INSTRUCTOR GUIDE

SESSION FOURTEEN

STUDENT LEARNING GOALS

❖ Understand concepts of spatial relationships.
❖ Identify spatial thinking and vocabulary used in ramps and balls explorations.
❖ Analyze constructivist aspects of ball run constructions.

Materials List

General
- Computer with internet access/speakers
- PowerPoint slides for Session 14 (downloaded from website)
- Data projector
- Sign-in sheet (customizable printable)
- Course Reader
- Big Ideas of Early Mathematics textbook

For the Math Activity
- Recommended: Rosie’s Walk by Pat Hutchins

Additional Copies/Handouts
- Partner Drawing Game Sheets #1 and #2 (printable)
- Structures Group Activity assignment (printable)
- Final Assignment (customizable printable)

For the Science Focus
- Ball Runs exemplar activity guide
  - Engage
    - Cardboard tube (such as a paper towel tube)
    - Tissue box or other small cardboard box
    - Marble or small ball
    - Roll of masking tape
  - Explore
    - For every group of 4-6 students:
      - Assorted marbles and small balls, such as rubber bouncy balls or ping pong balls (at least 5)
      - Scissors (1-2 pairs)
      - Roll of masking tape
      - Optional: extra materials for making ball tracks, such as pieces of flexible foam pipe insulation ¾ - 1 inch diameter
      - Students provide: paper tubes, small boxes and other recycled materials
Session at a Glance

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
<th>Estimated Time (In Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrival Activity</td>
<td>Students do an exercise that requires them to mentally manipulate a shape as a “warm up” for learning about spatial relationships.</td>
<td>10</td>
</tr>
<tr>
<td>Welcome, Announcements, and Agenda</td>
<td>Give a general overview of the session and any relevant announcements, and provide time for sharing. Review the guidelines for the Final Assignment.</td>
<td>10</td>
</tr>
<tr>
<td>Math Focus: Spatial Relationships</td>
<td>Students explore the big ideas about spatial relationships. They participate in a partner drawing game to highlight spatial vocabulary. They watch and discuss an Erikson video demonstrating a classroom activity in which students explore spatial relationships by describing and traversing an obstacle course based on the storybook, Rosie’s Walk.</td>
<td>40</td>
</tr>
<tr>
<td>Discussion: Engineering in Early Childhood</td>
<td>Students discuss engineering in early childhood and are introduced to the Engineering Design Process.</td>
<td>15</td>
</tr>
<tr>
<td>Science Focus: Ball Runs</td>
<td>Students participate in the exemplar activity: Ball Runs. They watch and discuss a video of preschoolers engaged in designing, building, and testing marble runs using blocks and wooden track ways.</td>
<td>60</td>
</tr>
<tr>
<td>Looking Ahead to Next Session</td>
<td>Students are introduced to the Structures Group Activity. Each group is assigned one of the Structures activities for the following class. Students are given time to coordinate materials they will need to supply for their group’s assigned activity. Go over the reading assignment and homework for the following session.</td>
<td>15</td>
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</tbody>
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Total Estimated Time: 2 hr 30 min

Before Session

- Review the materials relevant to this session:
  - Chapter 8: Spatial Relationships in *Big Ideas of Early Mathematics*
  - Exemplar activity guide: Ball Runs
  - PowerPoint for Session 14 (downloaded from website)
  - Reader Section: Session 14
- Make copies of any printables and/or handouts.
  - Half the class will need a copy of the Partner Drawing Game Sheet #1 and the other half will need a copy of Sheet #2. Do not let students see these sheets before playing the game.
- Set up materials:
  - Place a marble, cardboard paper towel tube, a small box, and a roll of masking tape in the area where you will do the Engage section of the Ball Runs exemplar activity.

As Students Arrive

- Have students sign in on attendance sheet and check off if they brought their materials for ball runs to class.
- Have students turn in their homework.
Arrival Activity: Students mentally manipulate shapes to identify which figure is identical to the first one.

1. Debrief Arrival Activity.
   - Ask students to share their answers to the question posed in the Arrival Activity.
   - Reveal the correct answer. (B is the correct answer – slide is animated to rotate shapes on click.)
   - Ask them to share their feelings about the activity (i.e. was it easy, challenging, frustrating, fun? etc.). Point out that spatial ability can be viewed as a unique type of intelligence and can continue to develop throughout one’s life.
   - Tell students that this activity required them to use their spatial abilities as well as logical reasoning and language skills. This will be the math focus for today’s class.

