

Mathematical Practices in Early Childhood Education

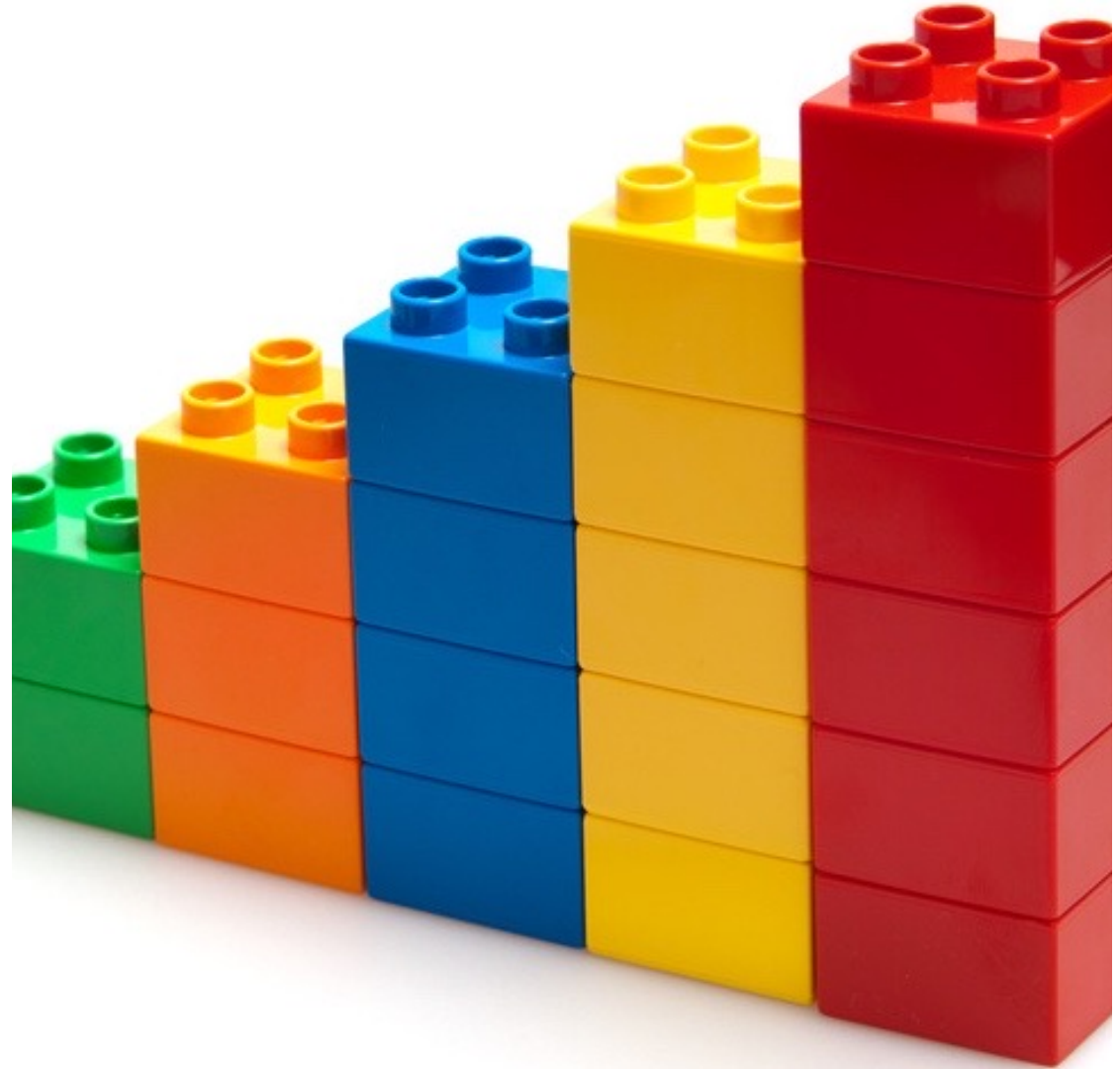
We can do this!



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San Francisco State University
23 June 2023

