

# Response to Instruction and Intervention in Mathematics

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## A Candid Look at Where We Stand with the Evidence Base

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Instructional Research Group

# Overview of Session

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1. What is a practice guide
2. Overview of levels of evidence
3. Brief background on RTII
4. Highlights on what to teach and how to teach effectively in Tier 2 and Tier 3
  - ✓ Will include Think-Pair-Share activities, so
    - ✓ **Pick a partner now**

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



# Structure of the Practice Guide

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- Recommendations
- How to carry out the recommendations
- Levels of evidence
- Potential roadblocks & suggestions

*Downloadable for free at IES website  
(information is on handout)*

# The Research Evidence

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- The panel considered:
  - High quality experimental and quasi-experimental studies.
  - Also examined studies of screening and progress monitoring measures for recommendations relating to assessment.

# Evidence Rating

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- Each recommendation receives a rating based on the strength of the research evidence.
  - Strong
  - Moderate
  - Low

1. IDENTIFY THE SPECIFICS OF THE PROBLEM BEHAVIOR AND THE CONDITIONS THAT PROMPT AND REINFORCE IT

Nevertheless, the evidence suggests that the practice of understanding a problem behavior's context can yield an effective

- Silvia frequently leaves her seat without permission during small-group instruction.

### Checklist for carrying out the recommendations

#### Recommendation 1. Identify the specifics of the problem behavior and the conditions that prompt and reinforce it

- Concretely describe the behavior problem and its effect on learning.
- Observe and record the frequency and context of the problem behavior.
- Identify what prompts and reinforces the problem behavior.

#### Recommendation 2. Modify the classroom learning environment to decrease problem behavior

raising his hand during whole-class instruction.

- Thanh is physically aggressive toward his peers (hits, kicks, punches) during recess.

9. Evertson, Emmer, and Worsham (2006).

10. Wolery, Bailey, and Sugai (1988) review characteristics of problem behaviors that warrant attention due to the behavior's impact on classroom climate and instructional time.

#### Recommendation 4. Draw on relationships with professional colleagues and students' families for continued guidance and support

- Collaborate with other teachers for continued guidance and support.
- Build collaborative partnerships with school, district, and community behavior experts who can consult with teachers when problems are serious enough to warrant help from outside the classroom.
- Encourage parents and other family members to participate as active partners in teaching and reinforcing appropriate behavior.

#### Recommendation 5.

of the problem, when and where it most often occurs, and how to intervene appropriately. Examples of concrete descriptions of problem behaviors are:

1. IDENTIFY THE SPECIFICS OF THE PROBLEM BEHAVIOR AND THE CONDITIONS THAT PROMPT AND REINFORCE IT

Adjust the difficulty of the problems on the basis of the students' success.

**Consequences:** If misbehavior occurs, take Michael aside and remind him of behavior expectations during whole-group lessons. Describe how the observed behavior affects students' learning. If behavior persists, give Michael a choice of participating in the lesson or relocating to a designated area to work on problems independently until he is ready to return to the whole group.

As demonstrated in the example, teachers' attention to the antecedents and consequences of reoccurring behavior problems can inform the development of more effective and efficient behavioral support strategies to prevent or reduce behaviors that interfere with successful classroom learning.

**Potential roadblocks and solutions**

**Roadblock 1.1.** *"I don't know how to collect all this information about behavior problems when I'm trying to teach a room full of students."* General education teachers in public schools must attend to, on average, more than 20 students in their classroom,<sup>15</sup> so to add data collection responsibilities to their tasks can seem impractical or impossible.

**Suggested Approach.** We recommend keeping methods of information gathering very simple. For example, if the problem behavior occurs several times a day, we recommend that teachers record occurrences over just a few days. If the problem behavior occurs infrequently (such as a few times a week), we recommend that teachers gather data over one or two weeks to be sure to include enough instances of the behavior to inform a plan for intervention. For daily observations teachers can use a chart of their daily classroom

schedule and make a simple tally under the time of day and lesson activity when the target behavior occurs (see table 3).<sup>16</sup> Over time patterns should become apparent, showing when the behavior is more likely and less likely to occur. For a behavior of low frequency teachers can make a very brief entry in a notebook or journal during transition periods (for example, at recess or between lessons) or at the end of the day about the immediate antecedents and consequences of the target behavior (see table 4).<sup>17</sup> After recording and reviewing a number of these observations, teachers should be able to denote patterns in the frequency and triggers of the misbehavior.

