QUALITY QUESTIONING FOR FORMATIVE ASSESSMENT IN THE MATHEMATICS CLASSROOM

A Presentation by

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Nicholls State University
Thibodaux, LA

Nicholls State University

GOAL OF PRESENTATION

For each audience member to not only

think about the questions that are posed as mathematical problems,

but also to

1) think about questions asked during the problem-solving process,

2) think about responses given, and

3) think about questions asked by students after they believe they have solved the problem

in order to formatively assess students.

OVERVIEW

- *WHAT IS QUALITY QUESTIONING?*
- *PURPOSE OF QUALITY QUESTIONING*
- *WHAT IS FORMATIVE ASSESSMENT?*
- *THE FORMATIVE 5*
- *BENEFITS OF FORMATIVE ASSESSMENT*
- *QUALITY QUESTIONING and FORMATIVE ASSESSMENT within MATHEMATICAL STRANDS*
- *DISCUSSION/QUESTIONS*

WHAT IS QUALITY QUESTIONING?

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QUALITY QUESTIONING?

Your thoughts?

QUALITY QUESTIONING?

- …NOT a simple tool for extracting memorized information Walsh and Sattes, 2011
- …is a dynamic process through which a teacher intentionally engages students in both cognitive and metacognitive operations Walsh and Sattes, 2011
- …invites students to think and to understand as well as sharing their "mathematical journey" with other students and teachers Schuster and Anderson, 2004
- …sets the stage for meaningful classroom discussion and learning Schuster and Anderson, 2004

QUALITY QUESTIONING?

Careful, intentional, and mindful questioning is one of the most powerful tools a skillful teacher possesses.

Costa and Kallick, 2000

THE "LOOK" OF QUALITY QUESTIONS

- Assist students to make sense of the math
- Are open-ended
- Empower students to unravel misconceptions
- Require application of facts and procedures AND encourage students to make connections and generalizations
- Are accessible to all students
- Lead students to **WONDER** more about the math

Schuster and Anderson, 2004

WONDER

"He who can no longer pause to wonder and stand rapt in awe, is as good as dead; his eyes are closed."

Albert Einstein

WONDER

"Wisdom begins in wonder."