2. Announcements and sharing.
   - If you have students who are working with children, ask if anyone tried any activities from previous sessions and to share their observations and insights.
   - Share any observations, clarifications, or notable comments that you feel should be mentioned related to the previous session’s homework.

3. Review Agenda.

4. Review the guidelines for the Final Assignment. Give out the assignment sheet and answer any questions students have. It may be helpful to have students who are experienced with the practice of providing parent handouts to help explain their purpose to those students who are unfamiliar with this practice.

Math Focus

5. Introduce Spatial Relationships as described in Chapter 8 in the Big Ideas of Early Mathematics textbook.
   - Define Spatial Relationships as relationships between objects and places.
   - Ask students to brainstorm examples of tasks in their everyday lives that depend on their visual-spatial skills (using a map, driving, arranging furniture, etc.). Show slides of other examples.
   - Ask students to think about the many fields of study and careers that require well-developed spatial abilities.
   - Talk about activities that help children develop their spatial abilities. The examples in the slides involve the relationships between objects and space.
Blocks and other construction materials involve manipulating and organizing shapes into various positions;
- Puzzles require children to move pieces by turning and flipping them in some way to make them fit;
- Dancing, movement games, and songs develop a sense of where their bodies are in relation to other objects in space;
- Navigating climbing structures and obstacle courses involve physical coordination while moving through space;
- Making maps is a way to represent and model space through drawing.

6. Stress that understanding spatial concepts for young children is inseparable from language development.
   - Review spatial vocabulary that is embedded in understanding spatial relationships:
     - Location/position words: on, off, on top of, over, under, in, out, into, out of, top, bottom, above, below, in front of, in back of, behind, beside, by, next to, between, same/different side, upside down
     - Movement words: up, down, forward, backward, around, through, to, from, toward, away from, sideways, across, back and forth, straight/curved path
     - Distance words: near, far, close to, far from, shortest/longest
     - Transformation words: turn, flip
   - To demonstrate how confusing spatial relationship vocabulary can be, read the sentences on the slide letting students fill in the blanks with the correct prepositions.
   - If you have non-native English speakers in the class, ask them if this aspect of learning English was challenging for them. It is important to be aware of the fact that position words do not necessarily translate from one language to another. Because of this, spatial relationships can be especially difficult for English Language Learners (ELLs) to master. For this reason, lots of visuals, gestures, and kinesthetic supports are important for ELLs. These strategies are also beneficial for all children.

7. Engage students in the Partner Drawing Game to highlight spatial vocabulary.
   - Give directions for playing the Partner Drawing Game:
     - Students will work in pairs. Ask them to identify as Partner A and Partner B.
     - Partner A will choose one of the images on Sheet #1 to describe to Partner B.
     - Partner B cannot look at the image. Partner A has to get their partner to draw an exact duplicate of the picture using only verbal directions, no gestures and no pointing.
     - Partner B may ask questions, but cannot use gestures.
• Give students who are Partner A a copy of the Partner Drawing Sheet #1. Make sure Partner Bs do not look at the sheet. (The reason that there are 4 images on the sheet is so that people sitting at the same table will be focusing on different images and therefore will not be influenced by what other partner pairs are saying and drawing.)
• When partners finish, they should compare the drawing made by Partner B with the image that Partner A described. What matches and what is different from the original drawing?
• Debrief the game after the first round.
  o Ask the Partner As what it was like to describe the drawing. What made it hard?
  o Ask the Partner Bs what the experience was like. What information was most useful? What could your partner have done differently to make the picture easier to replicate?
• Have partners switch roles and play again. Give a copy of the Partner Drawing Sheet #2 to Partner B so they have new images to choose from. Make sure Partner As do not look at the sheet.
• After the second round, debrief by asking, “Which role did you prefer – A or B?” “Why?”
• Wrap up the game by pointing out how language is inextricably connected to spatial thinking. Teachers need to realize that directional and positional words are actually mathematical. They need to provide opportunities for children to talk about, draw, and model spatial relationships. If the teacher’s spatial language is rich and precise, over time, children’s language will become more specific, as will their understanding.

8. Read aloud or show sample pages on the PowerPoint slide of the book Rosie’s Walk by Pat Hutchins as an example of a literature connection to learning about spatial relationships.
• Rosie the hen goes for a walk around the farmyard, not realizing a fox is following her. Rich spatial vocabulary is featured as the fox tries to keep up with Rosie on her winding route.

