



Early Math in Everyday Practice

Framing the Work: Achieving
Excellence in Early Childhood Education
Summer 2017 Institute
June 21, 2017



Whose in The Room?



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Early Math Family Engagement Objectives

- Gain awareness and knowledge of current research and best practices for early math experiences with children 0-5
- Have opportunities for hands-on learning and brainstorming to strengthen early math implementation in program and homes
- Identify how early math addresses multiple SR domains, FE outcomes and CLASS dimensions
- Work together in small groups to develop draft action plans for implementation of early math concepts for program year 2016-17

This project is funded by a grant from the Heising-Simons Foundation and developed by CA Head Start Association

Math in Our Daily Lives

- Activity: Everyday Math Bingo
- Math is an important tool, not just in school but in everyday life.



What is Early Mathematics?

Early Math Knowledge includes skills and concepts related to

- Number
- Geometry & Spatial Sense
- Measurement
- Patterns

Frye et al., 2013; Ginsburg et al., 2008; NAEYC & NCTM, 2002; National Research Council, 2009; Sarama & Clements, 2009

What is Early Mathematics?

- Early math knowledge is rooted in children's everyday experiences and interactions, beginning in infancy.
- Young children develop math skills and concepts as they
 - **explore, think and talk** about concrete objects and situations;
 - learn **math language and skills** from others.
- Early math forms a “concrete” foundation for symbol-based school math.

Baroody et al., 2006; Frye et al., 2013; Ginsburg et al., 2008; Mix et al., 2002; NAEYC & NCTM, 2002; National Research Council, 2009; Sophian, 2007

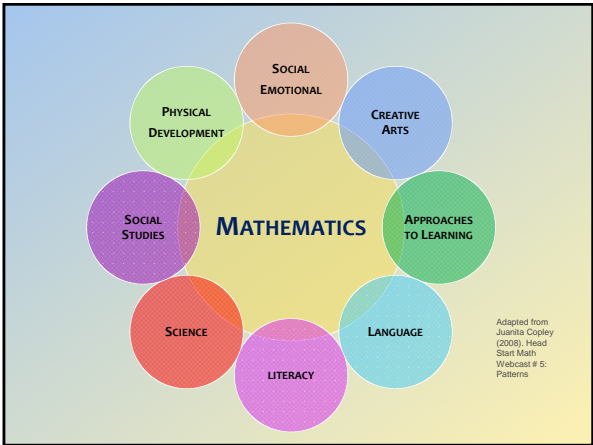
Head Start Early Learning Outcomes Framework 2015:
Mathematics Development

Infant/Toddler

Domain: Cognition
Sub-domain
Emergent Mathematical Thinking

Preschool

Domain: Mathematics Development
Sub-domain
Counting and Cardinality
Operations and Algebraic Thinking
(includes Patterns)
Measurement
Geometry and Spatial Sense



What Kinds of Experiences Support
Early Math Learning?

Evidence-based Teaching Practices

- Experiences designed for how young children learn
 - play, exploration, hands-on
 - focused math activities and games with concrete objects
- Developmental approach to teaching skills and concepts
- Emphasis on math-related language

Clements & Sarama, 2011; Clements et al., 2011; Frye et al., 2013 (review); Greenes et al., 2004; Griffin, 2004; NAEYC & NCTM, 2002; Ramani & Siegler, 2011; Clements & Sarama & 2011; Starkey et al., 2004

“Math Talk” Supports Math Learning!

Research on Math Talk

- “Math Talk” in preschool classrooms
- “Math Talk” during parent-child interactions



What is Math Talk?

Math Talk is using words about number (or quantity), shapes, space, and dimensions

Some examples

- number words (one, two, three, etc.), many, few, more than, same number
- circle, square, flat, round, pointy, wide
- in, on, under, up, down, forward, backward
- big, little, taller, heavier, shortest, fastest

Where Do Children Learn Math? Learning Environments

At home, at school, and in the community

- during play
- in daily routines
- through interactions with family members and Head Start staff



Math is for Everyone!

