UNDERSTANDING RTI IN MATHEMATICS

Session 2: Understanding RtI
RtI Framework and Screening

New York State Webinars on RTI Mathematics

Tuesday, November 25, 2014

4:00 – 5:15 pm EST

Russell Gersten, Ph.D.
Director, Instructional Research Group
Professor Emeritus, University of Oregon

Instructional Research Group

AGENDA FOR SESSION 2

Webinar Title	Date/Time	Agenda
EVIDENCE BASE FOR RtI IN MATHEMATICS and Brief Overview of Universal Screening	Tuesday, November 25th 4:00-5:15 pm EST	1. Framework: Evidence Based Principles of RtI (from the IES Practice Guide) 2. The Need for Preventative Intervention in mathematics ▪ Evidence base (importance of preK to 1) ▪ Fractions as the gateway to algebra 3. Screening ▪ Tools and measures ▪ Reliability, Predictive Validity ▪ False positives and resource allocation

UPCOMING: SESSIONS 3 & 4

Webinar Title	Date/Time	Agenda
Effective Instructional Practices in Mathematics for Tier 2 and Tier 3 Instruction	Tuesday, December 2nd 4:00-5:15 pm EST	• What to Teach • Nature of Instruction: Controversies and what we know about the nature of explicit instruction • Intervention Materials/Resources • Roadblocks & Suggestions
Progress Monitoring and its Use in intensive intervention	Tuesday, December 9th 4:00-5:15 pm EST	

POLL ITEM 1 & 2:

LINKED TO HIGHER MATHEMATICS PROFICIENCY

1. **For first grade**, linked with higher mathematics proficiency:
   - Teachers telling students the strategy to use in response to students' work or answers
2. **For second grade: linked with higher mathematics proficiency**
   - Teachers asking the class if it agrees with a student's answer
   - Number of representations that teachers demonstrate
   - Students help one another understand math concepts or procedures
3. **Linked with LOWER mathematics proficiency:**
   - Teachers eliciting multiple strategies or solutions
   - Teachers prompting a student to guide practice or lead the class in a routine

Note: Red means linked to earlier discussion

Instructional Research Group

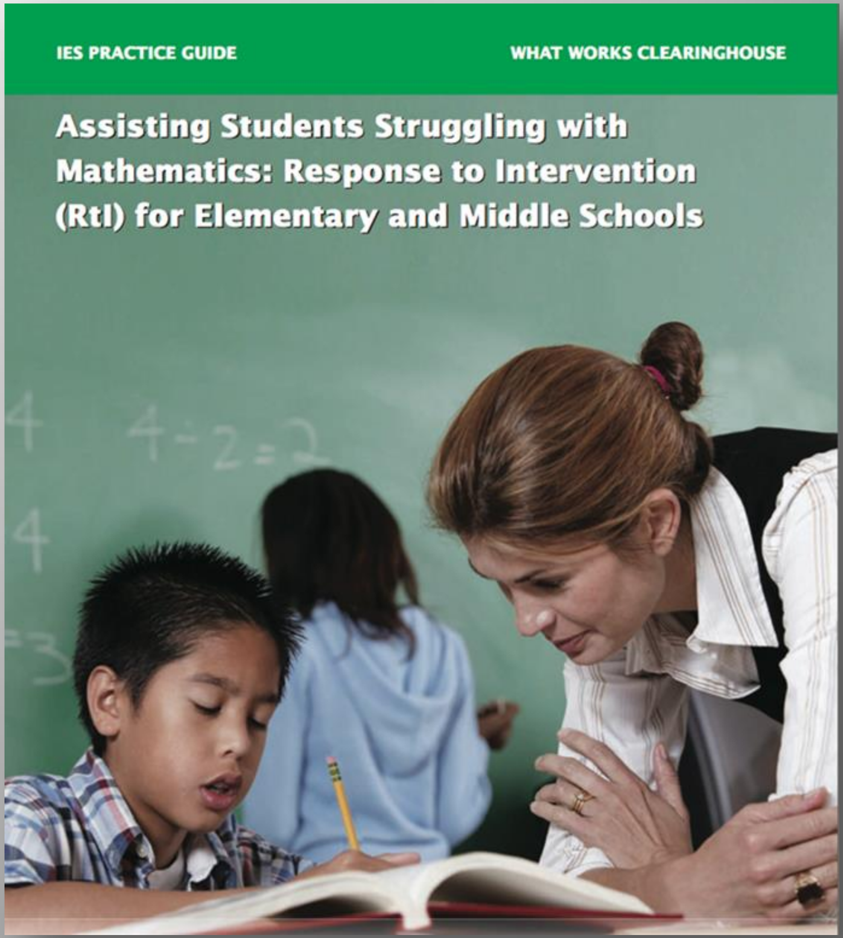
Morgan, P. L., Farkas, G., & Maczuga, S. (2014). ***Which instructional practices most help 1st grade students with and without mathematics difficulties?***

