Teaching
Early
Math by
Providing
Language
Exploration

The TEMPLE Read-Alouds Project

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The Meadows Center for the Prevention of Educational Risk

Getting to Know You

1. What positions do you hold?

2. What ages/grade levels do you work with?

3. How do you usually teach math to your students?

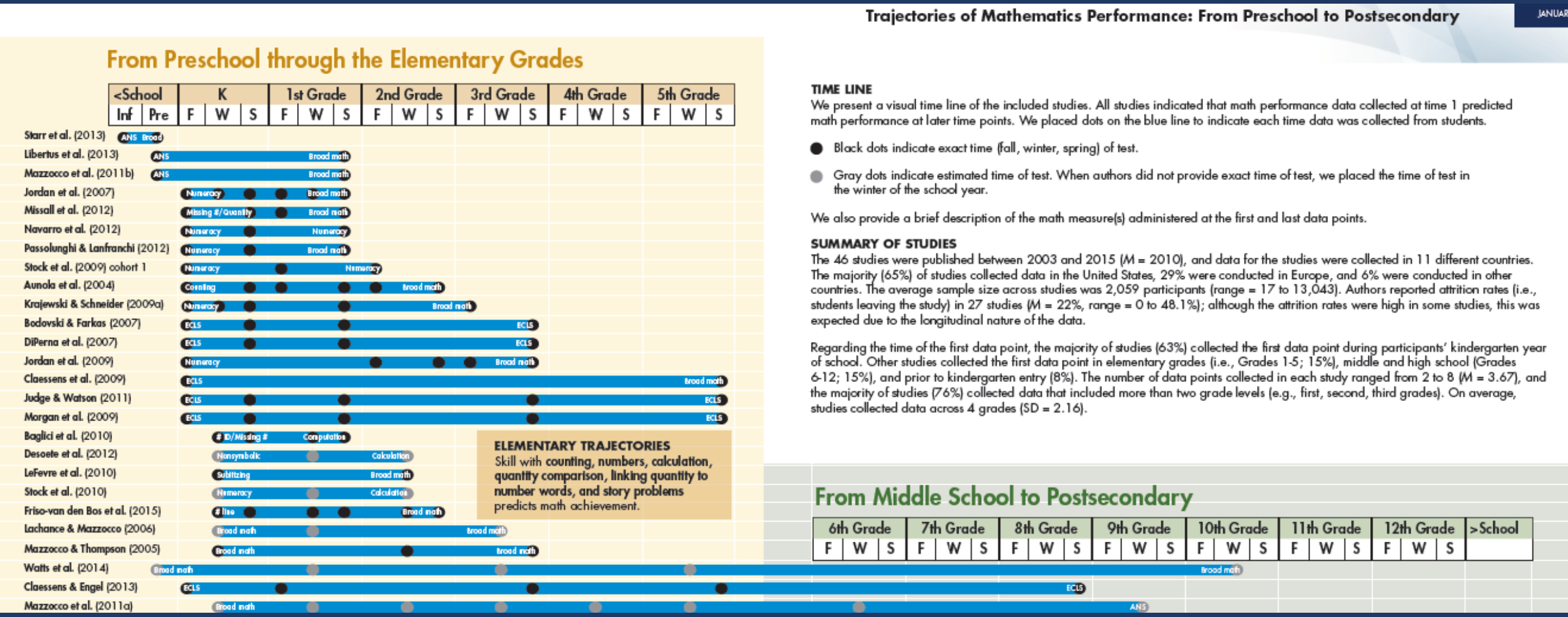
Teaching Early Math by Providing Language Exploration

Overview

- Background Research
- Math Language
- TEMPLE Read-Alouds Project
- Using the Routine
- You try it!!!

Teaching Early Math by Providing Language Exploration

Early Math Skills are Important



(Nelson & Powell, 2016)

Developmental Psychology
2017, Vol. 53, No. 9, 1633–1642

0012-1649/17/$12.00 http://dx.doi.org/10.1037/dev0000375

Why Do Early Mathematics Skills Predict Later Reading? The Role of Mathematical Language

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Temple University

Amy R. Napoli
Purdue University

A growing body of evidence indicates that the development of mathematics and literacy skills is highly related. The importance of literacy skills—specifically language—for mathematics development has been well rationalized. However, despite several prominent studies indicating that mathematics skills are highly predictive of literacy development, the reason for this relation is not well understood. The purpose of this study was to identify how and why early mathematics is predictive of early literacy development. Participants included 125 preschool children 3–5 years old (M = 4 years 3 months). Participants were assessed on mathematics, literacy, and cognitive measures in both the fall and spring of their preschool year. Mediation analyses indicated that the relation between early mathematics and literacy skills is mediated by children's mathematical language skills. These findings suggest that, in prior research identifying mathematical performance as a significant predictor of later literacy skills, mathematical performance may have acted only as a proxy measure for more complex language skills such as those assessed on a mathematical language measure.

Keywords: preschool, numeracy, mathematics, literacy, language

Mathematical Thinking and Learning, 17: 197–218, 2015

ISSN: 1098-6065 print / 1532-7833 online
DOI: 10.1080/10986065.2015.1016817

Routledge
Taylor & Francis Group

Early Numeracy and Literacy: Untangling the Relation Between Specific Components

David J. Purpura and Amy R. Napoli
Purdue University

Although it is evident that advanced aspects of numeracy are dependent on the successful acquisition of early skills, this developmental process does not occur in isolation from other academic factors. Early literacy skills are intertwined with the acquisition of early numeracy skills, particularly at the informal numeracy and numeral knowledge phases. However, the localization of these domains' impact in early numeracy development is unclear. To address this issue, 180 preschool children 3.13 to 5.88 years (51.1% female, 66.7% Caucasian, 14.4% African-American, 4.4% Hispanic, 14.4% other race/ethnicity) were assessed on measures of print knowledge, vocabulary, informal numeracy, and numeral knowledge. Results indicated that the relation between language and numeral knowledge is fully mediated by informal numeracy skills and the relation between informal numeracy skills and numeral knowledge skills is partially mediated by print knowledge. Explanations of the findings, implications for mathematics education, and future directions are discussed.

