Incorporating Language Into Early Math Instruction:

Using Research-Based, Developmentally-Appropriate Strategies and Activities

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Funding

- Work presented here is made possible by grants from the National Science Foundation (DRL-1019576 & DRL-1417040).

- Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

2

Overview

- **Introduction** - why math, talk, and math talk matter
- **Teaching Strategies** - discussion and illustrative examples
- **Conclusion** - bringing it all together

3

Early Mathematics

- Early math skills are critical for later school achievement in both math and reading (Duncan, et al., 2007; Grissmer et al., 2010; Watts, et al., 2014)
- Children from lower SES homes and from ethnic and language minority backgrounds are at risk for lack of readiness in math and other domains (e.g., Denton & West, 2002)

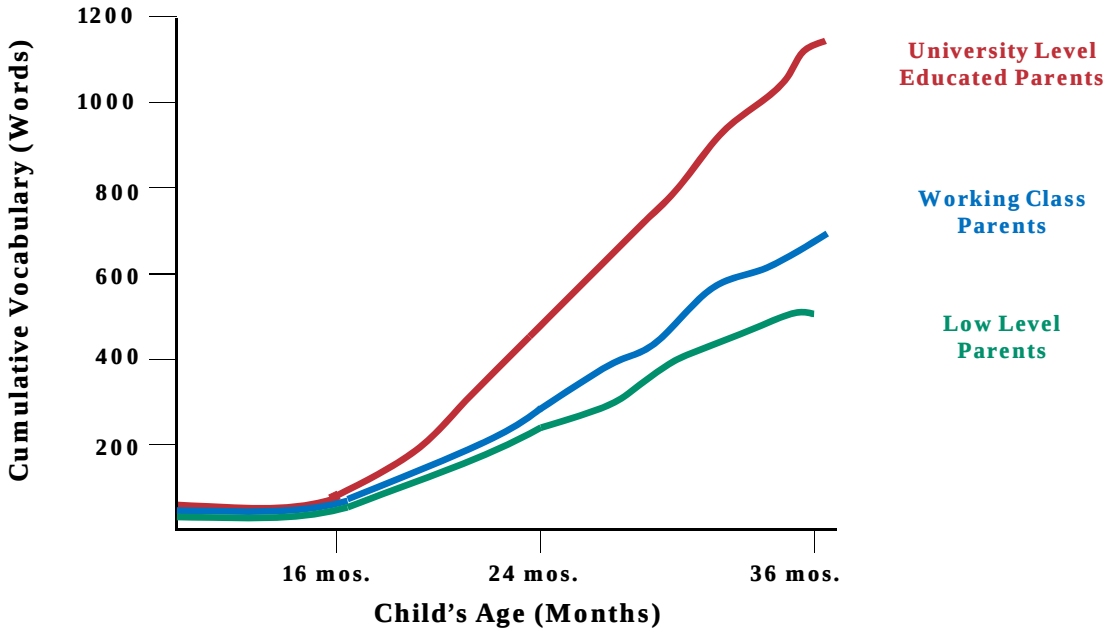
4

Early Language

- The language adults use impacts children
  - Gap in number of words disadvantaged versus advantaged children hear (Hart & Risley, 1995)
  - Vocabulary gap by age 2 (Hart & Risley, 1995)
  - Not just number of words, but also quality of words parents use that matter (Hirsh-Pasek, NAEYC, 2014)
  - Rich vocabulary impacts reading achievement (Strickland & Riley-Ayers, 2006)

5

The Achievement Gap Emerges by Age Two



6

Source: Hart & Risley (1995)

Mathematics and Language

- Math and language are inextricably connected (e.g., Whitin & Whitin 2003).
- Teaching math with attention to teachers' and children's math language can lead to gains in math and in language (Sarama, Lange, Clements, & Wolfe, 2012)
- Amount and diversity of math language teachers use improves children's math learning (Klibanoff et al., 2006)
- Teachers can plan experiences that connect new mathematical terms or phrases to ideas children already know (Rubenstein & Thompson 2002).

