Algebra Progress Monitoring: Learn to Put Research Results Into Practice

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Council for Exceptional Children
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Introductions

- About me
  - Anne
- About you
  - Teachers (special education/general education/algebra)
  - Administrators/School Psychologists/Consultants
  - Levels of algebra
  - Familiarity with Curriculum-Based Measurement/Progress Monitoring
Goals for Today’s Session

- Review/expand understanding of progress monitoring
- Understand four alternative algebra progress monitoring measures
- Understand the research evidence for the measures
- Learn administration and scoring for one of the measures
- Obtain resources for getting more information

Project AAIMS

- AAIMS: Algebra Assessment and Instruction: Meeting Standards
  [www.ci.hs.iastate.edu/aaims](http://www.ci.hs.iastate.edu/aaims)
- Descriptive studies of algebra instruction for students with and without disabilities
- Development and documentation of validity evidence for algebra progress monitoring measures
Progress Monitoring: General Concepts

- Terminology: CBM, GOM, PM
- Approaches to assessment (NCTM)
- Important concepts
  - Indicators
  - Efficiency
  - Frequent administration
  - Technical adequacy
  - Evaluating student progress: level and slope (graph examples)

Graph for Progress Monitoring: Special Education
Graph for Progress Monitoring-General Education

Approaches to Progress Monitoring (CBM) (Fuchs, 2004)

- **Curriculum sampling**
  - Goal is to reflect the content of instruction (annual curriculum)
  - Example: mixed computation math probes
  - Development requires creating proportional representations of the annual curriculum

- **Robust indicators**
  - Goal is to identify tasks which serve as robust indicators of general proficiency in a content area
  - Global behaviors that encompass many skills taught in the annual curriculum or predictive of proficiency in annual curriculum
  - Examples: oral reading fluency, writing samples, estimation
  - Development requires exploring correlations with established indicators of proficiency
Design Criteria

- Brief measures that can be administered repeatedly
- “Frequent” administration
- Multiple forms of constant difficulty
- Timed administration using standardized procedures
- Efficient scoring using counts or points earned, rather than percent correct
- Acceptable technical adequacy levels

Developing Algebra Measures

- Design criteria
- 5 measures
- Research “horse race”
- Iterative research process (3 years)
- “Winners”
Basic Skills (in Algebra)

- 60 items; 5 minutes
- Focus is on skills for which some level of automaticity is desirable
- Problems include:
  - Solving basic fact equations;
  - Applying the distributive property;
  - Working with integers;
  - Combining like terms;
  - Applying proportional reasoning
- Scoring: # of problems correct
Algebra Foundations

- 42 items (50 points); 5 minutes
- Problems represent five core concepts/skills essential to conceptual understanding in algebra
  - Writing and evaluating variables and expressions
  - Computing expressions (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
- Scoring: # of problems correct
Translations

- 43 items; 7 minutes
- Problems are modeled on an NSF-funded middle school curriculum (*Connected Math Concepts*) in which algebra is taught in a manner consistent with the NCTM standards
- Task requires students to match varying representations for relationships between two variables: equations, data tables, graphs, story scenarios
- Scoring: Number correct - number incorrect
### Content Analysis

- **16 items; 7 minutes**
- Multiple choice format with a penalty for guessing
- Problems are sampled from core concepts in the initial 2/3 of a traditional Algebra 1 course (through systems of linear equations and inequalities)
- Students encouraged to show work to obtain partial credit
- Scoring: Up to 3 points per problem, -1 pt. penalty for circling an incorrect answer without showing any work (guessing); scoring rubric

