REL CENTRAL
Regional Educational Laboratory at Marzano Research

Who We Are

The Regional Educational Laboratory (REL) Central at Marzano Research serves the applied education research needs of Colorado, Kansas, Missouri, Nebraska, North Dakota, South Dakota, and Wyoming.

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Language, Discussion, and Questions in Early Math

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Douglas H. Clements, Julie Sarama
Crystal Day-Hess
University of Denver

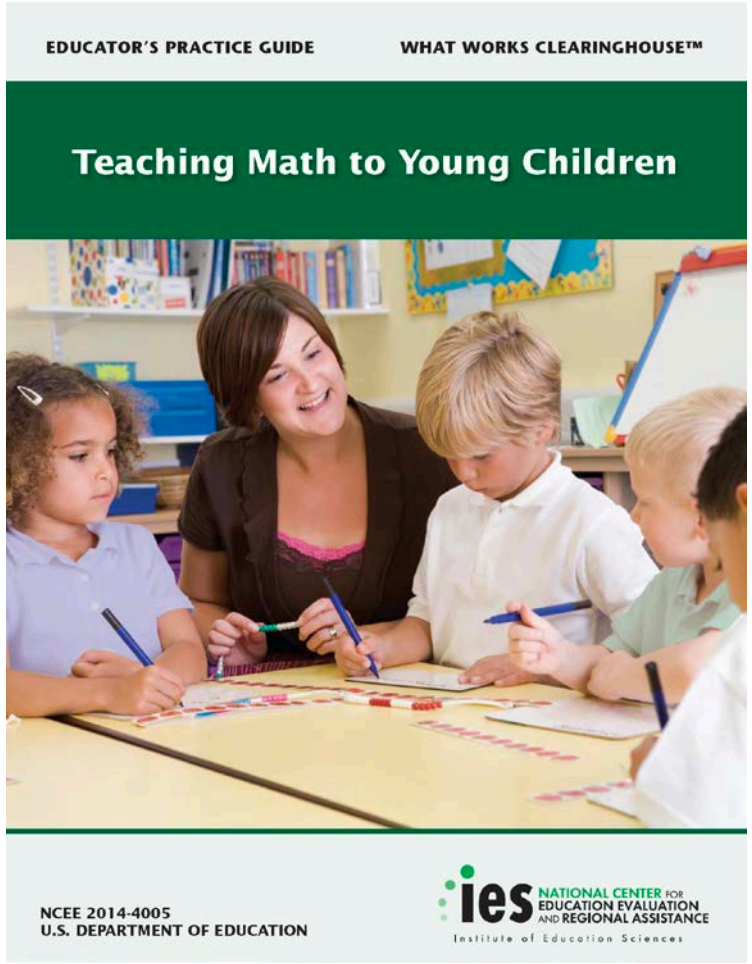
Goals and Outcomes

- Participants will learn about:
  - The importance of language for developing early mathematics thinking and learning, and the contributions that high-quality early mathematical instruction and experiences can make to language development in general
  - The recommendations from the practice guide, “Teaching Math to Young Children”
  - Multiple strategies for implementing Recommendation 4 from the practice guide and the adjustments necessary to make them relevant to their classroom settings and populations.

What Works Clearinghouse Practice Guide

Teaching Math To Young Children

https://ies.ed.gov/ncee/wwc/PracticeGuide/18



IES WWC What Works Clearinghouse ≡ MENU Search Go

PRACTICE GUIDE

Teaching Math to Young Children

Released: November 2013
PDF (3.7 MB)

Recommendations | Details | Panel

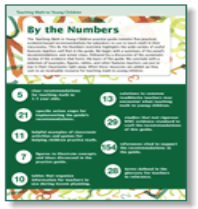
This practice guide provides five recommendations for teaching math to children in preschool, prekindergarten, and kindergarten. Each recommendation includes implementation steps and solutions for common roadblocks. The recommendations also summarize and rate supporting evidence. This guide is geared toward teachers, administrators, and other educators who want to build a strong foundation for later math learning.

1 Teach number and operations using a developmental progression. MODERATE EVIDENCE	2 Teach geometry, patterns, measurement, and data analysis using a developmental progression. MINIMAL EVIDENCE	3 Use progress monitoring to ensure that math instruction builds on what each child knows. MINIMAL EVIDENCE	4 Teach children to view and describe their world mathematically. MINIMAL EVIDENCE	5 Dedicate time each day to teaching math, and integrate math instruction throughout the school day. MINIMAL EVIDENCE
Show More	Show More	Show More	Show More	Show More

The practice guide is accompanied by supplemental resources, including a practice guide summary and quick overview for understanding the guide. The guide is also available in e-book format. Click below to access any of the available resources.

Educators Practice Guide Summary (3.8 MB)

This eight-page summary reviews expert recommendations from the



By the Numbers: Five Recommendations for Teaching Math to Young Children (4.8 MB)

EPUB (8.4 MB)

Download this e-book format to view the practice guide on a smartphone, iPad, or Nook.

MOBI (10.0 MB)

Download this e-book format to view the practice guide on a smartphone or Kindle.

All Recommendations Are Relevant

Recommendation 1. Teach number and operations using a developmental progression.

