Your Presenters

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Presentation Objectives:

• Review and discuss math and science foundations appropriate early childhood learners

• Explore play-based activities that support math and science foundations through subitizing, sorting, drawing, patterns, and loose parts

• Discuss ways to incorporate play-based math and science activities to enhance established lessons
Why STEAM in Early Childhood:

STEM education is not culturally neutral. It is subject to the same types of cultural biases and stereotypes as other topics in education.

- The Early Childhood STEM Working Group

School readiness data indicates that young children are not being provided with learning opportunities necessary to be successful in math and science.

- Nurturing STEM Skills in Young Learners

Our youngest students are naturally inquisitive, ask questions without reserve, and are often unheard in taking risks.

- McClure et al. (2017)

Brain and skill-building experiences early in life are critical for child development.

Developmentally-appropriate, rigorous STEM learning remains a missing link in most children's early educational experiences.

- Hadani and Rood (2018)

Approximately 40% of U.S. children are not ready for kindergarten, and too many children reach Grade 4 lacking key science and math skills and knowledge.

- STEM Smart Brief

imsa.edu
The Importance of Play:

- According to NAEYC, STEM and STEAM learning falls under the umbrella of *inquiry instruction*, which includes the use of projects, problems, and **play**.

- “The highest form of research is essentially play”
  
  - N.V. Scarfe

- Play naturally requires students to ask their own questions and engage in learning that is most interesting to them.

- Other learning opportunities are entwined in play, including social-emotional skills, literacy, and the development of executive functioning skills.
3-Dimensional Science:

**Science and Engineering Practices**
- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

**Disciplinary Core Ideas**

<table>
<thead>
<tr>
<th>Life Science</th>
<th>Earth &amp; Space Science</th>
<th>Physical Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>From molecules to organisms:</td>
<td>Earth's place in the universe</td>
<td>Matter and its interactions</td>
</tr>
<tr>
<td>Structures and processes</td>
<td></td>
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</tr>
<tr>
<td>Ecosystems: Interactions, energy,</td>
<td>Earth's systems</td>
<td>Motion and stability: Forces and</td>
</tr>
<tr>
<td>and dynamics</td>
<td></td>
<td>interactions</td>
</tr>
<tr>
<td>Heredity: Inheritance and variation</td>
<td>Earth and human activity</td>
<td>Energy</td>
</tr>
<tr>
<td>of traits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biological evolution:</td>
<td></td>
<td>Waves and their applications in</td>
</tr>
<tr>
<td>Unity and diversity</td>
<td></td>
<td>technologies for information</td>
</tr>
<tr>
<td></td>
<td></td>
<td>transfer</td>
</tr>
</tbody>
</table>

**Crosscutting Concepts**

- Patterns
- Cause and effect
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter
- Structure and function
- Stability and change

https://doi.org/10.17226/13165

imsa.edu
Early Childhood Math Foundations

- Sets
- Pattern
- Number Sense
- Counting & Number Operations
- Measurement
- Data Analysis
- Spatial Relationships & Shape

Foundations are compiled from Erikson Institute’s Big Ideas and NCTM’s Catalyzing Change.
Executive Functioning and STEAM Skills:

Creative Play

Dramatic Play

Fine Motor

Gross Motor

Hand-Eye Coordination

Language Development

Life Skills

Listening

Math Skills

Problem Solving

Scientific Inquiry
Playing with Math and Science Outline

- Sorting  Part I
- Patterns  Part I
- Subitizing  Part II
- Drawing  Part II
- Loose Parts  Part II
Sorting
What would you do?
Match
Sort/Categorize/Classify
How do we organize?

1. Match
2. Sort
3. Categorize/Classify
Activity

Emoji Mix-Up
### Sorting
- Find the blue crayons
- Separate the dirty laundry by color
- Order the socks from shortest to longest
- Pick out the square beads

### Classifying
- Put away the groceries
- Organize the art supplies
- Sort the laundry
- Place the cards into piles

Source: Platz 2004
Why Should My Students Be Doing This?

