Mathematical Discourse: "Talk" is Only Part of the Equation

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Mathematics Learning Environments

(Face-to-Face, Virtual, Hybrid)

Ethnically
Racially
Linguistically
Culturally
Economically
Cognitively
Physically

Diverse

Mathematics Education Community

"The discourse of a classroom—the ways of representing, thinking, talking, agreeing, and disagreeing—is **central to what and how students learn mathematics**" (NCTM, 2007, Mathematics Teaching Today, p. 46).

Mathematical discussion is viewed as "a primary mechanism for developing **conceptual understanding and meaningful learning of mathematics**" (NCTM, 2014, Principles to Action, p. 30).

Mathematical Practices

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

What are features of a discourse-rich mathematics learning environment?

Why is Mathematical Discourse important?

Access and Assess

- ✓ What students know
- ✓ How students know it
- ✓ Use of math language
- ✓ Ability to formulate and critique argument

Learning Mathematics Content

Engage with Mathematics

Conceptual Learning

Mathematical Argumentation

Critical Reasoning

Social and Cognitive Support

Safe Learning Environment

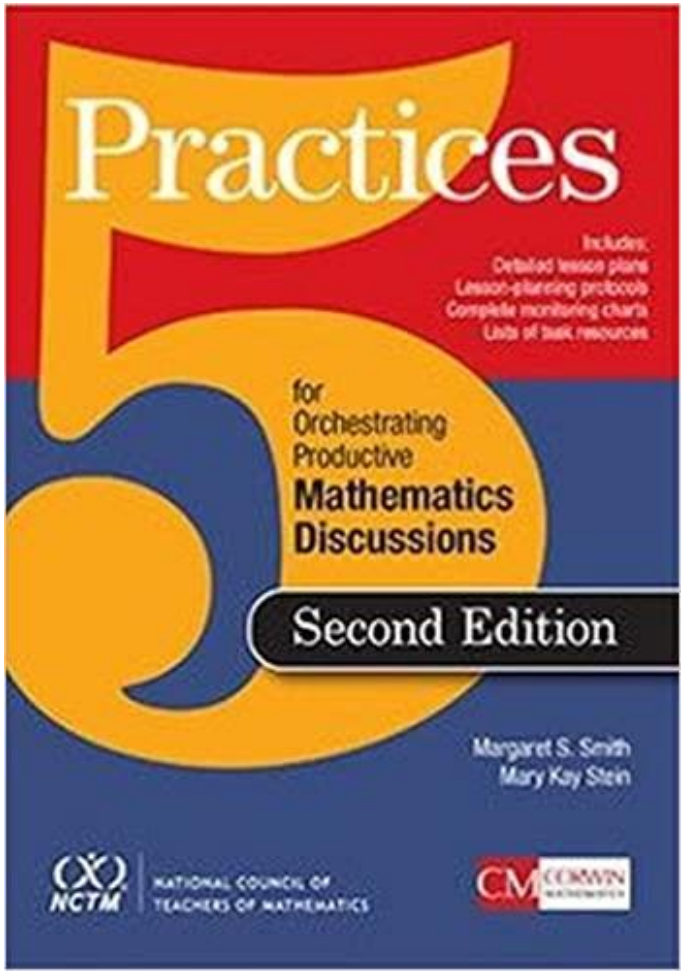
Supports Risk Taking

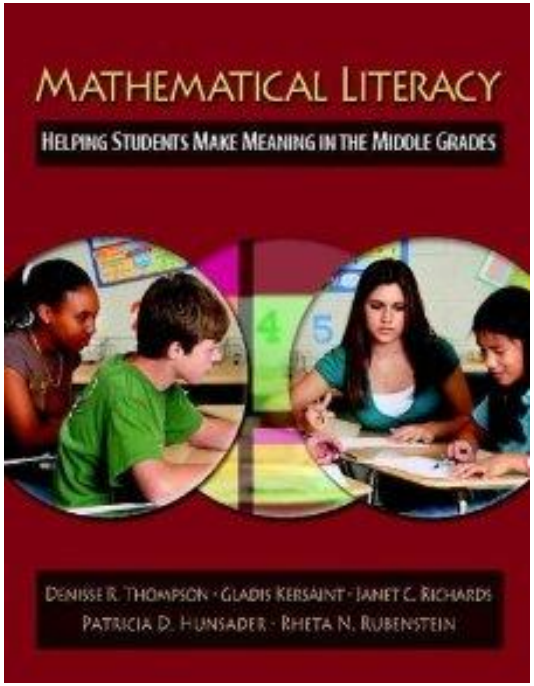
Addresses Power and Authority
(Who's taking? Who's talking most often?)

