REL CENTRAL
Regional Educational Laboratory at Marzano Research

Using Questioning Strategies to Support Struggling Math Students

Barbara Dougherty, PhD

University of Hawai'i

REL CENTRAL
Regional Educational Laboratory at Marzano Research

Who We Are

The Regional Educational Laboratory (REL) Central at Marzano Research serves the applied education research needs of Colorado, Kansas, Missouri, Nebraska, North Dakota, South Dakota, and Wyoming.

Webinar Objectives

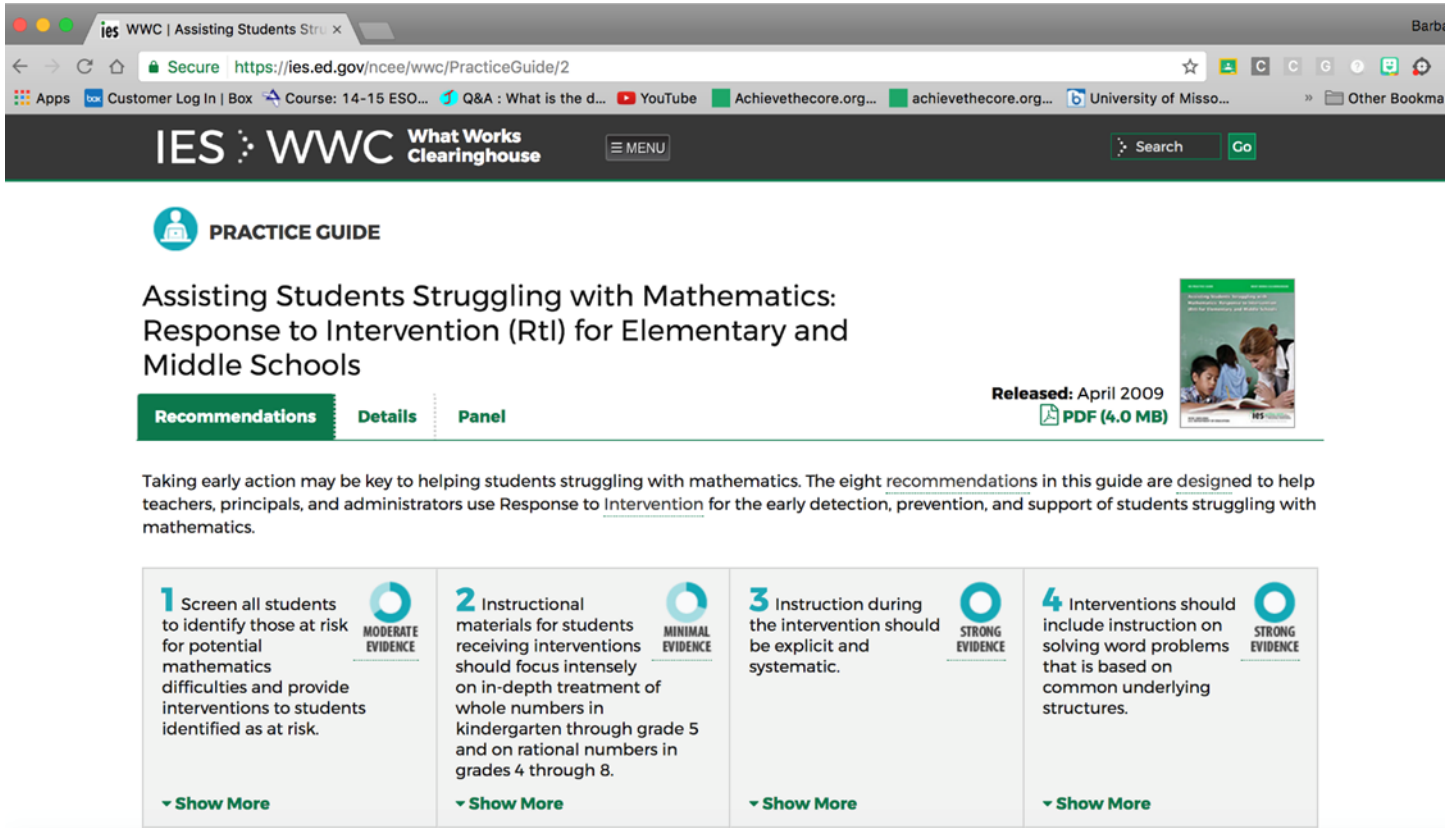
Participants will become familiar with:

- The evidence levels used in the practice guide.
- The eight recommendations of the practice guide.
- A questioning framework to support student understanding.