Recommendation 2. Teach geometry, patterns, measurement, and data analysis using a developmental progression.

Recommendation 3. Use progress monitoring to ensure that math instruction builds on what each child knows.

Recommendation 4. Teach children to view and describe their world mathematically.

Recommendation 5. Dedicate time each day to teaching math, and integrate math instruction throughout the school day.

Recommendation 4

Teach children to view and describe their world mathematically.

- Encourage children to use informal methods.
- Help children link formal math to their informal knowledge.
- Use open-ended questions.
- Encourage children to recognize and talk about math.

Recommendation 5

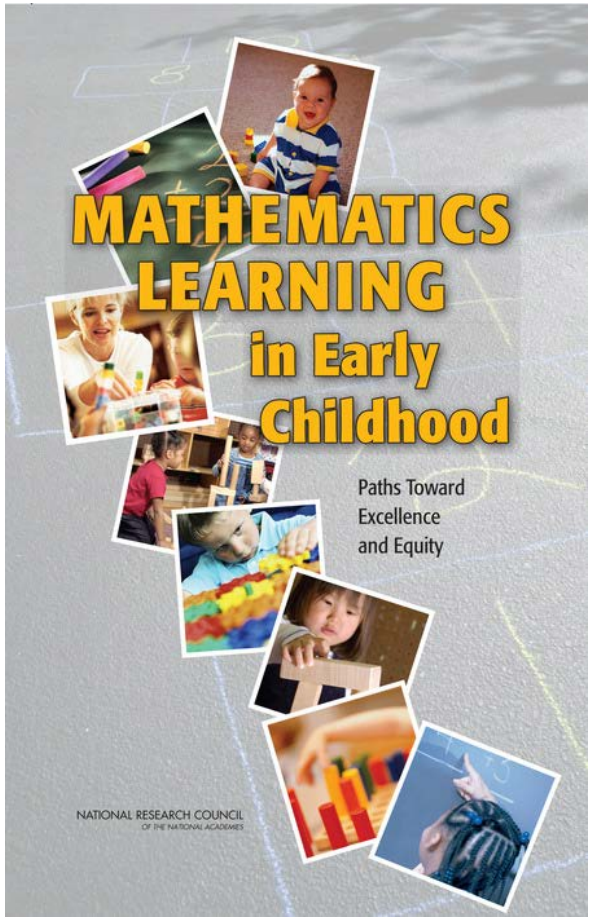
Dedicate time each day to teaching math, and integrate math instruction throughout the school day.

- Plan daily instruction on specific math concepts and skills
- Embed math in classroom routines and activities
- Highlight math within topics of study across the curriculum
- Create a math-rich environment
- Use games to teach math

Mathematics Learning in Early Childhood: Paths Toward Excellence and Equity

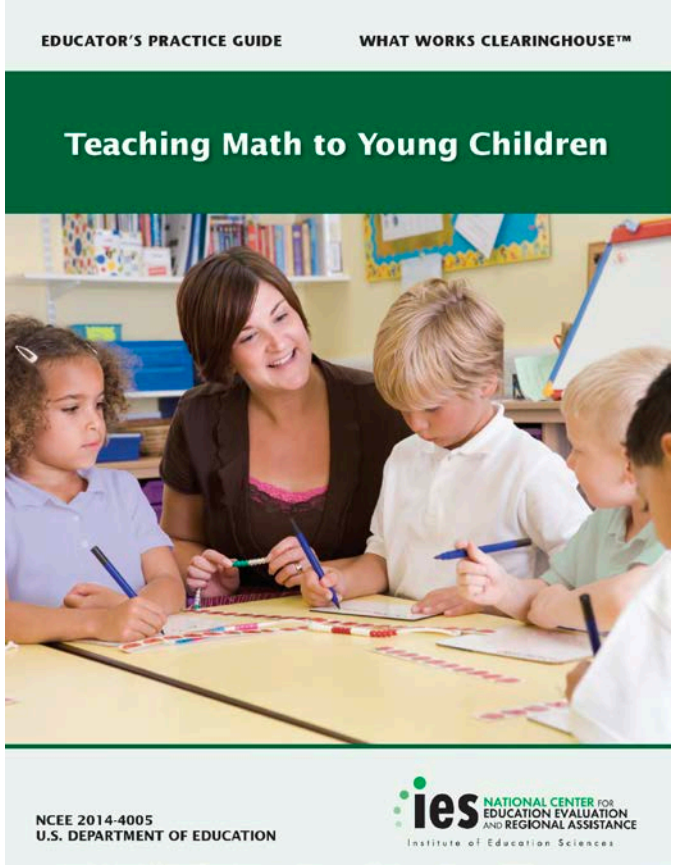
Mathematics learning is best done along paths, *which is the exact same thing as the developmental progressions of learning trajectories.*

- Using learning trajectories helps teachers and children achieve *excellence.*
- Using learning trajectories helps teachers achieve *equity and social justice.*



