

Progress Monitoring for Elementary Mathematics

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Presented at the Center on Instruction Mathematics Summit November 13, 2006



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Progress Monitoring for Elementary Mathematics

Pamela M. Stecker, PhD Clemson University Presented at the Center on Instruction Meeting: Mathematics Strand Annapolis, Maryland November 13, 2006

Progress Monitoring in Mathematics

Center on Instruction Mathematics Strand

Overview of the Presentation

- Describe progress monitoring
- Explain common techniques that are often mistaken for progress monitoring
- Discuss features of progress monitoring in elementary grades
- Review brief history of progress monitoring measures in mathematics
- Provide overview of commonly used computer and Web-based progress monitoring systems

General Definition of Student Progress Monitoring

- The process of collecting and evaluating data to make decisions about the adequacy of student progress toward a goal
- Evaluation of student rate of change (slope) as compared to the slope of anticipated progress

General Definition of Student Progress Monitoring

• Requires:

- Technically sound measures
- Multiple forms of the same measure
- Assessment systems that are sensitive to student growth
- Standardized administration procedures
- Frequent measurement (occurs at least monthly)

Display of Progress Monitoring Data



Common Assessment Approaches That ARE NOT Progress Monitoring Common Assessment Approaches That Are Not Progress Monitoring

- Curriculum-Embedded Assessment
- Benchmarking

Curriculum-Embedded Assessment

- Helps teachers identify whether students learned a particular concept/skill or what was taught in the chapter or unit
- Tracks mastery of short-term instructional objectives
- Sampling of items is representative of a limited set of problems, concepts, or skills
- Assessment materials mirror instructional materials

Teachers' Use of Curriculum-Embedded Assessments

- Teacher-created
 - Teacher develops assessments that focus on a particular concept or skill
 - Multiple forms are created
 - Teacher gives assessment until student has learned that skill or concept
 - Often used with students who are struggling with a particular concepts or skills

Teachers' Use of Curriculum-Embedded Assessments

- Publisher-developed
 - Teacher gives chapter and unit exams included with the textbook series to evaluate students' learning
 - Typically used with the entire class

An Example from an Elementary Tutoring Context

- Mr. Jones is tutoring a fourth grade student who struggles with math computation skills
- He examines the sequence of skills for fourth grade computation and develops a criterion-referenced test for each skill within the sequence

An Example from an Elementary Tutoring Context

- He provides instruction and gives alternate forms of the criterionreferenced test until the skill is learned
- Then he moves to the next skill in the sequence

Hypothetical Fourth-Grade Math Computation Curriculum

- 1. Multidigit addition with regrouping
- 2. Multidigit subtraction with regrouping
- 3. Multiplication facts, factors to 9
- 4. Multiply 2-digit numbers by a 1-digit number
- 5. Multiply 2-digit numbers by a 2-digit number
- 6. Division facts, divisors to 9
- 7. Divide 2-digit numbers by a 1-digit number
- 8. Divide 3-digit numbers by a 1-digit number
- 9. Add/subtract simple fractions, like denominators
- 10. Add/subtract whole number and mixed number

Multidigit Addition Test

Name: Date								
		Adding						
36521	53429	84525	67842	57321				
+ <u>63758</u>	+ <u>63421</u>	+ <u>75632</u>	+ <u>53937</u>	+ <u>46391</u>				
56382	36422	34824	32415	45321				
+ <u>94742</u>	+ <u>57529</u>	+ <u>69426</u>	+ <u>85439</u>	+ <u>86274</u>				

Mastery of Multidigit Addition



Hypothetical Fourth-Grade Math Computation Curriculum

- 1. Multidigit addition with regrouping
- 2. Multidigit subtraction with regrouping
- 3. Multiplication facts, factors to 9
- 4. Multiply 2-digit numbers by a 1-digit number
- 5. Multiply 2-digit numbers by a 2-digit number
- 6. Division facts, divisors to 9
- 7. Divide 2-digit numbers by a 1-digit number
- 8. Divide 3-digit numbers by a 1-digit number
- 9. Add/subtract simple fractions, like denominators
- 10. Add/subtract whole number and mixed number

Multidigit Subtraction Test

Name:	ame: Date							
		Subtractir	ng					
6521	5429	8455	6782	7321				
<u>- 375</u>	<u>- 634</u>	<u>- 756</u>	<u>- 937</u>	- <u>391</u>				
5682	6422	3484	2415	4321				
<u>- 942</u>	- 529	- 426	- 854	<u>- 874</u>				

Mastery of Multidigit Addition and Subtraction



Adapted from NCSPM

Potential Difficulties with Curriculum-Embedded Assessment

- Sequence of concepts/skills or chapters is logical, not empirical.
- Difficulty of tasks may vary from test to test.
- Performance on limited-skill assessments can be misleading.