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JOURNAL OF RESEARCH ON EDUCATIONAL EFFECTIVENESS
2017, VOL. 10, NO. 1, 116–137
http://dx.doi.org/10.1080/19345747.2016.1204639

Causal Connections Between Mathematical Language and Mathematical Knowledge: A Dialogic Reading Intervention

David J. Purpura[a], Amy R. Napoli[a], Elizabeth A. Wehrspann[a], and Zachary S. Gold[a]

ABSTRACT
The acquisition of early mathematical knowledge is critical for successful long-term academic development. Mathematical language is one of the strongest predictors of children's early mathematical success. Findings from previous studies have provided correlational evidence supporting the importance of mathematical language to the development of children's mathematics skills, but there is limited causal evidence supporting this link. To address this research gap, 47 Head Start children were randomly assigned to a mathematical language intervention group or a business-as-usual group. Over the course of eight weeks, interventionists implemented a dialogic reading intervention focused on quantitative and spatial mathematical language. At posttest, students in the intervention group significantly outperformed the students in the comparison group not only on a mathematical language assessment, but on a mathematical knowledge assessment as well. These findings indicate that increasing children's exposure to mathematical language can positively affect their general mathematics skills. This study is an important first step in providing causal evidence of the importance of early mathematical language for children's general mathematical knowledge and the potential for mathematical language interventions to increase children's overall mathematics abilities.

KEYWORDS
mathematical language
mathematics
vocabulary
preschool
dialogic reading

READING STORIES TO LEARN MATH

Mathematics Vocabulary Instruction for Children with Early Numeracy Difficulties

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UNIVERSITY OF DELAWARE

ABSTRACT
The present study involved examining whether a storybook reading intervention targeting mathematics vocabulary, such as "equal," "more," and "less," and associated number concepts would increase at-risk children's vocabulary knowledge and number competencies. Children with early numeracy difficulties ($N = 124$) were recruited from kindergarten classes in four schools. Participants were randomly assigned to one of three groups: a storybook number competencies (SNC) intervention, a number sense intervention, or a business-as-usual control. Interventions were carried out in groups of four children over 8 weeks (24 30-minute sessions). Findings demonstrated that the SNC intervention group outperformed the other groups on measures of mathematics vocabulary, both in terms of words that were closely aligned to the intervention and those that were not. There was no effect of the SNC intervention, however, on general mathematics measures, suggesting a need to provide the mathematics vocabulary work along with more intensive instruction in number concepts.

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Language Ability Linked to Elementary Math Skills

- Early Numeracy Skills
- Number Recall
- Math Facts
- Measurement
- Number Line Concepts
- Accuracy and Speed of Calculations
- Magnitude Comparison
- Fraction Competence
- Data Analysis
- Geometry

(Chow & Jacobs, 2015; Fazio, 1999; LeFevre et al., 2010; Purpura & Ganley, 2014; Purpura, Logan, Hassinger-Das, & Napoli, 2017; Seethaler, Fuchs, Star, & Bryant, 2011; Toll & Van Luit, 2014; Vukovic & Lesaux, 2013)

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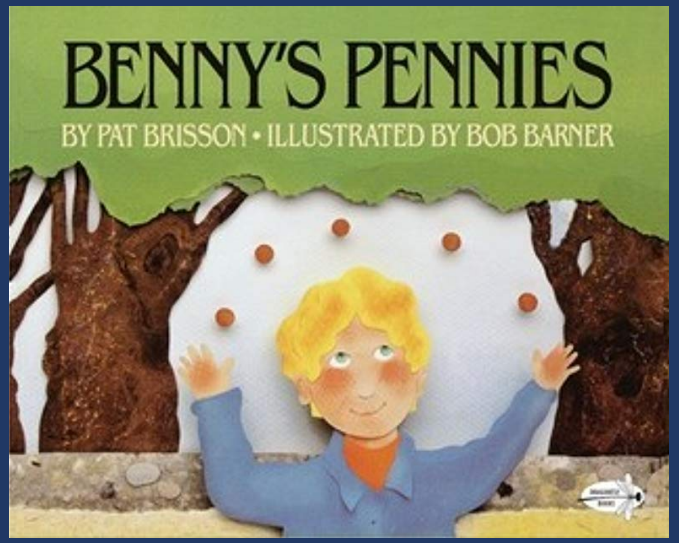
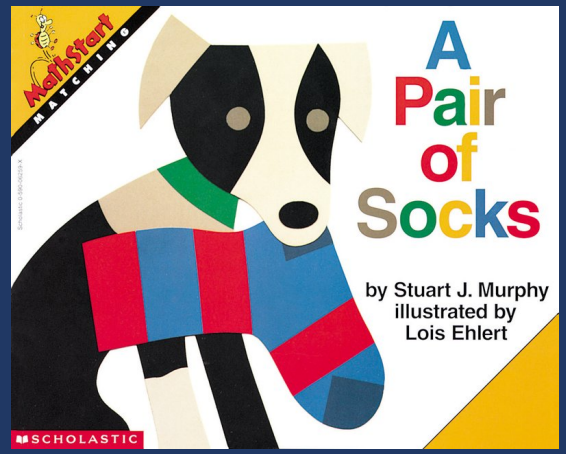
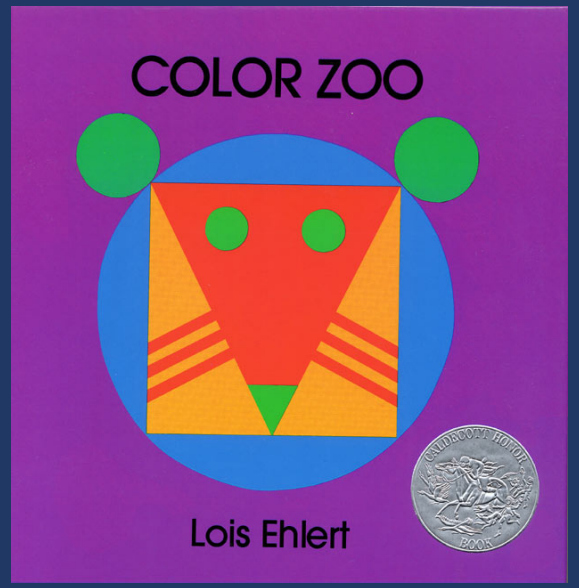
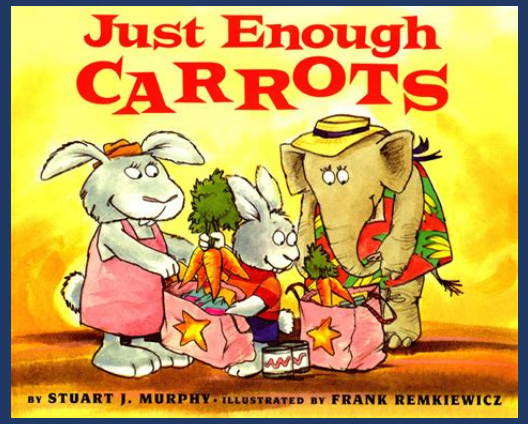
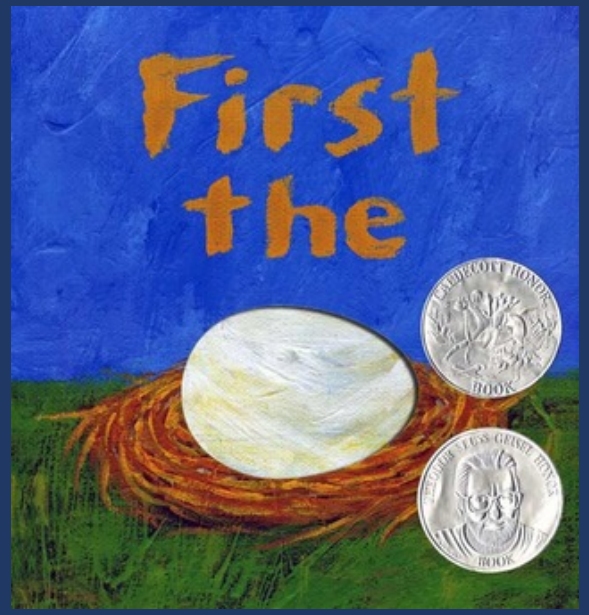
Building Vocabulary in Preschoolers