Our Presenter…

Barbara Dougherty, PhD
University of Hawai'i

Assisting Students Struggling with Mathematics: Response to Intervention (RtI) for Elementary and Middle Schools



Levels of Evidence

- Minimal
  - No causal evidence.
  - Cannot point to a body of research that demonstrates the positive effect of a practice on student achievement.
  - Practice would be difficult to study in a rigorous, experimental fashion.
  - Indicates that researchers have not yet studied this practice, or that there is weak or conflicting evidence of effectiveness.

A minimal evidence rating does not indicate that the recommendation is any less important than other recommendations with a strong evidence or moderate evidence rating.

Levels of Evidence

- Moderate
  - Limited evidence for a practice guide recommendation.
  - Panel finds high-quality causal research that links a practice with positive results, but the research may not adequately rule out other causes of the positive results, or the school and classrooms are not similar to those targeted by the guide.

Levels of Evidence

- Strong
  - Consistent evidence supporting a practice guide recommendation.
  - Panel finds high-quality causal research that links a practice with positive results, ruling out other causes of the positive results.

Recommendations from the Practice Guide

Recommendations from Practice Guide

- Screening
- In-depth study of whole numbers in grades K–5 and rational numbers in grades 4–8
- Explicit and systematic instruction
- Instruction on approaches to solving word problems
- Using visual representations of mathematical ideas
- Consistent practice to build fluency in retrieval of basic math facts
- Monitoring progress
- Motivational strategies

Recommendations from Practice Guide

- Screening
- In-depth study of whole numbers in grades K–5 and rational numbers in grades 4–8
- Explicit and systematic instruction
- Instruction on approaches to solving word problems
- Using visual representations of mathematical ideas
- Consistent practice to build fluency in retrieval of basic math facts
- Monitoring progress
- Motivational strategies

Recommendations from Practice Guide: Screening (Moderate)

Good screening tools:

- Have predictive validity.
- Are reliable.
- Are efficient.

Recommendations from Practice Guide: In-Depth Study of Number (Minimal)

Important mathematical topics include:

- Whole number concepts and operations in grades K–5.
- Rational number concepts and operations in grades 4–8.

Recommendations from Practice Guide: Solving Word Problems (Strong)

Solving word problems:

- Should not focus on keywords.
- Should emphasize structure and relationships.

The Myth of Keywords

- Keywords do not:
  - Develop sense-making or support making meaning.
  - Build structures for more advanced learning.
  - Appear in many problems.
- Students use keywords inappropriately.
- Multi-step problems are impossible to solve with keywords.

Van de Walle, J., Karp, K., & Bay Williams, J. (2010). *Elementary and Middle School Mathematics: Teaching developmentally*. New York: Pearson.

Recommendations from Practice Guide: Visual Representation (Moderate)

Using visual representations may involve:

- A CSA approach (CRA).
- **Concurrently** presenting three forms of representations, or more.