• Before showing the video, ask students to watch for the different ways the teacher supports children’s understanding of spatial relationships and scaffolds language development.
• After viewing the video, ask students to identify the ways the teacher supported student learning. For example:
  o She read the story aloud.
  o She introduced the obstacle course, modeling each movement using language to describe what she was doing.
  o When it was the students' turn to go through the obstacle course, she asked students to narrate their actions.
o She asked the whole group to review what they did in the obstacle course.
o She used student input to arrange sticky notes on a map and used her finger to trace the obstacle course on the map while describing movements.

• Reiterate that it is important to recognize that children may understand spatial concepts, but may not have the vocabulary they need to talk about and explain their thinking so it is important to offer non-verbal ways for them to represent their thinking.

10. Introduce the Big Ideas about Spatial Relationships from the Big Ideas of Early Mathematics textbook.

#1. Relationships between objects and places can be described with mathematical precision. Children come to know that “where something is” can be conveyed by talking, drawing, writing, and creating models to represent movement and direction.

#2. Our own experience of space and two-dimensional representation of space reflects a specific point of view. Teachers can help children develop awareness of perspective: the understanding that spatial relationships look different when viewed from different positions. Position and location are described in terms of relative to ourselves. The ability to truly de-center and think about how something looks from someone else’s point of view takes time to develop and it cannot be taught or forced. It will take some time before a child understands that when he is face to face with his friend, something on his left appears to their friend on her right.

#3. Spatial relationships can be visualized and manipulated mentally. Learning how to hold a spatial representation in the “mind’s eye” can be challenging for young learners. They build proficiency in this skill when teachers provide concrete and pictorial experiences with spatial transformations, such as cutting an item in half, flipping it upside down, or rotating it to make it “fit.”

11. Access students’ background knowledge about engineering.

• Ask students if they have heard of the acronym STEM (Science, Technology, Engineering, Math). Currently in K-12 education, there is a great deal of attention being placed on the “E” – engineering.

• Access students’ prior knowledge about engineering. Have them turn and talk to a partner to discuss the following questions:
  o What do engineers do?
  o What do you think is the difference between science and engineering?

• Debrief their responses. Emphasize that engineering is everywhere! Look around the classroom and identify things that were designed by engineers (chairs, desks, lights, building materials, computers, etc.). Engineers are
people who use their mathematics and science knowledge to design, create, or modify things so that they will be useful. There are many different types of engineering, generally divided into four major branches: Mechanical, Chemical, Civil, and Electrical.

- Point out that science and engineering overlap in many ways, with the exception of their goals - science proposes questions about the natural world and proposes answers in the form of evidence-based explanations. Engineering identifies problems of human needs and aspirations and proposes solutions in the form of new products and processes. Science and engineering practices are parallel and complementary.

12. Lead a discussion about Engineering in Early Childhood.

- Ask students, “What does engineering look like in early childhood?”
- Building on their comments, stress that children are natural engineers who continuously engage in problem solving activities. They use blocks and other construction toys to build structures, roads, and bridges. They naturally assemble materials and construct things that fit their needs, be it a fort made of blankets, sand castles, or their own inventions.


- Explain that the Engineering Design Process is a series of steps that engineering teams use to guide them as they solve problems. The design process is cyclical, meaning that engineers repeat the steps as many times as needed, making improvements along the way. Engineers do not always follow the Engineering Design Process steps in order, one after another. It is very common to design something, test it, find a problem, and then go back to an earlier step to make a modification or change to your design. They learn through trial and error.
- The way that young children engage in the engineering process is less systematic than we might expect from older children. Share the following quote:

“For young children, the engineering design process does not reveal itself as steps but rather as non-sequential components that may often be enacted by children simultaneously (sometimes within a few seconds) and often quickly result in new questions. Much like engineers in the field, the children use, repeat, or skip components of brainstorming, planning, testing, and improving as the project or question dictated.”

From Revealing the Work of Young Engineers in Early Childhood Education by Beth Van Meeteren and Betty Zan, University of Northern Iowa.
14. Introduce the Ball Run exemplar activity.
   • Introduce the Ball Run exemplar activity as an open-ended exploration that integrates science, math, engineering, and language.
   • Several types of balls can be used for this investigation, such as small or large marbles, ping-pong balls, or rubber bouncy balls. Point out that when working with children under three years old it is best to use balls instead of marbles to avoid a choking hazard.
   • Let students know that you are going to model the Engage part of the activity in much the same way as if you were doing it with children in order to help them experience the activity through a child’s eyes and to demonstrate the teaching strategies as written in the exemplar activity guide.