When researchers statistically adjusted for pretest score and demographic factors:

1. **At risk students** did better when
   - Teacher-directed practices were used.
   - There was more drill and practice.
2. For students not considered at risk
   - both teacher-directed and student-centered practices were helpful.

FRAMEWORK FOR MATHEMATICS INTERVENTION

1. Russell Gersten (Chair)
2. Sybilla Beckman
3. Ben Clarke
4. Anne Foegen
5. Laurel Marsh
6. Jon R. Star
7. Bradley Witzel



Instructional Research Group

Recommendation	Level of Scientific Evidence
1. Universal screening (Tier I)	Moderate
2. Focus instruction on whole number for grades k-5 and rational number and whole number for grades 4-8	Minimal
3. Systematic, focused instruction	Strong
4. Solving word problems	Strong
5. Visual representations	Moderate
6. Building fluency with basic arithmetic facts	Moderate
7. Progress monitoring of all students receiving intervention or at risk	Minimal
8. Use of motivational strategies	Minimal

POLL ITEM 3

SCREENING:
DECISIONS, DECISIONS, DECISIONS

1. What grade levels should we begin at?
   - Same as reading? Early intervention in primary grades?
   - How does algebra readiness and double dose algebra and double dose mathematics in mid school fit in?
2. Should we use the same system as reading?
3. Which are important criteria to look at in tech reports for screeners: predictive validity, concurrent validity, anything else?

POLL ITEM 4

EMPIRICAL BASE SUPPORTIVE OF EARLY INTERVENTION

1. It is recent
2. It is becoming every bit as strong as the base for early intervention in reading

WHAT'S PAST IS PROLOGUE: RELATIONS BETWEEN EARLY MATHEMATICS KNOWLEDGE AND HIGH SCHOOL ACHIEVEMENT: FINDINGS FROM NATIONAL DATABASE

Best predictors of mathematics proficiency at age 15:

1. Growth between entry to K and end of first grade
2. Correlation of almost .4
3. Statistically significant

Note that correlation of most screeners from fall to spring in one year usually .6. So VERY IMPORTANT TO HAVE .4 over a decade.

hot off the press:

Watts, T. W., Duncan, G. J., Siegler, R. S., & Davis-Kean, P. E. (2014). What's past is prologue: Relations between early mathematics knowledge and high school achievement. *Educational Researcher, 43*, 352-360.

RELATIONS BETWEEN EARLY MATHEMATICS KNOWLEDGE AND HIGH SCHOOL ACHIEVEMENT

Longitudinal study of 1,364 students using a nationally representative (albeit imperfect, unlike Morgan/Farkas) from NIH. Watts, T. W., Duncan, G. J., Siegler, R. S., & Davis-Kean, P. E. (2014).

- Data extends from K – 12.

Key findings:

1. Mathematics knowledge about entering K still a sold, statistically significant predictor of how students do in high school mathematics–This is above and beyond family income, IQ etc.
2. Growth between K and end of 1st grade is an even stronger predictor of high school mathematics performance!
3. Working memory growth also important.

SO WHAT IS WORKING MEMORY?

1. Ability to store abstract information in memory (e.g., principles of commutativity and base ten knowledge)
2. Often measured by task such as reverse digit span: how many numbers an individual can repeat backwards from memory (e.g., 9,7,3,2,5,4)

Predictive Power of Early Mathematics: Achievement (Morgan, Farkas & Wu, 2009)