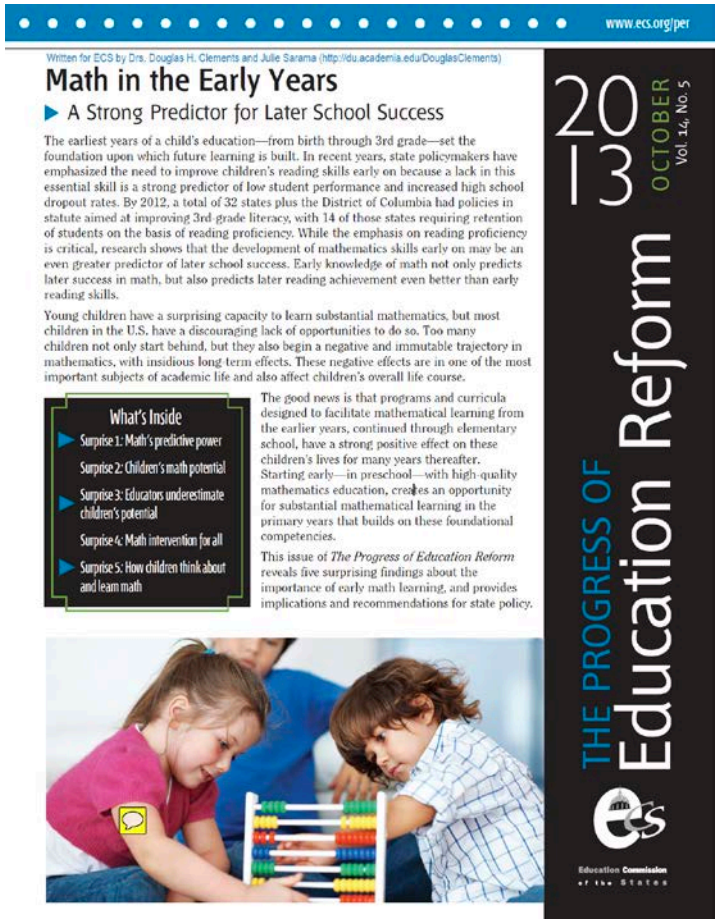
Your Turn!

1. Skim the practice guide.
2. Look specifically at the *How to carry out this recommendation* section for each recommendation (e.g., this section starts on p. 15 for Recommendation 1).
3. Enter comments or questions into the chat box.



Young Children and Math

- Math predicts later school success.
- Children can engage in impressively deep and broad mathematical thinking.
- Equity is a concern, and we can address it.
- We know a lot about how children learn math and how to teach it, using *learning trajectories.*



Math and Language—Missing Links

- An equity issue.
- Homes vary:
  - Some children hear about 1,500 number words a year.
  - Others hear 93,000.
  - That's *60 times as many words!*
- Language and math talk predict number knowledge.
- But math talk is a missing link for many educators.

Math and Language—Missing Links

- In classrooms, too, we could do more.
- When children make a math utterance, teachers:
  - Ignore it 60% of the time.
  - Respond mathematically only 10% of the time.

Math and Language—Missing Links

- There were marked differences, associated with income level, in children's mathematical knowledge by 4 years of age.
- Teachers' math talk ranged from 1 to 104 instances.
- The amount of teachers' math-related talk was significantly related to the growth of preschoolers' mathematical knowledge over the school year.

Your Turn!

- Please enter *your* example of children's math talk into the chat box. Consider, for example:
  - What is the last math question that a child asked you and how did you answer?
  - What question did *you* ask and how did children respond?
- Questions and answers.

Dual Language Learners (DLLs)

- Children who are members of linguistic minority groups also deserve special attention.
- A defining characteristic is these children's diversity.
- Most lag behind their monolinguistic peers in educational achievement.
- Limited proficiency in English poses a high barrier.

Dual Language Learners (DLLs)

- Many challenges, many developmental benefits.
  - Bilingual children can often see a general mathematical idea more clearly than monolingual children can.
- And children can learn 2 languages as easily as 1.

Strategies for DLLs

- All teachers can use strategies to support both languages.
- When possible, bilingual approaches in school are best.
- The following characteristics of instructional programs support oral language development of DLLs:
  - Specialized instruction focused on components of oral language.
  - Opportunities for interaction with speakers proficient in the second language.
  - Feedback to students during conversational interactions.
  - Dedicated time for instruction focused on oral English.

Myths About DLLs and Math

Myth	Fact
• Math is based on numbers and symbols, so language is less of a concern.	• Children learn math from oral language.

IMPLICATIONS for TEACHERS:

Teachers need to understand the linguistic characteristics of classroom language and also master ways to connect everyday language with the language of math.

Math Strategies for DLLs

"Math talk" is much more than just using math vocabulary.

- Teach specific vocabulary terms ahead of time and emphasize cognates.
- Provide visual and verbal supports.
- But vocabulary alone is insufficient. Teachers need to:
  - Help students see multiple meanings (and conflicts) of terms in both languages.
  - Address the language of mathematics, not just the "terms."
- Build on the resources that bilingual children bring to mathematics.

Math and Language—A Two-Way Street

Math

Language
Literacy
Reading

Math and Language

- **Recommendation 4:** Help children link formal math vocabulary, symbols, and procedures to their informal knowledge or experiences.