**Roadblock 1.2.** *"This class has so many behavior problems, I don't know where to start."* Students' problem behaviors can be a source of great frustration and confusion to teachers, especially when they are persistent and appear to be inexplicable.

**Suggested Approach.** Multiple problem behaviors, such as disruption, inattention, and noncompliance, often originate from similar student needs, so by concentrating on one behavior in one setting, teachers may have a positive impact on others. We suggest that the teacher identify one priority behavior problem—not necessarily the most troublesome or disruptive—on which to focus initial efforts. By assessing the antecedents and consequences that prompt and reinforce the problem behavior and developing strategies that specifically link to the underlying function of the student's

16. The example data collection tool was adapted from O'Neill et al. (1997), p. 29. In table 3, each tally mark represents an occurrence of the high-frequency target behavior.

17. The example data collection tool was adapted from O'Neill et al. (1997), p. 33. Using table 4, teachers can enter information about low-frequency problem behaviors by describing the behavior in concrete terms and its antecedent(s) and consequence(s).

15. U.S. Department of Education (2004).

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# Panelists

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- Russell Gersten (Chair), *Instructional Research Group (IRG), Professor Emeritus University of Oregon*
- Sybilla Beckmann, *University of Georgia*
- Ben Clarke, *Pacific Institute for Research/Instructional Research Group*
- Anne Foegen, *Iowa State University*
- Laurel Marsh, *Howard Count Maryland School District*
- Jon R. Star, *Harvard University*
- Bradley Witzel, *Winthrop University*

# Search for Coherence

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Panel works to develop 5 to 10 assertions that are:

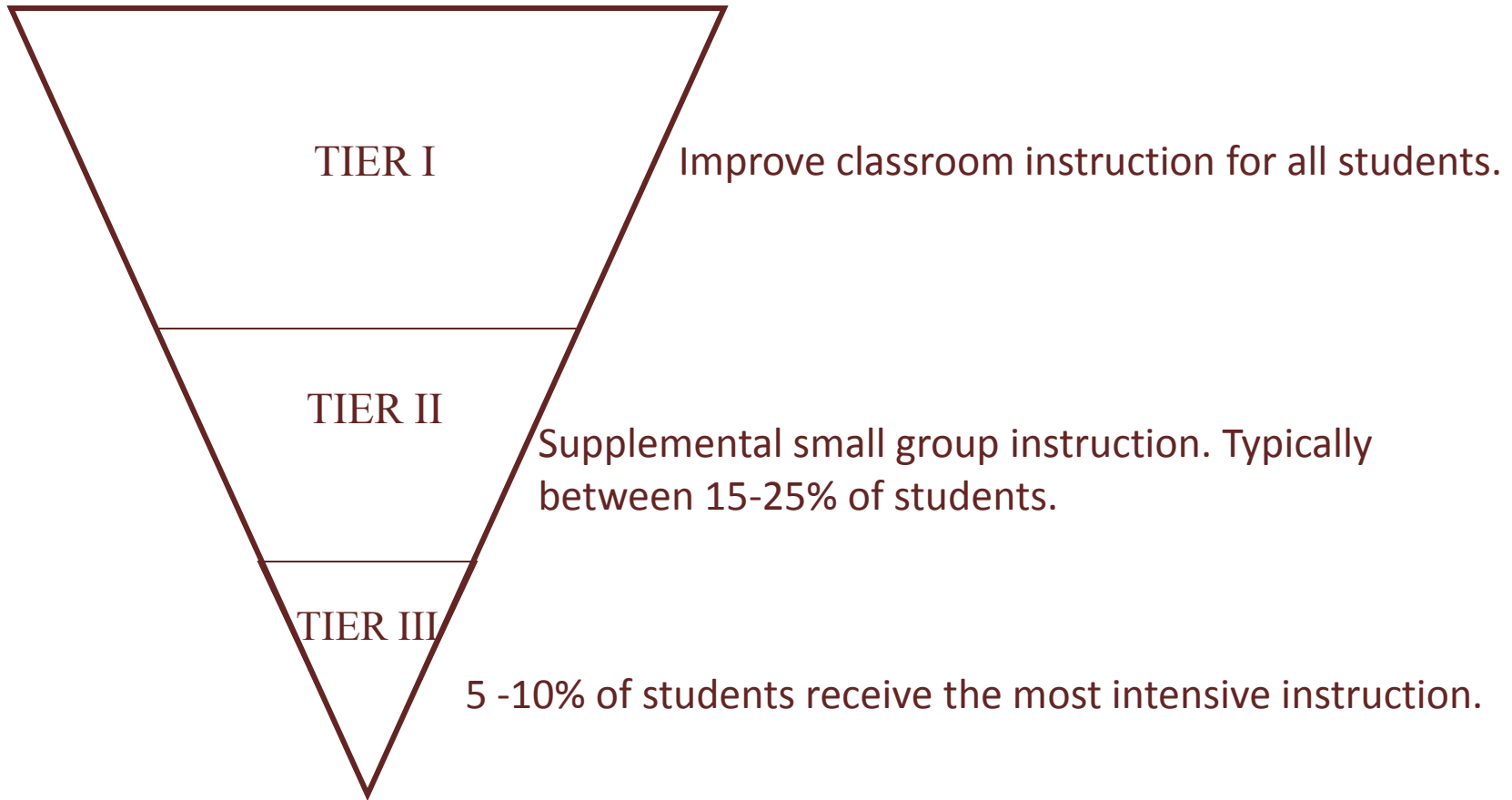
- Forceful and useful
- And COHERENT
- Do not encompass all things for all people
- Do not read like a book chapter or article
- Cover grades K-8

Challenges for the panel:

- State of math research
- Paucity of rigorous research on mathematics instruction

*Jump start the process by using individuals with topical expertise and complementary views*

# RTII Model



<b>Recommendation</b>	<b>Level of Scientific Evidence</b>
1. Universal screening (Tier I)	Moderate
2. Focus instruction on whole number for grades k-5 and rational number for grades 6-8	Low
3. Systematic instruction	Strong
4. Solving word problems	Strong
5. Visual representations	Moderate
6. Building fluency with basic arithmetic facts	Moderate
7. Progress monitoring	Low
8. Use of motivational strategies	Low

# *Think Pair Share #1*

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Which level of evidence is the  
biggest surprise for you?

Why?

# Recommendation 1

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Screen all students to identify those at risk for potential mathematics difficulties and provide interventions to students identified as at risk.

Level of Evidence: **Moderate**

# Evidence

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- Technical evidence for *validity and reliability* of assessments:
  - K-2: **Strong**
  - Grades 3 and up: **Limited**

# Evidence

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- Content of Measures
  - Single aspect of number sense (e.g. strategic counting, magnitude comparison) for K/1.
  - For grades 2 and up: Probably measures reflecting major state standards, National Mathematics Panel Benchmarks, Core Standards when they evolve etc. (*A lot of work to do here*)



# Examples of Missing Number Items

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\_\_\_\_\_, 20, 21

8, \_\_\_\_\_, 10

9, 10, \_\_\_\_\_

# Magnitude Comparison

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Which is bigger?

- 11 or 9?
- 79 or 95?
- 19 or 23?