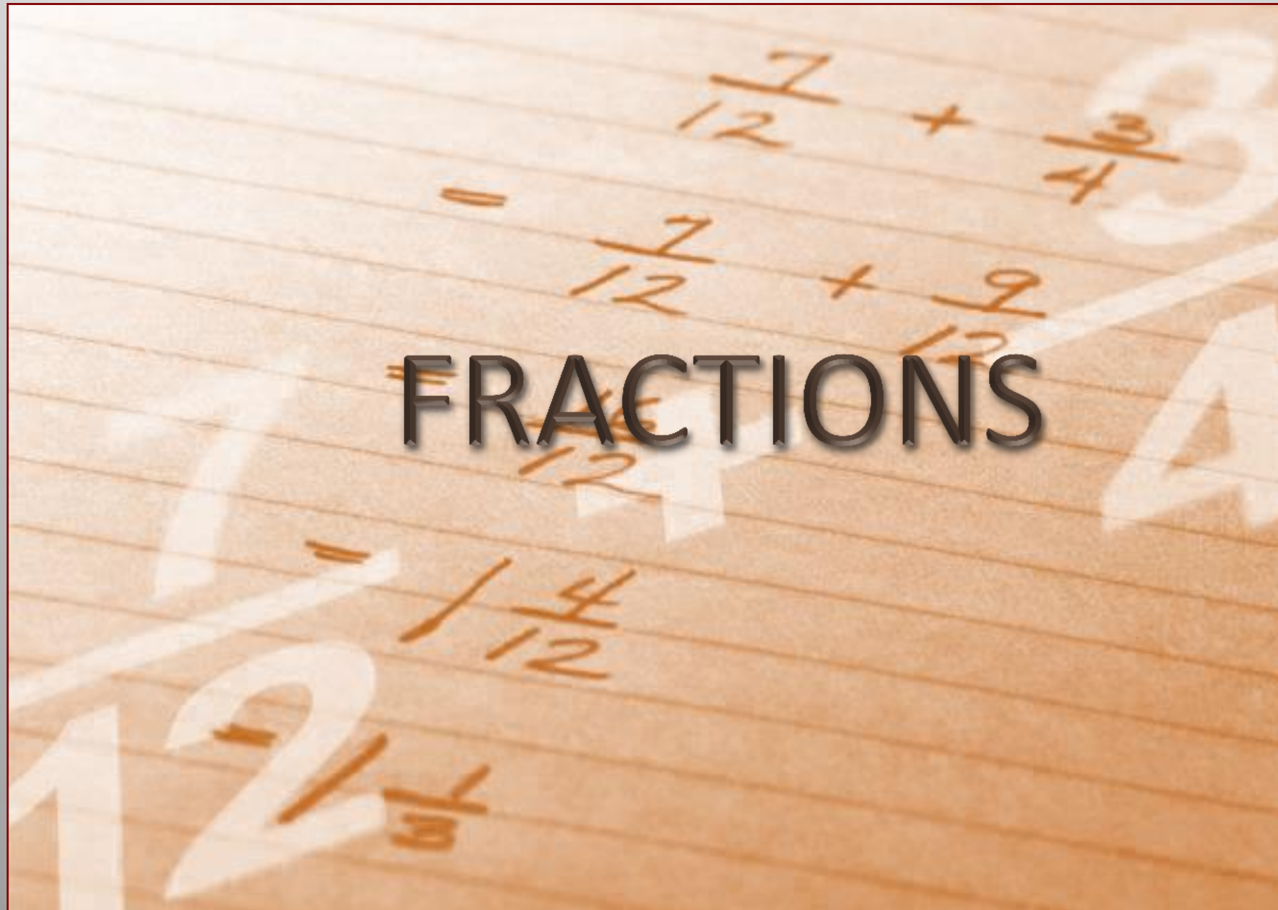
Examined growth from K through 5th grade in nationally representative sample:

1. Low in preK and no growth thru K augurs badly for future success in mathematics (Morgan, Farkas, & Wu, 2009)
2. Attentiveness (in K) also solid predictor

Note: Both working memory and attention are part of what is called executive functions

Study based on data from 1998 so not contemporary.

CASE FOR RTI IN THE INTERMEDIATE GRADES



Instructional Research Group

CASE FOR EMPHASIZING FRACTIONS

1. Fractions knowledge (understanding and procedural but especially understanding of the ideas) is critical for success in algebra (National Mathematics Panel, 2009) mathematically.
2. Fractions predictive work of Siegler/Duncan et al (2015) using large data sets supported this empirically.
3. Specifically, fractions knowledge at end of 5^{th} grade predicted success in 8^{th} grade mathematics and algebra better than any other measure of mathematics knowledge or achievement.