- The development of pattern recognition.
- The understanding of categories and characteristics.
- Building a foundation for algebraic thinking.
- The development of strong observational skills
Strong sorting skills correlate with:
- Making matches
- Identifying sets
- Classifying items by single attributes
- Recognizing & creating patterns
- Understanding patterns, relations, & functions
- Comparing sets for differences & similarities
- Recognizing relationships between sets
- Understanding how rules apply to sets

Lack of sorting skills correlates with possible struggles in:
- Understanding how to connect new pieces of knowledge with what is already known
- Making informed judgements
- Making and enacting decisions
- Coping with events that are out of routine
- Dealing with the unexpected

Source: Sorting Skill Importance
How Do I Get Started?
Through Play.
Guidelines

1. Children decide which characteristic to sort by
2. Children should **physically** sort the objects
3. They will be able to describe their rationale for sorting

Source: Benefits of Sorting Activities
Rock Sorting
Center Explorations and Daily Activities

- Include a variety of ‘sortable’ objects in sensory table/sensory bin
- Use ‘math talk’ when discussing sortable objects: Most, least, more, fewer, same as, equal, etc...
- Sort ‘science’ items: rocks, leaves, flowers, etc...
- Literacy: Books about sorting; ability to discuss how and why objects were sorted certain ways

Source: Sorting Materials
Games and Activities

- Books & Activities from [Erikson Institute](#)
- A Mixed Up Animal Collage ([Education.com](#))
- Sorting by Sounds
  - Jingle Bell Sort ([Sample Activity](#))
  - Initial Sounds ([Sample Activity](#))
- Sort another way...
- How are they sorted?
Patterns
When do we develop the ability to recognize patterns?
8 Weeks
What comes next?

1. □ □ ○ □ □ □ ○
2. □ □ □ □ □ □ □
3. A, B, C. A, B, C.
Static/Repeating Patterns
What comes next?

1.  

2.  

---

[IMSA Logo]
Dynamic/Growing Patterns
Why Should My Students Be Doing This?

Common Core Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

Next Generation Science Standards Crosscutting Concepts

1. Patterns
2. Cause and Effect
3. Scale, Proportion, and Quantity
4. Systems and System Models
5. Energy and Matter
6. Structure and Function
7. Stability and Change
Look for and make use of structure

Seven and three more is the same as three and seven more.

\[ 7 \times 8 = (7 \times 5) + (7 \times 3) = 7(3 + 5) \]

\[ x^2 + 9x + 14 \; ; \; 14 \text{ is the same as } 2 \times 7; \; 9 \text{ is the same as } 2 + 7; \; \text{so } x^2 + 9x + 14 = (x + 2)(x + 7) \]
Patterns

- **Day**
  - Sunlight
  - Green leaves on trees

- **Night**
  - Moonlight
  - Trees with no leaves

- **Seasons**
  - Spring
  - Summer
  - Autumn
  - Winter

- **Wave**
  - Short Wavelength (High Frequency)
  - Long Wavelength (Low Frequency)
Patterns
“Patterns are things—numbers, shapes, images—that repeat in a logical way. Patterns help children learn to make predictions, to understand what comes next, to make logical connections, and to use reasoning skills.”

Source: Zero to Three: Early Math Connections
Approaches to Teaching Patterns
Seize Teachable Moments

- Take note of students drawings, artwork, or use of toys—many will contain patterns
- Point out patterns in nursery rhymes, stories, or songs
- Use content to emphasize patterns—weather, seasons, examples in nature
- Comment on patterns on students clothing or within the classroom

Source: Stanford Early Math & MSU Early Childhood Development
Guided Instruction

- Color Patterns
- Shape Patterns
- Dance Moves/Choreography
- Music & Rhythm
- Time (seconds, minutes, hours, days, weeks, months, years, decades, centuries...)

Identify
Predict
Extend
Materials for Pattern Play

- Linking Cubes
- Buttons
- Foam Shapes/Animals
- Beads/Pipe Cleaners
- Pattern Blocks
- Bingo Markers/Bingo Chips
- Stamps/Ink Pads
- Stencils
- Art Supplies

Source: Prekinders Patterns

IMSA
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Questions?