Agenda

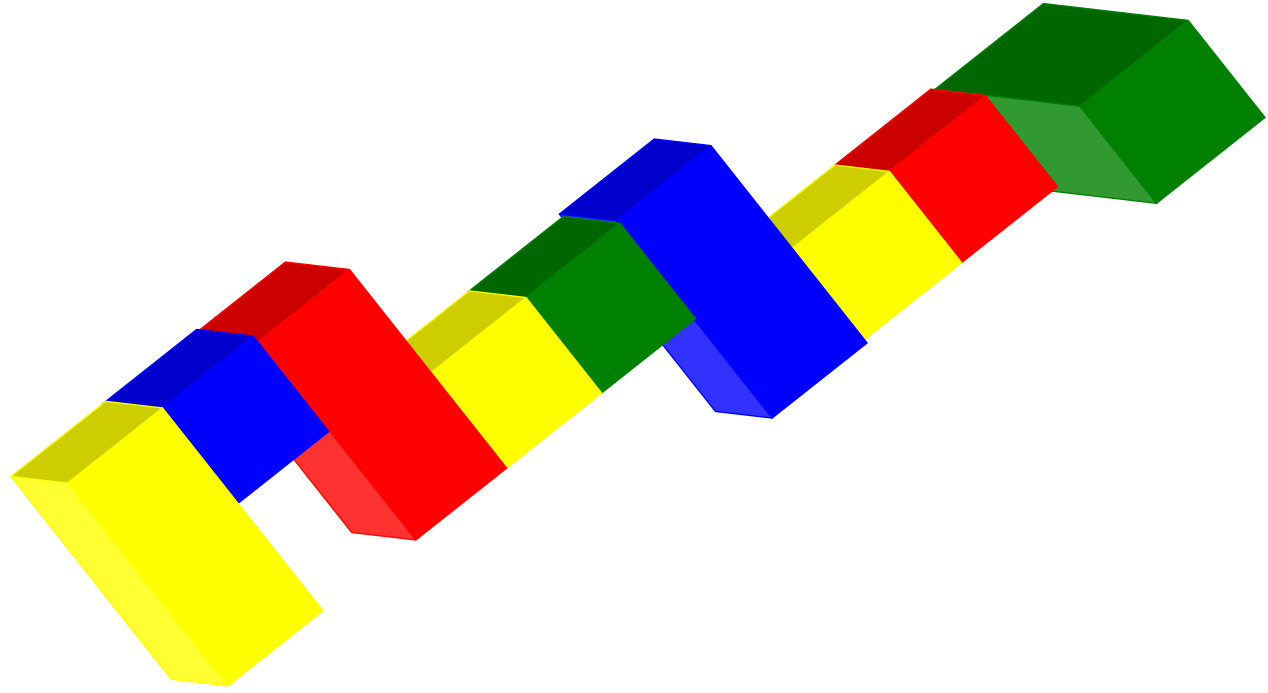
- + Mathematical Practices
- + Foundational Supports
- + We can do this
- + Q & A



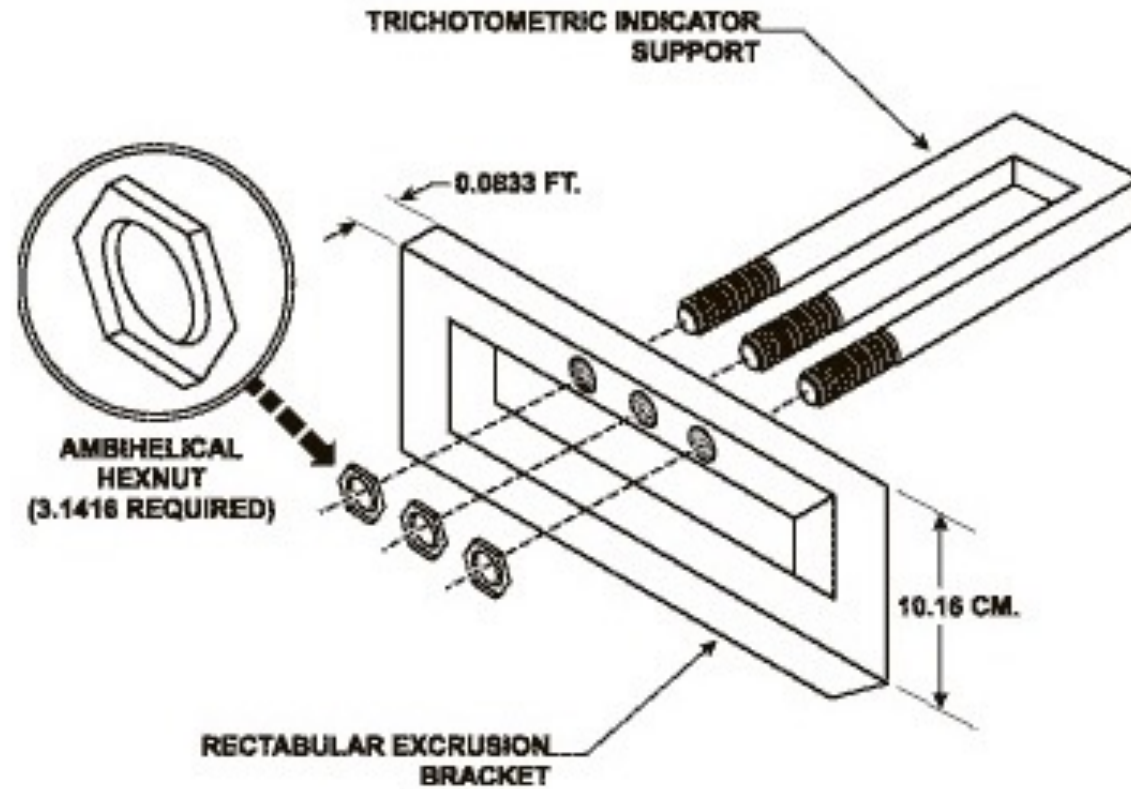
Your role

- + What do you do to support early mathematical development?
- + What can you do to support early mathematical development?