# Roadblocks

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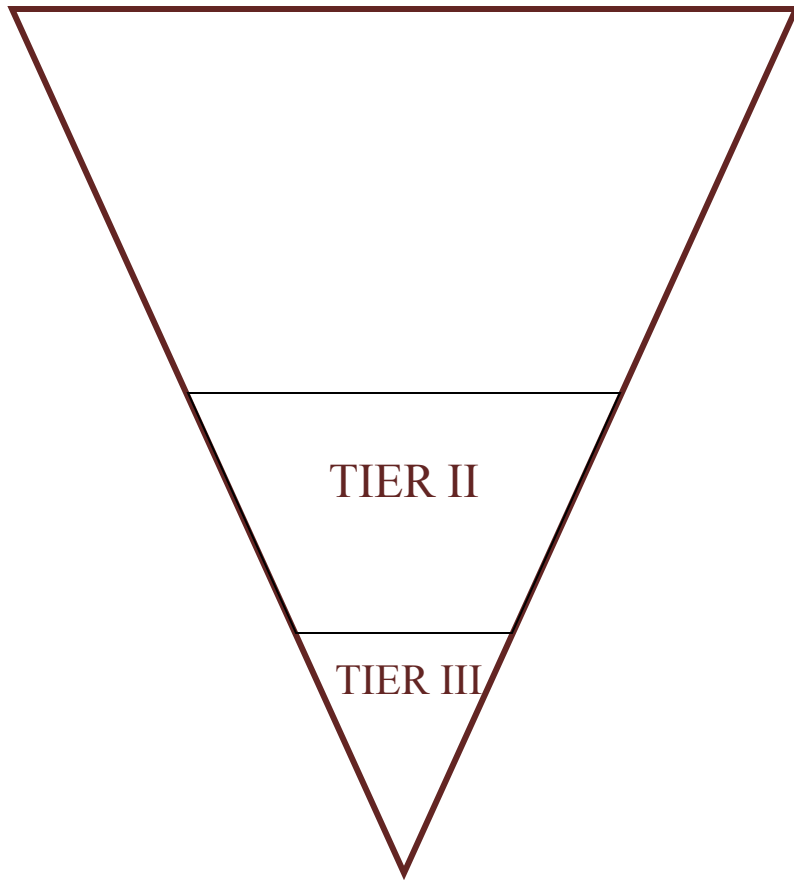
- Screening may identify students as at-risk who do not need services and miss students who do.
- Suggested Approach: Consider delaying screening in kindergarten and first grade until November.

# Roadblocks

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- Screening may identify large numbers of students who need support beyond the current resources of the school or district.
- Suggested Approach: *Think Pair Share #2*

# TIER II & TIER III



- **Tier II**
  - Is individual or small-group intervention *in addition to the time allotted for core mathematics instruction.*
  - Includes curriculum, strategies, and procedures designed to *supplement, enhance, and support* core classroom instruction.
  - Can backtrack and/or elaborate/reinforce classroom curriculum.
- **Tier III**
  - Includes some one-to-one work and more intense methods.

All the following relate to Tier 2 and Tier 3

Participants were students with learning disabilities or problems in learning mathematics

# Recommendation 2

## What to Teach in Intervention

Instructional materials for students receiving interventions should focus in-depth on:

- Whole numbers in kindergarten through grade 6
  - Rational numbers in grades 4 through 8
  - Applications to geometry and measurement
- Level of Evidence: **Low**

# Evidence

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- Consensus across mathematicians, professional organizations, and research panels
  - National Council Teachers of Mathematics (NCTM) and National Mathematics Advisory Panel (NMAP)
  - International comparisons
  - *We made the leap to nature of intervention curricula...*



# What to Teach in Intervention (continued)

- Instruction includes:
  - procedures
  - AND concepts
  - AND word problems
- Whole number work consistently links operations to number properties