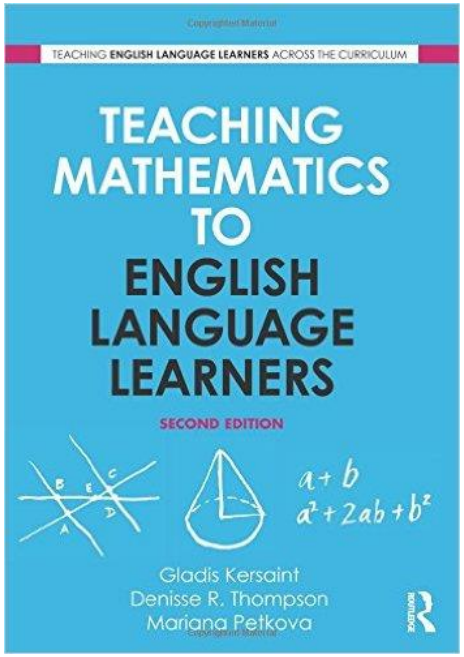
FROM Increased Participation…

TO Conceptual Math Talk

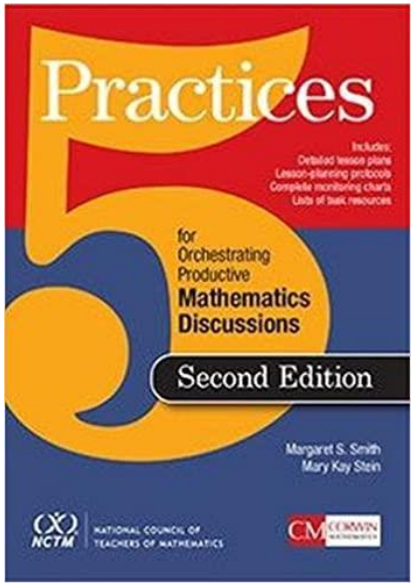
What do I draw on?







5 Practices for Orchestrating Mathematics Discussions



Setting Goals and Selecting a Task

Anticipating student responses prior to the lesson

Monitoring students' work on and engagement with the tasks

Selecting particular students to present their mathematical work

Sequencing students' responses in a specific order for discussions

Connecting different students' responses and connecting the responses to key mathematical ideas

NCTM: 100 Days of Professional Learning
Title: **Orchestrating Mathematical Discussions: Overcoming Challenges (Grade 6-8)**
Speaker: Margaret (Peg) Smith
Date: April 8,2020

What challenges have you experienced….?

…engaging ALL students?
… getting students to listen to each other?
… getting students to use the language of mathematics?
.. understanding what students are attempting to convey?
… assessing students' thinking?

What do you assess most often?

students' solutions
or
students' thinking

What do we (as teachers) learn from students' responses?