Math–Language Links: An Example

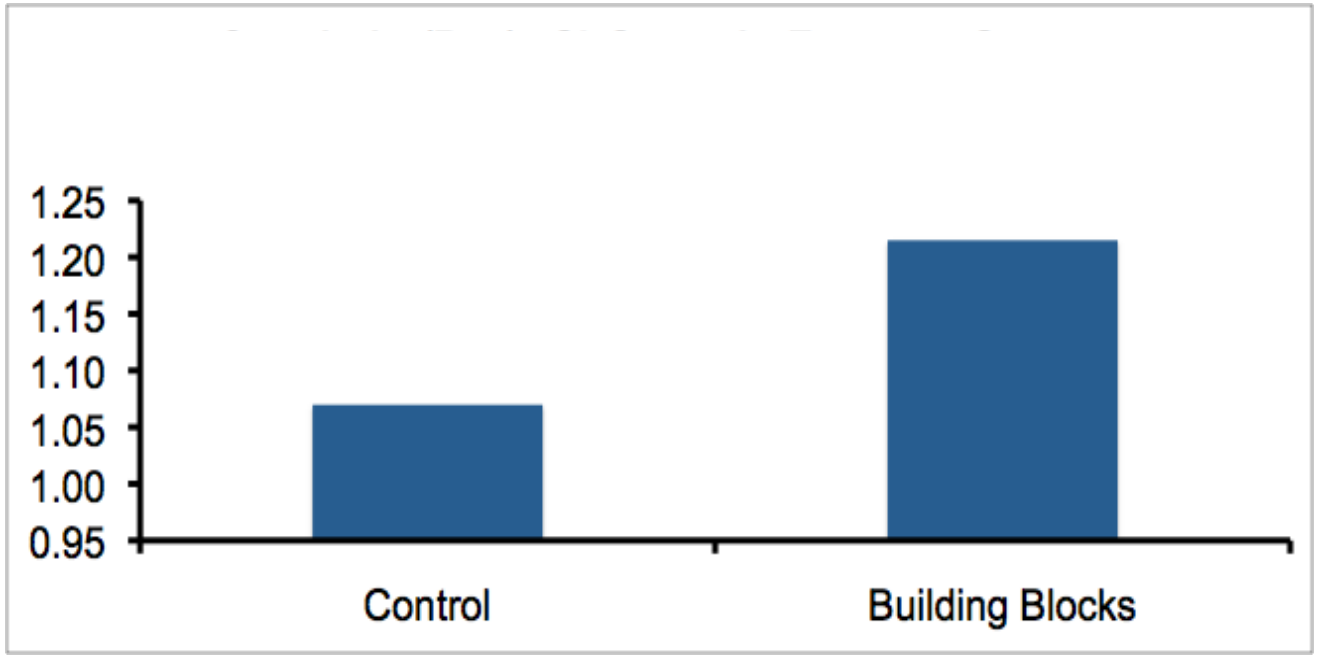
"The children got good at math tasks, being able to verbalize, talk about them, not just doing them. I think this is why my kids do well on the Brigance. Their verbal skills got better. They transported it to language. I worried about it. I never taught so much math in a day. I thought reading comprehension was being sacrificed. When I stepped back and looked, I realized doing math *was* doing language."

—Joan, pre-K teacher

Math Increases Language

- Preschool teachers in one study loved math learning, but some worried that their coordinators and principals cared more about language and literacy scores.
- Would the focus on math take away from language and literacy learning?
- Literacy scores did not differ groups.

- *Significantly higher* for math on:
  - Information (number of vocabulary words used)
  - Grammatical complexity
  - Independence
  - Inferential questions



Informal and Formal Math: Research Summary

- Children have intuitive strengths in math.
- And even adults invent strategies to solve math problems.
- But school math is “out of balance.”
- Too many children do *not* make sense of math in school.

What Is Informal Math?

- All children reason informally—and impressively—in math.
  - Four-year-old Carmen had almost filled her pretend pizzas with toppings. As she got ready to roll the number cube, she said, “I’m going to get a high number and win!” “You can’t,” replied her friend, “You have 4 spaces and the number cube only has 1s, 2s, and 3s on it.”
- The numbers may be small, but the reasoning is impressive. *Children can reason mathematically*.

What Is Informal Math?

- Carmen's friend probably intuitively used logic that might be described as the following:
  - To win, Carmen must get at least a 4.
  - The number cube has only 1, 2, and 3.
  - These numbers are less than 4.
  - Therefore, Carmen cannot win on her next roll.

Questioning Strategies

- The main question for teachers is (some version of) *How do you know?*
  - Alex is 5 years old. Her brother, Paul, is 3. Alex bounds into the kitchen. Alex says, "When Paul is 6, I'll be 8; when Paul is 9, I'll be 11; when Paul is 12, I'll be 14" (she continues until Paul is 18 and she is 20).

    Her father says, "My word! *How* on earth *did you figure all that out*?"

    Alex responds, "It's easy. You just go 'three-FOUR-five'; you go 'six-SEVEN [clap]-eight'; you go 'nine-TEN [clap!]-eleven."

    (Davis, 1984, p. 154)

Questioning Strategies

- Children as young as preschoolers can learn to talk about the many strategies they invent.