## Commutative Property

- $8 + 7 = 7 + 8$
- $a + b = b + a$

## Associative

- $9 \times 3 \times 5 = 3 \times 9 \times 5$
- $a(bc) = (ab)c$

## Distributive

- $7(13) = 7(10) + 7(3)$   
 $= 70 + 21$
- $a(b + c) = ab + ac$

# Fractions Defined

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- Fractions arise naturally whenever we want to consider one or more parts of an object or quantity that is divided into pieces.
  - $\frac{1}{8}$  of a pizza
  - $\frac{2}{3}$  of the houses in the neighborhood
  - $\frac{3}{4}$  of a cup of water
- All of these examples use the word *of*, and all the fractions represent part *of* some object, collection of objects, or quantity. Source: Beckmann (2008), Mathematics for Elementary Teachers (2nd Ed.)
- Dilemma: how to convey this to kids
- Precursor: teacher must understand all this so that she or he can teach it

# Recommendation 3

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Instruction during the intervention should be **systematic and explicit**. This includes providing models of proficient problem-solving, verbalization of thought processes, guided practice, corrective feedback, and frequent cumulative review.

– Level of Evidence: **Strong**

# Evidence

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- Six randomized controlled trials met standards
- Key themes
  1. *Extensive practice with feedback*
  2. *Let students provide rationale for their decisions*
  3. *Instructors and fellow students model approaches to problem solving*

# Example

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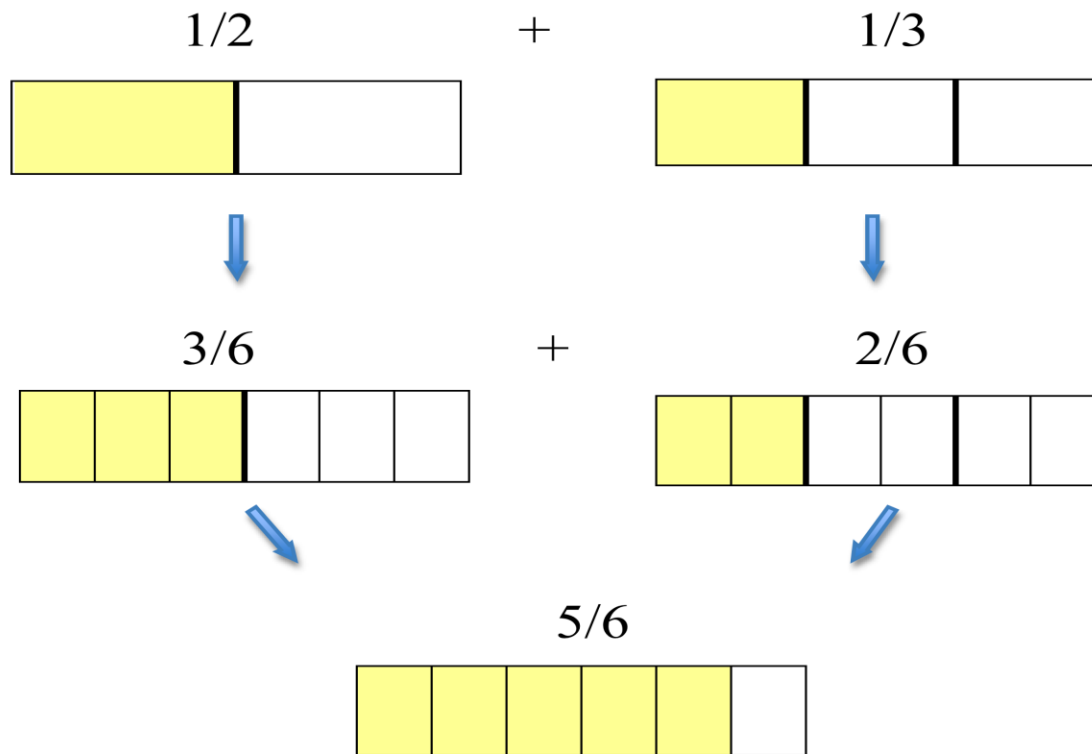
- Assignment: Use the lowest common denominator when appropriate

