Progress Monitoring for Elementary Mathematics

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

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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 criterion-referenced 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

Adapted from NCSPM

Multidigit Addition Test

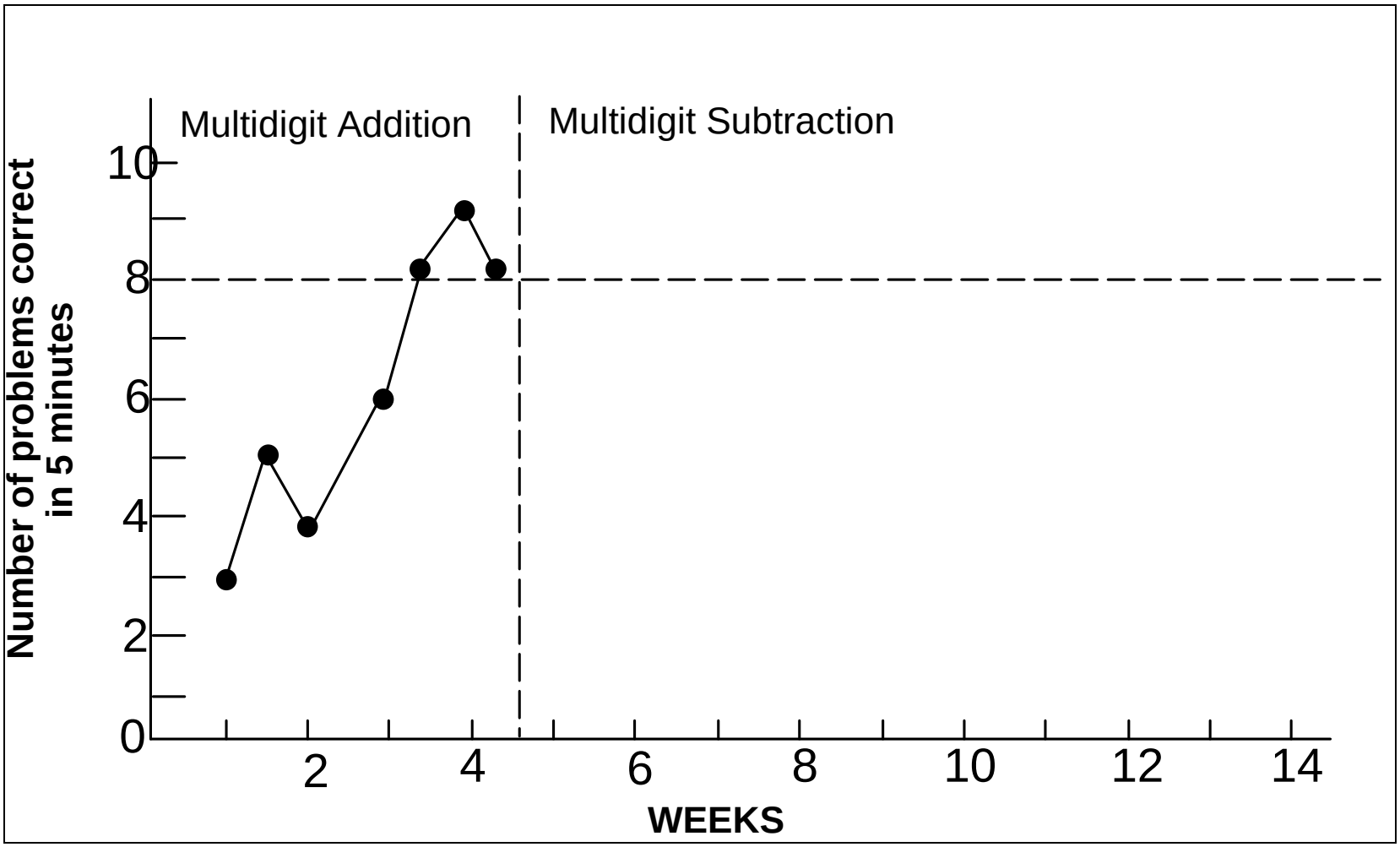
Name: _____ Date _____

Adding

36521 + 63758	53429 + 63421	84525 + 75632	67842 + 53937	57321 + 46391
56382 + 94742	36422 + 57529	34824 + 69426	32415 + 85439	45321 + 86274

Adapted from NCSPM

Mastery of Multidigit Addition



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9. Add/subtract simple fractions, like denominators
10. Add/subtract whole number and mixed number