- Children have unique abilities, needs, interests, language and cultural backgrounds, and home environments.
- We need to
 - plan so that all children and families have math experiences and opportunities.
 - individualize or make modifications to meet the needs of children and their families.

Number and Operations

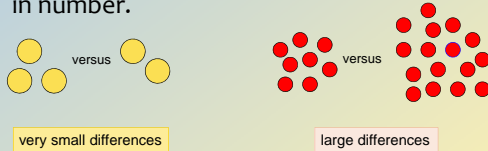


Number and Operations

- Early number knowledge includes a wide range of developing skills and concepts, including:
 - Counting
 - Comparing quantities
 - Adding to and taking away
 - Representing number
 - Solving problems with numbers
- Number knowledge is critical to all areas of math learning in preschool and beyond.

Number and Operations Infant and Toddler Beginnings

- Infants and toddlers are sensitive to number and amount in their environment.
- They notice when groups of objects differ in number.



Antell & Keating, 1983; Starkey & Cooper, 1980; Strauss & Curtis, 1981; Xu & Spelke, 2000

Number and Operations Infant and Toddler Beginnings

- Infants and toddlers explore and manipulate quantities when they play with objects.
 - organize objects into groups
 - change amounts by adding or removing objects.
- Toddlers know that “adding to” makes more and “taking away” makes fewer/less.



Langer, et al., 2003; Mix, 2002; Sophian & Adams, 1987; Starkey, 1992

Number and Operations Infant and Toddler Beginnings

Toddlers begin to use **Math Talk** when they

- understand and use number-words and other words that refer to quantity.
- use the word “two” to accurately to label groups of two objects.
- recite strings of counting numbers, like “one-two-three” or “one-two-four-six.”
- try counting objects—touching or pointing and saying number-words.

Fuson, 1988; Mix, 2009; Wagner & Walters, 1982

Parents and staff support infants' and toddlers' learning by



"You were so thirsty! You're drinking a lot of milk aren't you?"

- providing opportunities for exploring quantity with objects.
- talking about quantity—more, less, a lot, a little
- using number words.
- singing songs, reading books, and playing games.

Number Songs and Rhymes with Infants and Toddlers



What Preschoolers Learn About Number and Operations



- Learn to count and use counting to find out “how many.”
- Develop strategies to compare numbers of objects and solve simple number problems.
- Expand vocabulary and concepts.
- Begin to understand what numerals represent.

Baroody, 2004; Baroody & Wilkins, 1999; Fuson, 1988; Shane, 1999; ; Zur & Gelman, 2004

Exploring and Learning About Number and Operations

- Knowing How Many
- Relationships: Comparing
- Representing Number
- Operations: Adding and Subtracting

Number: Knowing “How Many”

- Subitizing
- Counting

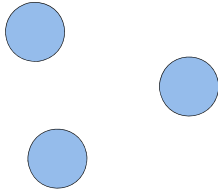


Subitizing

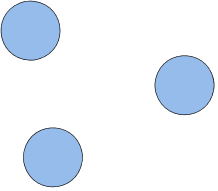
Subitizing refers to the ability to **instantly identify the number** of objects in a group **without counting** them.

Fischer, 1992; Starkey & Cooper, 1995

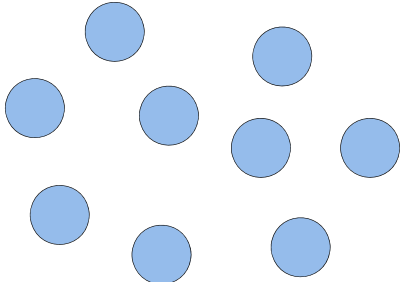
How many dots do you see?



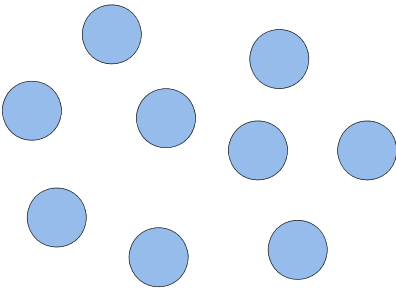
How many dots did you see?