Strategy	Example
Wait time	"Hmm, let's give everyone a minute to think."
Revoice	"You used a 'diamond' you say—a *rhombus*." "Can someone else say in their own words what Emma said?"
Model	"I'm going to move the blocks as I count to keep track."

Questions Encourage Discussions—Math Talk

- *Ask* children to share, clarify, and justify their ideas.
  - **SCENARIO 1:** The teacher is working with a group of children, who are completing several geometric puzzles.
    - "How did you solve that puzzle?…What if you didn't have any hexagons, could you still have solved it?"
  - **SCENARIO 2:** Children are to make groups of four toys. One boy says, "I don't know if I have four. Do I?"
    - "You don't know if you have four? How can you find out?" He counts…to five. The teacher asks, "Do you have four? No? Is it too many or too few? What can you do?" He fixes it. "How do you know you have four? How did you solve it?"

Questions Encourage Discussions—Math Talk

- *Facilitate* children's responding.
  - **SCENARIO 1:** Start with "Think-Pair-Share."
    - The teacher asks one child to figure out how many 1 more than 3 is.
      - When a child has difficulty, the teacher says, "Can you show me 3 to get started?"
      - The child says "four." The teacher asks, "Can you teach us how you did that?"
      - The teacher asks, "Did anybody do it a different way?"
    - Be sure to revoice and model *mathematical* vocabulary.

Questions Encourage Discussions—Math Talk

- *Encourage* children to *listen to* and *evaluate* others' thinking, ideas, and strategies.
  - **SCENARIO 1:** In circle time, two children explain to the group what they did.
    - The teacher asks another child, "What did Dominic do?"
    - The teacher asks, "Did anyone do something like Juanita? Would that work?"

Open-Ended Questions

- IES practice guide:
  - "Use open-ended questions to prompt children to apply their math knowledge."

Table 8. Examples of open-ended questions

How are these the same/different?
What can you use (in the block area) to make a pattern?
What patterns do you see (on the seashells in the science center)?
How could we change this pattern to make a new one?
How can we find out who is taller or shorter?
What can we use to find out...?
What can we do to find out who has more/fewer?
How else can you show it?
How does it show what we know?

Strategies and Representations

- Discussing strategies helps build rich representations of mathematical ideas.

Representations are objects, actions, words, pictures, or symbols that stand for ideas.

Table 6. Using informal representations

Concept	Informal Representation	Teaching the Concept
whole number	"three"	Collections of blocks, dots, tally marks, fingers, or other countable objects can represent numerals. For example, when playing a game, use blocks to represent children's scores so everyone can track each player's score.
equal	"same number as" or "same as"	Provide opportunities for children to begin to recognize that collections that have the same number when counted are equal. For example, a collection of four plates is the same number as a collection of four cups.
unequal	"more than" or "fewer than"	Point out that a collection is more (or fewer) than another if it requires a longer (or shorter) count. For example, seven is more than six because it requires counting beyond six.
addition	"and" or "more"	Start with a collection and add more items to make it larger. For example, start with three crayons and add one more. Then ask, "How many?"
subtraction	"take away" or "fewer"	Start with a collection and take away some items to make it smaller. For example, start with three crayons and take away one. Then ask, "How many?"

Everyday Questions

- Practice guide: “Encourage children to recognize and talk about math in everyday situations.”
  - **Example:** A teacher might say, “I have to figure out how many cups we are going to need for the birthday party. Can you help me? How should we do that?”
- Also encourage families to talk about mathematics, especially number, arithmetic, spatial relations, and patterns.

Connect Informal to Formal Math

- Provide meaningful problems.
- Ask children to share, to justify, and to listen to peers.
- Revoice, modeling *mathematical* vocabulary.
- Be aware of potentially ambiguous words.
- Observe children's use of the words and negotiate new meanings through practical experiences.

Toddlers Talk Math

- Toddlers (~18 months) learn “one” simultaneously with “two”!
- At about 2 years, they use “2” spontaneously and reliably.
- They learn “3” at about 3 years.

  But…

- Number words are not emphasized.
- *Non-examples* are rarely used (“That’s not 2; that’s 3!”).

Toddlers Talk Math, *If* Caregivers Do!

- Remember, parents talked in one week:
  - From 28 number words to…1,800!
  - Finding: Extends children's quantitative knowledge and contributes to differences in math competence (e.g., cardinality).
- Children need examples and non-examples.
  - "That's not 2; that's 3!"