(Dickinson et al., 2018; Grior, Grimaldo, Vaughn, & Roberts, 2015; Lever & Sénéchal, 2011; Mol, Bus, & DeJong, 2009; Toub et al., 2018; Wasik & Bond, 2001; Whitehurst et al., 1988).

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Language-Critical Subgroups

English Learners

- **Still learning basic English**
- Perform more poorly in math than native speakers

At-Risk Children (low SES)

- **Poor general language skills**
- Perform more poorly in math than children from higher SES families

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Math Language

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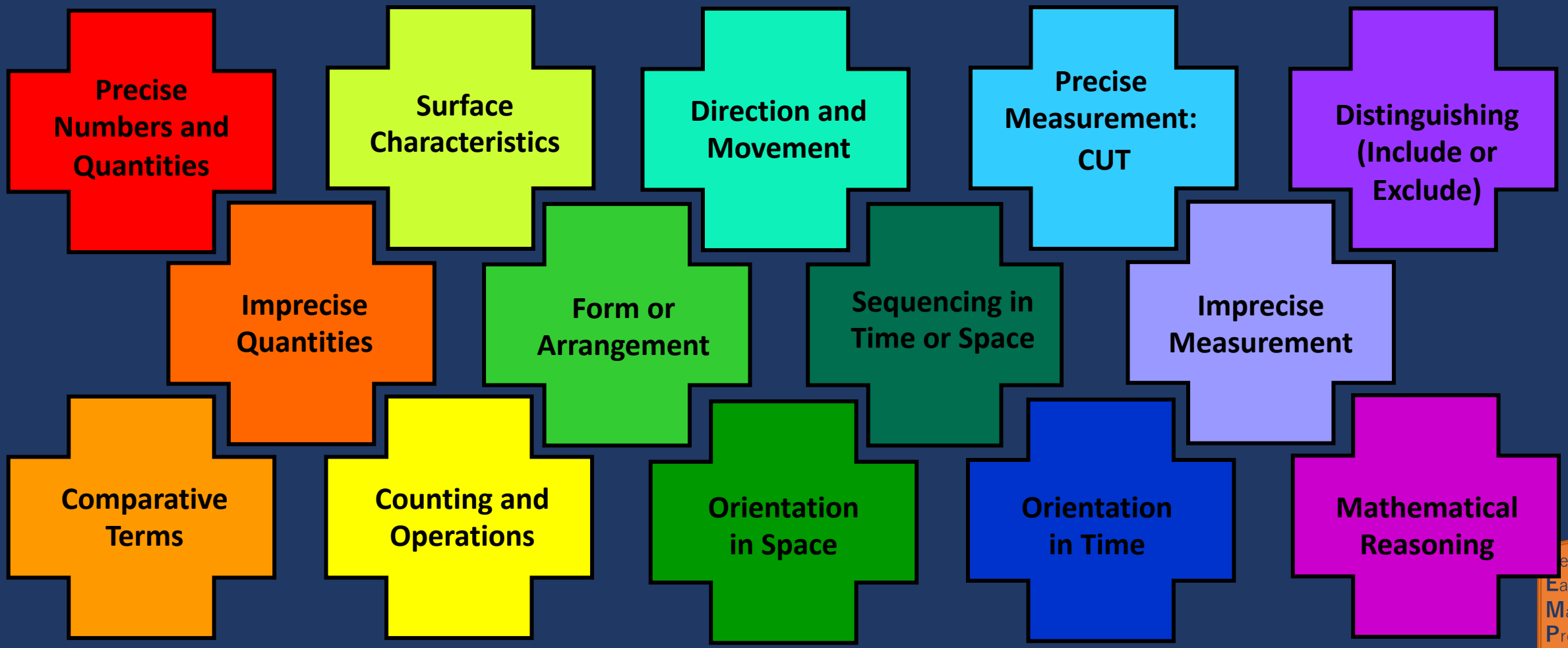
Why is Math Language So Difficult?



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Why is Math Language So Difficult?

What time is it?

How much time will that take?

Time

Three times two is six.

If you can hear me, clap one time.

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Why is Math Language So Difficult?

Square

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Why is Math Language So Difficult?

Next

next door

Front

in front of

Down

down the street

Up

call me up

Way

in the way

Out

out like a light

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Why is Math Language So Difficult?

Get some play-doh and make a snake.

Three and two make five.

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Why is Math Language So Difficult?

