

2011 NCTM Annual Conference

**Assessing Students'
Numerical Understanding
*and Skills***

Grades K–6

Marilyn Burns

Connections . . .

- Common Core
- Formative Assessment
- Gates Assessment project
- Classroom Teaching & Learning

ELA Common Core

. . . , the Standards lay out a vision of what it means to be a **literate** person in the twenty-first century. . . . Students who meet the Standards readily undertake the close, attentive **reading** that is at the heart of understanding and enjoying complex **works of literature**. They habitually perform the critical **reading** necessary to pick carefully through the staggering amount of information available today in print and digitally. They actively seek the wide, deep, and thoughtful engagement with high-quality **literary and informational texts** that builds knowledge, enlarges experience, and broadens worldviews. . . . In short, students who meet the Standards develop the skills in **reading, writing, speaking, and listening** that are the foundation for any creative and purposeful **expression in language**.

ELA Common Core

. . . , the Standards lay out a vision of what it means to be a **mathematically literate** person in the twenty-first century. . . . Students who meet the Standards readily undertake the close, attentive **mathematical reasoning** that is at the heart of understanding and enjoying complex **problems**. They habitually perform the critical **mathematical reasoning** necessary to pick carefully through the staggering amount of information available today in print and digitally. They actively seek the wide, deep, and thoughtful engagement with high-quality **mathematical information** that builds knowledge, enlarges experience, and broadens worldviews. . . . In short, students who meet the Standards develop the skills in **mathematical reasoning** that are the foundation for any creative and purposeful **mathematical expression**.

Common Core

- Standards for Mathematical Practice
(same throughout the grades)
- Standards for Mathematical Content
(different at each grade level)

Common Core

Standards for Mathematical Practice

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.

Common Core

Standards for Mathematical Content

- Understanding
- Procedures

"Students who lack understanding of a topic may rely on procedures too heavily. Without a flexible base from which to work, they may be less likely to . . . deviate from a known procedure to find a shortcut. In short, a lack of understanding effectively prevents a student from engaging in the mathematical practices."

MSMRI

Middle School Math Reasoning Inventory

**Funded by the Bill & Melinda Gates
Foundation**

Middle School Math Reasoning Inventory (MSMRI)

Interviews to assess numerical understanding and skills

Web-based formative/ diagnostic assessment to provide teachers information and insights into the numerical understanding and skills of their incoming middle school students