7

The Problem

- High-quality math teaching is not common (Ginsburg et al., 2008)
- Math content in teacher math talk is limited (Rudd et al., 2008)
- Preschool teachers are not typically well-prepared to teach STEM (NRC, 2009) or DLLs (Espinosa, 2010; Freedson, 2010)

8

An Example From One Study

Table 3 Descriptive statistics of observed math-mediated language

Math category	Frequency	Percentage	Mean	SD
Number	701	32	63.73	63.58
Spatial	885	41	80.45	30.44
Geometry	26	1.2	2.36	1.80
Measurement	428	20	38.91	14.57
Seriation	110	5	10.00	6.63
Operations	4	.1	.36	.67
Pattern	5	.3	.64	1.57
Display	2	.1	.18	.41

9

Source: Rudd, Lambert, Satterwhite, & Zaier (2008)

SciMath-DLL Model

- Workshops, PLCs, and in-class reflective coaching

- Encouraging development of STEM does not have to "take away" from literacy/language development

10

Teaching Strategies

- Discuss 4 strategies for incorporating more and higher-quality language into math instruction
- Illustrate using activities from SciMath-DLL work
- *Caveat - understanding how math and language develop is key, but not discussed here (e.g., learning trajectories: Clements & Sarama, 2014)

11

Strategy #1: Talk to Kids Intentionally About Math

- Start math number games by saying, "The numbers go from smallest here (1) to largest there (10)."

- Math games
  - Prior work (Ramani, Siegler, & Hitti, 2012; Laski & Siegler, 2014; Laski & Collins, in preparation)
  - Our work (Lange, Brenneman, & El-Moslimany, in preparation)

12

Example Activity: ***Math Number Games***

- Try it!
  - Look at instructions
  - Play game

- Think about
  - How can teacher language enhance game play?
  - How could children's language skill impact game play?

13

Source: Adapted from Ramani, Siegler, & Hitti (2012)

Strategy #2: Encourage Children to Explain Their Mathematical Reasoning

- Ask questions such as, "How do you know?"
  - Why?
    - Leads to explaining, which improves learning (Rittle-Johnson, Saylor, & Swygart, 2008)
    - Encourages children to think about their thinking (Greenes, 1999)
    - Allows children to hear peers describe their thinking
    - Provides teachers opportunity for formative assessment

14

Example Activity: ***Roll and Build***

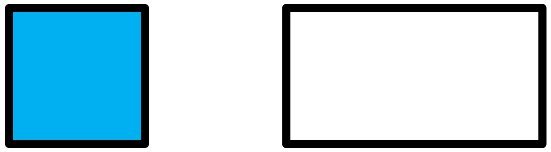
- Watch Video

- Think about
  - What mathematical language could teachers use, and elicit from children, while playing this game?
  - How might the multiple representations of numbers contribute to children's understanding and learning?

15

Strategy #3: Use Accurate Math Explanations and Vocabulary with Children

- Many adults say, "A rectangle has two long sides and two short sides?"

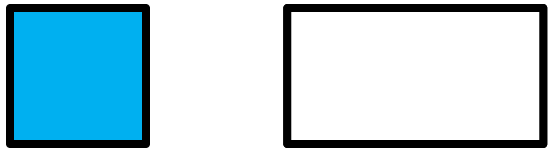


- Which of these is a square? Rectangle?
- How do you know?

16

The Case of the "Special Rectangle"

- Consider the definition: ***a rectangle is a 2D shape with four straight sides, all connected at four corners (points), all right angles.***

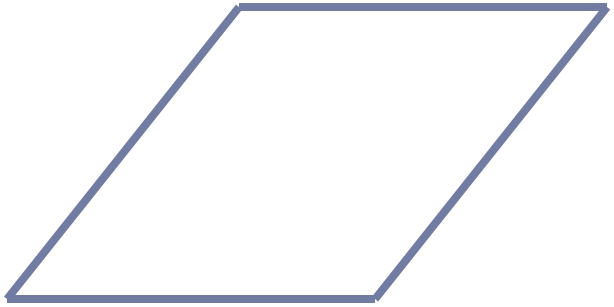


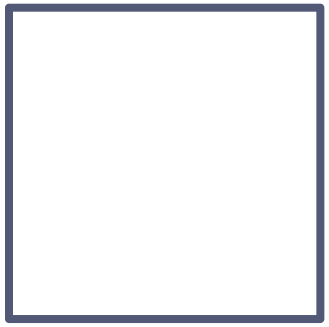
- Does a rectangle *necessarily* have "two long sides and two short sides"? **Why might it be a problem to teach children this definition?**

17

Accurate Vocabulary Can Be Age-Appropriate

- Vocabulary:
  - **rhombus** (diamond)
  - Spanish: **el rombo**

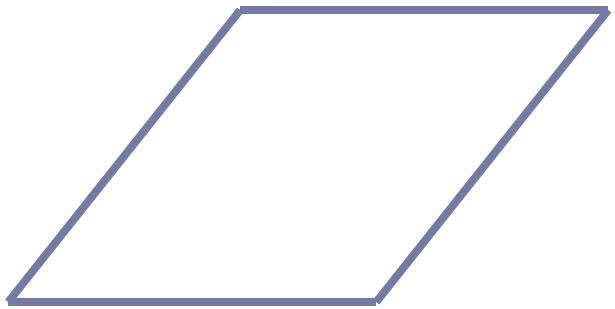




18

Teach Shapes by Their Properties

- A square is a rhombus, but a rhombus is ***not necessarily*** a square.
- How can children learn this?
  - "Is it or not?" game - Is this a square? Why or why not?