- Numbers and Quantity
- Time and Sequencing
- Location and Direction
- Compare or Distinguish
- Operational
- Reasoning

Fry's First 100 Words

1. the	21. at	41. there	61. some	81. my
2. of	22. be	42. use	62. her	82. than
3. and	23. this	43. an	63. would	83. first
4. a	24. have	44. each	64. make	84. water
5. to	25. from	45. which	65. like	85. been
6. in	26. or	46. she	66. him	86. called
7. is	27. one	47. do	67. into	87. who
8. you	28. had	48. how	68. time	88. am
9. that	29. by	49. their	69. has	89. its
10. it	30. words	50. if	70. look	90. now
11. he	31. but	51. will	71. two	91. find
12. was	32. not	52. up	72. more	92. long
13. for	33. what	53. other	73. write	93. down
14. on	34. all	54. about	74. go	94. day
15. are	35. were	55. out	75. see	95. did
16. as	36. we	56. many	76. number	96. get
17. with	37. when	57. then	77. no	97. come
18. his	38. your	58. them	78. way	98. made
19. they	39. can	59. these	79. could	99. may
20. I	40. said	60. so	80. people	100. part

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The Present Study: TEMPLE Read-Alouds

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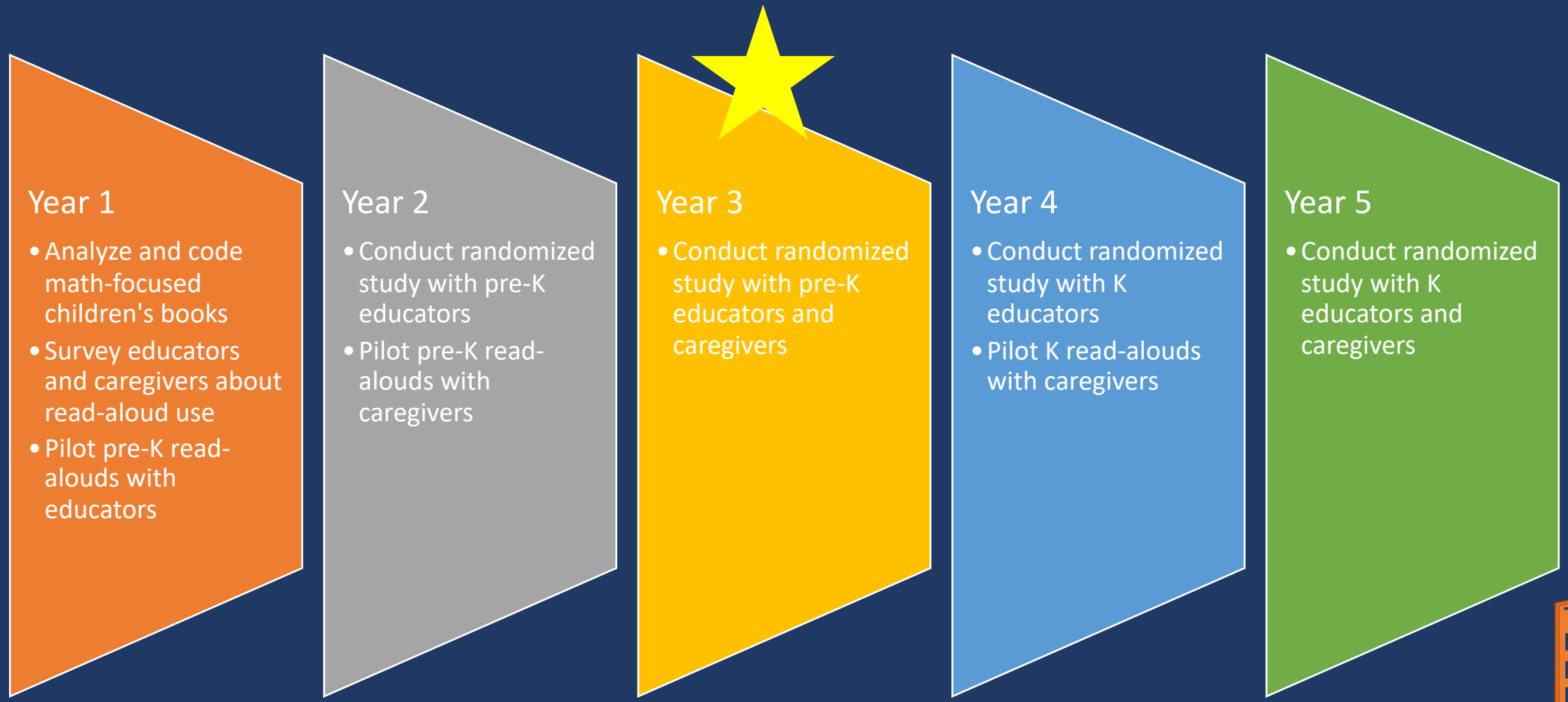
TEMPLE Read-Alouds: Five-Year Program



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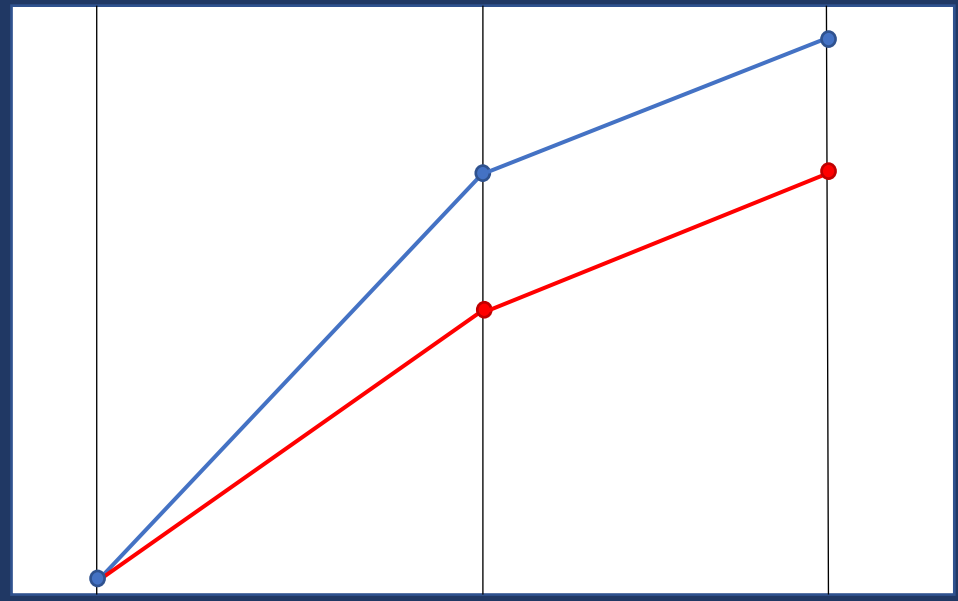
Year 2 Study Design