Response 1

```
   5
  17
x 18
----
 136
+ 17
----
 306
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Response 2

"To find 17 x 18, I multiplied 17 times 20 and got 340. Then I subtracted 34 or 2 groups of 17, so the answer is 306

What are different modes for communicating mathematics?

List as many different ways as possible.

Multiple Literacy in Mathematics

Ways to
Give and Make
Meaning

Vocabulary (Words)

Symbols

Reading - Interpreting

Writing - Producing

Speaking - Listening

Mathematics Tasks: Number

1. Mi az összege az összes számjegyet a sorrendben 1, 2, 3, 4, 5, 6, 7, ... 99, 100?

2. දත්ත කට්ටලයේ මාදිලිය සොයා ගන්න

56 23 34 45 56

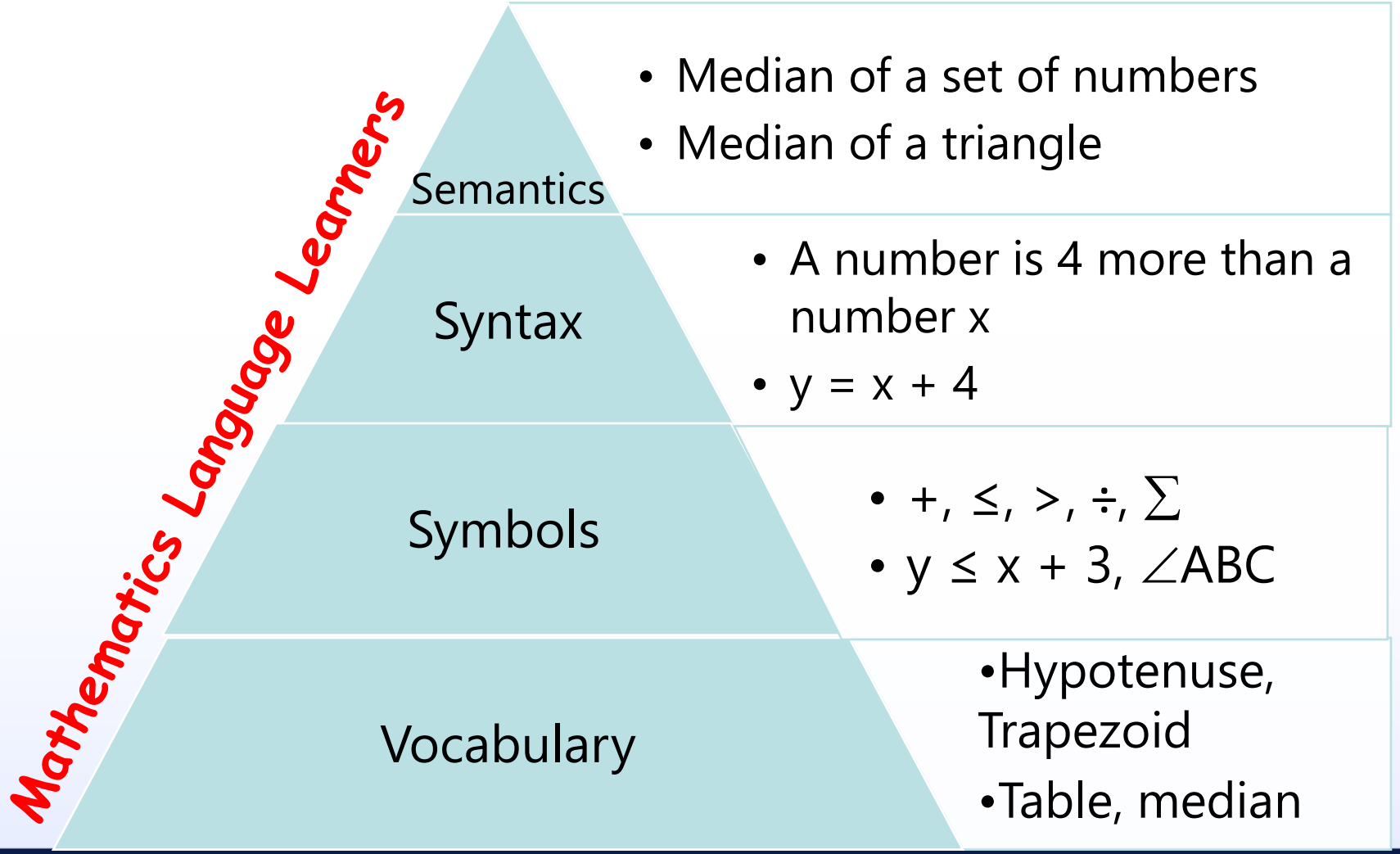
3. Determine the greatest common divisor of the elements of the set $\{n^{13} - n \mid n \in Z\}$.

Means of Communicating in Mathematics Learning Environments

- Common Everyday Language
- Mathematics verbal language (using words)
- Symbolic language (using mathematics symbols)
- Visual representations (using graphs, models, pictures)
- Gestures
- Unspoken "Taken as Shared" assumptions
- Quasi-Mathematical Language

  (e.g., "student utterances that may not be coherent")

Mathematics – A Foreign Language



- English Words with Different Meaning in Math
  - e.g., *positive/negative*, *table*, *rational*, *limit*
- Technical vocabulary
  - e.g., *hypotenuse*, *divisor*, *trapezoid*
- Terms with multiple meaning
  - e.g., *Square* (a geometric figure, a square of a number)
  - e.g., *Base* (of an exponential expression, of a triangle)
- Compound phrases that represent new concepts
  - e.g., *least common denominator*, *square root*

- Terms that are homonyms with common English words
  - e.g., *plain* vs. *plane*, *arc* vs. *ark*, *sum* vs. *some*
- Words with different meanings in different content registers or context

  - *Radical* (social studies vs. math)
  - *Solution* (science vs. math)
  - *Mean* (malicious behavior vs. average)

- Multiple Terms may convey the same mathematical concepts
  - Addition
    - *combine*, *plus*, *sum*, *increased by*
  - Subtraction
    - less, *minus*, *decrease*, *difference*, *less than*
  - Proof
    - *justification*, *argument*
  - Probability
    - *likelihood*, *chance*

Redundancy in Verbalizations

- Why is it important for students to recognize the multiple verbalizations?
- How might these different verbalizations influence the assessment of student learning?