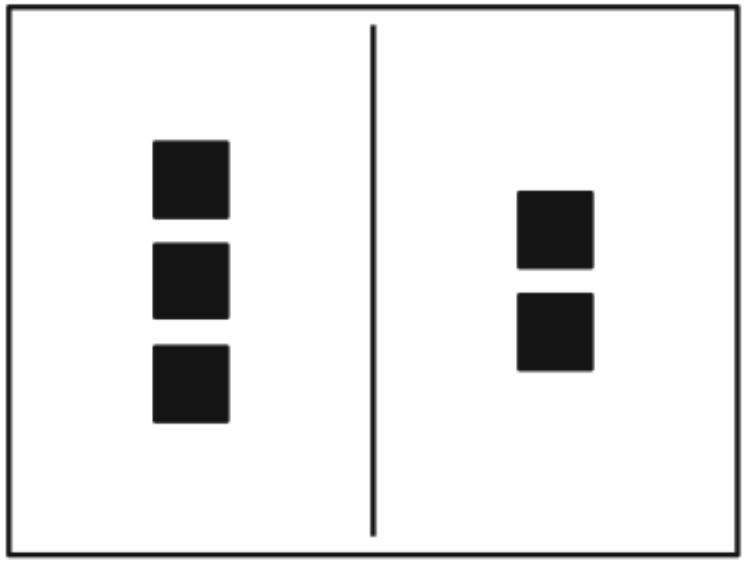


Figure 1. Sample item from the point-to-*x* task.

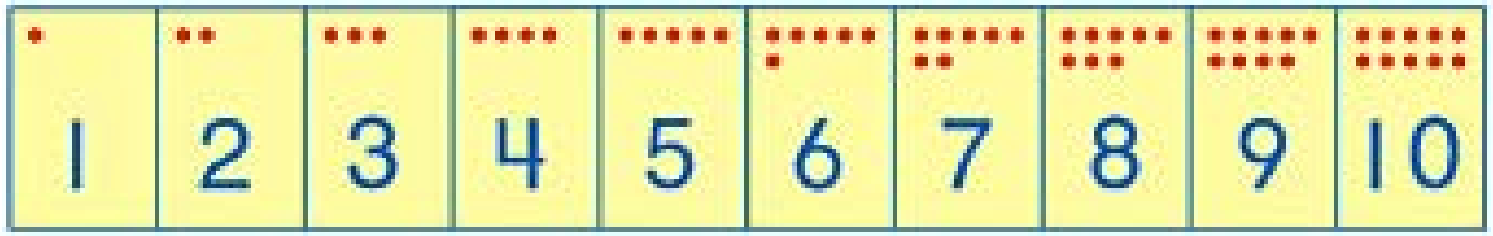
It Takes a Community…

Creating a Math Talk Community

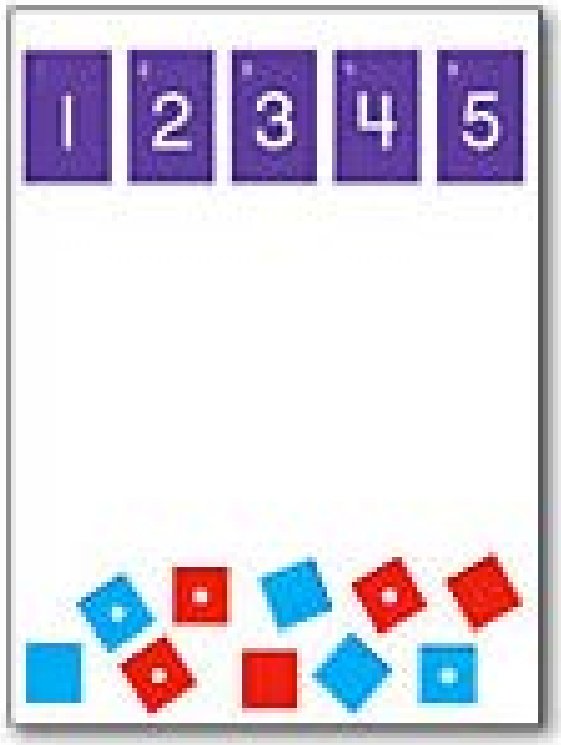
- The teacher creates a nurturing and supportive Math Talk Community:
  - Elicits thinking from students.
  - Helps students explain and help each other explain and solve problems.

Math Talk Example 1

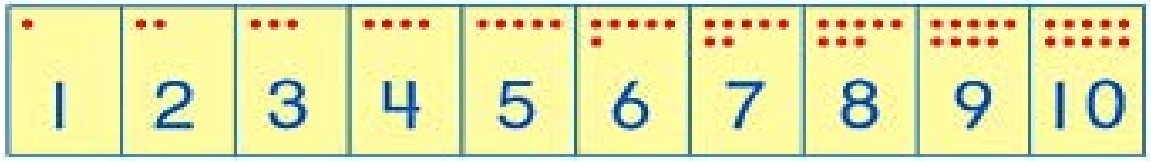
- *Math talk discussion:*
  - Relate the visual quantity 3 to 3 fingers, 3 sounds, and 3 body movements.
  - Practice visual imagery: Close your eyes. Visualize. (*See* the *three*.)
  - Describe different arrangements of your fingers to make each number.
  - Count 1 to 10 as one child points to each number in the Number Parade.
  - Children raise fingers or jump with each number word.