Engage
   • Place a marble (or ball) on the floor or table. Ask the students how we could make the marble move. Students will likely respond with ideas such as roll it, push it, throw it, etc. Acknowledge that these are all ways that we can make the marble move. Demonstrate their different ideas.
   • Lay a cardboard tube and tissue box (or other small cardboard box) on the floor in front of you. Ask, “What ideas do you have about how we could make the marble move using these materials?” As they share their ideas, establish that the materials can be used to make ramps and pathways for the marbles to roll on. Demonstrate how to make a simple ramp (a surface with one end higher than the other). Model how to use the tape to hold things in place if needed.
   • Emphasize that there are many different ways to make “ball runs,” and that they can try out lots of ideas. If something does not work, try to fix it. Be creative!
   • Ask the group to come up with any rules or procedures they think might be necessary to review with children about safety, sharing materials, etc.

Explore
   • Give each group a roll of masking tape and scissors to use along with the materials they brought to class.
   • Let students know how much time they have for making their ball runs.
   • As students are working, notice what challenges they set for themselves and support their investigations by helping them notice cause and effect, encouraging them not to give up, helping attach materials, or providing additional materials.
   • As they build and test their ball runs they will engage in problem solving skills such as:
     o Figuring out what needs to be changed in order for a ball to go where they want it to go.
     o Connecting materials together to make a continuous pathway.
     o Making their structures stable and balanced.
     o Troubleshooting and finding solutions when their ball run does not work.

Instructor Note:
Depending on classroom space available, students can use tabletops or build on the floor. Students may want to use objects in the room (chairs, tables, walls, etc.) as supports for their ball runs.
• Constructing relationships between different variables and experimenting with cause and effect.
• Give students 10 and 5 minute “warnings” before it is time to stop working.

Reflect
• Take a “tour” of the different ball runs to see each group’s constructions. Gather students around the ball runs one at a time and invite each group to share about their design and building process and to show how their ball run works.
• Reassure them that it is okay if their ball run is not complete. The goal was not to necessarily have a finished product, but to collaborate as a team to experience the engineering design process. Focus on the challenges encountered, use of materials, and how they solved problems.

Clean up: Direct students to clean up their materials. If there are not sufficient recycling bins available, have students take their materials back home with them.

15. Show photos of children building ball runs using recycled materials. Ask for students’ ideas on modifications for different ages and developmental levels.

16. Watch and discuss the Ramps and Pathways video.
• Tell the students that Ramps and Pathways is a STEM curriculum that engages children in designing inclined planes and experimenting with the movement of objects. It is similar to the Ball Run exemplar, but instead of cardboard tubes and recycled materials, the ramps are made from pieces of wooden cove molding, which are kept in the block area where they are readily available. The book, Ramps and Pathways as well as the “Ramps and Pathways” article the students read for homework was written by educational researchers at the University of Iowa who have developed an in-depth constructivist curriculum. There is an extensive Ramps and Pathways website with resources for educators, videos, lesson plans, materials lists, etc. It is a great example of integrating science, math, and engineering.
• After watching, ask students for their observations about how the children were using the materials.
• Discuss how constructivist principles relate to these kinds of activities.
• Summarize key constructivist principles that relate to the Ramps and Pathways activities. (Slide is animated so bullets appear on click.)
  • Appeals to children’s desire to make something interesting happen.
  • Fosters initiative, problem-solving, persistence, and creativity.
  • The results are immediate and happen right away.
  • Children can observe the results on their own.
  • Children can change variables in order to get a different result.
  • Focuses on reasoning rather than right answers.
17. Looking ahead to next session.
   • **Introduce the Structures Group Activity and give groups time to plan for supplying required materials for next class.**
     o Explain that shape and building structures will be the focus of the next class. Give out the Structures Group Activity assignment.
     o Review the directions and answer any questions.
     o Divide students into 5 groups. Assign each group a different structure. Each group will be responsible for bringing the materials needed for their assigned Structures activities described on the assignment sheet. If you have a small class size, you might want to make fewer groups and do fewer of the activities.
     o Give students time to coordinate with their group about which materials each person will bring.
     o Emphasize that student-supplied materials are essential for the hands-on activities in each class. Students should share contact information with group members. If they will be absent, it is important that they let someone in their group know as soon as possible and make arrangements so that their group is still able to provide all the necessary materials.
   • **Review homework assignment due next session.** Remind students that their Reflective Essay is due next session.