MESSAGE:

DON'T STOP WITH EARLY INTERVENTION IN PRIMARY GRADES

RECOMMENDATIONS

1. Choose not only target grade levels but also key instructional targets.
2. These need to be linked to assessment
3. Recommendations:
   - Number sense/number knowledge in primary grades (involving whole number)
   - Understanding of– and procedural fluency with fractions (including decimals, proportion, word problems) in grades 4-7
   - Intervene so students can succeed in algebra
     - ✓Requires Tier 1 and Tier 2 work, i.e. time allocation

OTHER CRITICAL DECISIONS

1. Use of timed measures
2. Use of general outcome measures (e.g. magnitude comparison) versus curriculum sampling (e.g. from Standards)
3. Use of number line estimation as a potential screening measure based on very recent research

POLL ITEM 5:
TRUE OR FALSE (OR RARELY TRUE)

1. Screening measures can provide useful diagnostic information.
2. The best screening measures in mathematics are timed because fluency is so very important.
3. Systems are available for integration formative assessments with screening and progress monitoring measures.
4. Benchmark administration of screening measures in the spring provides useful information on student progress.

DOES YOUR SCHOOL COLLECT DATA TO MAKE DECISIONS OR TO COLLECT DATA?

Common pitfalls:

1. Focus is on procedure
2. Data collected don't match purpose for collecting data (e.g. collecting diagnostic data on all students)
3. Layering of data sources
4. Different data for different programs (e.g. Title 1)

WHAT IS ASSESSMENT?

Definition:

Assessment is the collection of data to make decisions. (Salvia & Ysseldyke, 1997)

1. To say an assessment is valid, we need to demonstrate Consequentially Validity (Samuel Messick) i.e., we need to show it helps us make socially useful and valid decisions.
2. Assessment is useless if we don't use it to guide our actions.

SCREENING ASSESSMENT

1. Purpose: To determine children who are likely to require additional instructional support (predictive validity).
2. When: Early in the academic year or when new students enter school. May be repeated in the Winter and Spring.
3. Who: All students
4. Relation to instruction: Most valuable when used to identify children who may need further assessment or additional instructional *support*.

WHAT DOES THE PRACTICE GUIDE HAVE TO SAY?

RECOMMENDATION 1

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**

TECHNICAL EVIDENCE

Correlational design studies

1. Greater evidence in the earlier grades

1. Reliability typically included inter-tester, internal consistency, test-retest, and alternate form
   - Most fall between r=.8 to .9

2. Validity primarily focused on criterion related with an emphasis on predictive validity
   - Most fall between r=.5 to .7

3. Measures are beginning to report on sensitivity and specificity

MAJOR RESOURCE

Tool	Area	Classification Accuracy Rating	Generalizability	Reliability	Validity	Disaggregated Reliability, Validity, and Classification Data for Diverse Population	Efficiency			
							Administration	Administration & Scoring Time	Scoring Key	Benchmarks / Norms
AIMSweb	Test of Early Numeracy - Quantity Discrimination	○	Broad	●	●	—	Individual	2 Minutes	Yes	Yes
easyCBM	Mathematics	●	Moderate High	◐	●	●	Individual Group	30 Minutes	Computer Scored	Yes
Formative Assessment System for Teachers (FAST): Adaptive Math	*aMath	●	Moderate Low	●	◐	—	Individual	10-45 Minutes	Yes	Yes
Measures of Academic Progress (MAP) for Primary Grades	Mathematics	●	Moderate High	◐	◐	◐	Individual Group	40 Minutes	Computer Scored	Yes

Legend: ● Convincing evidence ◐ Partially convincing evidence ○ Unconvincing evidence — Data unavailable or inadequate
** Information updated during the 2014 review * Added in the 2014 review

Retrieved from http://www.rti4success.org/resources/tools-charts/screening-tools-chart

Instructional Research Group

CONTENT

Content of Measures

1. Single aspect of number sense (e.g. strategic counting) – most common in earlier grades

2. Or Broad measures incorporating multiple aspects of number
   - Some measures are combination scores from multiple single aspect measures

3. Measures reflecting the Computation & Concepts and Applications objectives for a specific grade level – most common later grades
   - Often referred to as CBM or curriculum sample

FEATURES

1. Short duration measures (1 minute fluency measures)
   - Note many measures that are short duration also used in progress monitoring.