Translation Task – Link Sheet

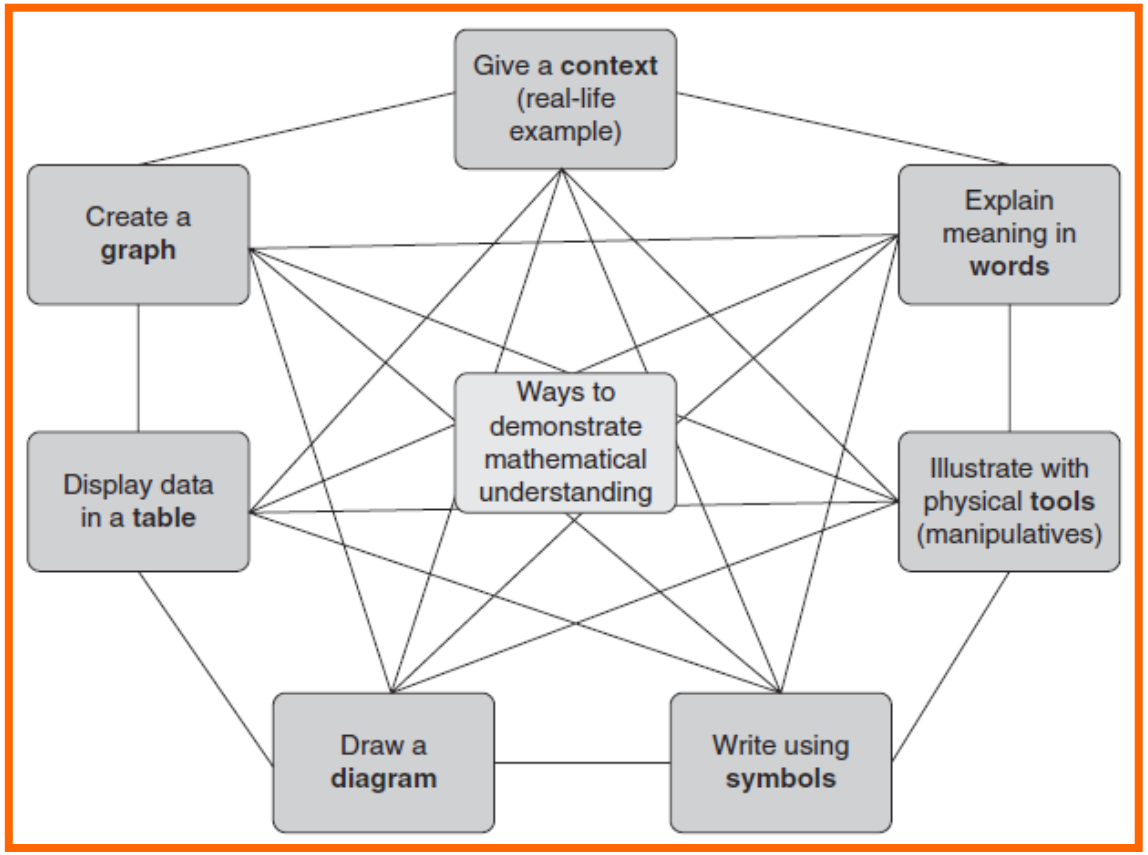
Equation	Word Problem
Model/Illustration	**Explain your Thinking**

At the Middle School Level

Algebraically	Graphically
Numerically in Tables	**Verbal Description**

Van de Walle, J., Karp, K., & Bay Williams, J. (2013). *Elementary and Middle School Mathematics: Teaching developmentally*. New York: Pearson.

Multiple Representations



From *Teaching Student Centered Mathematics* (2014) (Volumes I - III)

Review

- Select one of the topics that was shared.
- Skim the section ‘How to Carry Out This Recommendation’ for the topic you selected.
- What issues does this raise for you?

Questions?