Pretest | Group 1 | Mid-test | Group 2 | Posttest

TEAM – Texas Guidelines
PALM – PreK Math Language
TEMA-3 – Early Numeracy



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Study Plan Year 3

1. Recruit **schools**: Randomly assign **teachers**
   - Read 16 books over 16 weeks

and

2. Recruit **parents**: Randomly assign **parents**
   - Read 10 books over 10 weeks

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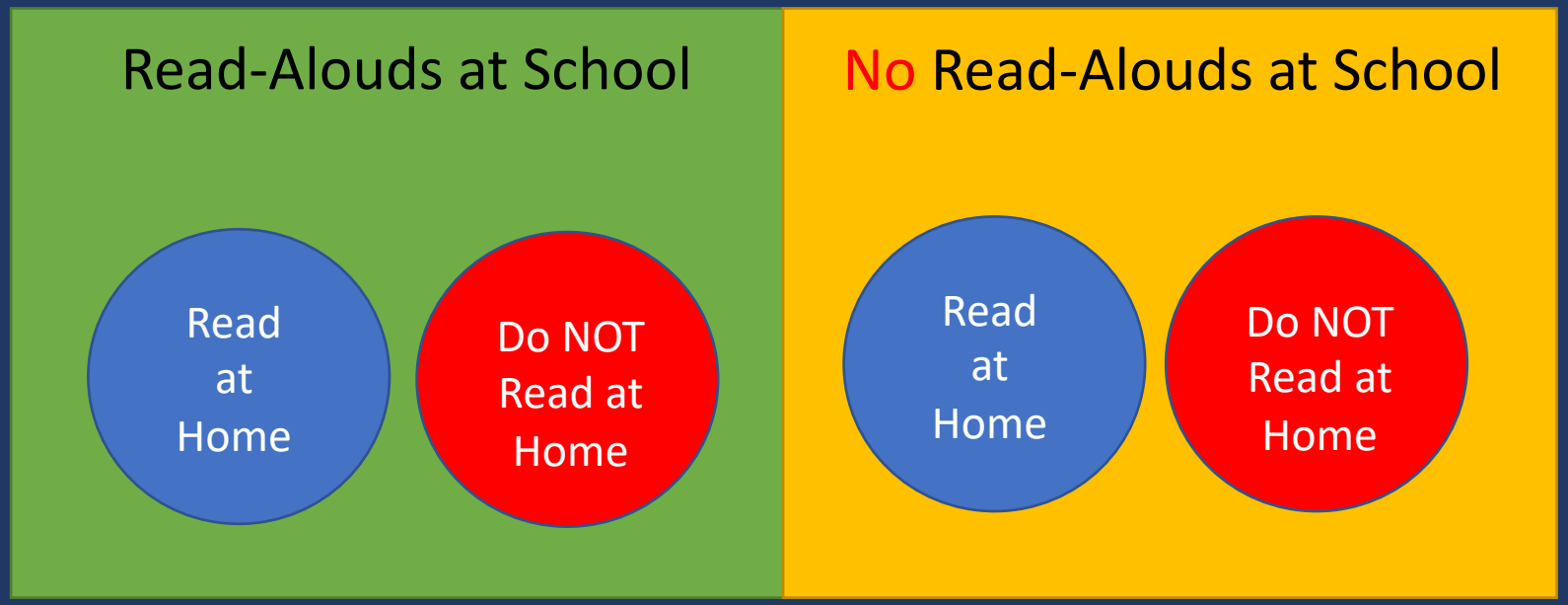
Study Plan Year 3

Examining effects across 4 groups of children:



1. school and home
2. school only
3. home only
4. no read-alouds

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Read-Aloud Routine

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Dual Purposes of Project

1. Is using the **TEMPLE Read-Aloud Routine** with supplied books and materials effective in teaching **early math language** and **early numeracy skills**?

2. Professional development: modeling **how** to use a read-aloud routine to teach **early math concepts** with **any** math-focused story book.

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Using the Read-Aloud Routine - Framework

1 book – over 3 days each week

Day 1

- Introduce the target math concept.
- Introduce the book.
- Introduce 3-5 new vocabulary words from the book.
- Read the book.
- Review the new vocabulary words.
- Make real-life connections through discussion.
- Reread the book, stopping at each target vocabulary word and using illustrations to clarify concepts and check for understanding.
- Explore new concepts and build skill with a hands-on activity.
- Use the skill as you go through the day.

Day 2

- Review concepts and vocabulary from the previous day's reading.
- Reread the book, stopping at each target vocabulary word and illustration to clarify concepts and check for understanding.
- Reinforce the new skill with another hands-on activity.
- Use the skill as you go through the day.

Day 3

- Review target vocabulary words.
- If desired, reread the book.
- Reinforce new skill with another related math activity.
- Ask students how they used their new math skills throughout the week.