Potential Difficulties with Curriculum-Embedded Assessment

- Assessments do not reflect maintenance or generalization of the concepts/skills.
- Assessments typically are designed by teachers or sold with textbooks with unknown reliability and validity.
- Number of concepts/skills or chapters passed does not relate well to performance on high-stakes tests.

Benchmarking

- The process of collecting and evaluating data to determine if students will meet terminal goal (often thought of as end-ofthe-year performance goals)
- Benchmark goal is typically associated with proficiency on state standards in relation to AYP categories
- Uses:
 - Screening: Identify students who may be at risk for failure

Features of Benchmarking

- Features of the Assessment System:
 - Aligned with the content and cognitive complexity of the benchmark goal (typically the state standards)
 - Samples a range of skills and knowledge in similar proportions as the benchmark goal OR is a valid predictor of benchmark goal
- Data are collected and evaluated typically three or four times per year
- All students are assessed

Display of Benchmarking Data



Potential Difficulties With Benchmarking

- Static performance of student at one point in time
- Comparison against a criterion
- Unable to use slope to determine whether student is progressing at a typical rate
- Unable to target student who may meet benchmark but may not be growing adequately

Specific Features of Mathematics Progress Monitoring

Progress Monitoring

 The process of collecting and evaluating data to determine whether students are making progress toward instructional goals and/or responding to instructional interventions

Progress Monitoring

- Uses:
 - Estimate rates of student improvement
 - Describe student response to instructional program
 - Inform teachers' instructional decision making
 - Aid teachers in targeting areas/skills that need remediation
 - Help teachers build potentially more effective programs for particular students

Research Supports the Use of Progress Monitoring

- Progress monitoring data produce accurate, meaningful information about students' academic levels and their rates of improvement
- Progress monitoring data are sensitive to student improvement

Research Supports the Use of Progress Monitoring

- Performance on progress monitoring measures corresponds well to performance on high-stakes tests
- When teachers use progress monitoring data to inform their instructional decisions, students make greater learning gains

Process of Progress Monitoring

- Progress monitoring is a data-based instructional decision making tool
- Steps for using data:
 - Gather baseline performance data
 - Set instructional goals
 - Provide targeted instruction
 - Monitor progress toward goal
 - Adjust goal upward or modify instruction as needed



Donald's teacher has implemented four different instructional programs across the year. Using progress monitoring data to test data to test effectiveness of adaptations to class instruction

Features of Progress Monitoring Systems

- Data are collected and evaluated frequently
 - Schedule is determined by goal and current level of student performance
 - Typically ranges from 2 times per week to monthly

Features of Progress Monitoring Systems

- Teachers may choose to monitor progress of all students in class
- Typically, students at-risk of failure are assessed until they reach proficiency
- Data-based decision rules are applied to graphed data to determine when goals should be raised or instruction should be modified

Features of Progress Monitoring Measures

- Difficulty of tasks remains consistent across the year
- Allotted time typically does not allow for completion of test, so student growth still can be assessed

Features of Progress Monitoring Measures

- Uses standardized administration and scoring
 - Test administration is timed (relatively short tests in duration)
 - Specific scoring rules are applied
 - Scoring typically uses counts, rather than percent correct

Two Approaches to Developing Progress Monitoring Measures (Fuchs, 2004)

- Curriculum Sampling
 - Systematically sample items from the annual curriculum on each measure
- Robust Indicator
 - Identify a global behavior that either encompasses many skills taught in the annual curriculum or is predictive of proficiency in the annual curriculum

Curriculum Sampling

- Each probe is a proportional sampling of the annual curriculum
- Advantages
 - May conduct skills analysis
 - May evaluate maintenance and generalization of skills
- Disadvantages
 - Measures tend to be longer in duration
 - May not generalize to other curricular programs
 - Are grade-level specific

Robust Indicators

- Also referenced as general outcome measures
 - Probes are comprised of tasks that represent proficiency in the content domain
 - INDICATORS; not the "whole" of instruction
 - Examples: oral reading fluency; estimation
 - Empirically determined through correlations with other indicators of proficiency in mathematics