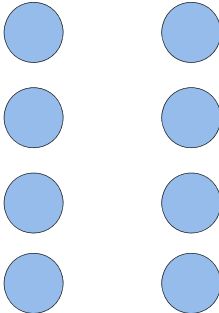
How many dots do you see?



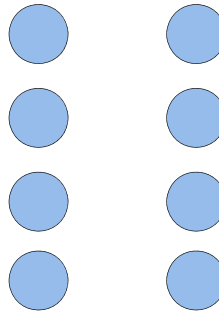
How many dots did you see?



How many dots do you see?



How many dots did you see?



Why is subitizing important?

With very small groups of objects young children can

- know “how many” or compare without needing to count.
- add or subtract objects and **see** how the number changes.



Learning to Count

Learning the Number Word Sequence
Learning to Count Objects



Learning the Number-Word Sequence

- Toddlers recite some counting words
- By 3 1/2 to 4 1/2 years of age, children typically count to 10 and begin to count to 20 or higher.
- The first 20 numbers have to be memorized or learned by rote.
- Counting beyond 20 is easier, once the pattern is learned.

Fuson, 1988; Wagner & Walters, 1982

Learning to Count Objects

Children need lots of meaningful and engaging opportunities to count

- to keep track of things
- to find out how many
- to compare quantities
- to solve problems



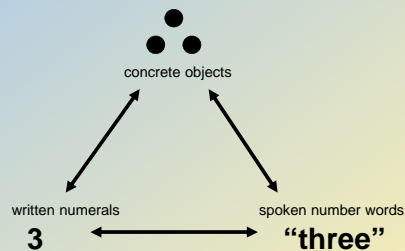
Number Relationships: Comparing

- Young children compare using
 - perceptual clues
 - one-to-one correspondence (matching)
 - counting
- use comparison words, such as **more than**, **less/fewer**, and **same number**



"Are there **more** red pegs or **more** blue pegs? How can you find out?"

Understanding and Representing Number



Adapted from Shane, R. (1999). Making connections: A "number curriculum" for preschoolers. In J. Copley (Ed.) *Mathematics in the early years*, (pp. 129-134). Reston, VA: NCTM.

More Games That Help Children Learn Number Skills

- Board (path) Games
- Lotto Games
- Games with Objects
- Action Games
- Games with Dice



Reflect and Review

- Think about what we have done and discussed about number and operations.
- What key points, ideas, or strategies do you want to remember?
- What ideas and activities do you want to share with families and staff?



Patterns

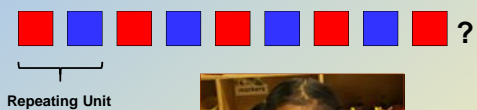


What is a Pattern?

- A pattern is a regular, predictable arrangement of things.
- Objects, numbers, shapes, sounds, actions, or events can make a pattern.



Repeating Patterns



Growing Patterns



Let's Make a Pattern!

- With the other people at your table, create a **repeating** or **growing pattern** of your own.
- Use **sounds, actions, or objects**.



Do, Re, Moo!
Do, Re, Moo!
Do, Re, Moo!

Jump, stomp
Jump, jump, stomp
Jump, jump, jump, stomp
Jump, jump, jump, jump, stomp

Importance of Patterns in Young Children's Daily Lives

Patterns provide a structure that helps infants, toddlers, and preschoolers

- learn language.
- participate in routines, games, songs, and stories/books.
- build their cognitive abilities, including memory.
- feel secure.



Patterns Infant and Toddler Beginnings

Infants and Toddlers


- experience and respond to patterns in language, play, daily routines, and interactions.
- delight in repetition
 - repeat action sequences *over and over again* in their play (put it in, dump it out)



Copley, 2010; Geist et al., 2012

What Preschoolers Learn About Patterns

- Remember and follow patterns in their daily routines and play.
- Begin to recognize, duplicate, extend, create, and describe patterns.