<table>
<thead>
<tr>
<th>Solve: $3x + 4 = 19$</th>
<th>Evaluate $e^x - b + 2$ when $a = 4$ and $b = 6$</th>
<th>Which line on the graph is $y = 2x + 4$?</th>
<th>Simplify: $3(m + 2) + 2(m - 1)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) $x = 5$</td>
<td>a) 1</td>
<td>a) Line A</td>
<td>a) 5m + 4</td>
</tr>
<tr>
<td>b) $x = 22$</td>
<td>b) 5</td>
<td>b) Line B</td>
<td>b) 5m + 1</td>
</tr>
<tr>
<td>c) $x = 15$</td>
<td>c) 10</td>
<td>c) Line C</td>
<td>c) $6m + 8$</td>
</tr>
<tr>
<td>d) $x = 5$</td>
<td>d) 13</td>
<td>d) Line D</td>
<td>d) $6m - 8$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluate the expression: $4^2$</th>
<th>Solve the linear system: $x - y = 4$ and $x + 2y = 19$</th>
<th>This graph shows the solution for which equation?</th>
<th>Write the equation in slope-intercept form if $m = \frac{1}{2}$ and $b = 3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) $-16$</td>
<td>a) $(-1, -5)$</td>
<td>a) $x &gt; 3$</td>
<td>a) $y = 2x + 3$</td>
</tr>
<tr>
<td>b) $\frac{1}{8}$</td>
<td>b) $(8, 1)$</td>
<td>b) $2x - 6$</td>
<td>b) $y = 3x + \frac{1}{2}$</td>
</tr>
<tr>
<td>c) $-8$</td>
<td>c) $(2, 19)$</td>
<td>c) $-3x &gt; 9$</td>
<td>c) $x = \frac{1}{2}y - 3$</td>
</tr>
<tr>
<td>d) $\frac{1}{8}$</td>
<td>d) $(9, 5)$</td>
<td>d) $3x &gt; 9$</td>
<td>d) $y = \frac{1}{2}x + 3$</td>
</tr>
</tbody>
</table>
Research Overview

Project AAIMS Research Process

- Iterative studies to refine and revise measures
- Input from teachers
- Data on the reliability and validity of the measures
- WHY DOES IT MATTER???
Understanding Correlation Coefficients

- Measure of relationship between two sets of data
- Important for considering the reliability and validity of the algebra measures
- Reliability: test-retest, alternate form
- Criterion validity: concurrent and predictive
- Evaluating the magnitude of correlation coefficients

Desirable Characteristics of Screening Measures

- Reliable across administrations (test-retest) and equivalent across forms (alternate form)
- Correlated with performance on other indicators of proficiency
- Predictive of future performance levels
- Summary of previous studies
## Test-Retest Reliability Evidence for Algebra Measures

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Basic Skills</th>
<th>Algebra Foundations</th>
<th>Content Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>F 05</td>
<td>135</td>
<td>.75 - .89</td>
<td>--</td>
<td>.75 - .77</td>
</tr>
<tr>
<td>Sp 06</td>
<td>105</td>
<td>.79 - .86</td>
<td>--</td>
<td>.73 - .78</td>
</tr>
<tr>
<td>05-06</td>
<td>86</td>
<td>--</td>
<td>.80 - .91</td>
<td>.64 - .88</td>
</tr>
<tr>
<td>F 06</td>
<td>168</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Sp 07</td>
<td>164</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Note. All correlations significant at $p < .05$. Correlations based on administrations of single probes.

## Alternate Form Reliability Evidence for Algebra Measures

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<th>Content Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>F 05</td>
<td>135</td>
<td>.82 - .91</td>
<td>--</td>
<td>.61 - .85</td>
</tr>
<tr>
<td>Sp 06</td>
<td>105</td>
<td>.81 - .89</td>
<td>--</td>
<td>.68 - .83</td>
</tr>
<tr>
<td>05-06</td>
<td>86</td>
<td>--</td>
<td>.72 - .91</td>
<td>.48 - .91</td>
</tr>
<tr>
<td>F 06</td>
<td>168</td>
<td>.65 - .93†</td>
<td>--</td>
<td>.51 - .85</td>
</tr>
<tr>
<td>Sp 07</td>
<td>164</td>
<td>.49 - .83†</td>
<td>--</td>
<td>.62 - .94</td>
</tr>
</tbody>
</table>

Note. All correlations significant at $p < .05$. Correlations based on administrations of single probes.