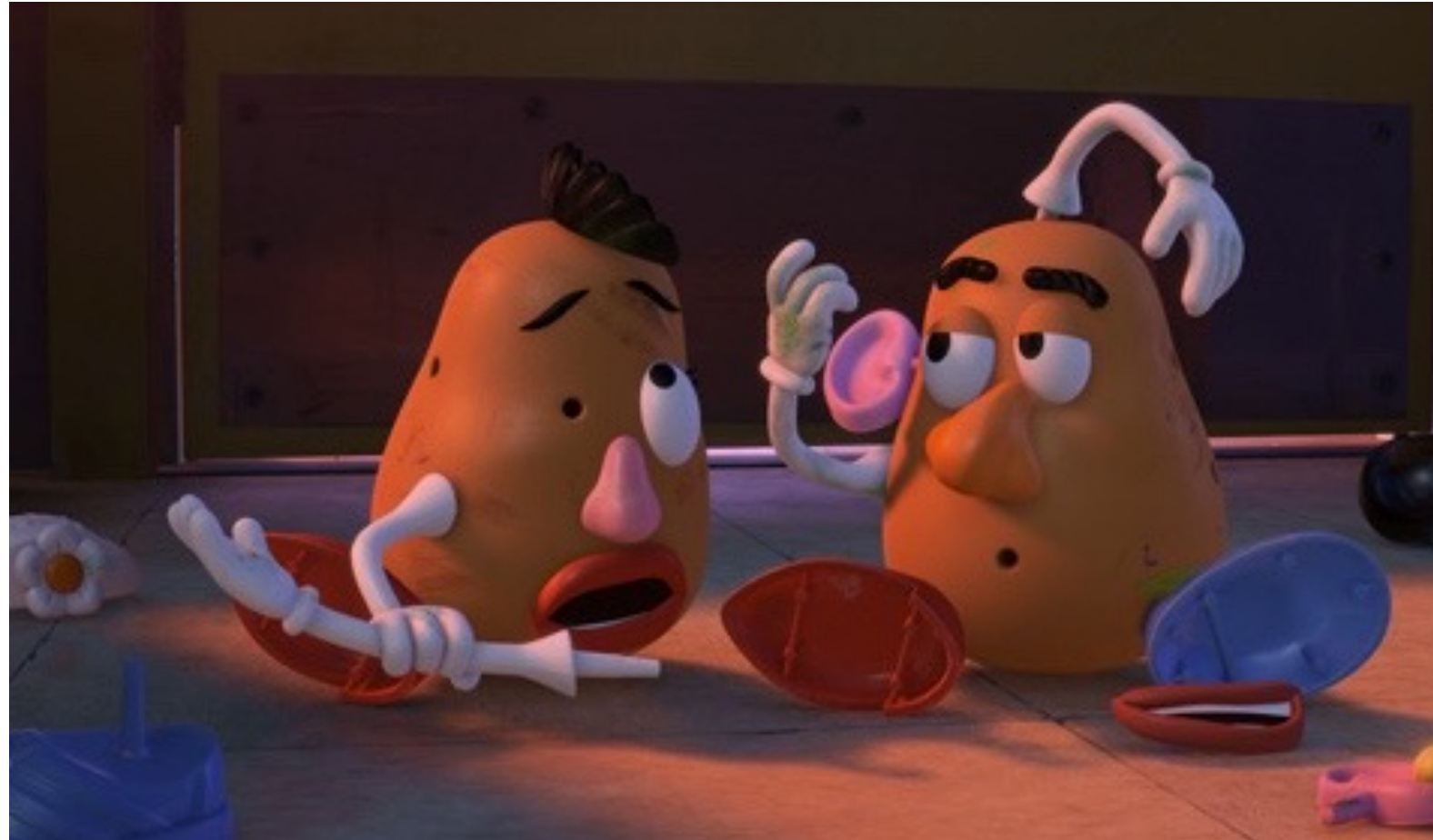
https://www.reddit.com/r/funny/comments/qbcu8/the_instructions_from_hell/



Putting together furniture...