Focus on Recommendation 3: Explicit Instruction

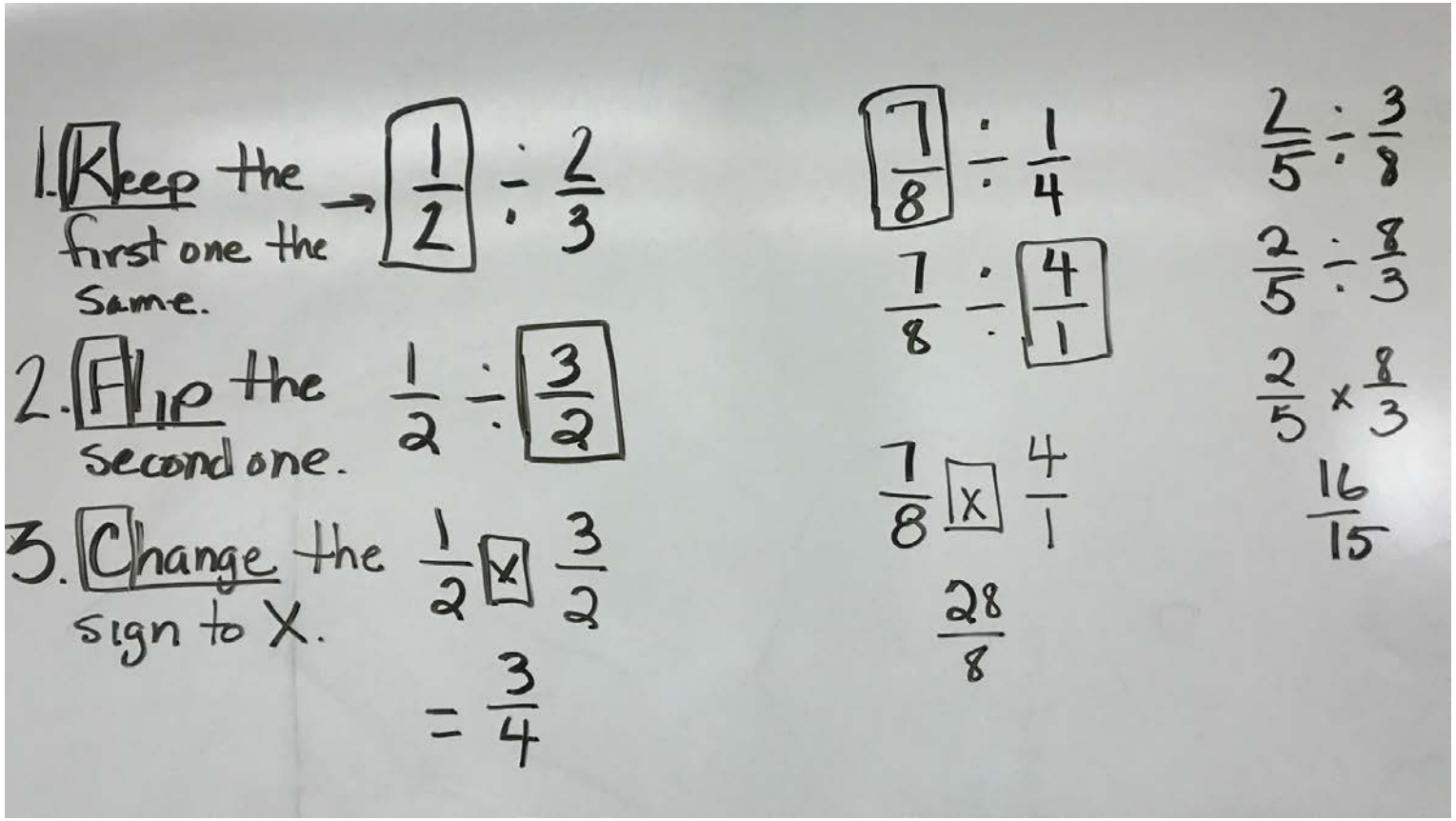
Typical Instruction Follows a Format

I do.

You do.

We Do.

Does This Look Familiar?



Effects of Example-Based Instruction

- Requires students who are struggling to make generalizations about the structure of the class of problems.
- Assumes all problems can be reduced to a series of steps.
- Lessens opportunities for students to engage in a meaningful way.

Recommendations from Practice Guide: Explicit and Systematic Instruction (Strong)

Explicit instruction is NOT direct instruction. It includes:

- Modeling and demonstrations
- Think-alouds
- Significant practice
- Consistent feedback
- Cumulative review

The Big Difference

- Focusing students attention on particular structures or ideas:
  - Asking questions so that students ‘see’ the mathematics.
  - Providing tasks that allow students to explore the topic.

Implementing Explicit Instruction

Intervention Materials

Two studies revealed that teachers providing Tier 2 mathematics instruction to elementary and middle grades students largely used worksheets (Foegen & Dougherty, 2011; Swanson, Solis, Ciullo & McKenna, 2012).

One-size-fits-all computer programs.

Curriculum Materials

- Choose materials that have multiple problem types and include appropriate, and accurate, representations (physical and diagrammatic).

Discourse

- Students [and teacher(s)] should verbalize their thought processes.
  - The description of the process should focus on the reasoning and not just the computational steps.
  - Oral presentation should be paired with written.
  - If multiple processes are shared and are different, students should be asked to find the similarities (and differences) between or among them.
  - Verbalization of thinking should not be a 1-1 discussion (promote critical listening).
  - Scaffold public sharing of their work.

Small-Group Problem Solving

- Use problems that are not just routine, application problems (non-routine).
- Can be ill defined, missing information or have multiple solutions—or no solution.
- Focus on relationships.
- Begin the year with problem solving using cooperative tasks.
- Show exemplar videos of what cooperative or collaborative problem solving looks like.
- Be purposeful in selecting problem solutions for discussion.
- Name problems and methods.

Provide Feedback

- Affirm thinking and process.
- Prepare students to do a public presentation of their work.
- Be specific and focused on targets.

Reflect

- What one implementation strategy that you had not used in your class before might you be able to use or consider?

Enhancing Instruction for Students Who Struggle

Questioning

- Factual questions comprise the majority of questions asked in a mathematics class.
  - More than 145 questions in 48 minute class period.
  - Less than 2 seconds for response.

Dougherty, B. J. & Foegen, A. (2011). *Evaluation of the mathematics project for special education and general education teachers*. Report prepared for the Iowa Department of Education. Ames, IA: Iowa State University.

Traditional Tasks: Low-Level Questions

$$\frac{3}{4} \div \frac{1}{3}$$

Reversibility Questions

- Find 2 fractions whose quotient is $2\frac{1}{2}$.
- Find another pair.
- Find 3 more pairs.

Reversibility Questions

- Promote the ability to think in different ways.
- Give the answer, students create the problem.

