Screening in Mathematics: Building Effective Systems

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Successful Learning Conference
Sydney, Australia
June 28, 2016

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

Copies are available on the IES website:
http://ies.ed.gov/ncee
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

Challenges for the panel:
- State of math research
- Distinguishing between tiers of support

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

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**Structure of the Practice Guide**

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

Screening Assessment

• **Purpose**: To determine children who are likely to require additional instructional support (predictive validity)

• **When**: Early in the academic year or when new students enter school. May be repeated in the Winter and Spring

• **Who**: All students

• **Relation to instruction**: Most valuable when used to identify children who may need further assessment or additional instructional support
Technical Evidence

• Correlational design studies
  – Greater evidence in the earlier grades
  – Reliability typically included inter-tester, internal consistency, test-retest, and alternate form
    ♦ Most fall between r=.8 to .9
  – Validity primarily focused on criterion related with an emphasis on predictive validity
    ♦ Most fall between r=.5 to .7
  – Measures are beginning to report on sensitivity and specificity

Content (1)

• Content of Measures
  – Single aspect of number sense (e.g., strategic counting) – most common in earlier grades
  – Or broad measures incorporating multiple aspects of number
    ♦ Some measures are combination scores from multiple single aspect measures
  – Measures reflecting the computation and concepts, and applications objectives for a specific grade level – most common in later grades
    ♦ Often referred to as CBM or General Outcome
Content (2)

- Promising measures include
  - Word problems
  - Pre-algebra and algebra skills
  - Based on state standards or NCTM/NMAP benchmarks

Features

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

- Longer duration measures (untimed up to 20 minutes) often examine multiple aspects of number sense
  - Issue of purpose is critical to examine

- 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 | __ |

Example – Single aspect of number sense

- Base 10 understanding – addition and subtraction problems that require cross 10
  - 7 + 5
  - 15 - 9
Example: Multiple aspects number sense

• Number Knowledge Test
  – Level 1
    ♦ If you had 4 chocolates and someone gave you 3 more, how many chocolates would you have?
    ♦ Which is bigger: 5 or 4?
  – Level 3
    ♦ What number comes 9 after 999?
    ♦ Which difference is smaller: the difference between 48 and 36 or the difference between 84 and 73?

Examples: 2nd grade and above

• Number combinations
• Word problems
• Grade-level computation objectives
• Grade-level concepts and applications
• Measures tied to CCSS; NMAP; Focal Points
General Outcome: Computation and Concepts, and Application Objectives

• For students in grades 1–6

• Student is presented with 25 computation or concepts and applications problems representing the year-long, grade-level math curriculum

• Student works for set amount of time (time limit varies for each grade)

• Teacher grades test after student finishes
Example: Reflecting critical math content

- easy-CBM
- Items created according to NCTM Focal Points for grade level
- 48 items for screening (16 per focal point)
- Ongoing research (not reviewed in practice guide)
**easy-CBM: Number and Operations**

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

**Middle School**

- **Algebra measures**
  - Designed by Foegen and colleagues assess pre-algebra and basic algebra skills. Administered and scored similar to Math-CBM

- **Math CBM Computation and Concepts and Applications**
  - Concepts and Applications showed greater validity in 6th, 7th, and 8th grade
Basic Skills (in Algebra)

- 60 items; 5 minutes
- Problems include:
  - Solving basic fact equations;
  - Applying the distributive property;
  - Working with integers;
  - Combining like terms;
  - Simplifying expressions;
  - Applying proportional reasoning
- Scoring: # of problems correct

Basic Pre-algebra Skills

<table>
<thead>
<tr>
<th>Solve: 9 + a = 15</th>
<th>Solve: 40 + r = g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solve: 12 + (a + 3)</td>
<td>g =</td>
</tr>
<tr>
<td>Simplify: 2x + 4 + 3x + 5</td>
<td>Simplify: 7a/4 + 2 + 7d</td>
</tr>
<tr>
<td>Solve: 12 - a = 4</td>
<td>Solve: 3(0 - a) + 3</td>
</tr>
<tr>
<td>Simplify: 4(3 + a) + 7</td>
<td>Simplify: 3(0 - a) + 3</td>
</tr>
<tr>
<td>Simplify: 9 + b + 6</td>
<td>Simplify: 3(0 - a) + 3</td>
</tr>
<tr>
<td>Solve: 12 + 2b</td>
<td>Solve: a + 5 = 30</td>
</tr>
<tr>
<td>Simplify: 0 + 6 + 2b</td>
<td>Simplify: 3(0 - a) + 3</td>
</tr>
<tr>
<td>Solve: x + 4 = 7</td>
<td>Solve: 1 foot = 12 inches</td>
</tr>
<tr>
<td>Simplify: 4 + b + 5</td>
<td>Simplify: 3(0 - a) + 3</td>
</tr>
<tr>
<td>Solve: 63 + c = 9</td>
<td>Solve: 1 foot = 12 inches</td>
</tr>
<tr>
<td>Simplify: 2x + 1 + 4 + 5x</td>
<td>Simplify: 3(0 - a) + 3</td>
</tr>
<tr>
<td>Solve: 30 + 2</td>
<td>Simplify: 2 + 3(0 - a)</td>
</tr>
<tr>
<td>Simplify: 6x + (a + 4) + 2</td>
<td>Simplify: 3(0 - a) + 3</td>
</tr>
<tr>
<td>Simplify: 30 + 2</td>
<td>Simplify: 2 + 3(0 - a)</td>
</tr>
<tr>
<td>Solve: 6x + (a + 4) + 2</td>
<td>Simplify: 3(0 - a) + 3</td>
</tr>
<tr>
<td>Simplify: 30 + 2</td>
<td>Simplify: 2 + 3(0 - a)</td>
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</table>
Suggestions (1)