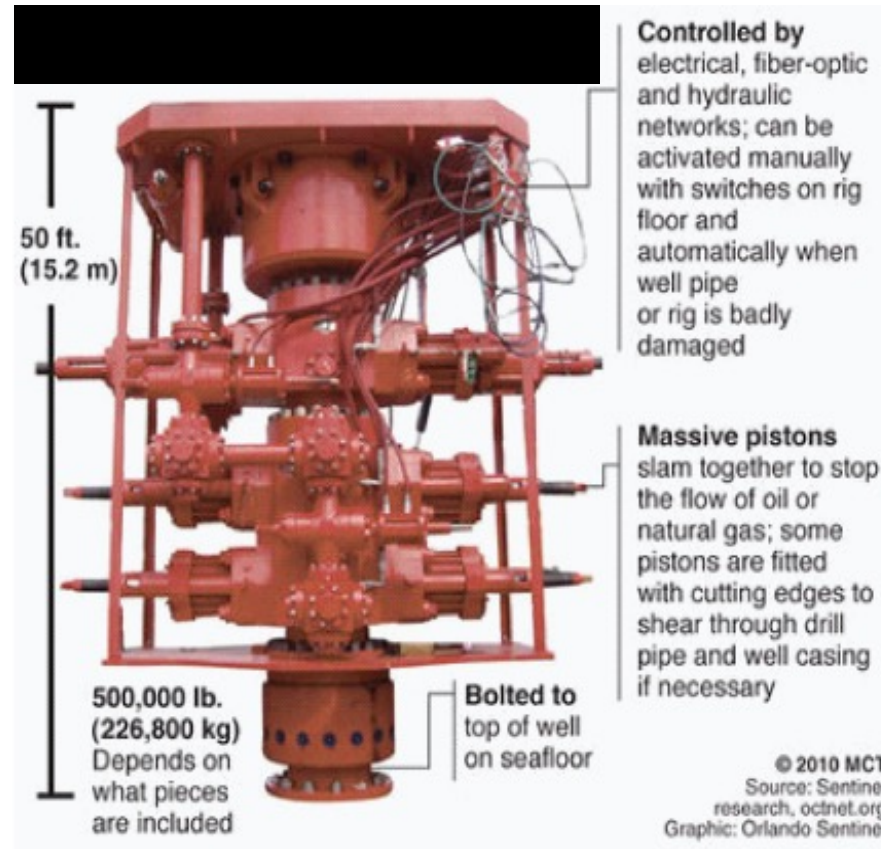
Computer Generated Animation

https://toystory.disney.com/?int_cmp=toy_site_charaport_thumb_Int#/movies/toystory-3/gallery



A job with Pixar

Transocean Blow-out Preventer



Curbing pollution in the Gulf of Mexico

Common Core: Mathematical Practices

Amandla counting



Mathematical Practices in the Early Grades

- + Mathematical Practices are actions in which we want students to engage
 - Young students bring a wide variety of mathematical experiences to the classroom
- + Students need modeling
- + Students need scaffolding



#1 **Make sense of problems and persevere in solving them**

Students...

- + Explain the meaning of the problem
- + Look for entry points to solutions
- + Consider similar problems
- + Use concrete objects or representations to solve problems
- + Check their answers

#1 **Make sense of problems and persevere in solving them**

Teachers...

- + Provide appropriately challenging problems
- + Make sure the mathematical problems make sense
What are students being asked to do and why?
- + Ask students to evaluate their answers/solutions
Ask students, "Does this make sense?" "Is there more than one way to solve this problem?"
- + Instill a joy in problem-solving



#2 Reason abstractly and quantitatively

Students...

- + Make sense of quantities and relationships
- + Develop an ability to decontextualize and recontextualize
- + Attend to units
- + Attend to the meaning of quantities

#2 Reason abstractly and quantitatively

Teachers...

- + Encourage discussions of relationships
- + Make connections from the concrete to the abstract
- + Encourage the use of representations
- + Reinforce the concept of a quantity
 - "Four" can describe innumerable sets



#3 Construct viable arguments and critique the reasoning of others

Students...

- + Understand and use stated assumptions and definitions
- + Make conjectures
- + Justify and communicate conclusions
- + Make plausible arguments
- + Constructively critique the reasoning of others
- + Ask useful questions to clarify



#3 Construct viable arguments and critique the reasoning of others

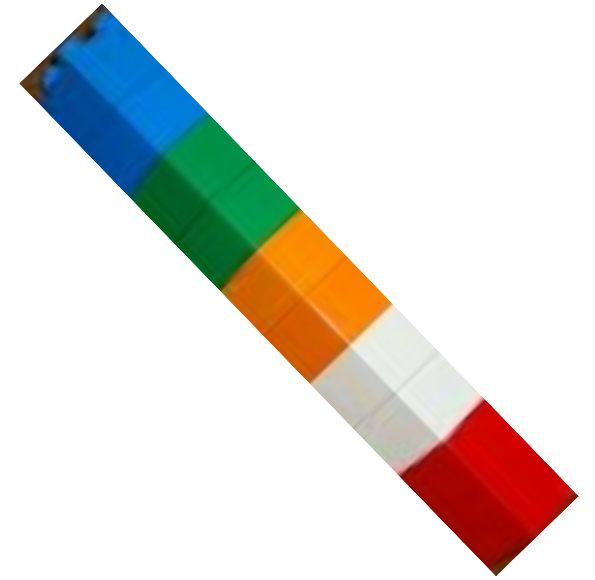
Teachers...

- + Use prompts to help students think critically and express their mathematical ideas
- + Help students develop definitions
A triangle is a closed three-sided figure
- + Provide opportunities for students to talk about their problem-solving strategies

#4 **Model with mathematics**

Students...