Adapted from NCSPM

Multidigit Subtraction Test

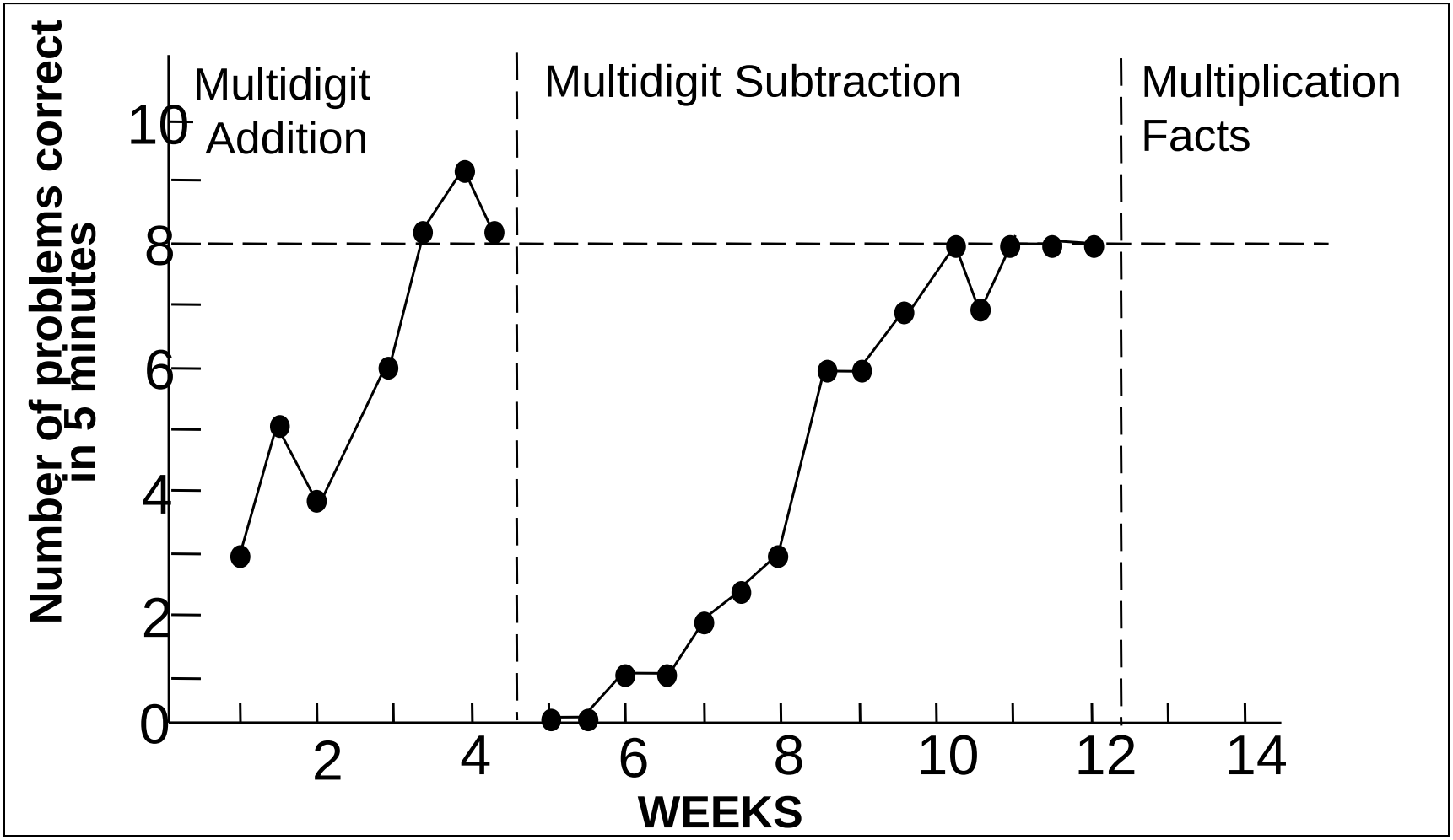
Name: _____ Date _____

Subtracting

6521 - 375	5429 - 634	8455 - 756	6782 - 937	7321 - 391
5682 - 942	6422 - 529	3484 - 426	2415 - 854	4321 - 874

Adapted from NCSPM

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.