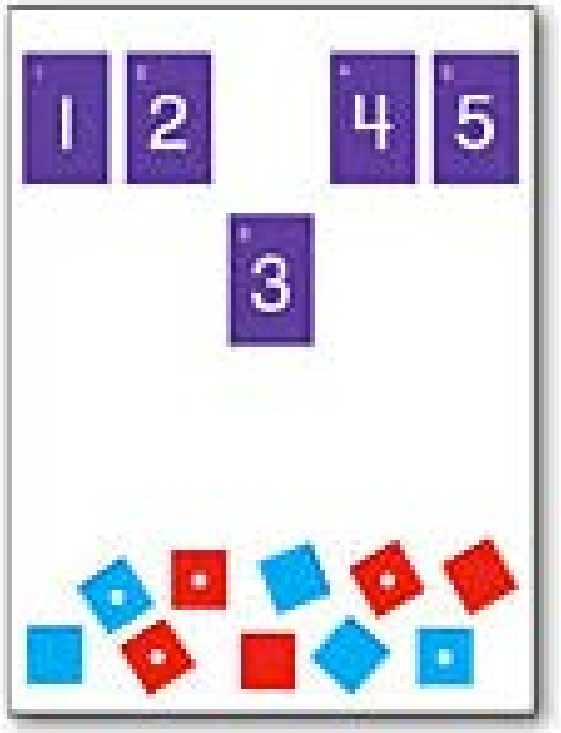
Math Talk Example 2



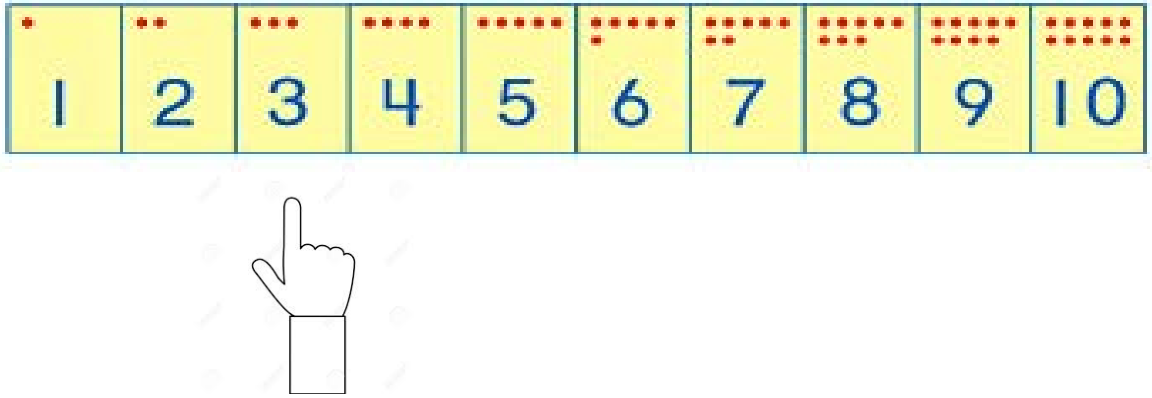
- Each child has a mat, numerals 1–5, red and blue tiles at bottom (5 red and 5 blue in a baggie; one side is plain and the other side has a white dot).
- To begin, children put the number tiles in order at top of the mat (they can look at the Number Parade).



Math Talk Example 2

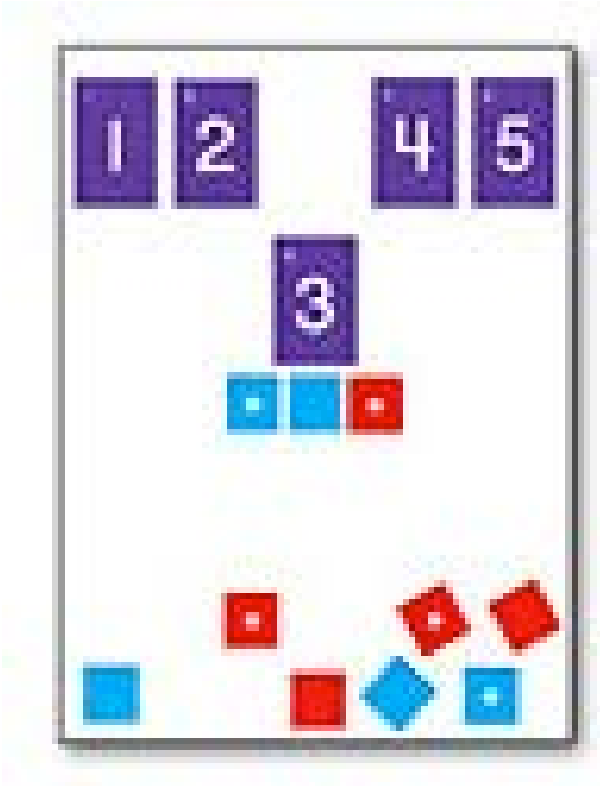


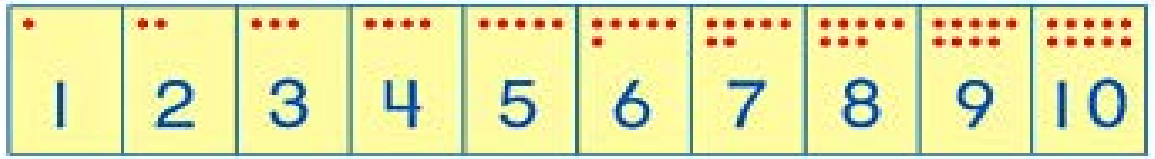
- Teacher or child points to the number tiles in order and says the number on that tile.
- Children pull down the number tile for the number.