Socrates

PURPOSE OF QUALITY QUESTIONING

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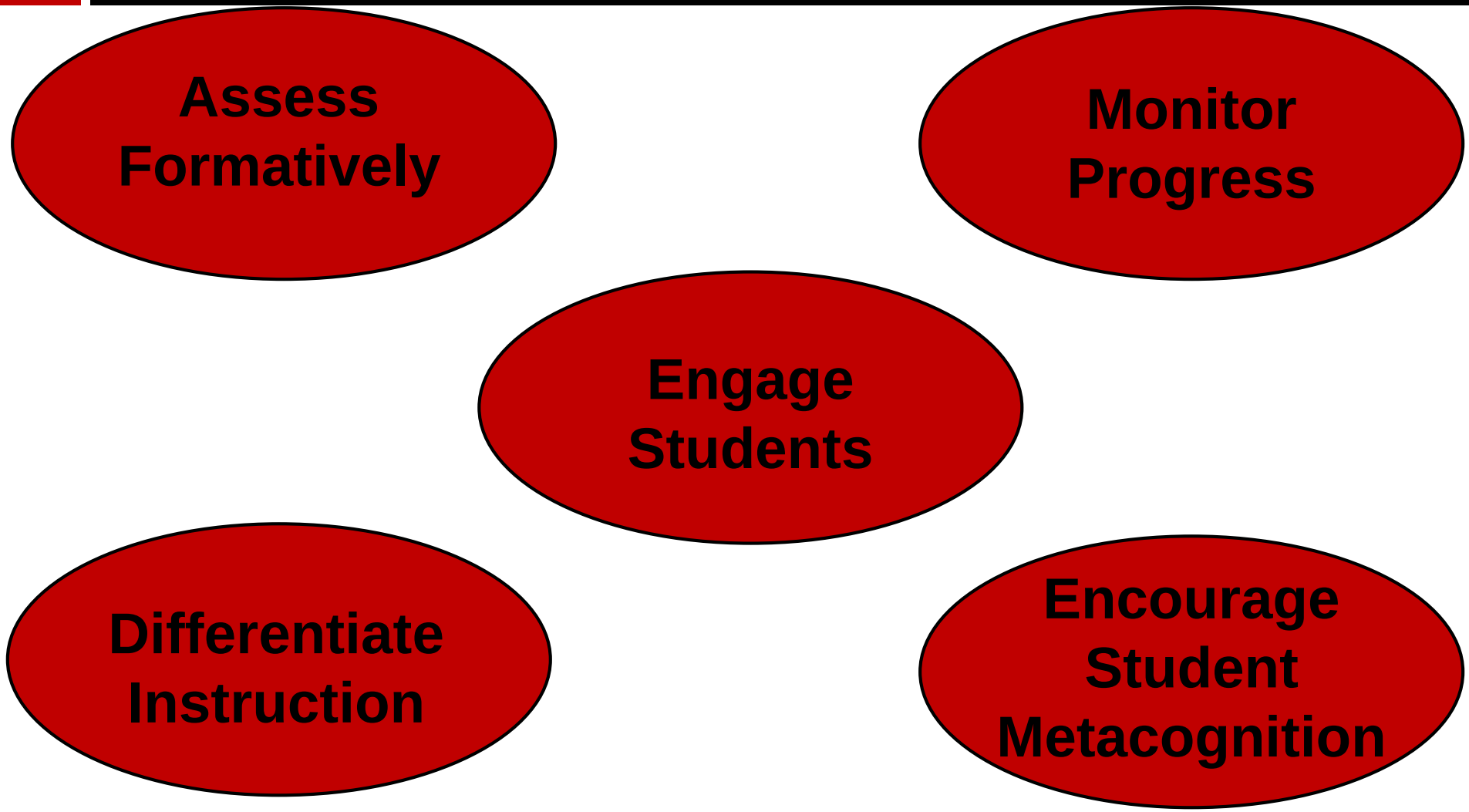
PURPOSE OF QUALITY QUESTIONS