Robust Indicators

- Advantages
 - Do not have to be grade specific
 - Tend to be shorter in duration
 - May be used across curricular programs
- Disadvantages
 - May not be tied closely to instructional content
 - May not be able to provide skills analysis on instructional content
 - May not be able to evaluate maintenance and generalization of instructional skills

Mathematics Progress Monitoring in Elementary Grades

Measuring Elementary Students' Progress in Mathematics

- Mathematics measures for progress monitoring have been used with success in elementary grades since the 1980s
- Elementary measures include examples of both curriculum sampling and robust indicators
- Several measures are available commercially as computer programs or Web-based systems

Brief Historical Perspective of Progress Monitoring in Mathematics

- Roots of progress monitoring (specifically curriculum-based measurement) at Institute for Research on Learning Disabilities at the Univ. of MN (mid-1970s - early 1980s)
- Stan Deno and colleagues conducted several early studies in reading that failed to demonstrate significantly improved student achievement despite teachers' accurate implementation: Researchers concluded that teachers did not comply with data-based rules for instructional decision making

Brief History

- First large-scale experimental-contrast study that showed significantly improved student achievement was conducted by Fuchs, Deno, & Mirkin (1984) in NYC schools in reading
- Early mathematics measures focused on basic mathematics facts and some mixedskills computational measures
- In late 1980s, Fuchs and Fuchs team developed grade-level computational measures representing skills tested in statewide high-stakes assessment program

Brief History

- With research demonstration of improved achievement for students with mild disabilities whose teachers used progress monitoring for instructional planning in mathematics, the Fuchs and Fuchs team expanded measures to include concepts and applications
- Simultaneously, Fuchs and Fuchs implemented progress monitoring in mathematics in general education classrooms

Features Included in Fuchs and Fuchs Program of Research

- Graphed performance and data-based decision rules
- Computer software (data management and test taking)
- Skills analysis (individual and classwide)
- Instructional recommendations
- Paired with peer-assisted learning strategies (PALS) in general education

Elementary-Level Measures: Curriculum Sampling Approach

- Test items represent the critical skills in the grade-level curriculum (or represent grade-level state standards)
- Although administration time is held constant across the year, it may vary by grade level

Elementary-Level Measures: Curriculum Sampling Approach

- Measures may contain only computation problems or problems representing concepts and applications, or a combination of both
- Because the same skill types are tested repeatedly, analysis of student performance with respect to specific skills is possible

Examples of Progress Monitoring Measures Developed Through Curriculum Sampling

Monitoring Basic Skills Progress: Basic Math

Computation

- For Grades 1-6, test administration varies from 2-6 minutes, depending on grade level
- Scored as number of digits correct in answers (using specified scoring algorithms)

Monitoring Basic Skills Progress: Basic Math

- Concepts and Applications
 - For Grades 2-6, test administration varies from 6-8 minutes, depending on grade level
 - Scored as one number of blanks correct
- Computer program provides skills analyses

Sheet #2

Computation 4

Password: AIR

•Random numerals within problems

•Random placement of problem types on page

Measure taken from Monitoring Basic Skills Progress: Basic Math Computation (2nd ed.) (1998)

Name:		Date		
A	В	С	D	E
9)24	52852 <u>+64708</u>	9 <u>× 0</u>	4)72	8285 4304 <u>+ 90</u>
F	G	Н	I	J
6)30	35 <u>x 74</u>	4 <u>× 5</u>	7 <u>x 9</u>	$\frac{2}{3} - \frac{1}{3} =$
К	L	Μ	N	0
32 <u>× 2</u> 3	8 <u>× 6</u>	5)65	6)30	3-47 - 1 =
Ρ	Q	R	S	Т
107 <u>x_3</u>	2)9	416 <u>- 44</u>	$\frac{5}{11} + \frac{3}{11} =$	6 <u>x 2</u>
U	V	W	Х	Y
$4\frac{1}{2} + 6 =$	1504 <u>- 1441</u>	9)81	130 <u>x 7</u>	5)10

•One page of a three-page measure for math concepts and applications (24 problems total)

Measure taken from Monitoring Basic Skills Progress: Basic Math Concepts and Applications (1999)