Please join us for *Part II* at 1:00

This presentation can be downloaded at:
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Playing with Math and Science
In the Early Childhood Classroom
Part II
Cassandra Armstrong & Lindsey Herlehy
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Early Childhood Foundations

3-Dimensional Science

Science and Engineering Practices
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Crosscutting Concepts

- Patterns
- Cause and effect
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- Systems and system models
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- Stability and change

Mathematics

- Sets
- Pattern
- Number Sense
- Counting & Number Operations
- Measurement
- Data Analysis
- Spatial Relationships & Shape

Books:
- Catalyzing Change in Early Childhood and Elementary Mathematics: Initiating Critical Conversations
- Big Ideas of Early Mathematics: What Teachers of Young Children Need to Know
Playing with Math and Science Outline

- Sorting  Part I
- Patterns  Part I
- Subitizing  Part II
- Drawing  Part II
- Loose Parts  Part II
Subitizing

What is subitizing?
How did you know how many?

Share your thoughts with the group using the Chat feature on your Zoom toolbar.
Subitizing:

Coined in 1949 by E.L. Kaufman and supported by the work of theorist Jean Piaget

From the Latin adjective *subitus* meaning “sudden”

Defined as “instantly seeing how many”

Types of Subitizing:

Perceptual Subitizing

- Recognizing a number without using other mathematical processes.
- Many children will instantly recognize and verbally label sets of items made of five or fewer before leaving preschool.

Conceptual Subitizing

- Recognizing a number pattern as a composite of parts of a whole.
- Some children will be able to verbally label two sets of subgroups up to six and then one more subgroup when subitizing up to ten items.
What do you see?

Share your thoughts with the group using the Chat feature on your Zoom toolbar.
Maria (4 years, 4 months)

Me: “What did you see?”
Maria: “I saw 5.”
Me: “How did you see it?”
Maria: “I saw two, two, and one.”
Me: “I also saw five, but in a different way. Do you want to look at it again?”
Maria: “Ok…” I proceeded to show the card again and again she said, “I saw 5.”
Me: “How did you see it?”
Maria: “I saw two, two, and one.”

Omar (just turned 4)

Me: “What did you see?”
Omar: “I saw a square with a dot in the middle.”
Me: “How many dots did you see?”
Omar: “Five. I saw four and one in the inside.”
Me: “I see how you saw that.”
Omar: “Hey, I see two on the top, one in the middle, and two on the bottom, too.”
Me: “Yeah, I can see it that way too.”
Why Should My Students Be Doing This?

- The development of pattern recognition.
- The understanding of numbers and number sense.
- Building a foundation for algebraic thinking.
- It is efficient.
But Shouldn’t They Be Counting?

6 + 5

Source: Building Math Minds
6 + 7 = 13
How Do I Get Started?

Through Play.
### Games
- Memory
- War
- Sorting
- Go Fish
- Flash It!
- BINGO

### Math Talks
Which One Doesn't Belong?

### Brain Breaks
Songs by Jack Hartmann

![Build Math Minds](image1)

![Songs by Jack Hartmann](image2)

### Small Group Activities
- Roll and Circle
- Counting With Kids

### Sensory Exploration
- Sensory Store

### Centers
- [Color Counting](image3)
- [Number Matching](image4)
Transitions (Erikson Institute)
What does drawing look like in your educational setting?
Why Do We Want Students to Draw?

- Develops fine motor skills
- Improves hand-eye coordination
- Helps establish concentration
- Encourages visual analysis
- Increases confidence
- Teaches creative problem solving

Source: Kid’s Country
## The Development of Drawing:

<table>
<thead>
<tr>
<th>18 months</th>
<th>2-3 years old</th>
<th>Preschool age</th>
<th>6-8 years old</th>
</tr>
</thead>
</table>
| • Scribbling  
  • Holds instrument with fists  
  • Uses large movements | • Improve control of the wrist and finger movements  
  • Rhythmic scribbling, color, and line  
  • “Fortuitous realism” | • World vs. reality  
  • “Tadpole man”  
  • Imagination develops and influences drawings | • Realism  
  • Self-criticism and motivation  
  • Individual techniques and styles |

Source: Early Childhood News
Rhoda Kellogg

Misunderstanding Children’s Art

— we know that arm, hand, eye, and brain activity utilized for art has no age level beginning or end.

— We know that young children the world over leave a record of scribbling movements in mud or sand or wet surfaces, and adults can see what lines their fingers have drawn.