- + Apply mathematics they know to real-life problems
- + Map relationships of quantities
- + Use representations to think about and solve problems
- + Interpret mathematical results in context



#4 **Model with mathematics**

Teachers...

- + Are role models for students
- + Use mathematics to solve their problems in the classroom
- + Ask students to illustrate/model mathematical problems in a variety of ways
- + Support the use of symbols to represent real-world situations and problems



<https://www.craftsy.com/post/miter-joints/> ; <https://www.youtube.com/watch?v=A9HmMojYRw4>

#5 Use appropriate tools strategically

Students...

- + Consider available tools
- + Make sound decisions about the use of tools
- + Detect errors using tools like estimation
- + Use technological tools and resources when applicable

#5 Use appropriate tools strategically



Teachers...

- + Provide opportunities for students to choose tools in mathematical problem-solving
 - “Which tools would help you compare the weights/heights/temperatures?”
- + Ask students to model problems with manipulatives of their choosing

#6 Attend to precision

Students...

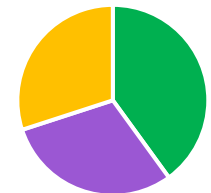
- + Communicate precisely to others
- + Know and use clear definitions
- + Use the equal sign appropriately



#6 Attend to precision

Teachers...

- + Provide students with accurate definitions and accurate depictions
 - A rectangle is a closed figure with four sides and four right angles
- + Provide opportunities to explore the meaning of equality (equal sign)
- + Provide accurate representations



#7 Look for and make use of structure

Students...

- + Look for and create patterns
- + Look for and make use of structure
- + See the relationships between mathematical topics



#7 Look for and make use of structure

Teachers...

- + Provide opportunities for students to identify, extend, and create patterns
- + Call attention to symmetry
- + Make connections between mathematical topics explicit
- + Encourage students to look for structure while problem-solving
 - $4 + 3$ is the same as $3 + 4$
 - Model with objects

#8 Look for and express regularity in repeated reasoning

Students...

- + Notice regularity in the way they solve problems
- + Explain regularity in their problem-solving
- + Make generalizations for future use

#8 Look for and express regularity in repeated reasoning

Teachers

- + Create sets of problems that can use the same problem-solving process - ask students to talk about their solutions
“What do you know about these problems?”
- + Ask students to think of other problems that are similar to the one at hand. How are they similar?

Mathematical Practices

- + Make sense of problems and persevere in solving them
- + Reason abstractly and quantitatively
- + Construct viable arguments and critique the reasoning of others
- + Model with mathematics
- + Use appropriate tools strategically
- + Attend to precision
- + Look for and make use of structure
- + Look for and express regularity in repeated reasoning

Your turn!

Jayden Film Clip

- + When students reach the classroom they are not blank slates

Jayden & Arithmetic

What does Jayden know?

Which Mathematical Practices does he use?

Put your answers in the chat (list them all together)

- 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**

Jada Film Clip

What does Jada know?

Which Mathematical Practices is she engaging in?

Jada division

A young girl with braided hair is sitting in a library, looking thoughtful. She is wearing a dark, patterned top. The background shows bookshelves filled with books.

What does Jada know?

Which Mathematical Practices does she use?

Put your answers in the chat (can be all together)

- 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**

Foundational Supports and Resources



Meeting children where they are

- + Children come to our classrooms with a wealth of informal mathematical knowledge
- + The knowledge that children bring to the classroom will vary widely
- + Teachers need to meet children where they are and support them as they gain new and increasingly sophisticated mathematical skills and knowledge



Meeting children where they are

- + Formative assessment and differentiated instruction are key

Formative Assessment



- + Unlike older students, most children in early childhood cannot be assessed with written assessments
- + Teachers need to be keen observers and engagers of children
 - Accurately assessing children’s mathematical abilities can be difficult because we can’t really see inside children’s heads. If we hear a child say to another, “You have more dinosaurs than I do!” we can probably assume that child has some sense of number. But is their claim based on the size of the pile of dinosaurs, or the numerosity of both sets of dinosaurs, or maybe even some history of playing with this individual child? These different possibilities make it clear that more information is needed.
 - Useful prompts include “Tell me how you know.” “How did you figure that out?” “Why do you think that?” “Can you show me how you know?” Be ready to follow-up with clarifying questions during the conversation



Instill a joy

- + Successful mathematics learning requires a positive learning environment that fully engages children and promotes their enthusiasm for learning.

Your role

- + Bringing it back to the beginning-

What do you do to support early mathematical development?

What can you do to support early mathematical development?

Resources

+ DREME Network

- <https://prek-math-te.stanford.edu/>



What is DREME?

Established in 2014, Development and Research in Early Mathematics Education (DREME) is a network of scholars across the country who engage in collaborative research and development with the goal of advancing the field of early math learning and teaching.





Family Math

This project conducts research to inform effective practices for promoting young children's math experiences at home with the support of parents and caregivers.

[Learn more about this project](#) →



Teachers

This project develops research-informed materials that build the capacity of early childhood educators to promote children's math and executive function skills.