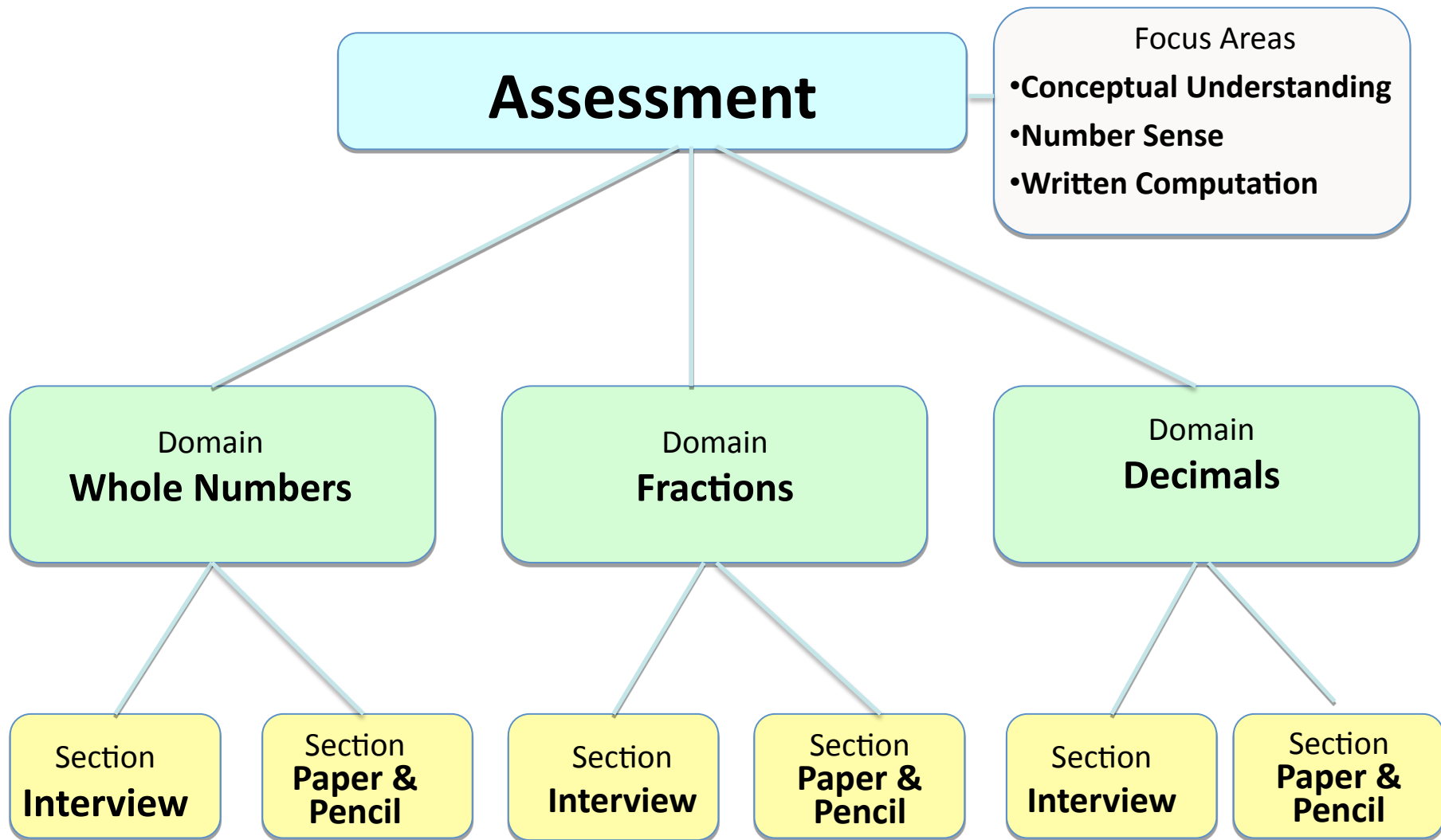
Overview of ASSESSMENT

Focus Areas

- **Conceptual Understanding**
- **Number Sense**
- **Written Computation**

Number Sense

- understands relationships, properties, and procedures
- is able to explain and justify one's actions on numbers
- is able to use strategies appropriately and efficiently



Development Process

- Development by the author team
- Tryouts by “trusted” teachers
- Piloting by philosophically aligned teachers
- Field Testing by unknown teachers who may or may not be philosophically aligned
- Implementation (widespread scaling up)

Overview of MSMRI

- **Assessment tool**
- Formative/diagnostic
- Face-to-face interview
- Includes brief written survey
- Focuses on number
- Assesses standards for mathematical practice, understanding, and skills
- Web based
- Informs classroom instruction
- Identifies students who need intervention

Which is greater—
 $\frac{3}{5}$ or $\frac{1}{2}$?

How did you decide?

Strategy Choices

Which is greater— $3/5$ or $1/2$?

- Converted to common denominators
- Converted to decimals or percents
- Explained that 3 is more than half of 5
- Described a visual or physical model
- Gave other reasonable explanation
[record]
- Guessed, did not explain, or gave faulty explanation

$$5/6 + 12/13$$

Don't figure out the exact answer.
Without paper and pencil, decide
which of these choices is closest to
the answer.

$\frac{1}{2}$, 1, 2, 8

Why do you think that?

Strategy Choices

$$5/6 + 12/13$$

- Rounded one or both fractions to 1, then added
- Compared to $1/2$ (e.g., both are greater than $1/2$ so the answer is greater than 1)
- Analyzed choices and chose one that seemed most reasonable
- Gave other reasonable explanation
[record]
- Guessed, did not explain, or gave faulty explanation

$$1/2 + 2/3$$

Without using paper and pencil, decide if the answer to this is greater than 1 or less than 1.

Why do you think that?

Strategy Choices

$$1/2 + 2/3$$

- Converted to common denominators
- Explained that $2/3$ is greater than $1/2$ so answer must be greater than 1
- Converted to decimals or percents
- Described a visual or physical model
- Gave other reasonable explanation
[record]
- Guessed, did not explain, or gave faulty explanation

School Bus Problem

There are 295 students in the school. School buses hold 25 students. How many school buses are needed to fit all the students?

How did you figure out the answer?

A comment about students
written work . . .

Students should use
paper & pencil to keep
track of their thinking.

$$3.9 \times 4.75$$

5 10 20 30

Don't figure out the exact answer to this problem. Without using paper and pencil, decide which of the choices is closest to the answer—5, 10, 20, or 30.

Strategy Choices

3.9 x 4.75

- Used standard algorithm
- Rounded then multiplied
- Analyzed choices and chose one that seemed most reasonable
- Gave other reasonable explanation [record]
- Guessed, did not explain, or gave faulty explanation

A Few Surprises

- Results from a class provides insights into teaching.
- Students assessed over time improve in both their understanding and ability to explain their reasoning.
- Incorrect answers can hide understanding and correct answers can be false indicators of understanding.



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