$$\frac{1}{2} + \frac{1}{3} =$$

- Student Response

$$\frac{1}{2} + \frac{1}{3} = \frac{2}{5}$$

# Explicit instruction helps with understanding of fractions



# Developing Understanding of Fractions

- Concrete



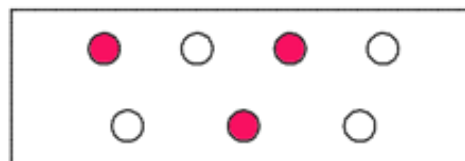
- Visual



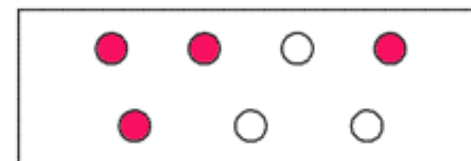
Area model for  $\frac{3}{7}$



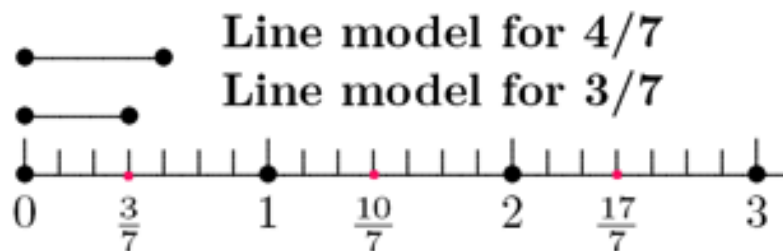
Area model for  $\frac{4}{7}$



Partitive model for  $\frac{3}{7}$



Partitive model for  $\frac{4}{7}$



Line model for  $\frac{4}{7}$

Line model for  $\frac{3}{7}$



# Roadblocks

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- Intervention curricula may not have explicit instruction and may underestimate the amount of practice and review needed by Tier 2 and Tier 3 students.
- Suggested Approach:
  1. Develop guidebooks for school staff to adapt the lessons.
  2. Add new review problems.

# Recommendation 4

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Interventions should include instruction on solving word problems that is based on common underlying structures.

– Level of Evidence: **Strong**

# Suggestions

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- Teach students about the structure of various problem types, **how to categorize problems**, and how to determine appropriate solutions.
- Middle step –  
Is it:
  - Quantity (compare)?  
And/Or
  - Change (over time)?

# Explicitly Teach the Underlying Structure

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- Addition and Subtraction Story Problems
  - Change Problems
    - A quantity is increased or decreased
  - Group Problems
    - Two groups are combined to form a large group
  - Compare Problems
    - Two things are compared to find the difference

# Change, Group, or Compare?

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## *Think Pair Share #3*

1. Dillon leaped 32 inches. Marcus leaped 27 inches. How many more inches did Dillon leap? (Everyday Math 4)
2. Uranus has 11 rings. Neptune has 4 rings. How many rings do they have altogether? (SF/AW 3)
3. There are 18 ducks. Then 5 more swim over. How many ducks are there now? (Math Expressions 1)