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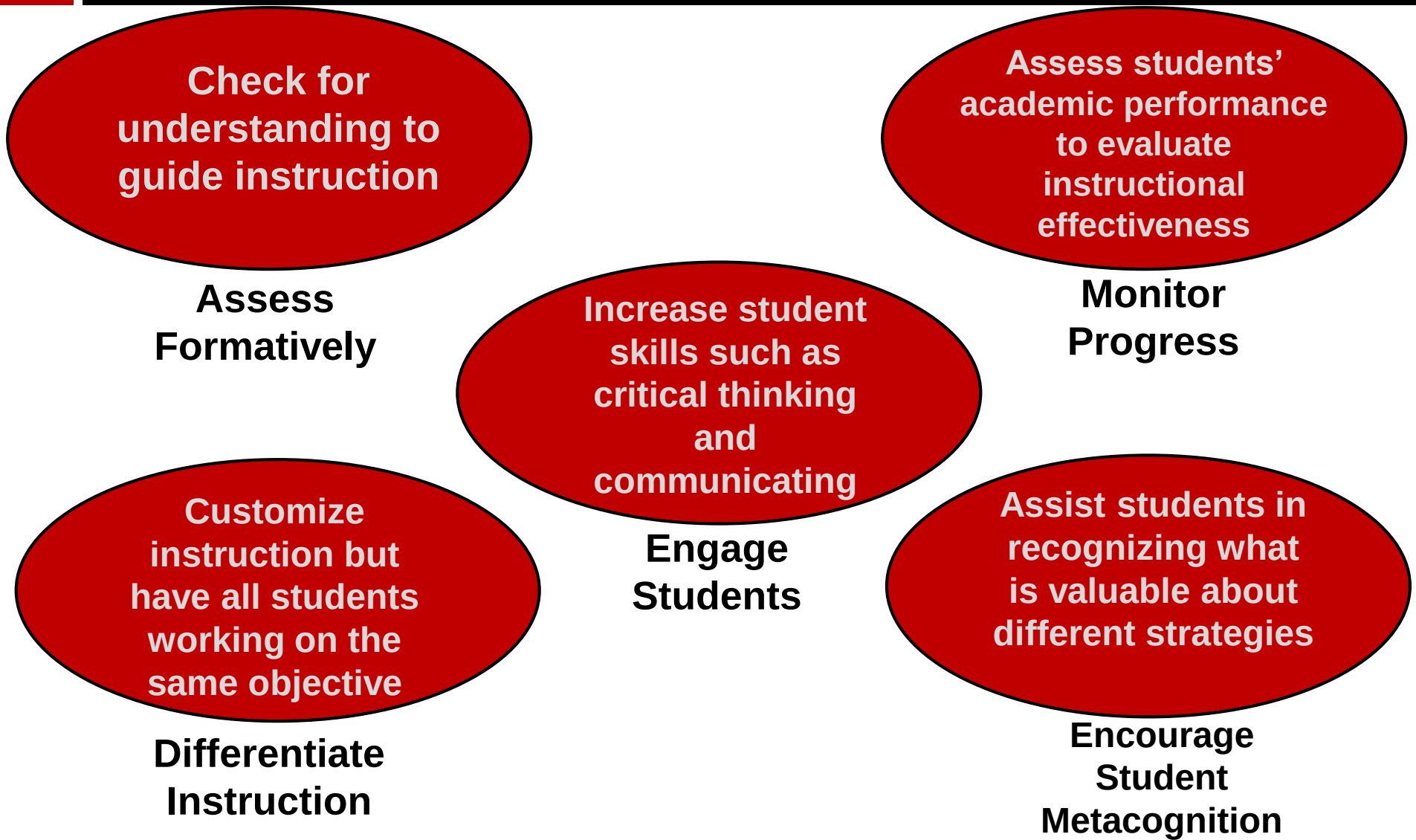

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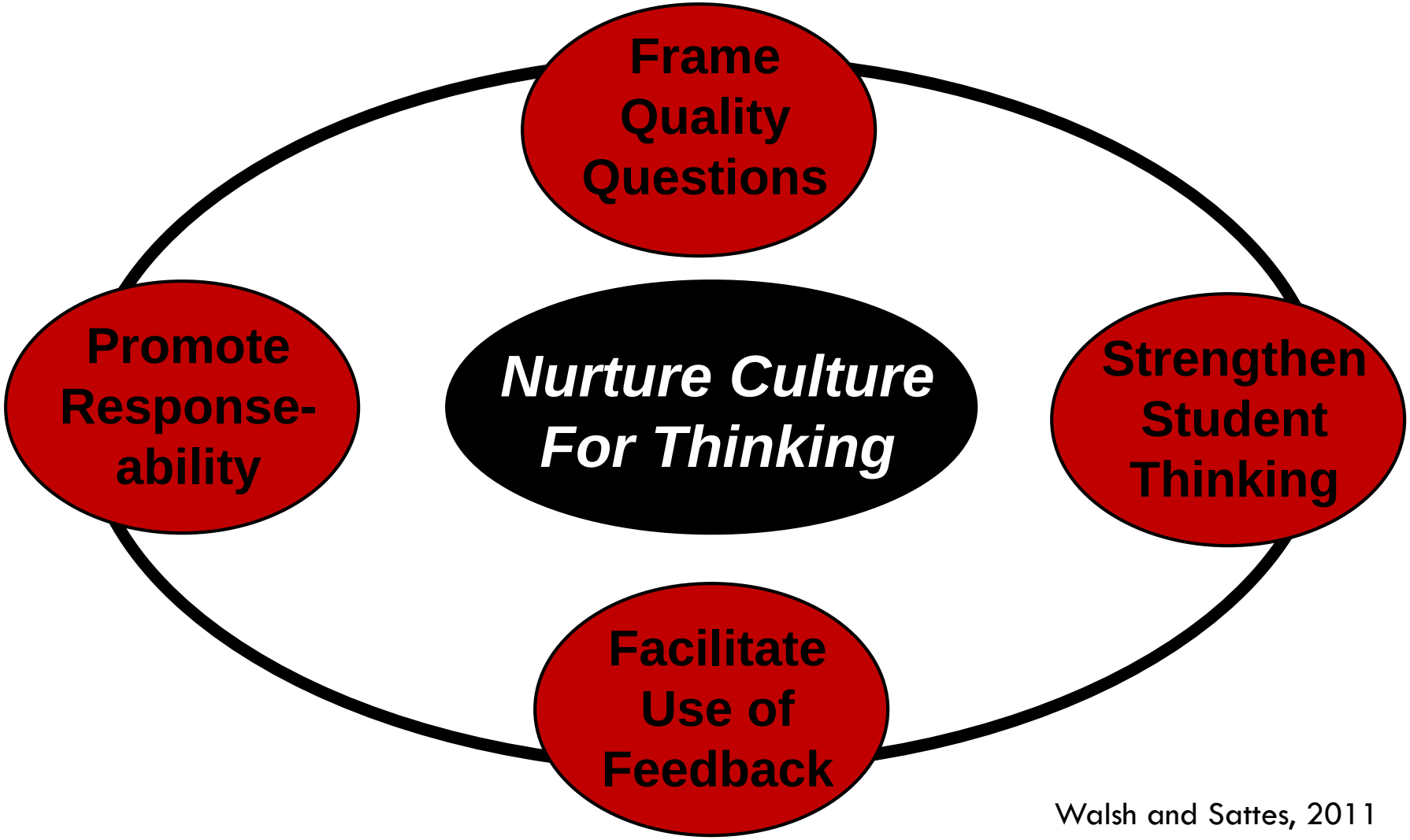