Nam	ne	Date Tes	t 4 Page 1
Colur	nn A Appl	ications 4	Column B
(1)	Write the letter in each blank. Z (A) line segment $ \begin{array}{c} \\ \hline \\ $	(5) Write a number in the blank. 1 week = days (6) Vacation Plans for Summ School Students Summer School	it
(2) Whi (3)	Look at this numbers.: 356.17 ch number is in the hundredths place? Solve the problem by estimating the sum or difference to the nearest ten. Jeff wheels his wheelchair for 33 hours a week at school and for 28 hours a week in his neighborhood. About how many hours does Jeff spend each week wheeling his wheelchair?	Travel Travel Stay home Travel Stay home Travel Stay home Travel Stay home Travel Stay home The P.T.A. will buy a Summit School T-Shirt for each student who goes to summer school. Each shirt costs \$4.00. How much money will the P.T.A. spend on these T shirts? How many students are planning to travel during the summer? How many fewer students are planning to go to summer school than planning	\$.00 stions.
(4)	Write the number in each blank. 3 ten thousands, 6 hundreds, 8 ones 2 thousands, 8 hundreds, 4 tens, 6 ones	 (7) (7)	ous ou rs meters eters

CLASS SKILLS PROFILE - Computation

Teacher: Mrs. Smith Report through 3/17

<u>Skills</u> <u>Profile</u>--by problem <u>Class</u> type for each student

From Monitoring Basic Skills Progress: Basic Math Computation (2nd ed.) (1998)

<u>Name</u>	<u>A1</u>	<u>S1</u>	<u>M1</u>	<u>M2</u>	<u>M3</u>	<u>D1</u>	<u>D2</u>	<u>D3</u>	<u>F1</u>	<u>F2</u>
Adam Qualls		-	-	\square	Ш	\square	\square			\square
Amanda Ramirez		Ш	-	Ш	Ш	Ħ				
Anthony Jones	П	Ш	-	Ш	Ш	Ш		Ш		
Aroun Phung								Ш		
Becca Jarrett					Ш			Ш		
Charles McBride					Ш			Ш		
Cindy Lincoln	⊞	Ш			Ħ					
David Anderson	П	Ш		-	Ш	Ħ		Ш		
Emily Waters				-	Ш			Ш		
Erica Jernigan		Ш	-	Ξ						
Gary McKnight								Ш		
Icon										
Jenna Clover					Ħ					
Jonathan Nichols		Ħ		-	Ш					Ħ
Jung Lee			-							
Kaitlin Laird		Ш	-	Ħ	Ш	Ħ				
Kathy Taylor								Ħ		
Matthew Hayes						Ħ				
Michael Elliott					Ш		Ш	Ш	Ш	
Michael Sanders	<u> </u>	Ш		Ξ		Ħ				Ш
Samantha Spain					Ħ					
Vicente Gonzalez				-		Ħ				
Victoria Dillard		Ш			Ш			Ш		Ш
Yasmine Sallee								-		
	0	4	0	0	0	0	0	0	0	-
	0	1	0	0	0	0	2	8	2	5
WARM Ctarting to get it	3	8	0	5	14	3	16	10	3	3
	2	1	0	1	3	6	0	2	0	1
VERY WARM. Almost have it.	5	3	8	4	0	4	0	1	1	0
HOT. You've got it!	13	10	15	13	6	10	5	2	17	14

<u>Ranked</u> <u>Scores</u>--Average of Last Two Scores and

<u>Slope</u>--Average Weekly Increase

From Monitoring Basic Skills Progress: Basic Math Computation (2nd ed.) (1998)

RANKED SCORES - Computation

Teacher: Mrs. Smith Report through 3/17

Name	<u>Score</u>	<u>Growth</u>
Samantha Spain	57	+1.89
Aroun Phung	56	+1.60
Gary McKnight	54	+1.14
Yasmine Sallee	53	+1.34
Kathy Taylor	53	+1.11
Jung Lee	53	+1.23
Matthew Hayes	51	+1.00
Emily Waters	48	+1.04
Charles McBride	43	+1.12
Michael Elliott	42	+0.83
Jenna Clover	42	+0.78
Becca Jarrett	41	+1.14
David Anderson	38	+0.79
Cindy Lincoln	36	+1.04
Kaitlin Laird	35	+0.71
Victoria Dillard	34	+0.64
Vicente Gonzalez	29	+0.28
Adam Qualls	26	+0.60
Michael Sanders	25	+0.70
Jonathan Nichols	25	+2.57
Amanda Ramirez	23	+0.85
Anthony Jones	19	+0.05
Erica Jernigan	18	+0.23
Icon	0	+0.00

Yearly Progress Pro[™]

- Web-based progress monitoring system
- Both computation and problem-solving items are included on each form
- Each test, Grades 1-8, is administered for 15 minutes
- Multiple-choice format (scratch paper allowed)

Yearly Progress Pro[™]

- Scored as number of problems correct (out of a total of 30)
- Provides skills analyses for class and individual students
- Program also contains instructional exercises by skill





See http://www.mhdigitallearning.com



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🔋 Florida Sale...