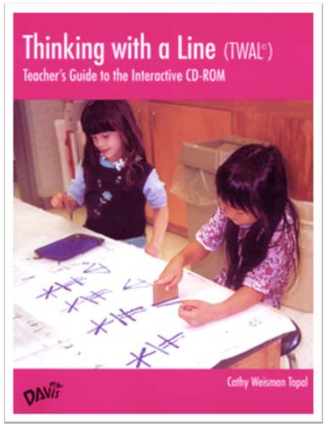


19

Source: Adapted from Clements & Sarama (2014)

Example Activity: ***Shapes with a Line***

- Watch Video



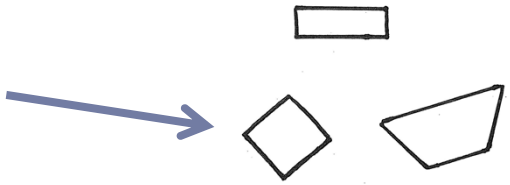
- Try it!
  - Look at instructions
  - Do activity
- Think about
  - How can teacher language encourage learning about shape properties?
  - How does this activity allow children to practice and talk about correct and incorrect notions of shape?

20

Source: Adapted from Cathy Weisman Topal (2005)

Strategy #4: Adapt Questioning for Children at Different Levels of Language Proficiency

- Asking children, "Where is a square?" versus "How do you know it is a square?"



- When are simple, closed-ended questions or commands okay (or even preferred)?

21

DLLs: Tiered Levels of Questions

Language Level	Example Questions	Types of Questions
Home Use/ Non-Verbal	Show me… Point to… Where is? Who has?	-Known answer -Closed
Telegraphic/ Formulaic	Yes/No questions Either/Or questions Who? Which? What? Where?	-Known answer -Closed -Yes/No
Productive	Why? How? Explain	-Thought-provoking -Open-ended
More Advanced Productive	What would happen if? Why do you think? Retell…	-Thought-provoking -Open-ended -Prediction

22

Sources: Krashen & Terrell (1983); Tabors (2008)

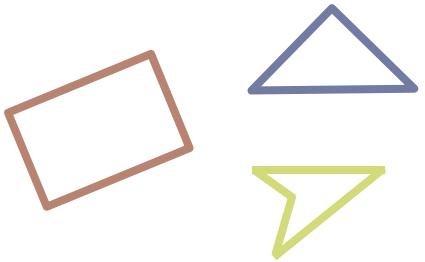
Remember…

- Giving children time to respond matters
  (Cohrssen, Church, & Tayler, 2014; Mauigoa-Tekene, 2006)

23

Example Activity: ***Find a Shape!***

- Try it!
  - Look at instructions
  - Do activity



- Think about
  - How could you adapt your questioning and language to engage children at different levels of English-language proficiency?

24

The Four Strategies Were…

- Strategy #1: Talk to Kids Intentionally About Math
- Strategy #2: Encourage Children to Explain Their Mathematical Reasoning
- Strategy #3: Use Accurate Math Explanations and Vocabulary with Children
- Strategy #4: Adapt Questioning for Children at Different Levels of Language Proficiency

25

Results - Preliminary Findings

- Teacher and coach report, observational notes
  - **Strategy #1:** Less directive teacher language
  - **Strategy #2:** More questioning
  - **Strategy #3:**
    - Increased teacher use of math and science vocabulary
    - Improved student vocabulary and language skills (noted by many)
  - **Strategy #4:** Greater use of science and math vocabulary and in English language by DLLs, more wait time for children to respond

26

Results - Example Participant Quotes

- "Students are excited about building their vocabulary! They love demonstrating new concepts and what they have learned…"
- "This child comes from a home where English is never spoken and yet he spent over half an hour engaged in play activities that promoted a conversation in English that was rich not only in science vocabulary but also in the way he uses question words, grammar, and sentence structure in his play."
- "Students are answering in their home language and or better English language. Students are making connections with whole sentences made."

27

To Conclude

- Teachers can change their practice to use more of the math (and science) language that improves learning for children.

- Our next project will evaluate program impacts on teachers and children experimentally.

28

THANK YOU!

EC STEM Lab

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29

More Information

EC STEM Lab

- Please email us at alange@nieer.org for copies of the lesson plans for the Example Activities
- In order to make copies of the lesson plans to share with colleagues, please email us your specific request.

30

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31

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32