[Learn more about this project](#) →



Teacher Educators

This project conducts research and develops materials that prepare teacher educators to support in-service and pre-service teachers in promoting young children's math learning.

[Learn more about this project](#) →



PreK-3 Alignment

This project conducts research to identify policies and practices that are associated with high quality, continuous math education from preschool through the early primary grades.

[Learn more about this project](#) →

DREME Network

DREME TE: MODULES

- **Overview**
- **Counting**
- **Operations**
- **Patterns & Algebra**
- **Spatial Relations**
- **Measurement & Data**

| | | |
|---|--|--|
| Counting The deceptively simple act of counting, and developing children's number sense. Go to module > | Spatial Relations Early learning of geometric ideas, and how things are related in space. Go to module > | Operations Young children reason about the four operations (yes, even multiplication and division!). Go to module > |
| Patterns & Algebra Making sense of and describing patterns paves the way for early algebraic reasoning. Go to module > | Measurement & Data Is it longer? Heavier? How can we figure this out? Building from children's ideas about measurement & data. Go to module > | Overview These overview resources provide background and span the content of our other modules. Go to module > |

DREME TE: Layout

[Counting Example]

**Why and
What of
Counting**

**Mathematics
of Counting**

**Development
of Children's
Counting**

**Assessing
Counting**

**Supporting
Classroom
Practice**

Vignettes

**Getting
Started**

Verbal counting

- Ask an individual child to count as high as he or she can.
- Ask children to count objects (or stairs) while on walks or around the yard.
- Suggest that children count in preparation for a *Hide and Go Seek* game.
- Ask a child to tell you when you make a mistake (then skip or repeat a number in the counting sequence).

Numbers before and after

- Play *I'm Thinking of a Number* ("I'm thinking of a number that comes right after/before six").
- In a group, ask a child to say a number, and then ask another child to state the next number or the number before. Continue with this pattern (the next child provides the initial number, the following child states the number before/after) around the circle or group. You can limit the numbers that are named by the children to one through ten, one through 20, etc.

Number comparison

- Play *I'm Thinking of a Number* ("I'm thinking of a number that is greater/less than 11").
- In a group, ask two children to each state a number. Then ask another child to decide which is the greater/lesser of the two numbers.
- If children recognize numerals, write numerals 1-10 on ten cards placed randomly in front of a child and ask her to line them up in order of the numerals.
- Use collage-making or drawing as a counting activity. You can come back after the collages/drawings are made and ask each child to count how many of each object he or she chose or drew.
- Create opportunities during free play for assessing counting. How many blocks were used to build the tower? How many letters in their name? How many shovelfuls does it take to fill the bucket? How many eyes in the classroom? Ears? Arms? Legs? Shoes?

Cardinal value (numerosity of the set)

- During counting-object or counting-movement activities, ask at the end of the counting sequence, "So, how many are there all together?" or "How many is that?"
- Have the child or children line up two rows of countable objects such dominoes, teddy bears, or cars, and ask them to count how many there are in each row. At the end of each row ask them to tell you how many in that row.