📴 CBM Repor... 🛛 🖉 Exercises ...



Examples of Progress Monitoring Measures Developed as Robust Indicators

EdCheckup: Cloze Math

- Web-based progress monitoring system
- Robust indicator consisting of basic facts in addition, subtraction, multiplication, and division--80 problems administered for 2 minutes
- May select electronic scoring option or paper and pencil option

EdCheckup: Cloze Math



AIMSweb

- Web-based progress monitoring system
- Measures are printed and administered to students
- Variety of measures for Grades 1-6:
 - Basic facts by single operation or mixed operations (robust indicators)--score by correct digits in answers
 - Mixed skills by grade level (curriculum sampling)--no skills analysis available; score by correct digits in answers or by correct digits in answers and critical processes (as indicated on answer key)
- Graphs of student progress are provided

Sample AIMSweb Basic Facts Measures

9 (9)

11 (20)

11 (31)

8 (39)

8 (47)

8 (55)

Page 1 of 2

	AIMSweb8	Basic Addition	and Subtractio	n Facts #1 - Inte	ermediate Answ	er Key			AIMS	Sweb® Basic M	ultiplication and	d Division Facts	#1 Answer H
4 - 0 4 (1)	7 + 7 14	4 + 7 11 (2)	4 - 4 0 (1)	9 + 0 9 (1)	2 - 0 2 (1)	5 - 5 0	9 (9)	$\frac{0}{\mathbf{x} \cdot 4}_{(1)}$	7 <u>x 7</u> <u>49</u> (2)	4 <u>x 7</u> 28 (2)	5 35 (1)	9 <u>x 0</u> (1)	2 2 (1)
11 - 8 3 (1)	12 - 6 (1)	7 - 3 4	1 + 7 8 (1)	8 - 6 2 (1)	9 - 9 0 (1)	1 + 5 6 (1)	7 (16)	11 <u>x 8</u> 88 (2)	9 <u>x 5</u> 45	5 <u>x 2</u> 10	8 <mark>8</mark> (1)	896 (2)	9 9 81 ⑴
	10 - 5 5 (1)	7 - 3 4	8 - 6 2 (1)	12 + 4 16	9 + 0 9 (1)	8 - 1 7 (1)	8 (24)	8 <mark>96</mark> (2)	7 <u>x 4</u> 28	3 <u>x 7</u> 21 (2)	10 <u>x 8</u> 80 (2)	9 4 36	6 <u>x 0</u> 0
	8 + 8 16 (2)	9 - 7 2 (1)	12 - 2 10	$\frac{3}{+6}{9}$	1 - 1 0	10 - 2 8 (1)	9 (33)	3 <u>x 2</u> 6	9 11 99	6 48 (1)	9 <u>x 2</u> 18	7 <mark>7</mark>	1 <u>x 1</u> 1
	1 + 8 9 (1)	9 - 2 7 (1)	5 - 0 5 (1)	0 + 3 3 (1)	9 + 1 10	5 +3 8 (1)	8 (41)	8 <mark>8</mark> (1)	8 <mark>8</mark> (1)	9 <u>x 2</u> 18	0 <u>x 5</u> 0	0 <u>x 3</u> 0	9 <u>x 1</u> 9 (1)
9 9 0	8 - 7 1 (1)	4 + 9 13	10 -6 4	3 + 7 10	6 + 0 6 (1)	9 - 5 4	9 (50)	7 <mark>6</mark> 7 42	8 40 (1)	12 <u>x 6</u> 72	8 40 (1)	8 <mark>8</mark> (1)	5 <u>x C</u> 0

Taken from http://www.aimsweb.com

Additional Resources

Progress Monitoring Measures

- AIMSweb website: http://www.aimsweb.com
- Edcheckup website:
 <u>http://www.edcheckup.com</u>
- Monitoring Basic Skills Progress (Macintosh (OS 9) computer program available through <u>http://www.proedinc.com</u>
- Project AAIMS website (algebra progress monitoring measures and research results) <u>www.ci.hs.iastate.edu/aaims</u>
- Yearly Progress Pro website: <u>http://www.mhdigitallearning.com</u>

Additional Resources

National Centers

- National Center on Student Progress Monitoring (NCSPM): <u>http://www.studentprogress.org</u>
- Research Institute on Progress Monitoring (RIPM): <u>http://www.progressmonitoring.org</u>