2. Longer duration measures (untimed up to 20-30 minutes) often examine multiple aspects of number sense and number knowledge

1. Most research examines predictive validity from Fall to Spring.

EXAMPLES: SINGLE ASPECT NUMBER SENSE

Example: Magnitude comparison

12 3	4 1	5 11	9 4

Example: Strategic counting

__ 13 14	6 __ 8	3 4 __

NUMBER SENSE SCREENING BATTERY

The items assess counting knowledge and principles number recognition, number comparisons, nonverbal calculation, story problems and number combinations (basic addition and subtractions facts)

The measure is reliable, with a coefficient alpha of .84

Developed by Nancy Jordan and colleagues.

Jordan, N. C., Glutting, J., & Ramineni, C. (2010). The importance of number sense to mathematics achievement in first and third grades. *Learning and individual differences, 20*(2), 82-88.

SAMPLE ITEMS FROM NUMBER SENSE BATTERY

1. What number comes two numbers after 7?

1. Which is bigger: 7 or 9?

1. Which is smaller: 8 or 6?

1. Which is smaller: 5 or 7?

2. Which number is closer to 5: 6 or 2?

THE NUMBER LINE TASK

1. "Where does 87 go?"

2. ____________________________________

3. 0 1000

MAJOR ISSUE TO CONSIDER IN SELECTING SCREENING MEASURES

1. Screening measures meant to be efficient.
2. In 1980s and 1990s, brief timed measures deemed most efficient.
3. With widespread availability of technology, this issue MUST BE REVISITED.

CURRICULUM SAMPLINGS: COMPUTATION OBJECTIVES

1. For students in grades 1–6.
2. Student is presented with 25 computation problems representing the year-long, grade-level math curriculum.
3. Student works for set amount of time (time limit varies for each grade).
4. Teacher grades test after student finishes.

E.g., AIMSweb, Easy CBM, DiBELS Mathematics (in advanced field test phase)

CURRICULUM SAMPLING : CONCEPTS AND APPLICATIONS

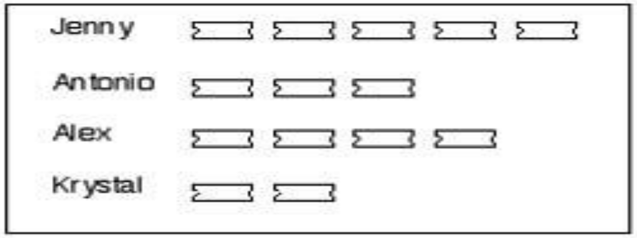
1. For students in grades 2–6.
2. Student is presented with 18–25 Concepts and Applications problems representing the year-long grade-level math curriculum.
3. Student works for set amount of time (time limit varies by grade).
4. Teacher grades test after student finishes.

Name ______________________ Date ______________ Test 1 Page 1

Column A — Applications 1 — Column B

(1)

Tickets Sold



= 1 ticket

How many tickets did Krystal sell?

____

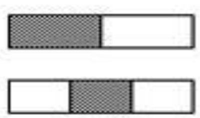
(2)

What number comes after 28?

28 ________

(3)

Write the letter for the shaded part in each blank.



______

______

(A) $\frac{1}{2}$

(B) $\frac{1}{4}$

(C) $\frac{1}{3}$

(4)

Of these numbers,

71 34 39

______ is the smallest.

______ is the largest.

(5)

Write + or - in the blank.

5 ______ 2 = 7

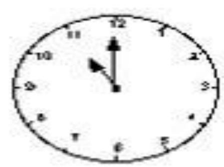
(6)

A B C D E F G H I J K L

Write the ninth letter. ______

(7)

Write the time.



____:____

EASY-CBM: NUMBER AND OPERATIONS

Previous | Next

A sack has 4 apples and 7 oranges.
You pick out one fruit.

What is the chance it is an apple?