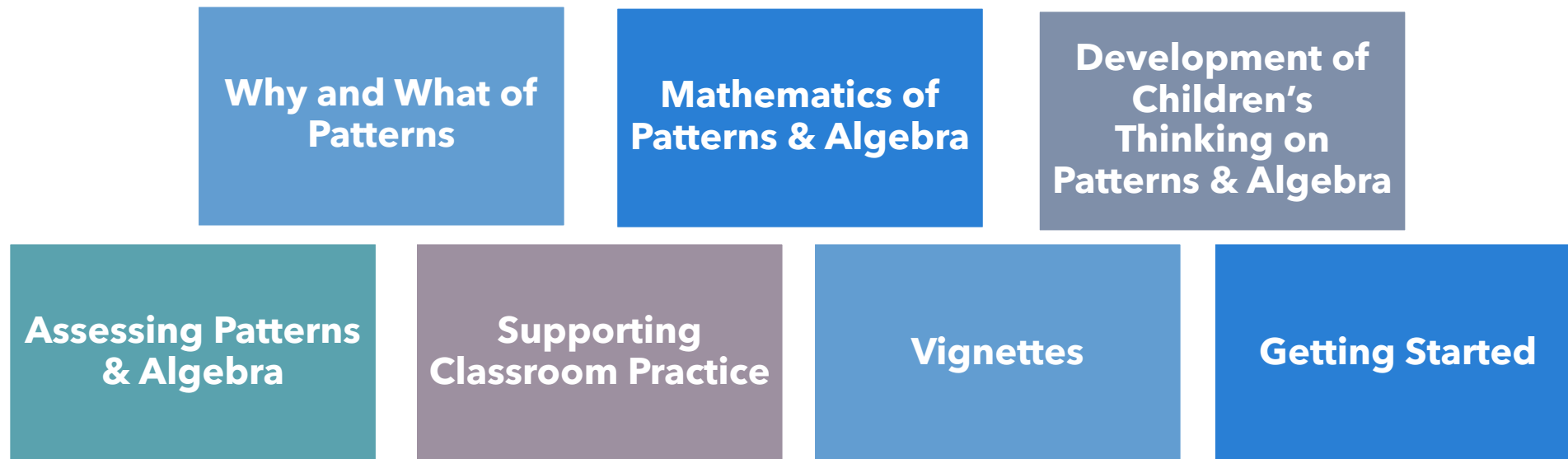
Set size comparison

- During individual or group conversations about *same*, *more* and *less* which use the numerical value of the sets, keep track of children's knowledge of greater-than and lesser-than.
- In the cardinal value activity with two rows described above, ask the child which of the two rows has the most objects.
- Have pairs of children draw varying sized sets of shapes on the board, then ask individual children which of two sets is larger or smaller.

Example of Formative Assessments on Counting from the DREME TE Website

DREME TE: Layout

[Patterns & Algebra Example]



Formative Assessments

Noticing regularity (and irregularity!)

- Pattern skills build on children's ability to discern differences. Ask children to sort a set of objects that can be sorted into distinct groups (colors, size, animal vs. insect, etc). Ask children: *How did they sort them? What makes the objects the same? What makes them different?*
- Children notice patterns all around them but may not be able to articulate what the pattern is ("Look Teacher! The recycle sign. That's a pattern too!"). Ask questions that elicit children's thinking ("Can you tell me what you see?").

Pattern recognition

- In a group, ask children to look around the classroom and point out patterns. Remind them that the pattern unit has to repeat at least twice. Examples are stripes on someone's shirt, pants or dress; or the repeating figures 0-9 in the "ones' place" column on a hundreds chart. Ask questions to bring out children's thinking ("Can you describe the pattern?")
- Play I-Spy in small or large groups using patterns outside or inside the classroom ("I see a pattern with red-blue-red-blue."). Once the children understand the game, allow them to take the teacher role.