Adapted from NCSPM

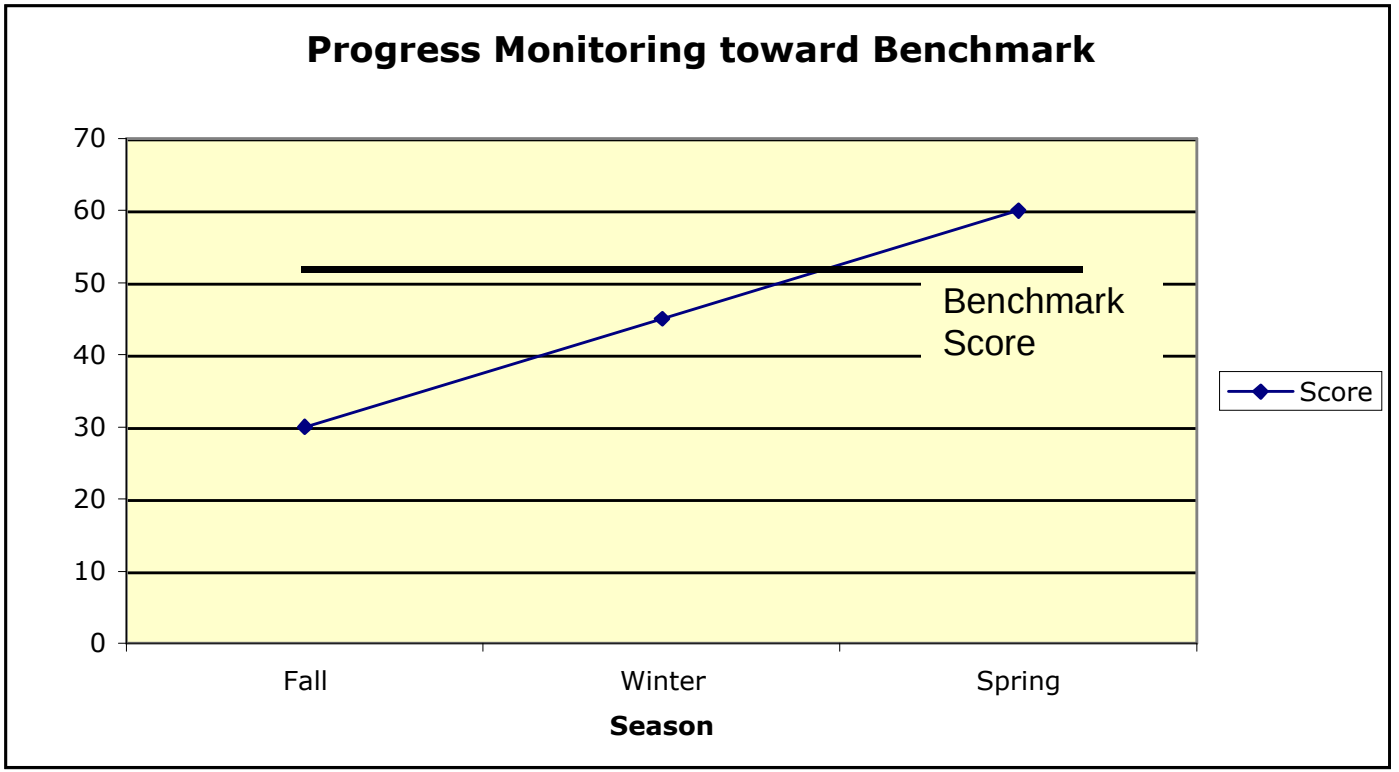
Benchmarking

- The process of collecting and evaluating data to determine if students will meet terminal goal (often thought of as end-of-the-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