- How might these different verbalizations influence the assessment of EB knowledge?
- What can be done to support student in making meaning for these different verbalization?

12 – 5

12 subtract 5

5 less than 12

12 less 5

12 take away 5

The difference of 12 and 5

➢ Paraphrases of statements

Triangle A is as large as Triangle B
Triangle A and B are equal in size
Triangle A and Triangle B are the same size

Four divided into nine equal nine-fourths
Nine divided by four equals nine-fourths
If nine is divided by four, nine-fourths results

- Context implies mathematics operations

Mr. Brown in redoing is *lawn*. How much *sod* must Mr. Brown purchase for a lawn space that is 8 ft long by 4 ft wide?

- "Sod" implies to *cover the space*

Mathematics is

is a technical language that

conveys information using words, symbols, notations, icons, graphs, & representations

Mathematical Discourse involves the

transfer and exchange information through speaking, listening, reading, writing, interpreting, producing …

What other challenges might an students experience in a discourse-rich mathematics learning environment?

Instructional Goals

1. Content Development
   - ❖ Develop proficiency in subject matter content

2. Language Development
   - ❖ Proficiency using the language of mathematics
   - ❖ Its vocabulary, grammatical structure, and symbols

In sum, provide students opportunities to use the language of mathematics, in all of its forms productively.

Implicit messages

Teacher statements:

"If you don't do this carefully, you will *get the wrong answer*."

"Be sure to explain your thinking, so that I understand how you are approaching this program."

Implicit messages

Teacher statements:

"Can someone *identify the mistake* that Martha made?"

"Martha *is almost there;* can anyone *support her way of thinking*?"

Implicit messages

Teacher statements:

Mark and Paul, the two of you used similar strategies. Which one of you would like to explain *how you figured it out*?

"That was *powerful thinking*, please explain how you got that again. "

Conversational vs. Lecture

FROM *Detached*

"Today we will learn about …."

TO *Inviting*

"What do you think we'll have if…."

Use Active Voice

Be Direct

Colloquial Expressions

- May not be familiar to students, such as emergent bilinguals
    - e.g., “In the red”

Can you think of other colloquial expressions that might be used in the mathematics classroom?

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Questions or Comments