— All human-made art stems from basic human endowments common to the species, with varieties of art developing somewhat differently because of the individual's differing experiences in times and in places.

20 types of children’s scribbles

Scribble 1: Dot
Scribble 2: Single vertical line
Scribble 3: Single horizontal line
Scribble 4: Single diagonal line
Scribble 5: Single curved line
Scribble 6: Multiple vertical line
Scribble 7: Multiple horizontal line
Scribble 8: Multiple diagonal line
Scribble 9: Multiple curved line
Scribble 10: Roving open line
Scribble 11: Roving enclosing line
Scribble 12: Zigzag or waving line
Scribble 13: Single loop line
Scribble 14: Multiple loop line
Scribble 15: Spiral line
Scribble 16: Multiple-line overlaid circle
Scribble 17: Multiple-line circumference circle
Scribble 18: Circular line spread out
Scribble 19: Single crossed circle
Scribble 20: Imperfect circle
Types of Art:

**Process-Focused**

- Children are provided with an open-ended art project and encouraged to use their own creativity and choices to meet a goal.
- No step-by-step directions
- No sample to follow
- There is no right or wrong way to create
- A child-led art experience

**Product-Focused**

- Children begin an art project knowing what the end product should look like. Specific skills and techniques are usually required to meet a goal.
- May include directed instructions
- End products look similar
- Often incorporate specific skills or concepts for students to practice
### Process Art and STEAM Learning

**Science:** Students explore material properties.

**Technology:** Making choices about tools based on the process or intention

**Engineering:** Developing a plan or process

**Art:** Innovation requires creativity, critical thinking, and risk taking

**Math:** Learners determine what happens first, second, and third along with basic concepts such as quantity and measurement

### Process Art Materials

#### Drawing Supplies
- Liquid tempera (B & W, primaries, secondaries)
- Tempera cakes with trays
- Tempera cake storage rack
- Metallic or fluorescent tempera
- Watercolor cakes
- Watercolor refills
- Metallic watercolors
- Liquid watercolors
- Watercolor pencils
- India ink
- Flat brushes
- Round brushes
- Bamboo brushes
- Foam brushes
- Paint cups
- Paint palettes/trays
- Paint scrapers

#### Printmaking Supplies
- Rubber brayers
- Printing ink-black or assorted
- Printing foam
- Inking trays
- Washable stamp pads

#### Ceramic Supplies
- White and/or red clay
- Wire slab cutter
- Small sponges
- Modeling tools
- Needle tools
- Slip rolling strips
- Rolling pins
- Spray bottles
- Canvas roll
- Textured stamp set
- Kiln wash
- Star stumps
- Glaze

#### Adhesives and Tools
- School glue bottles
- Glue gallon with pump
- Glue sticks
- Glue gun with glue sticks
- Tacky glue bottles
- Transparent tape
- Masking tape
- Duct tape
- Rollers
- Scissors
- Compasses
- Paper punches
- Mirrors
- Tapestry needles
- Sponges

#### Sculpture Supplies
- Plastic mask forms
- Plaster gauss
- Art paste
- Newspaper
- Found objects
- Recyclables

#### Craft Supplies
- Puffy paints
- Sequins
- Glitter
- Glue stick
- Pom Poms
- Feathers
- Buttons
- Pipe cleaners
- Craft sticks
- Dowel rods
- Yarn
- Embroidery floss
- Tissue paper
- Tinfoil
- Fabric scraps
- Cotton swabs
- Wire
- Tin foil
- Felt
- Air dry clay

#### Paper
- Construction paper (assorted colors)
- Black construction paper
- Origami paper
- Newsprint
- Sulphite drawing paper (80lb)
- Tagboard
- Kraft paper
- Watercolor paper
- Cardboard

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*Source: The Art of Education University*
Directed Drawings:

- Instructions are given to a student to help them complete a picture.
- Allows students to draw and connect simple shapes that combine to create an image.
- Can be easily integrated into a unit of study.
- Encourages the development of executive functioning skills.
- Supports mathematical and scientific practices.
Activity

Directed Drawing
Examples

Source: First and Kinder Blue Skies
# Observational Drawings:

<table>
<thead>
<tr>
<th>Science</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual representations</td>
<td>A change of perspective</td>
</tr>
<tr>
<td>Manipulation of tools</td>
<td>Shapes and proportions</td>
</tr>
<tr>
<td>Investigating the natural world</td>
<td>Patterns, textures, and contours</td>
</tr>
<tr>
<td>Written evidence of work</td>
<td>Location and direction</td>
</tr>
</tbody>
</table>

What is this?  
Where does it come from?  
What do you think it's made out of?  
Is it smooth or bumpy?  
Does it have a smell?  
Can we taste it?  
Where have you seen this before?  