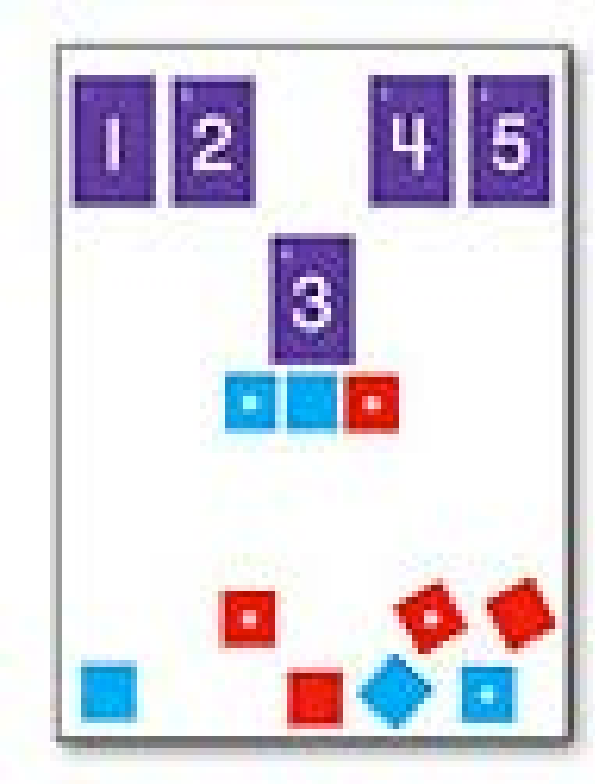
Math Talk Example 2

- Children show that number of tiles.



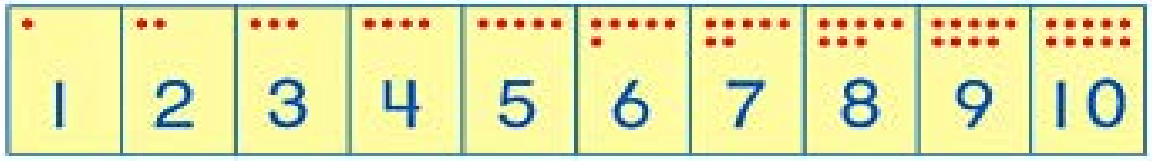


Math Talk Example 2



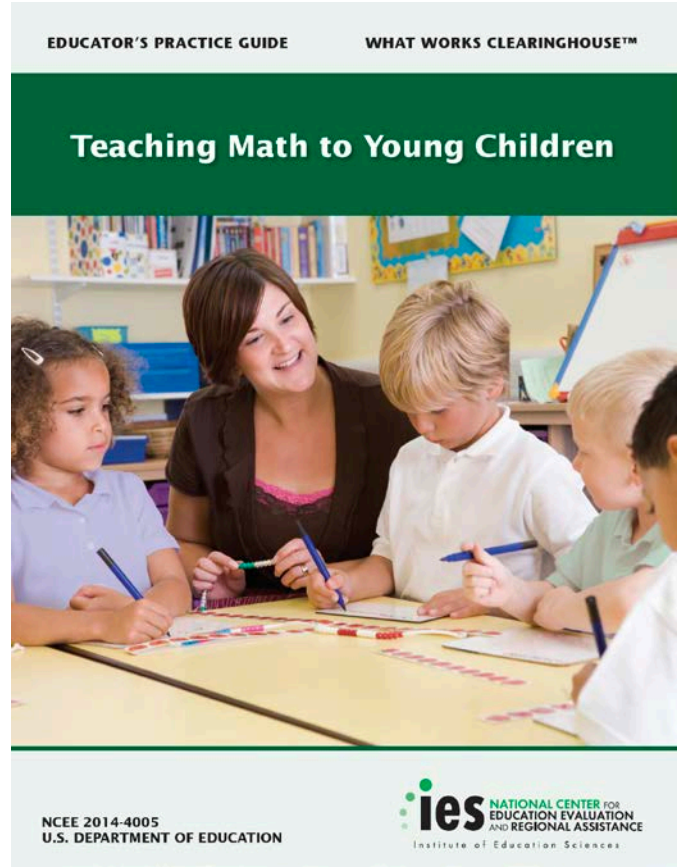
Math talk discussion:

- Describe different arrangements by color, dot/no dot, spatial relationships (e.g., 3 = 2 + 1).
- Change your arrangement and discuss why you still have 3.
- Copy the arrangement of another person.
- See and describe partners of 3 (decompositions of 3 into 2 numbers) and create new partners that make 3.



Your Turn!

- Reflect on the strategies from Recommendation 4 and develop one concrete step based on these strategies for improving math talk in classrooms.
- Enter comments or questions, if you wish, into the chat box.



Carrying out Recommendation 5

Recommendation 5 - Dedicate time each day to teaching math, and integrate math instruction throughout the school day.

- Plan daily instruction on specific math concepts and skills.
- Embed math in classroom routines and activities.
- Highlight math within topics of study across the curriculum.
- Create a math-rich environment.
- Use games to teach math.

Questions?

Thank You

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Or contact us at

RELCentral@marzanoresearch.com

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