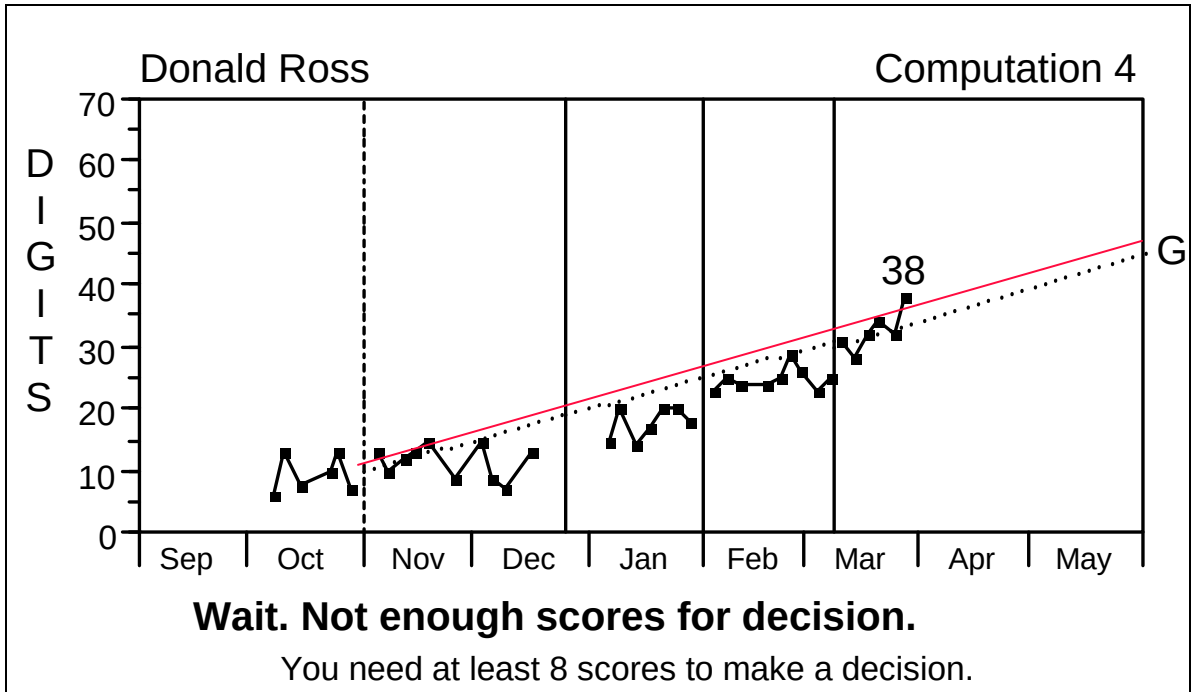
Research Supports the Use of Progress Monitoring

- 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

Adapted from NCSPM

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 effectiveness of adaptations to class instruction

Adapted from NCSPM

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

Adapted from NCSPM

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 mixed-skills 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

- Random numerals within problems
- Random placement of problem types on page

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

Sheet #2 Computation 4

Password: AIR

Name: _____ Date _____

A $9\overline{)24}$	B 52852 + 64708	C 9 x 0	D $4\overline{)72}$	E 8285 4304 + 90
F $6\overline{)30}$	G 35 x 74	H 4 x 5	I 7 x 9	J $\frac{2}{3} - \frac{1}{3} =$
K 32 x 23	L 8 x 6	M $5\overline{)65}$	N $6\overline{)30}$	O $3\frac{4}{7} - 1 =$
P 107 x 3	Q $2\overline{)9}$	R 416 - 44	S $\frac{5}{11} + \frac{3}{11} =$	T 6 x 2
U $4\frac{1}{2} + 6 =$	V 1504 - 1441	W $9\overline{)81}$	X 130 x 7	Y $5\overline{)10}$

Adapted from NCSPM

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

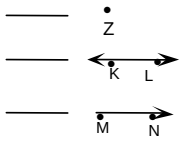
Measure taken from *Monitoring Basic Skills Progress: Basic Math Concepts and Applications* (1999)

Name _____ Date _____ Test 4 Page 1

Column A — Applications 4 — Column B

(1)

Write the letter in each blank.



(A) line segment
(B) line
(C) point
(D) ray

(2)

Look at this numbers.:

356.17

Which number is in the hundredths place? _____

(3)

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?

_____

(4)

Write the number in each blank.

3 ten thousands, 6 hundreds, 8 ones

_____

2 thousands, 8 hundreds, 4 tens, 6 ones

_____

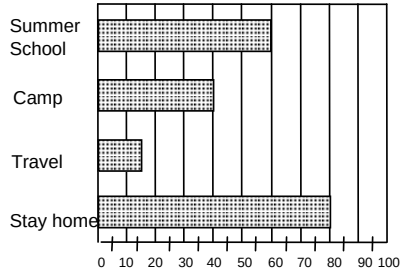
(5)

Write a number in the blank.

1 week = _____ days

(6)

Vacation Plans for Summit School Students



Number of Students

Use the bar graph to answer the questions.