Walsh and Sattes, 2011

WHAT IS FORMATIVE ASSESSMENT?

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FORMATIVE ASSESSMENT?

Your thoughts?

FORMATIVE ASSESSMENT?

… "a process used by teachers and students during instruction that provides feedback to adjust ongoing teaching and learning to improve students' achievement of intended instructional outcomes."

- From FASTSCASS (Formative Assessment for Students and Teachers State Collaborative on Assessment and Student Standards)

Popham, 2008

FORMATIVE ASSESSMENT?

Popham's (2008) more succinct and useful definition:

… "a planned process in which assessment-elicited evidence of students' status is used by teachers to adjust their ongoing instructional procedures or by students to adjust their current learning tactics."

FORMATIVE ASSESSMENT?

- …a process, not any particular test (a *planned* process involving a number of different activities)
- …takes place during instruction
- …is used not just by teachers but by both teachers and students (used to elicit *evidence regarding students' status:* the degree to which a particular student has mastered a particular skill or body of knowledge)
- …provides assessment-based feedback to help teachers and students make adjustments that will improve students' achievement of intended curricular aims

Popham, 2008

The Formative 5

Everyday assessment techniques for every math classroom

"It's all about assessment to inform teaching and learning – every day"

Fennell, Kobett, & Wray, 2017

The Formative 5

- **Observations** – "informal and targeted observations and professional noticing of students engaged in mathematics learning" occurring throughout the day with teachers continually gathering evidence of student progress as students engage in mathematics learning
- **Interviews** - "brief informal conversations between teachers and student or small group of students that provide a 'deeper dive' into student thinking and understandings" done regularly as follow-up or extension to observation

Fennell, Kobett, & Wray, 2017

The Formative 5

- **Show Me** – "single student or small group demonstration of mathematical thinking through written, hands-on, and/or oral responses" done "on the spot" as necessary after observations and interviews
- **Hinge Questions** – " the 'deal-breaker' question: A diagnostic check for understanding or proficiency of a full class or group that determines whether – and how – a teacher should move forward instructionally" at a specific "hinge point" within a lesson or near the end of a lesson

Fennell, Kobett, & Wray, 2017

The Formative 5

- **Exit Tasks** – "a task that captures the major focus of the lesson and provides a sample of student performance" assigned a minimum of a few days of a week and usually at the end of as lesson for approximately 5-10 minutes depending on the complexity of the task

