McCreedy and Zemsky 2002)

STEM experiences requiring little or no equipment, continued

Battleship (paper version)

The well-known board game actually began as a pen-and-paper game for two. The object is to "hit" your opponent's ships on her grid by making strategic guesses as to where they are. Create two grids for each player that are sectioned out 11 by 11; the top row marked 1-10, the side column reading A-J. (The top, left-hand corner square will be blank.) Each player gets the following:

- 1 carrier (5 squares)
- 2 battleships (4 squares each)
- 3 destroyers (2 squares each)
- 2 cruisers (3 squares each)
- 1 submarine (3 squares)

Have the children outline all their own ships on one grid, then they take turns guessing the other's coordinates, using their other grid to mark down and keep track of their guesses. Use one type of mark for a guess that misses and another type of mark for a hit. When one player hits all the squares of the ship, it's been sunk. Make guesses until all the ships are sunk. (How Stuff Works)

Elevens

In this one-player game, a child turns over nine playing cards at a time and tries to find groups of cards that add up to eleven. Change the sum to another number for additional practice. Students can also play "Seventeen" with a partner: Separate the deck so you have only aces and number cards two through eight. Each player gets five cards. The first player plays any card; the next player adds the card she plays to the first card played. The object is to get as close as possible to 17 without going over. The next hand begins after the winner gets as close as possible to seventeen and no one else can play a card. (eHow.com)

Hibernation heartbeat

Animal heartbeats slow down during winter hibernation. A slumbering black bear's heart rate is 40-50 beats per minute, but its heart may beat only 8 times each minute during hibernation. Investigate the difference between human heart beats during rest and activity. Work in pairs. One child watches a timer or clock, calling out start and stop for a minute time period. Have the other child hold her hand over her heart and count the number of times her heart beats in one minute. Children may be able to also feel the pulse at their wrist. Write down the number of beats. Now challenge the child to run (hard) in place for one minute. Recheck the heart beats per minute after the run is completed. Record this number and then compare. What other questions or challenges about heartbeats could children think of to measure? (eHow.com)

Simple experiences using your OST setting

(backyard, playground, gym)

Tracing shadows

Materials needed:

Sidewalk chalk

Sunshine

Digital camera (optional)

Plan for a time not too close to noon, so shadows are prominent. Children work in pairs, and as one child poses/stands still, another child uses chalk to trace the partner's shadow. Label shadows with the child's name and time of day. Notice the shadow is the reverse projection of the body (child lifts left arm but it appears the shadow's right arm is raised). If possible, return to the same spot later and trace a new shadow using a different color chalk. Consider the changes to the shadow. What causes those changes? What is the relationship between the position of the sun and the shape of the shadows? (Moomaw)

Fence percussion

Materials needed:

Spoons or other striking items

Invite children to create rhythmic patterns on the playground fence. Vary the taps, strums, force of striking, and striking instrument. Add vocalizations to complement the percussion. Layer one person's percussion pattern over another's. Experiment with similar percussion challenges on websites like http://www.patatap.com/ http://fizzd.itch.io/rhythm-doctor or http://www.incredibox.com/v3/# . (Moomaw)

For more ideas, check out these websites:

http://apod.nasa.gov/apod/ Astronomy Picture of the Day. View an astronomy picture or image of the day with descriptions and explanations. Each day a new visual wonder.

http://bie.org/project_search The Buck Institute for Education. A great resource for staff who are interested in implementing Project-Based Learning and need some support. Browse possible projects in STEM and other learning areas.

http://www.braingle.com/ Braingle. A great source of cryptography resources (codes) and lots of other digital games and challenges.

http://www.eie.org/ Engineering is Elementary. Offers ideas for in-school and out-of-school staff that develop children's engineering literacy.

https://www.khanacademy.org/ Khan Academy. Although known more for classroom teaching enrichment and tutoring support, Khan Academy offers many technology-based resources for use in OST settings to support active STEM learning.

http://sciencefriday.com/teacher-resources/03/27/2014/about-the-science-club.html?series=34 Science Friday Science Club. You and the children in your program may participate in a current challenge, or check out previous challenges and creations to replicate with your group of children or teens.

http://www.science-sparks.com/ Science Sparks. Preschool and school-age chemistry, biology, physics and kitchen science ideas. Seasonal features.

http://www.sciencemadesimple.com/ Science Made Simple. Once children have identified a topic to investigate, this site can provide excellent investigative resources and directions. Experiment instructions.

http://www.stevespanglerscience.com/lab/experiments Steve Spangler Science. Offers easy science experiments and science fair project ideas.

Teaching STEM in the Early Years, a book by Sally Moomaw, Redleaf Press, 2013 A collection of more than 85 STEM ideas, including quick ideas, outdoor ideas and ideas for centers. Each experience is accompanied by STEM explanations and connection notes. A beginning chapter provides foundational information for the novice facilitator.

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