# Change Problems (temporal)

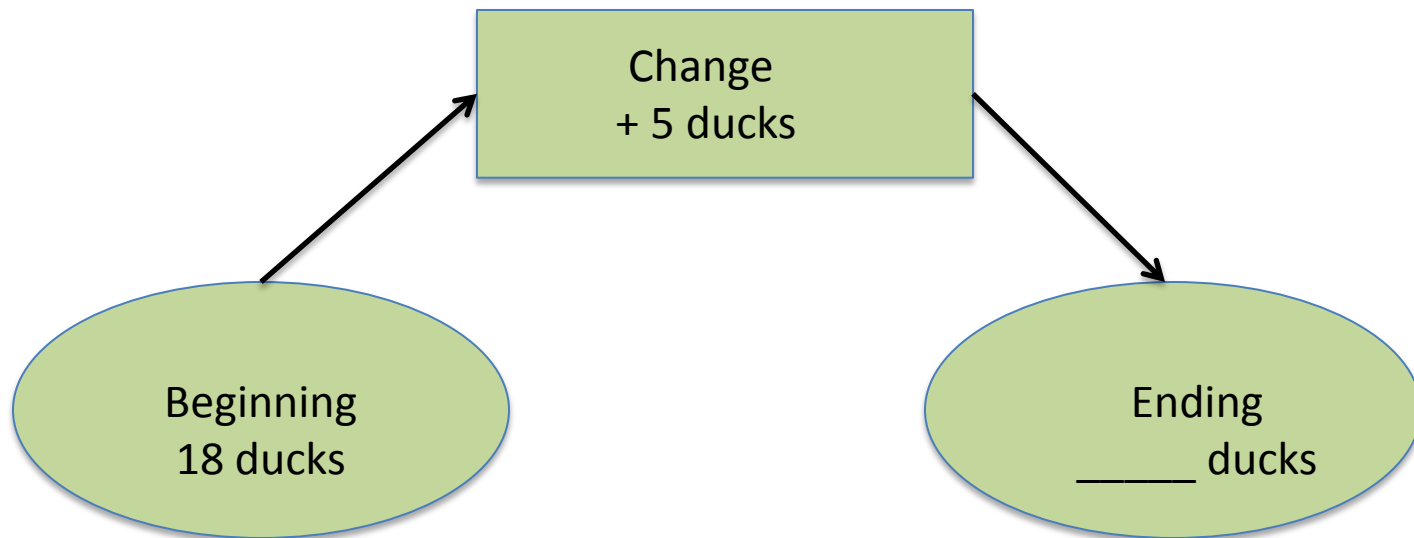
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- Sequence
  - Beginning quantity
  - Action – quantity is increased or decreased
  - Ending quantity
- Determine whether the change is more or less
  - Begin with quantity – increase – end up with more
  - Begin with quantity – decrease – end up with less
- Whether to add or subtract depends on whether there is an increase/decrease *and* which value is missing.

# Visual Representation for Change Problems

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- There are 18 ducks. Then 5 more swim over. How many ducks are there now?



# Solving similar problems that appear different

- Difficulties encountered by some students
  - Extraneous information
  - Different wording
- Even though the problems have a common underlying structure
- Creates problems for any student who needs intervention

Source: Fuchs et al. (2007)



# Recommendation 5

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Intervention materials should include opportunities for the student to work with visual representations of mathematical ideas, and interventionists should be proficient in the use of visual representations of mathematical ideas.

– Level of Evidence: **Moderate**

Strip diagrams can help students make sense of fractions.

Shauntay spent  $\frac{2}{3}$  of the money she had on a book that cost \$26. How much money did Shauntay have before she bought the book?

Shauntay's money at first

\$26 book

2 parts  $\longrightarrow$  \$26  
1 part  $\longrightarrow$   $\$26 \div 2 = \$13$   
3 parts  $\longrightarrow$   $3 \times \$13 = \$39$