Generalization Questions

- What do you notice about the quotient when you divide a fraction greater than 1 by a fraction that is less than $\frac{1}{2}$? Why?

- What do you notice about the quotient when you divide a fraction less than $\frac{1}{2}$ by a fraction that is greater than 1? Why?

Generalization Questions

- Ask students to find and describe patterns.
- What patterns do you notice?

Sophie wrote the following equations:

$14 = 7 \times 2$

$12 = 6 \times 2$

$10 = 5 \times 2$

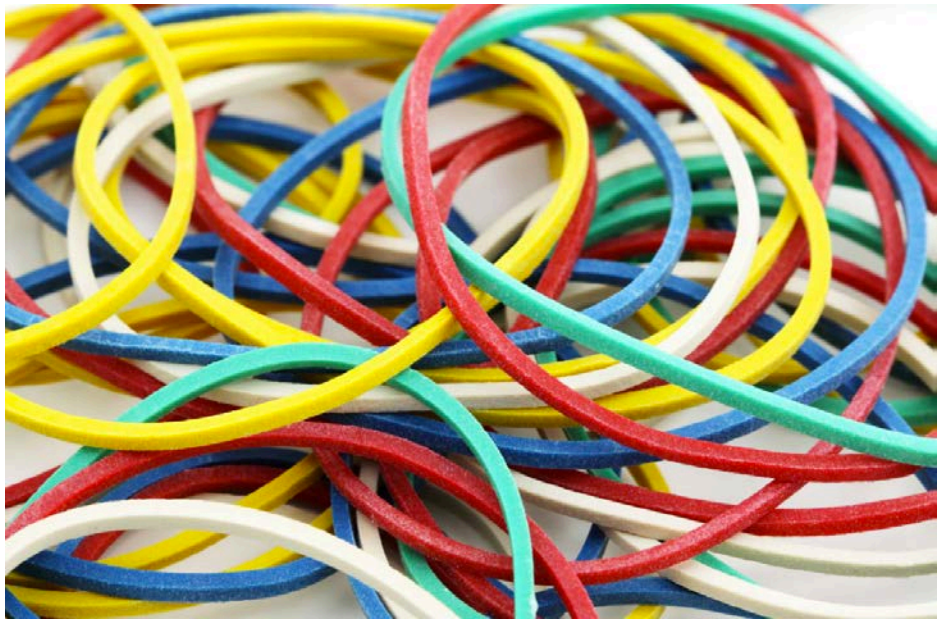
$8 = 4 \times 2$

She said, “I notice something.”
What do you think Sophie noticed?

Flexibility Questions

- Divide $\frac{3}{4} \div \frac{1}{3}$ using 2 different methods.
- How are the methods you used to divide them alike?
- How are they different?

Flexibility Questions



- Ask students to solve a problem in multiple ways OR to use what they know about one problem to solve another one.
- Solve the problem in another way.
- How are these solution methods alike? How are they different?

Reflect

- Which question type will be the easiest for you to implement?
- Which question type will be the most challenging to implement?

Questions?

Integrating Questioning into Instruction

Strategy 1: Teach Students the Question Types

- Introduce the type of question, be transparent.
  - Use a question type, model the procedure for answering.
  - Have students notice how that question is different from (or alike) a factual question.
  - Explicitly discuss the type of process for answering.

Strategy 2: Think-Pair-Share

- Enhances student responses.
- Present a question/task.
- Explicitly give time to think without talking or writing (show timer).
- Identify the person in the pair, give time to talk.
- Share out—record their responses.

Strategy 3: Group Discussions

- Provide opportunities for discussing in small groups; can stem from think-pair-share.
- Present question/task, explicitly set amount of time for discussion and explain how the debriefing of their discussion will take place.
- Ask groups to make notes (use of iPads).
- Randomly select someone to share.
- Record their discussion points.

Strategy 4: Provide Prompts or Guiding Questions

- Before lesson, prepare prompts or guiding questions—requires working through problems and thinking about places where students may be challenged.
- Be specific (What information do you need to move forward?).

Reflect

- How might you implement these question types into your class?
- What implementation strategy would be helpful for you?

Questions?

Thank You

Please visit our website and follow us on Twitter for more information about our events, priorities, research alliances, and access to our many free resources.
https://ies.ed.gov/ncee/edlabs/regions/central/index.asp

@RELCentral

Or contact us at

RELCentral@marzanoresearch.com

This webinar was prepared under Contract ED-IES-17-C-0005 by Regional Educational Laboratory Central, administered by Marzano Research. The content does not necessarily reflect the views or policies of IES or the U.S. of Education, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.