Fennell, Kobett, & Wray, 2017

BENEFITS OF FORMATIVE ASSESSMENT

- …produces greater increases in student achievement and is cheaper than other efforts to boost achievement, including reducing class sizes and increasing teachers' content knowledge
- …occurring within and between instructional units (medium-cycle assessment) as well as within and between lessons (short-cycle assessment) has been shown to improve students' achievement
- …using medium and short-cycle formative assessment, teachers reported greater professional satisfaction and increased student engagement

NCTM, 2007

QUALITY QUESTIONING WITHIN DIFFERENT MATHEMATICAL STRANDS

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CONTENT STRANDS

- **NUMBER & OPERATIONS**
- **ALGEBRA/ALGEBRAIC THINKING**

QUALITY QUESTIONS within NUMBER AND OPERATIONS

Some Big Ideas

- There are many ways to represent numbers.
- Numbers indicate how many or how much.
- Number benchmarks are helpful in relating numbers and estimating amounts.

Small, 2009

QUALITY QUESTIONS within NUMBER AND OPERATIONS

OPEN QUESTIONS

Different Ways to Represent Numbers

1) The answer is 56. What is the question?
2) You add two numbers and the sum is 1½. What are the two numbers?
3) Describe 10 thousand in as many different ways as you can.
4) Create a sentence that includes the following words: 20, percent, some, 100

QUALITY QUESTIONS within NUMBER AND OPERATIONS

OPEN QUESTIONS

Numbers Tell How Many or How Much

1) What makes 1 a special number?

2) A number describes the number of students in an elementary classroom. What might the number be?

3) A number can be written .33333333…. What do you know about the size of the number?

QUALITY QUESTIONS within NUMBER AND OPERATIONS

OPEN QUESTIONS

Number Benchmarks are Helpful in Relating Numbers and Estimating Amounts

1) Choose two numbers to compare. Tell which is the smaller number and how you know it is the smaller number.

2) You divide two numbers and the quotient is almost 3. What could the two numbers be? Explain your answer.

3) Choose a decimal and a percent. Tell which is smaller. Explain your answer.

Teaching Tip

"One of the simplest strategies for differentiating instruction is allowing students to choose the numbers with which they will work."

Small, 2009 (p. 26)

AND….WHAT DOES THE SPECIFIC NUMBERS CHOSEN TELL YOU ABOUT STUDENT UNDERSTANDING? How will this information allow you to handle future instruction?

Teaching Tip

"If a mathematically strong student always seems to select values that make a question too easy, the teacher should allow the student make the initial choice, but then challenge him or her to try other values as well."

Small, 2009 (p. 31)

QUALITY QUESTIONS within NUMBER AND OPERATIONS

OPEN QUESTIONS

There are many different ways to perform each operation.

1) Make up an addition problem that includes the digits 2, 3, and 4.

2) You multiply two fractions and the denominator of the quotient is 24. What could the fractions be?

Teaching Tip

"Teachers need to provide a significant amount of computational practice so students will gain procedural fluency. Rather than assigning large numbers of similar questions, posing one open question can efficiently create opportunities to practice in the context of lively class discussion."

Small, 2009 (p. 30)

QUALITY QUESTIONS within ALGEBRAIC THINKING

Some Big Ideas Relating to Algebra

- Patterns are all around us in the everyday world.
- Arranging information in charts and tables can make patterns easier to see
- Variables can be used to describe relationships.

Small, 2009

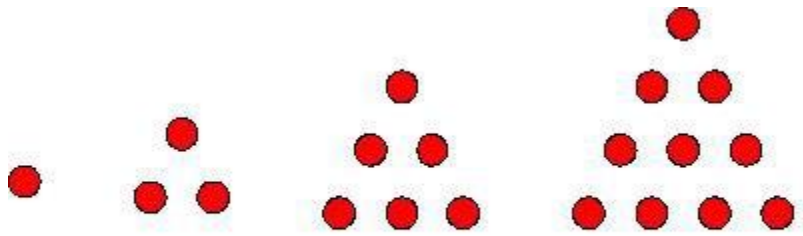
QUALITY QUESTIONS within ALGEBRAIC THINKING

Task 1

The Math Club has a way of greeting each other at the club meetings. They have a secret handshake. If each member shakes hands with each other member exactly once, how many handshakes will there be if there are 2 people in the club? 4 people? 10 people?