†All data from Algebra 1A/1B classes.
### Concurrent Criterion Validity Evidence for Algebra Measures

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<th>Content Analysis</th>
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</thead>
<tbody>
<tr>
<td>F 05</td>
<td>N=135</td>
<td>.47</td>
<td>.44</td>
</tr>
<tr>
<td>Sp 06</td>
<td>N=105</td>
<td>.58</td>
<td>.45</td>
</tr>
<tr>
<td>05-06</td>
<td>N=86</td>
<td>--</td>
<td>.72</td>
</tr>
<tr>
<td>F 06</td>
<td>N=168</td>
<td>.58†</td>
<td>.55</td>
</tr>
<tr>
<td>Sp 07</td>
<td>N=164</td>
<td>ns†</td>
<td>.57 / .59‡</td>
</tr>
</tbody>
</table>

Note. All correlations significant at $p < .05$. Correlations above dashed line are with teacher ratings of proficiency. Fall 06 and Spring 07 correlations based on algebra grade; ‡ based on semester exams. † All data from Algebra 1A/1B classes.

### Predictive Validity Evidence for Algebra Measures

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<th>Content Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>F 05</td>
<td>N=135</td>
<td>.33</td>
<td>.41</td>
</tr>
<tr>
<td>Sp 06</td>
<td>N=105</td>
<td>.47</td>
<td>.37</td>
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<tr>
<td>05-06</td>
<td>N=86</td>
<td>--</td>
<td>.51</td>
</tr>
<tr>
<td>F 06</td>
<td>N=168</td>
<td>ns†</td>
<td>.24</td>
</tr>
<tr>
<td>Sp 07</td>
<td>N=164</td>
<td>ns†</td>
<td>.48 / .51‡</td>
</tr>
</tbody>
</table>

Note. All correlations significant at $p < .05$. Correlations with final course grade in algebra; ‡‡ correlation with semester exams. † All data from Algebra 1A/1B classes.
Additional Characteristics for Progress Monitoring

- Reliable across time and forms
- Correlated to current and future performance
- Sensitive to changes in performance over time
- Sensitive to the effects of an intervention

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<tbody>
<tr>
<td>F 05</td>
<td>.51</td>
<td>--</td>
<td>.61</td>
</tr>
<tr>
<td>Sp 06</td>
<td>.42</td>
<td>--</td>
<td>1.54</td>
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<tr>
<td>05-06</td>
<td>--</td>
<td>.39</td>
<td>.54</td>
</tr>
<tr>
<td>F 06</td>
<td>.36†</td>
<td>--</td>
<td>.65</td>
</tr>
<tr>
<td>Sp 07</td>
<td>.25†</td>
<td>--</td>
<td>1.04</td>
</tr>
</tbody>
</table>

†Data drawn from Algebra 1A/1B classes only.
Administration And Scoring

Administration Concerns

- Standardized conditions
  - Scripts
  - Exact timing
- More elaborate directions first time through
- Sample script
  - Explain CBM concepts, especially for general education students
- Sample pages
- Discard data from first administration (learning curve issues)
Scoring Basic Skills

- Scoring rules
  - Mark correct items with C
  - Accept mathematically equivalent answers
  - Ignore skipped problems
  - TOTAL SCORE = # of problems correct

- Score Anna’s probe
  - Anna’s paper
  - Key
  - Comparing results

Resources for More Information
Algebra Progress Monitoring

Resources

- Project AAIMS Web site
  - www.ci.hs.iastate.edu/aaims
- Technical reports
- Project information
- Algebra resources
- Contact us for information on training
  - aaims@iastate.edu

Questions and Discussion

Thank You!

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