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Plan the Week

- Target a **math skill**

Counting

Adding to and Taking Away

Geometry and Spatial Sense

Measurement

Classification and Patterns

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Plan the Week

- Target a **math skill**
- Select a **book**

matches child understanding

engaging and interesting

considers cultural background

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Book Suggestions: ADDING TO/ TAKING AWAY SKILLS

1. **Child uses concrete objects, creates pictorial models, and shares a verbal word problem for adding up to 5 objects.**
    - *Just One More* by Jennifer Hansen Rolli (introduces idea of one more)
    - *Fish Eyes: A Book You Can Count On* by Lois Ehlert (adds 1 more)
    - *Rooster's Off to See the World* by Eric Carle (adds/subtracts in groups of 1 -5)
    - *Mouse Count* by Ellen Stoll Walsh (begins with 3, adds 3, then 4 more)
    - *Quack and Count* by Keith Baker (several ways to total 7)
    - *Twelve Ways to Get to 11* by Eve Merriam (twelve ways to total 11)
    - *What's New at the Zoo: An Animal Counting Adventure* by Suzanne Slade (sums of up to 20)
    - *Albert Adds Up* by Eleanor May (adds up to 11 and subtracts down to 0)
    - *Domino Addition* by Lynette Long (sums of 0 to 12)
    - *Teddy Bear Addition* by Barbara Barbieri McGrath (sums of up to 50)
2. **Child uses concrete models or makes a verbal word problem for subtracting 0-5 objects from a set.**
    - *Pete the Cat and His Four Groovy Buttons* by Eric Litwin and James Dean (four buttons pop off one by one)
    - *Benny's Pennies* by Pat Brisson (Benny spends 5 pennies)
    - *Monster Musical Chairs* by Stuart J. Murphy (from 6 down to 1 monster)
    - *Ten Flashing Fireflies* by Philemon Sturges (children capture fireflies 1 at a time from a group of 10)
    - *One Big Pair of Underwear* by Laura Gehl (groups of up to 9 animals all have 1 less item than needed for everyone, so there is always one left out)
    - *Elevator Magic* by Stuart J. Murphy (starts at 10th floor, goes down 2 floors, then 3, then 1, then 3 to get to the 1st floor)
    - *Albert Adds Up* by Eleanor May (adds up to 11 and subtracts down to 0)
    - *Teddy Bear Subtraction* by Barbara Barbieri McGrath

Book Selected: 2019 - 2020

Books Selected for TEMPLE Read-Alouds 2019-2010

Primary Math Strand	Objectives	Extension Strands and Objectives	Book Title and Focus	Examples of Math-Related Terminology Included in Book
Counting Skills				
A.	1, 3, 4, 5, 6, 8, 9	B.2, C.3	**Ten Wiggly, Wriggly Caterpillars** Counting down from 10	all, some, so much, on his own, left, too slow, in, through, inching up, off, late, all of the sudden
A.	1, 2, 3, 4, 5, 8, 6	D.4	**Monster Math** Counting up, then back down	each, amount, any, another, how many, left, little, monstrous, other, more, too many, away, at last, done, now
A.	7	D.4	**First the Egg** Sequencing terminology	first, then (allows for use of next, before, and after)
A.	8		**Just Enough Carrots** Comparing quantities	some, many, bunch, amount, a few, any, just, more, really, others, even, fewer, same, too many, enough, first, then, when
Adding To/ Taking Away Skills				
B.	1, 2	A.7, A.8, D.4	**Rooster's Off to See the World** Adding to/ taking away groups	some, few, enough, all, far, slowly, very, more, so much, behind, over, overhead, away, turned, without, began, after, finally, morning, just then
B.	1	C.3	**Quack and Count** Adding to 7	count, row, on, in, reaching high, start, as, plus
B.	2	A.7	**Benny's Pennies** Start with 5, subtract by 1 to 0	penny, out, in, on, morning, buy, sell, then (allows for use of ordinals/sequencing)

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Plan the Week

- Target a **math skill**
- Select a **book**
- Determine target **vocabulary** terms (words or phrases)

3 to 5
focus terms

child-friendly
definition

print terms –
cards or a
poster

gesture,
object, or
picture

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Vocabulary Ideas: EARLY MATH TERMS

Term	Considerations
Above	
Add	We **add** two numbers together. Watch this television **ad**.
After	
Again	
Alike	
Always	
And	Rachel **and** Juan are friends. Five **and** two equals seven. I had four **and** then Mike gave me more. I had four **and** then Mike took away two.
Balance	I can **balance** on one foot. We can **balance** the scale.
Before	Place the circle **before** the square. I brush my teeth **before** bed. I be **four**. (incorrect grammar)
Behind	
Below	
Between	
Big Bigger Biggest	
Bottom	This block is on the **bottom** of the stack. Please sit on your **bottom**.

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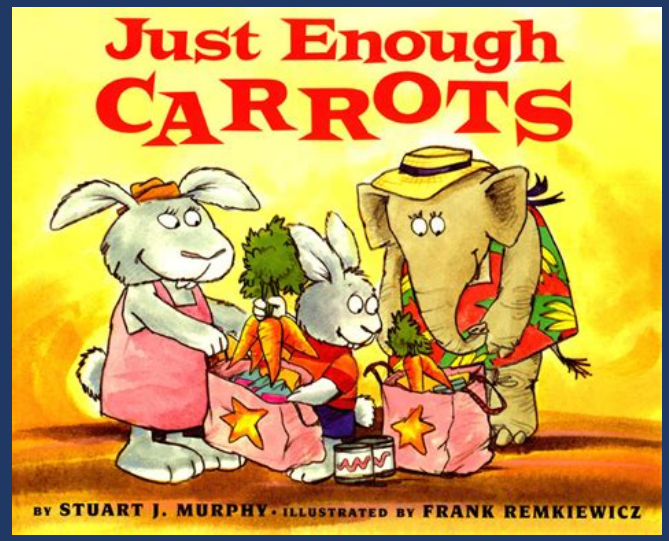
Vocabulary Cards: JUST ENOUGH CARROTS

some	part of it



any	more than 0

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Plan the Week

- Target a **math skill**
- Select a **book**
- Determine target **vocabulary** words and phrases
- Brain-storm **real-life connections**