Task 2

The triangular numbers can be viewed by arranging dots in triangular patterns. How many dots will there be in the eleventh sketch?



QUALITY QUESTIONS within ALGEBRAIC THINKING

Task 1

Make up two different "equations" that use "variables" and are true ALL of the time.

Examples:

♦ + 0 = ♦

3 ♦ = ♦ + ♦ + ♦

Task 2

Make up two different "equations" that use "variables" and are true only SOME of the time.

Examples:

□ + 2 = 5

2□ = 0

Teaching Tip

Parallel tasks are a good way to ask open questions with same idea but "are designed to suit the needs of students at different developmental levels. The tasks are similar enough in context that all students can participate fully in a single follow-up discussion." Note that when two tasks are given, alternating the difficulty of the tasks is recommended. Students will not know which is the "simpler" task and will consider both possibilities.

Small, 2009 (p. 136)

A Few More Teaching Tips

1) Don't just ask a student for an answer
   – ask how and why!

2) "Listen" to what a student says AND
   what he doesn't say.

3) Take the opportunity to "extend" the concept by
   asking related questions.

4) Use all of this information to formatively assess your
   students to guide your instruction.

One Final Tip

Seize every teachable moment and make the most of it.

That moment may never come around again!

DISCUSSION

QUESTIONS

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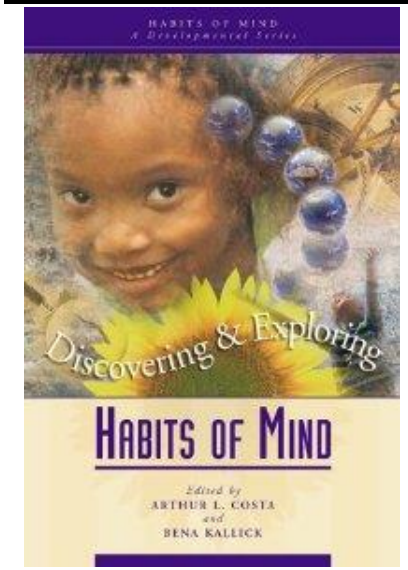

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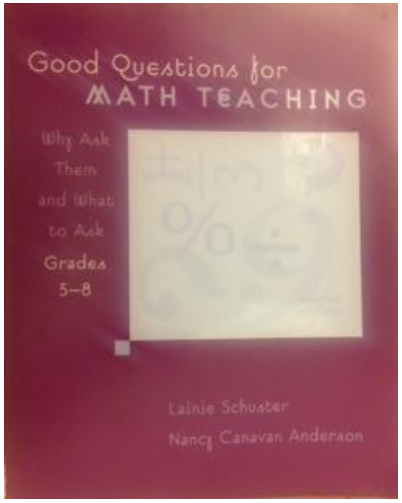

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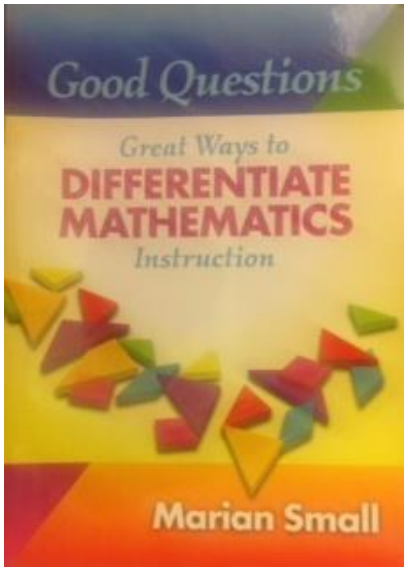