- $\frac{4}{11}$
- $\frac{7}{11}$
- $\frac{4}{7}$
- I don't know

Next

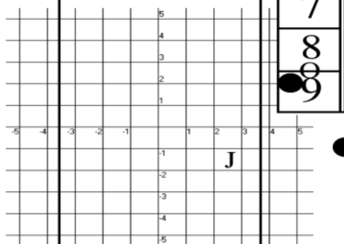
SECONDARY EXAMPLE: ALGEBRA FOUNDATIONS

1. 42 items (50 points); 5 minutes
2. Problems represent five core concepts/skills essential to conceptual understanding in algebra
   - Writing and evaluating variables and expressions
   - Computing expression (integers, exponents, and order of operations)
   - Graphing expressions and linear equations
   - Solving 1-step equations and simplifying expressions
   - Identifying and extending patterns in data tables

ALGEBRA FOUNDATIONS (B)

Find the ordered pair for each point:

J(,   )
O(,   )



Fill in the empty box:

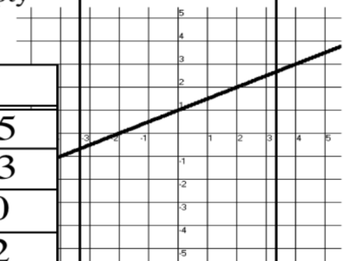
s	$3s$
6	18
7	21
8	
9	27

Fill in the empty box:

n	$4n + 7$
-1	3
-2	
-3	-5
-4	-9

Fill in the empty box:

b	
-2	-5
0	-3
3	0
5	2



What is the slope?

What is the y-intercept?

If $y > 9$, two possible values for y are ______ and ______

Evaluate: $9 \bullet 4 - 6$

Simplify: $7f + (2f + f)$

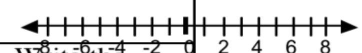
Solve: $n + 3 = 8$
$n =$

Evaluate $4b + 2$ when $b = 1$ __________

Write the expression for this phrase: *6 less than a number*

Evaluate: $(-2) \bullet (-4)$

Graph the expression $m > -5$



Write a word phrase for this expression: $n + 9$

Evaluate: $4 + (9 \div 3) - 2^2$

Evaluate: $(-2)^3$

Write the expression for this phrase: *9 multiplied*

Evaluate $2x + 4y$ when $x = 2$ and $y = -3$

Write a word phrase for this expression: $10b - 7$

Evaluate $8g - 4$ when

$g = 2$ __________

$g = -2$ __________

Simplify: $6 - 2(b - 4)$

Instructional Research Group

SUGGESTIONS

Have a building level team select measures based on critical criteria such as reliability, validity and efficiency.

- Team should have measurement expertise (e.g. school psychologist) and mathematics (e.g. math specialist)
- Set up a screening to occur twice a year (Fall and Winter)
- Be aware of students who fall near the cut scores

SUGGESTIONS

In grades 4-8, use screening measures in combination with state testing data.

1. Use state testing data from the previous year as the first cut in a screening system.
2. Can then use a screening measure with a reduced pool of students or a more diagnostic measure linked to the intervention program for a second cut.

Note: This is rarely done. Reading research suggests it could be more accurate and once a formula is worked out, easy to implement.

ROADBLOCKS

1. Resistance may be encountered in allocating time resources to the collection of screening data.

2. Suggested Approach: Use data collection SWAT teams to streamline the data collection and analysis process.

ROADBLOCKS

1. Questions may arise about testing students who are "doing fine."

2. <u>Suggested Approach:</u> Screening all students allows the school or district to evaluate the impact of instructional approaches
   - Screening all students creates a distribution of performance allowing the identification of at-risk students
   - You may also wish to choose your battles

ROADBLOCKS

1. Screening may identify large numbers of students who need support beyond the current resources of the school or district.

2. Suggested Approach: Schools and districts should
   - Allocate resources to the students with the most risk and at critical grade levels
   - Implement school wide interventions to all students in areas of school wide low performance (e.g. Fraction magnitudes)
   - Monitor progress of students just above and below benchmaker

SPECIFICITY

1. Set your cut score too high and
   - All kids that need help are identified) but poor specificity (lots of kids who don' t need help are identified)
2. Set your cut score too low and
   - You have good specificity (most kids who don't need help will not be identified as at-risk) but you may miss many kids who do need help

SPECIFICITY REFERS TO FALSE POSITIVE

(I.E., WASTED RESOURCES: ROWS 1 AND 2)

Example	Hit everyone who needs help	Specificity
CBMCBM Mathematics (30 min, computer)	0.93 (in one state)	0.65
AIMSweb Mathematics Concepts and Applications (18 min, group administered, computer scored)	0.80	0.68
AIMSweb Quantity Discrimination (2 minutes, individual administration) K version	0.50	0.92
Note: Predictive Validity Always Weakest in Kindergarten		
Formative Assessment System for Teachers: (20-30 min per student on computer	0.77	0 .80