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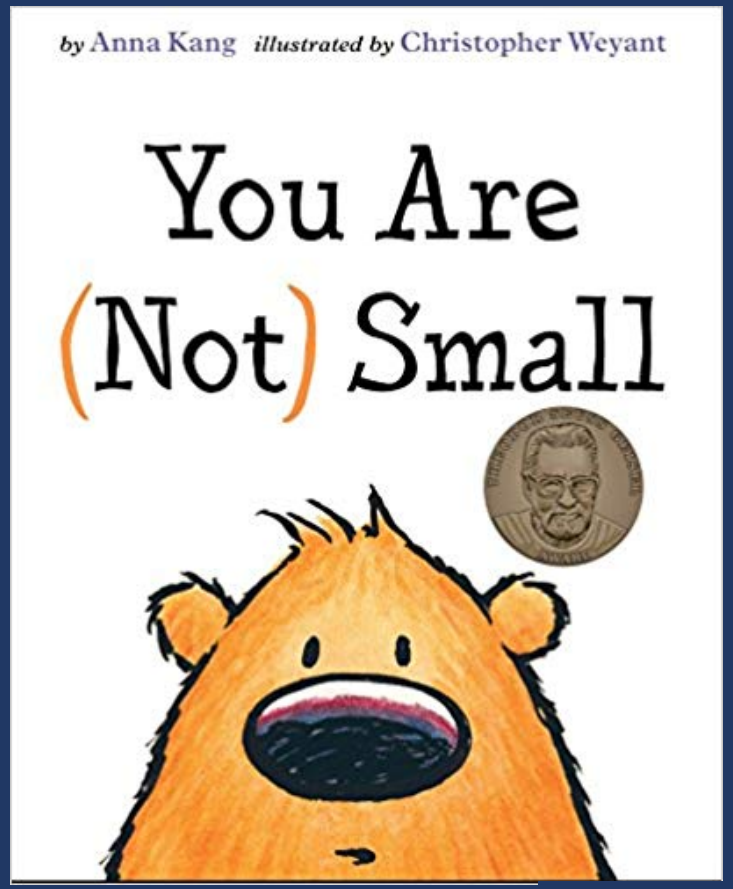
Real-Life Connections: MEASUREMENT



I use measurement skills when I:

- decide which of my friends is the tallest.
- determine whether the whole Gatorade will fit in my cup.
- realize which bucket holds the most sand.
- decide which rock is heavier.
- follow my schedule for the day.
- wait 5 minutes before I can have my turn.

Sometimes do you feel small?
When do you feel small?
Sometimes do you feel really big?
When do you feel really big?

Why do you think you sometimes feel like you're small...and other times you feel like you're big?

Teaching Early Math by Providing Language Exploration

Plan the Week

- Target a **math skill**
- Select a **book**
- Determine target **vocabulary** words and phrases
- Determine **real-life connections**
- Plan 3 different math **enrichment activities**
  - **Hands-on or whole body**
  - **Element of fun or discovery**

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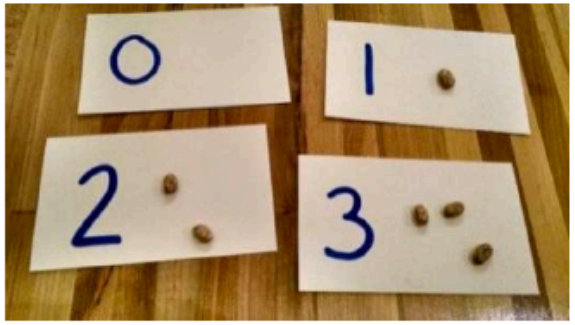
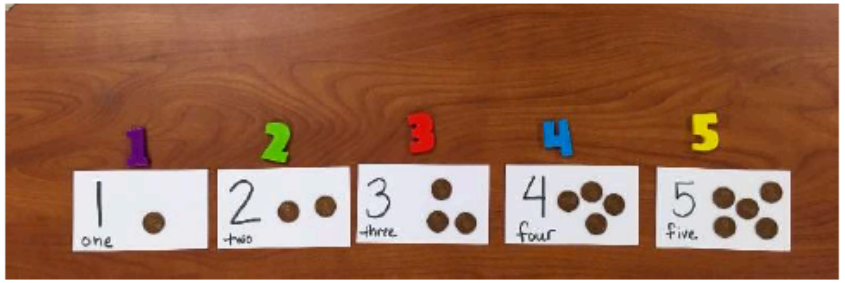
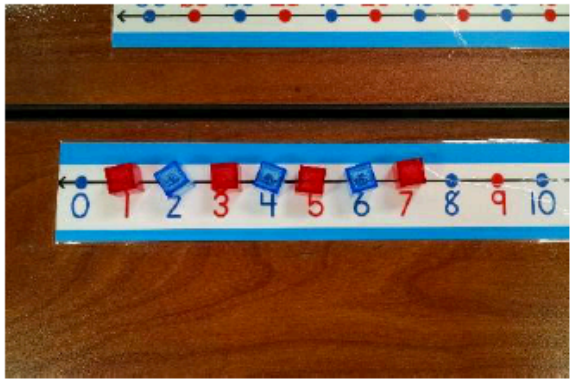
Activities: COUNTING

Using index cards, write the target number(s) on them and have children place (or glue) the matching quantity of small objects onto the card.







Using a number line, have children place counters on each number as they count.

Have children put magnetic numerals in order using a number line. (As they master numeral recognition, remove the number line and see if they can put them in order without one.)

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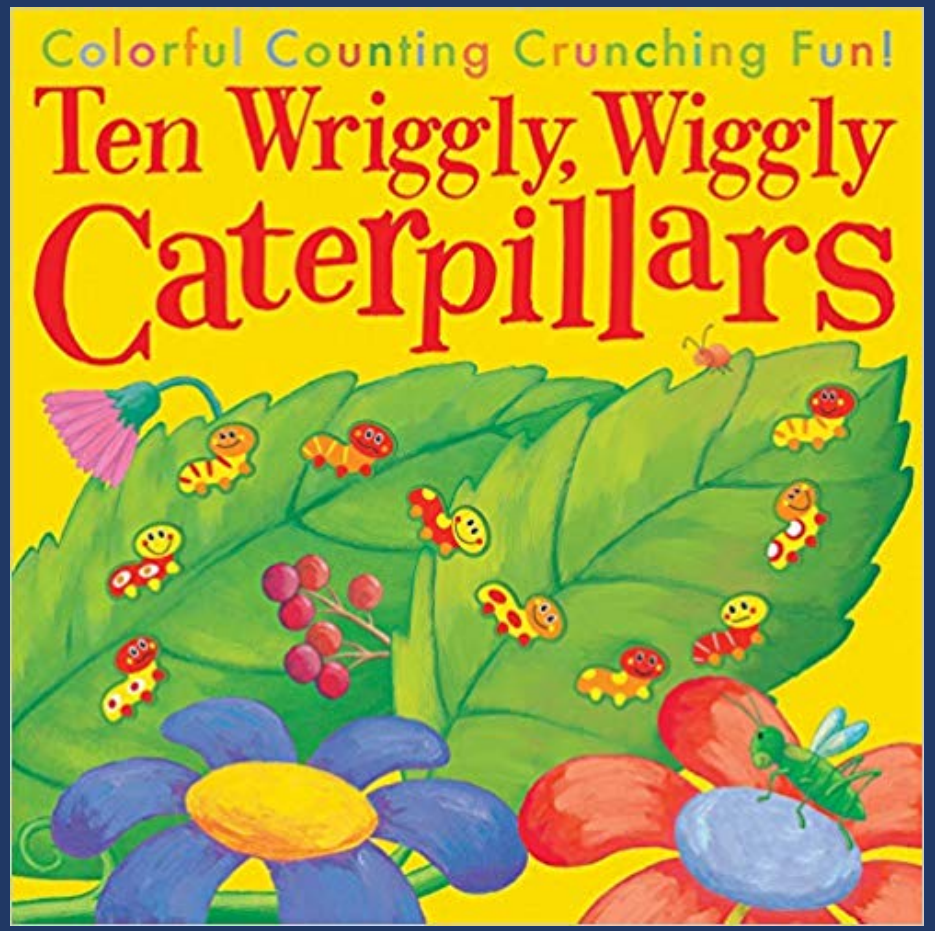
Activities: COUNTING