Ginsburg, et al. 2006; Pieraut-Le Bonniec, 1982; Starkey, et al., 2004

Reflect and Review

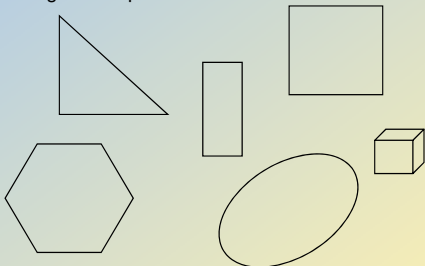
- Take just a quick moment to jot down any key points or ideas you want to remember from our discussion of Family Engagement.
- Begin thinking of something fun that you can do right away to engage your families in early math.
- Then you can tell us about it!

Geometry and Spatial Sense



Making Shapes with String

The inspiration for this activity came from a picture of 3 children holding a piece of string that formed a triangular shape.



Making Shapes With String Discussion

- How does this activity relate to the *HS Early Learning Outcomes Framework* Goals for Geometry and Spatial Sense?
 - Goal P-Math 9. Child Identifies, describes, compares, and composes shapes.
 - Goal P-Math 10. Child explores the positions of objects in space.
- Is this an activity that you could do with young children? ... with families?

Geometry and Spatial Sense

- Early geometry involves learning about shapes
 - what they look like
 - what you can do with them
 - what they are called
- Spatial sense involves reasoning about
 - how objects fit together and move in space
 - how one's body fits and moves in relation to objects in the environment

**Geometry and Spatial Sense
Infant and Toddler Beginnings**

Infants and Toddlers

- explore **shape and spatial relations** in their play with objects
- develop spatial sense as they **move their bodies** through space



Langer, et al., 2003; Sinclair, et al., 1989

**Geometry and Spatial Sense
Infant and Toddler Beginnings**



Parents and staff support infants' and toddlers' learning by

- providing opportunities
 - to manipulate shapes
 - to move through space in a variety of ways
- playing games with shapes and space (rolling a ball back and forth)
- using shape and spatial vocabulary



"You're coming down the stairs. Did you go over the bridge – up one side and down the other?"

What Preschoolers Learn About Geometry and Spatial Sense

Preschoolers

- recognize, name, and describe attributes of common geometric shapes.
- create and use shapes in constructions, drawings, and puzzles.



Clements, 2004

What Preschoolers Learn About Geometry and Spatial Sense

Preschoolers

- increase their understanding of spatial relations, including position, order, and directionality.
- develop concepts and vocabulary related to shapes and spatial relations.



Parents and staff support preschoolers' learning by

- providing a variety of experiences with shapes and spatial relations.
- helping children notice, “analyze”, and talk about shapes and their attributes.
- using and encouraging children to use descriptive spatial vocabulary.



Exploring and Learning About Shapes and Spatial Relations

- Geometric Shapes and Their Attributes
- Manipulating Shapes
- Spatial Concepts and Spatial Language (Math Talk)

Experiences That Help Children Learn About Shapes and Spatial Relations

Hands-on manipulating, exploring, and creating with

- Shape Sorters
- Containers and lids
- Puzzles
- Tangrams
- Pattern Blocks
- Building Blocks



Block Building



What are children learning when they build with blocks?

Puzzle Play



What are children learning when they play with puzzles?

Developing Spatial Sense

What IS spatial sense?

*Spatial sense gives children an awareness of themselves in relation to the people and objects around them. **

- How one's body relates to other objects and the environment
- How objects relate to other objects and the environment



* The Head Start Leaders Guide to Positive Child Outcomes: Strategies to Support Positive Child Outcomes, ACF, (2003)

Developing Spatial Concepts

Children develop spatial concepts as they

- manipulate or think about objects in relation to other objects
- move their bodies through space and in relation to other objects
- come to understand and use language that describes spatial concepts, including direction, position/location, order, size, and shape

Development of Spatial Concepts and Spatial Language

“Math Talk” Spatial Research Recap

More “spatial talk” during parent-child interactions from 14-46 months predicted

- the child’s spatial language production and
- performance on non-verbal spatial reasoning tasks at 54 months