WHAT IS COMMON PROBLEM

1. Cut scores set so low.
2. Early belief that no one should fail.
3. Result in lost resources since services given to students who required nothing.
4. Often prevented services in reading from going to upper grades.
5. Now: test developers sometimes more alert to this issue of balance

HOW TO START AND NEXT STEPS

As you get started, consider:

1. Focus on one grade or grade bands
   - Long term trajectories suggest end of K critical benchmark (remember the research of Duncan and Morgan on growth during K)
2. Seriously consider use of computer managed and computer administered instruction
3. Consider adaptive testing

ANOTHER POSSIBLE RESOURCE

TABLE 3

Diagnostic Utility Statistics and Receiver Operating Characteristics (ROC)

Study	Screening Measure	Grade Screened	n	Outcome Measure	MLD or At Risk	Grade of Outcome	Sensitivity	Specificity	Area Under Curve	Duration of the Prediction
Clarke, Nese, Alonzo, Smith, Tindal, Kame'enui, & Baker (2011)[a]	easyCBM: Standardized computer-administered measure with 45 items aligned to the National Council of Teachers in Mathematics Focal Point standards in mathematics.	1	145	< 25th percentile on the TerraNova 3	At risk Traditional	End of first grade	.83	.74	.83	1 year
				< 40th percentile on the TerraNova 3	At risk Liberal		.73	.73	.78	
Jordan, Glutting, Ramineni, & Watkins (2010)	Number Sense Brief: 33 items assessing counting, one-to-one correspondence, number recognition, nonverbal addition and subtraction.	K	204	Not meeting standards on the Delaware Student Testing in Mathematics (mix of concepts, procedures, and problem solving)	Low Achieving	End of third grade	.73	.85	.80	4 years

Table from Gersten et al., 2012.

Instructional Research Group

DECISIONS, DECISIONS, DECISIONS (REVISITED)

1. What grade levels should we begin at?
   - Same as reading? Early intervention in primary grades?
   - How does algebra readiness and double dose algebra and double dose mathematics in mid school fit in?
2. Do we have a general outcome measure as strong as oral reading fluency?
3. Which are important criteria to look at in tech reports for screeners: predictive validity, concurrent validity, anything else?

SESSIONS 3 & 4

Webinar Title	Date/Time	Agenda
Effective Instructional Practices in Mathematics for Tier 2 and Tier 3 Instruction	Tuesday, December 2nd 4:00-5:15 pm EST	• What to Teach • Nature of Instruction: Controversies and what we know about the nature of explicit instruction • Intervention Materials/Resources • Roadblocks & Suggestions
Progress Monitoring and its Use in intensive intervention	Tuesday, December 9th 4:00-5:15 pm EST	

Instructional Research Group

CITATATIONS

American Institute for Research. (n.d.). *Center on response for intervention*. Retrieved from http://www.rti4success.org/resources/tools-charts/screening-tools-chart

Clarke, B., Nese, J. F., Alonzo, J., Smith, J. L. M., Tindal, G., Kame'enui, E. J., & Baker, S. K. (2011). Classification accuracy of easyCBM first-grade mathematics measures: Findings and implications for the field. *Assessment for Effective Intervention*, *36*(4), 243–255.

Gersten, R., Beckmann, S., Clarke, B., Foegen, A., Marsh, L., Star, J. R., & Witzel, B. (2009). *Assisting students struggling with mathematics: Response to Intervention (RtI) for elementary and middle schools (NCEE 2009-4060)*. Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://ies.ed.gov/ncee/wwc/pdf/practice_guides/rti_math_pg_042109.pdf

Jordan, N. C., Glutting, J., & Ramineni, C. (2010). The importance of number sense to mathematics achievement in first and third grades. *Learning and individual differences, 20*(2), 82-88.

Jordan, N. C., Glutting, J., Ramineni, C., & Watkins, M. W. (2010). Validating a number sense screening tool for use in kindergarten and first grade: Prediction of mathematics proficiency in third grade. *School Psychology Review*, *39*(2), 181-195.

QUESTIONS?

THANK YOU!

AND HAVE A GREAT THANKSGIVING &
BEST WISHES TO FOLKS IN BUFFALO
AREA DURING THIS DIFFICULT TIME