- 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 (2)

- Select screening measures based on the content they cover, with an emphasis on critical instructional objectives for each grade level
  - Lower elementary: Whole Number
  - Upper elementary: Rational Number
  - Across grades: Computational Fluency (hallmark of mathematics learning disabilities)
Suggestions (3)

- In grades 4-8, use screening measures in combination with state testing data
  - Use state testing data from the previous year as the first cut in a screening system
  - 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

Suggestions (4)

- Use the same screening tool across a district to enable analyzing results across schools
  - Districts may use results to determine the effectiveness of district initiatives
  - May also be used to determine systematic areas of weakness and provide support in that area (e.g., fractions)
Roadblocks (1)

- Resistance may be encountered in allocating time and resources to the collection of screening data

- **Suggested Approach:** Use data collection teams to streamline the data collection and analysis process

Roadblocks (2)

- Questions may arise about testing students who are "doing fine"

- **Suggested Approach:** 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
Roadblocks (3)

- Screening may identify students as at-risk who do not need services and miss students who do

- **Suggested Approach:** Schools should frequently examine the sensitivity and specificity of screening measures to ensure a proper balance and accurate decisions about student risk status.

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**Sensitivity and Specificity**

<table>
<thead>
<tr>
<th>Students at-risk</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students identified as at-risk</td>
<td>YES</td>
<td>True positive (A)</td>
</tr>
<tr>
<td>NO</td>
<td>False negative (C)</td>
<td>True negative (D)</td>
</tr>
</tbody>
</table>

Sensitivity: Number of students correctly identified as at-risk or \( A/(A+C) \)

Specificity: Number of students correctly identified as not at risk or \( D/(D+B) \)
Sensitivity and Specificity

• Cut score is set too high:
  – You have good sensitivity (all kids that need help are identified), but poor specificity (lots of kids who don’t need help are identified)

• Cut score is set too low:
  – You have good specificity (most kids who don’t need help will not be identified as at-risk), but poor sensitivity (you may miss many kids who do need help)

An example - easyCBM

• Sensitivity at least .90 - Johnson, Jenkins, Petscher, & Catts (2009)
  • Favors higher cut scores

• Sensitivity and Specificity at least .70 - Silberglitt & Hintze (2005)
  • Favors lower cut scores
Example cont.

• Winter 25th%ile criteria

• Johnson procedure = cut of 34
  • 70 students identified as at-risk
  • 22 truly at-risk
  • 48 false positives (provided non needed services)
  • 1 false negative (not provided needed services)

Example cont.

• Winter 25th%ile criteria

• Silberglitt procedure = cut score 30
  • 41 students identified at-risk
  • 18 truly at-risk
  • 23 false positives
  • 5 false negatives
Example cont.

• To identify 4 additional at-risk students; you over identify an additional 29 students
  – If small group instruction provided (3-5 students per group) an additional 6-10 groups are needed.
  – Impact on limited school resources

• Schools rarely discuss what “at-risk” means

Roadblocks (4)

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

• Suggested Approach: Schools and districts should
  – Allocate resources to the students with the most risk and at critical grade levels; and
  – Implement school-wide interventions to all students in areas of school-wide low performance (e.g., fractions)
Activity

• Discuss with your team the screening process in your school including:
  – Measures utilized
  – Efficiency of measures
  – And Roadblocks encountered – solutions enacted or possible

How to start and next steps

• Focus on one grade or grade band

• Because there is accumulating evidence that math trajectories are established early and difficult to alter, K/1 may be a smart and strategic option
  – Greater comfort with whole number content and instruction
  – Greater array of researched and research-based instructional programs