Pruden, Levine, & Huttenlocher, 2011

“Math Talk” Spatial Concepts and Spatial Words

- Direction: up, down, forward, backward, sideways, left, right
- Position/location: in, on, above, below, over, under, around, in front of, behind, next to, beside, between, inside, outside
- Order: before, after, next, first, third, last
- Spatial properties of objects: big, little, deep, thin, wide, curvy, straight, round

Experiences that Support Spatial Concepts and Spatial Language

- Movement activities like *Find the Empty Space*
- Math Talk: Conversations about spatial relations (and shapes)
- Using Children’s Literature
 - *over, under, through* by Tana Hoban
 - acting out stories with spatial language like *The Three Billy Goat’s Gruff*
- *Simon Says*

Reflect and Review

- Think about what we have done and discussed about geometry and spatial sense.
- What key-points do you want to remember?
- What would you like to share with families and staff about **activities and interactions** that support learning about shapes and developing spatial concepts?

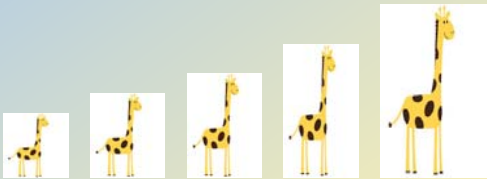


Measurement



Measurement Warm-up

From Shortest to Tallest!



Measurement and Comparison

- For young children, measurement is primarily about comparing.
 - They evaluate and compare things based on attributes like length or area.
 - They tend to use perceptual cues to compare.
- They enjoy measuring with rulers and other tools, but it's not standard measurement yet.

Measurement and Comparison Infant and Toddler Beginnings

Infants and Toddlers

- notice size and other dimensions.
- explore and learn about attributes such as size, weight, and capacity in their play.
- begin to understand and use words like, "Big!"



Sinclair et al., 1989; Sera & Smith, 1987

Adults support infants' and toddlers' learning by



"Look, here's a tiny little mouse
and here's a great big
elephant."

Rivera, et al., unpublished manuscript

- providing opportunities to explore properties like size and capacity.
- using measurement words.
- emphasizing measurable dimensions in playful games and interactions.

What Preschoolers Learn About Measurement and Comparison

Preschoolers

- continue to explore, compare, and learn about measureable attributes, such as height, length, weight, speed, etc.
- begin to use direct comparison strategies such as
 - lining up two objects to see which is longer or
 - picking up one object and then another to see which is heavier.
- explore measuring with units, using non-standard and standard measurement tools.

Non-standard measurement

Standard measurement



Clements & Stephen, 2004; Miller, 1984

Adults support preschoolers' learning by

- Providing lots of opportunities to explore measurement.
- Thoughtfully planning experiences that encourage measuring and comparing.
- Using descriptive measurement language.



Finding the Math in Books

- How can you share ideas with families about how reading with their child can support math learning?



Reflect and Review

- What key-points, ideas, or strategies do you want to remember about measurement and comparison?
- What do you want to share with families and staff about
 - supporting children's developing measurement knowledge?
 - "finding the math" in children's books?



Math is Everywhere!

- What are the children and adults doing?
- How might the adult mathematize this learning experience for the children in
 - Number and Operations
 - Patterns
 - Geometry & Spatial Sense
 - Measurement & Comparison



Putting it All Together Discussion

Turn to your neighbor and answer the following questions:

- What is one thing you know now that you didn't know before this training?
- At the beginning, our goal was for you to become "math experts" in your program or agency. Do you feel more like an expert?
- What excites you most about what you learned?

Acknowledgements

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- This workshop includes content originally developed by the National Head Start Family Literacy Center (NHSFLC) for the Office of Head Start, Administration for Children and Families and the U. S. Department of Health and Human Services under grant number 90YL002/05, 2010.
- Many of the photographs of young children used here are the work of Deborah Conn, originally included in NHSFLC training materials. We thank her!

Thanks for all your hard work today!