Shauntay had \$39

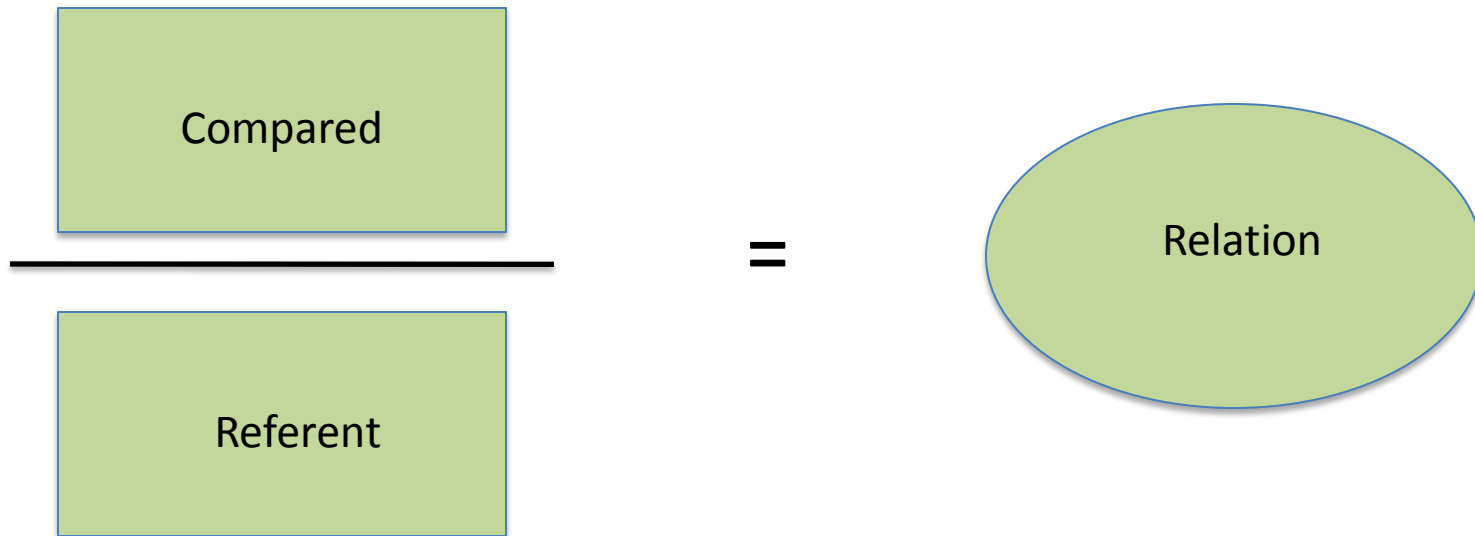
# Suggestions

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- Use visual representations such as number lines, arrays, and strip diagrams.
- If necessary consider expeditious use of concrete manipulatives before visual representations. The goal should be to move toward abstract understanding.

# Visual Representation for Multiplicative Compare

- Francine has 5 CDs. Millie has 3 times as many. How many CDs does Millie have? (SF/AW 3)



# Recommendation 6

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Interventions at all grades should devote about 10 minutes in each session to building fluent retrieval of basic arithmetic facts.

– Level of Evidence: **Moderate**

# Suggestions

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- Provide 10 minutes per session of instruction to build quick retrieval of basic facts.
- For student in K-2 grade explicitly teach strategies for efficient counting to improve the retrieval of math facts.
- Teach students in grades 2-8 how to use their knowledge of math properties to derive facts in their heads.

# Recommendation 7

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Monitor the progress of students receiving supplemental instruction and other students who are at risk.

– Level of evidence: **Low**

# Evidence

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- Non-experimental studies demonstrating the technical adequacy of progress monitoring measures.
- General outcome measures reflecting concepts and computation objectives for the grade level.
- Greater evidence in elementary grades.



# Suggestions

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- Monitor the progress of Tier 2, Tier 3 and borderline Tier 1 students at least once a month using grade appropriate general outcome measures.
- Use curriculum-embedded assessments in intervention materials
  - Frequency of measures can vary - every day to once every week.
  - Develop an understanding of their technical characteristics

# *Think Pair Share #4*

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- How could you develop an understanding of the technical characteristics of curriculum embedded tests?
  - Reliability
  - Are forms equivalent?
  - Who could help?

# Recommendation 8

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Include motivational strategies in tier 2 and tier 3 interventions.

– Level of Evidence: **Low**

# Roadblocks

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- Rewards can reduce genuine interest in mathematics by directing student attention to gathering rewards rather than learning math.
- Suggested Approach: Rewards have not shown to reduce intrinsic interest. As students become more successful rewards can be faded so student success becomes an intrinsic reward.

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# Questions?

# Resources

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- Center on Instruction (COI)  
[http://www.centeroninstruction.org/resources.cfm?category=math&subcategory=&grade\\_start=&grade\\_end=#226](http://www.centeroninstruction.org/resources.cfm?category=math&subcategory=&grade_start=&grade_end=#226)
- National Center for Learning Disabilities (NCLD) RTI Action Network <http://www.rtinetwork.org/>
- Glover, T. A., & Vaughn, S. (2010). The promise of response to intervention: Evaluating current science and practice. New York: Guilford Press.
- WWC Practice Guide <http://ies.ed.gov/ncee/wwc/publications/practiceguides/>

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Thank you

Contact Information:

<http://www.inresg.org/>