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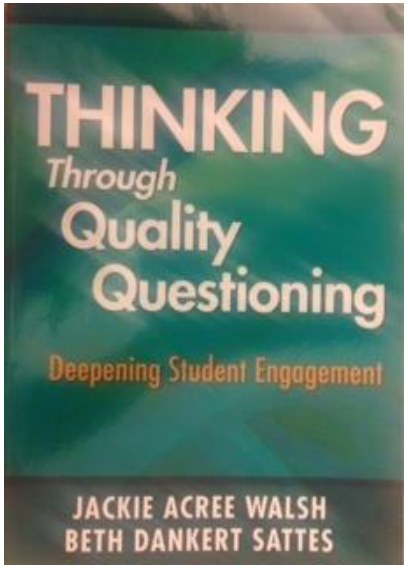

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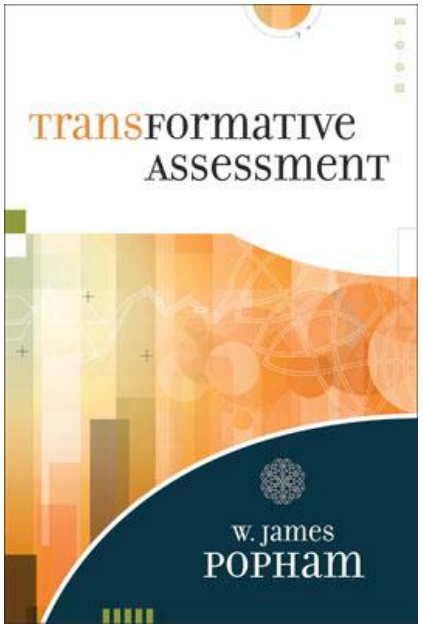

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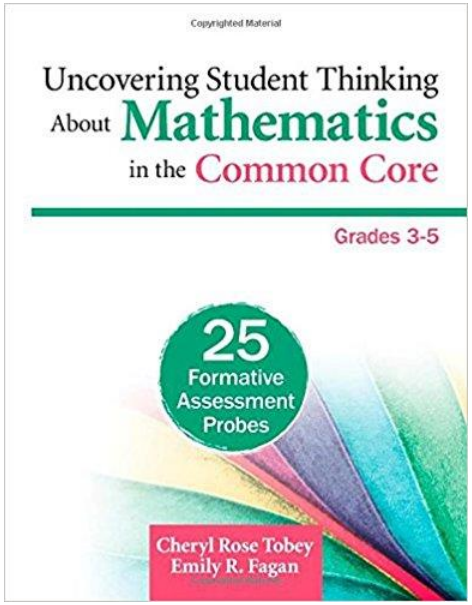

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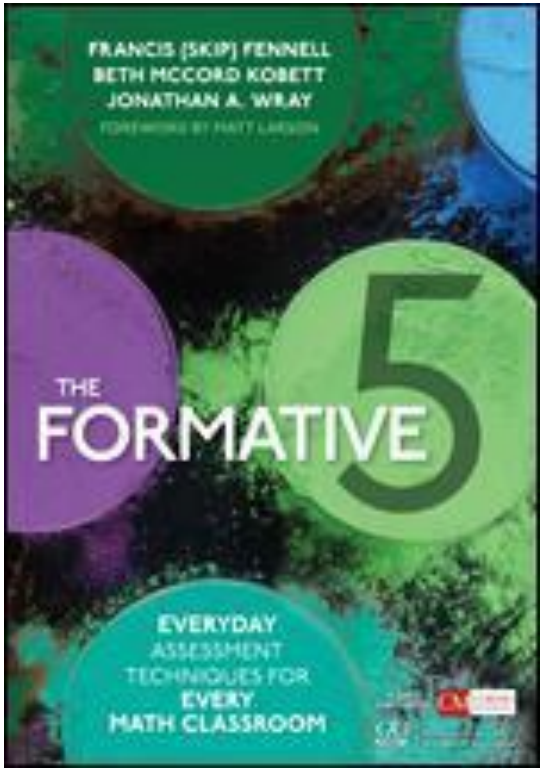

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