Rocket Ship Blast-Off

- Point out that in the story, the number of caterpillars was going *backwards* from 10 all the way to 1.
- Point out that when a rocket ship blasts off, we count down from 10 to 0 before it takes off.
- Ask students to pretend they are rocket ships.
  - Start by crouching low to the ground.
  - Count down 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0 (together).
  - Call out "blast-off," while jumping up and reaching towards the sky.
- Repeat several times.

  Variation: Have the numerals 10 to 0 printed out so that you can point to them as you all count backwards together.

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Implementation

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Day 1

Introduce and Preview the Book

Preview and activate **prior knowledge:**

- **Show front cover**
- **Picture walk**
- **“What do you think this story is about?”**
- **“What do you already know about….”**

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Day 1

Introduce and Preview the Book

Teach Key Vocabulary

Briefly introduce **target vocabulary terms:**

- **3 – 5 terms**
- **in print**
- **child-friendly definition**
- **provide an object, picture, or gesture**

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Day 1

Introduce and Preview the Book

Teach Key Vocabulary

Read the Book

Read straight through **without stopping to question/comment:**

- **Allow the focus to be understanding the story**
- **Pause briefly before turning pages**

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Day 1

Introduce and Preview the Book

Teach Key Vocabulary

Read the Book

Make Real-Life Connections

INTERACTIVE

Discuss the **story**:

- Ask **general questions** about the story.
- Ask about **how children's lives connect** to the story, characters, and concepts.

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Day 1

Introduce and Preview the Book

Teach Key Vocabulary

Review **target terms**

Provide a **gesture** for students to use when they hear one

Read the Book

Make Real-Life Connections

Re-read the Book

INTERACTIVE

- Pause at target vocabulary terms
- **Ask questions**
  - about **illustrations** and the **math** in the story
  - or real-life connections

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Day 1

Introduce and Preview the Book

Teach Key Vocabulary

Read the Book

Make Real-Life Connections

Re-read the Book

Practice Skills with An Activity

INTERACTIVE

- Connect to the **story**, **math**, and **characters** from the book
- Ask questions that require use of new math **vocabulary terms**

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Day 2

Review Key Vocabulary

Re-read the Book

Practice Skills with An Activity

INTERACTIVE

Day 3

(Re-read the Book)

Review Key Vocabulary

Revisit Real-Life Connections

Practice Skills with An Activity

INTERACTIVE

Teaching Early Math by Providing Language Exploration

Questions?





Teaching
Early
Math by
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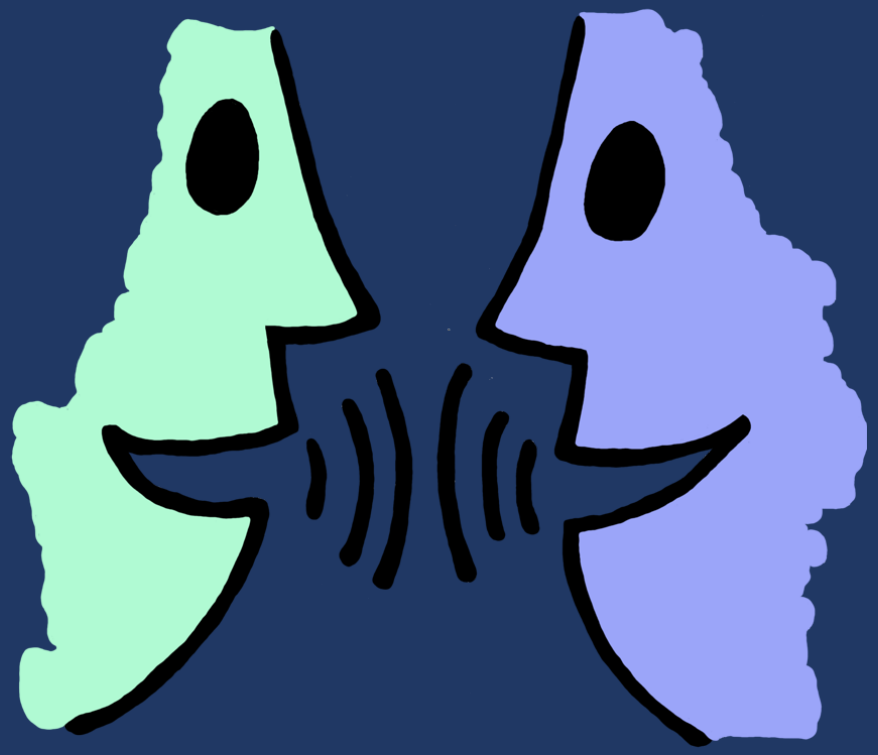
Language
Exploration

Now, YOU try it!



Math Read-Alouds Planning Sheet

Book Title:_____

Focus Terminology: (list words of interest; circle or highlight terms selected for instruction)

_____

_____

_____

Real Life Connections (to discuss on Day 1):

_____

_____

_____

_____

_____

Activity
Day1:_____

_____

_____

Activity
Day2:_____

_____

_____

Activity
Day3:_____

_____

_____

Other Notes/Needs:

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