What shape do you see?  
What color is it?  
Is it small or large?  
What part should we draw first?  
Where on our paper should we draw it?  
How many are there?  
Is that part on top of another part?

Source: Iowa Regents' Center for Early Developmental Education
Observational Drawings:

In the Classroom

- Select a simple object
- Act as a detective or storyteller
- Use your senses
- Spend as much time as possible investigating and describing the object
- Offer pencils, then coloring utensils

Source: Art History Kids
Creativity is for the gifted few: the rest of us are compelled to live in environments constructed by the gifted few, listen to the gifted few’s music, use gifted few’s inventions and art, and read the poems, fantasies and plays by the gifted few.

This is what our education and culture conditions us to believe, and this is a culturally induced and perpetuated lie.

Building upon this lie, the dominant cultural elite tell us that the planning, design and building of any part of the environment is so difficult and so special that only the gifted few—those with degrees and certificates in planning, engineering, architecture, art, education, behavioral psychology, and so on—can properly solve environmental problems.
What Are Loose Parts?

...well, almost anything.

- Interesting, intriguing, found objects
- Can be moved, manipulated, combined, lined up, taken apart, and put back together
- Do not come with instructions...or batteries.
- Rich in “affordances”
Loose Parts in Action

Incorporating Loose Parts to Promote Science, Technology, Engineering, Art and Math (STEAM) Content in the Early Childhood Learning Environment

http://www.dianawehrellgrabowski.com

IMSA
imsa.edu
The Parts of Loose Parts:

<table>
<thead>
<tr>
<th>Natural</th>
<th>Produced</th>
<th>Repurposed</th>
</tr>
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<tbody>
<tr>
<td><img src="image1.png" alt="Natural Parts" /></td>
<td><img src="image2.png" alt="Produced Parts" /></td>
<td><img src="image3.png" alt="Repurposed Parts" /></td>
</tr>
</tbody>
</table>
Why Loose Parts?

**Mental**
- Boosts creativity by exercising the imagination
- Requires a level of risk taking
- Exercises executive functioning skills

**Physical**
- Develops physical literacy
- Requires fine motor and gross motor skills
- Simultaneously engages the senses simultaneously

**Social & Emotional**
- Wellbeing is positively influenced by fresh air, physical movement, and natural light.
- Breaks down barriers of gender, ability, age, and background
- Encourages collaboration, discourse, and consensus building
Loose Parts and STEAM

Science
- Constructing ideas and explanations about the nonliving world
- Experimentation, physical properties, senses, gravity, force, weight

Technology
- Evaluating quality and effectiveness, and identifying tools the provide for a need
- Repurposing tools, considering efficiency, innovation

Engineering
- Design and redesign, tinkering, and problem solving
- Putting together and taking apart, testing limits, working within constraints

Arts
- Self-expression, invitation for innovation and creativity, and catering to interests
- Draw, sculpt, collage, indoor and outdoor exploration

Mathematics
- Spatial awareness, equivalency, measurement, and conservation
- Patterns, measurement, shapes, and numerical concepts
Loose Parts
Play Ideas

• Make a...
• What did you do over the weekend?
• Create part of the story.
• What can you make with 10 items?
• Build me a tower.
• Add a medium ~ water, light, playdough, or picture frames

Teacher Talk

Do not TEACH children how to play with loose parts.

• Attention-Focusing
  • Did you notice how...?
  • How do you think...?

• Measuring and Counting
  • How many...?
  • How long...?
  • How far...?

• Comparison
  • Is ____ different from ____?
  • How is ____ similar to ____?

• Action
  • What do you think will happen when...?
  • How do you think it will be different if...?

Source: STEM Learning Through Loose Parts Play and Tinkering
Resources are available for download.
Questions?

This presentation can be downloaded at:
Thank you

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