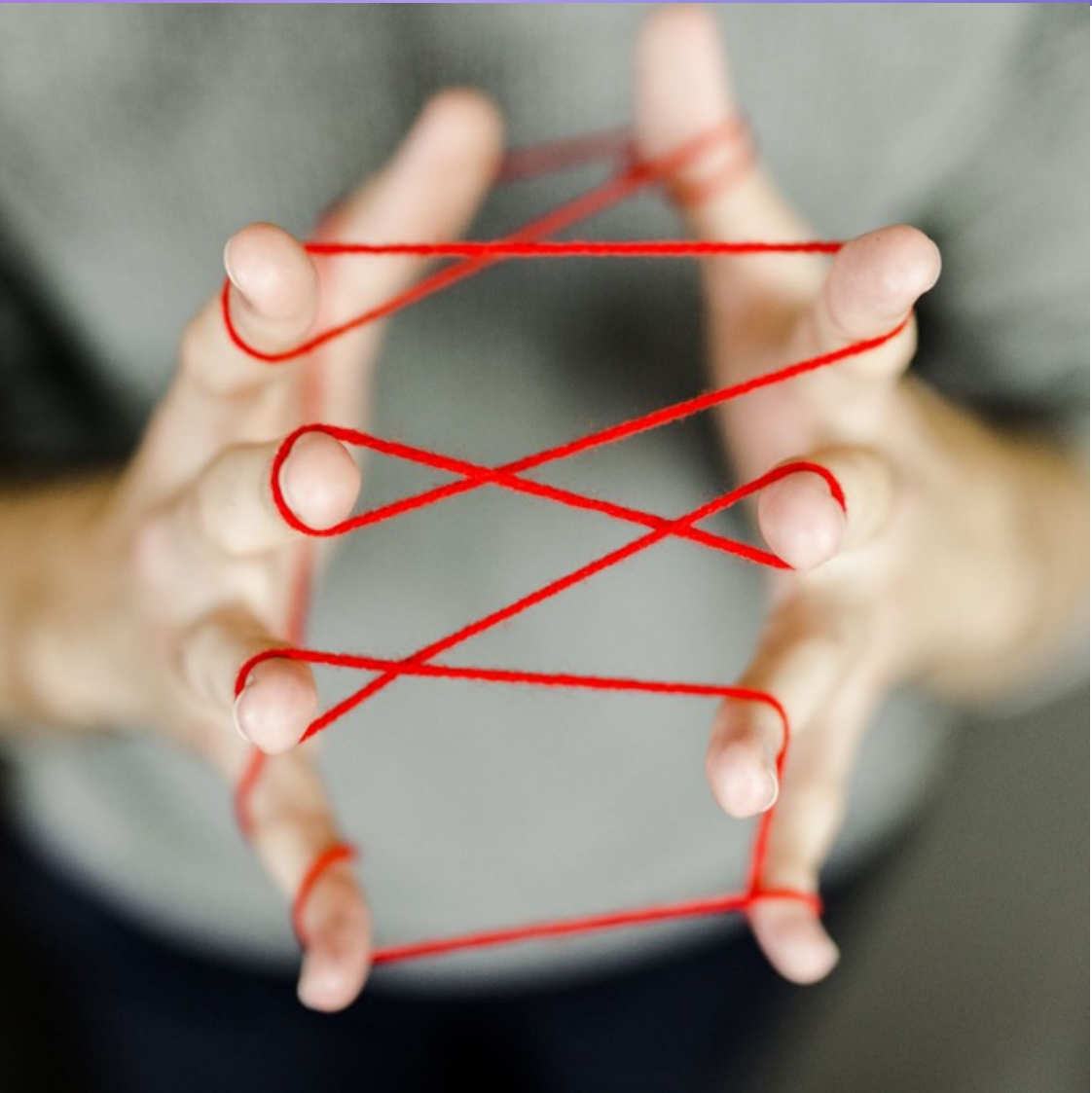
Pattern identification

- Ask one or more children to create their own patterns with beads, blocks, or other manipulatives. Ask another child to identify the pattern unit. This can be transformed into a center activity using collections of objects (teddy bears to put in lines, unifix cubes to connect, etc.).
- Create sound or movement patterns (remember to repeat the unit!) and ask the children to identify the pattern.

Example of Formative Assessments on Patterns & Algebra from the DREME TE Website

Practicing the Mathematical Practices

The screenshot shows the DREME TE website interface. At the top, the logo 'DREME TE' is displayed with the tagline 'Early Math Resources for Teacher Educators'. Navigation links for 'Modules', 'About', 'Home', and 'List All Resources' are visible. The breadcrumb trail indicates the current page is 'Overview / Background and Rationale'. The main heading is 'Overview', with a 'Print resource' button. A left sidebar lists various resources, including 'Math Matters', 'Practicing the Mathematical Practices', 'Mathematical Practices Activity', 'Who, What, Why of DLLs', 'DLLs and Math in Pre-K', 'Additional Overview Readings', 'Connecting Home and School Mathematics', 'Using Our Resources', and 'Getting Started: From the Community'. The main content area features the title 'Practicing the Mathematical Practices' and a summary: 'This paper elucidates the Common Core's vision of sound Mathematical Practices for young children, including reasoning abstractly and making sense of problems.' The author is identified as 'by Linda M. Piatas'. A paragraph below explains that the Common Core Mathematical Practices were designed to guide teachers in helping children develop a deep understanding of mathematical concepts. An image of two young girls playing with colorful blocks is shown in the bottom right corner of the main content area.



DREME TE Search Functions

- + **Topics**
 - Shapes
 - Addition
 - Fair sharing
- + **Type**
 - Videos
 - Handouts
 - Activities
 - Articles

Family Math



What is Family Math?

Resources

Family Activities ▾

Community

About

Do You Work with Families with Young Children?

Play a Big Role in Supporting Fun Math Learning at Home.

Explore Activities



Free, Research-Based Materials for Supporting Family Math

<https://familymath.stanford.edu/>

Free Math Materials for the Early Childhood Classroom

Explore Activities



Support Learning Throughout the School Day

Created by leading scholars in the field of early childhood education and with input from teachers, these playful and engaging activities promote young children's math and executive function skills.



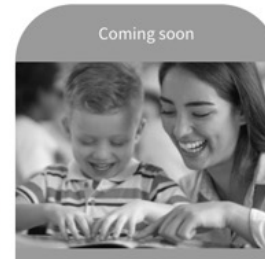
Center Time



Guided Activities



Math Moments



Coming soon

Reading Together

PreK-3 Alignment



Development and Research in
Early Mathematics Education

About DREME ▾ Resources ▾ Publications Events Blog

Advancing Preschool Through Elementary School Alignment and Continuity



Math learning in preschool is often disconnected from math learning in the early elementary grades. This disconnect can lead to students experiencing uneven instructional practices, which can compromise their learning. The goal of the DREME Preschool Through Elementary School Coherence (COHERE) project is to identify policies and practices that are associated with high quality, continuous math education from preschool through the early primary grades.

This is a collection of COHERE project-related policy briefs and research publications authored by DREME Network members and affiliates.

Policy Briefs

Building Infrastructure to Support Coaching Programs in School Districts

School districts are increasingly employing instructional coaches to support teacher learning. This move is supported by research demonstrating that ongoing coaching that is embedded in teachers' practice can be an effective strategy for improving teaching, more effective than short-term methods

<https://dreme.stanford.edu/prek-3-coherence/>

Questions & Answers



Thank you!

References

- + National Governors Association Center for Best Practices, Council of Chief State School Officers (2010). Common Core State Standards. Washington, DC: National Governors Association Center for Best Practices, Council of Chief State School Officers.
- + National Research Council. (2009). *Mathematics learning in early childhood: Paths toward excellence and equity*. Committee on Early Childhood Mathematics, Christopher T. Cross, Taniesha A. Woods, and Heidi Schweingruber, Editors. Center for Education, Division of Behavioral and Social Sciences and Education. Washington: DC: The National Academies Press.