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? $_____.00

How many students are planning to travel during the summer? _____

How many fewer students are planning to go to summer school than planning to stay home? _____

(7)

To measure the distance of the bus ride from school to your house you would use

(A) meters
(B) centimeters
(C) kilometers

_____

Adapted from NCSPM

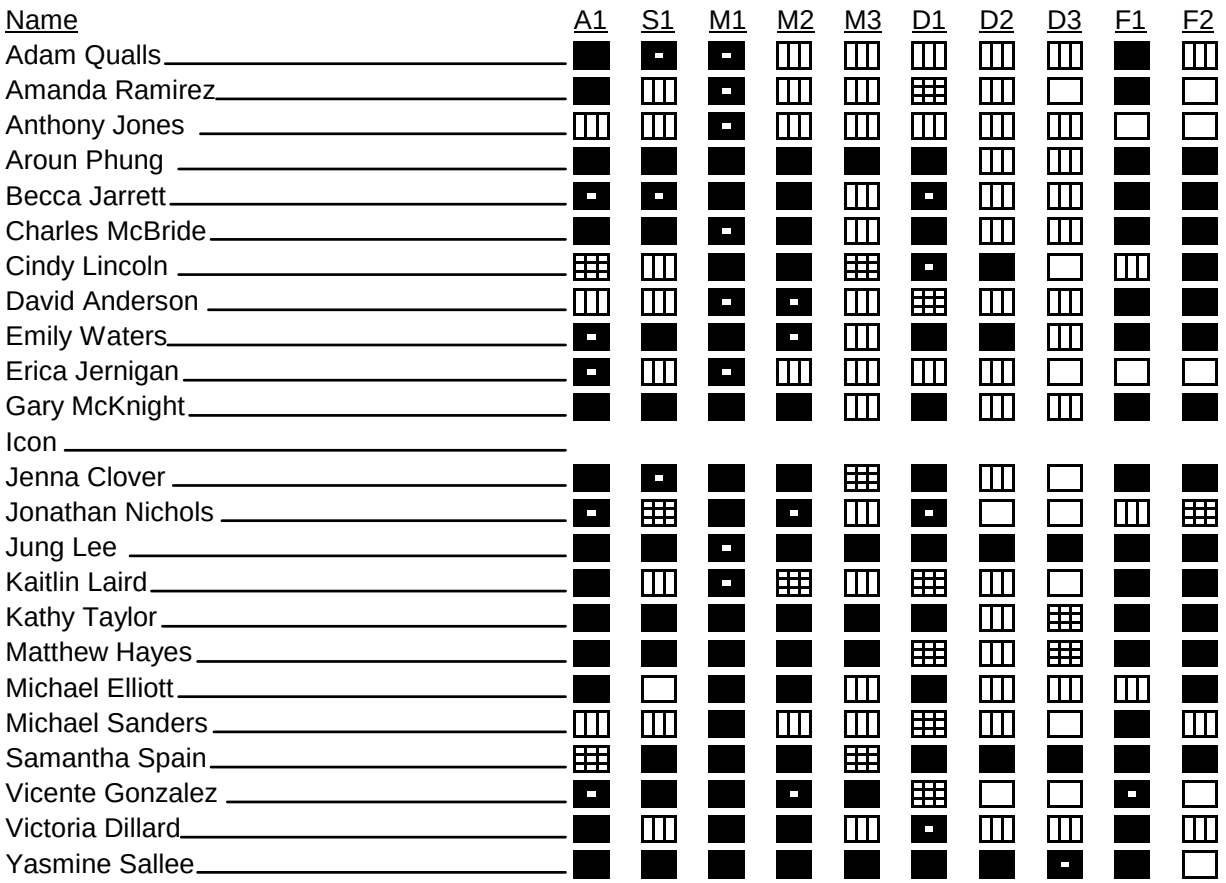
Skills Profile-- by problem Class type for each student

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

CLASS SKILLS PROFILE - Computation

Teacher: Mrs. Smith

Report through 3/17



Name	A1	S1	M1	M2	M3	D1	D2	D3	F1	F2
Adam Qualls										
Amanda Ramirez										
Anthony Jones										
Aroun Phung										
Becca Jarrett										
Charles McBride										
Cindy Lincoln										
David Anderson										
Emily Waters										
Erica Jernigan										
Gary McKnight										
Icon										
Jenna Clover										
Jonathan Nichols										
Jung Lee										
Kaitlin Laird										
Kathy Taylor										
Matthew Hayes										
Michael Elliott										
Michael Sanders										
Samantha Spain										
Vicente Gonzalez										
Victoria Dillard										
Yasmine Sallee										

	A1	S1	M1	M2	M3	D1	D2	D3	F1	F2
COLD. Not tried	0	1	0	0	0	0	2	8	2	5
COOL. Trying these.	3	8	0	5	14	3	16	10	3	3
WARM. Starting to get it.	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

Adapted from NCSPM

Ranked Scores-- Average of Last Two Scores and

Slope-- 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	Score	Growth
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

Adapted from NCSPM

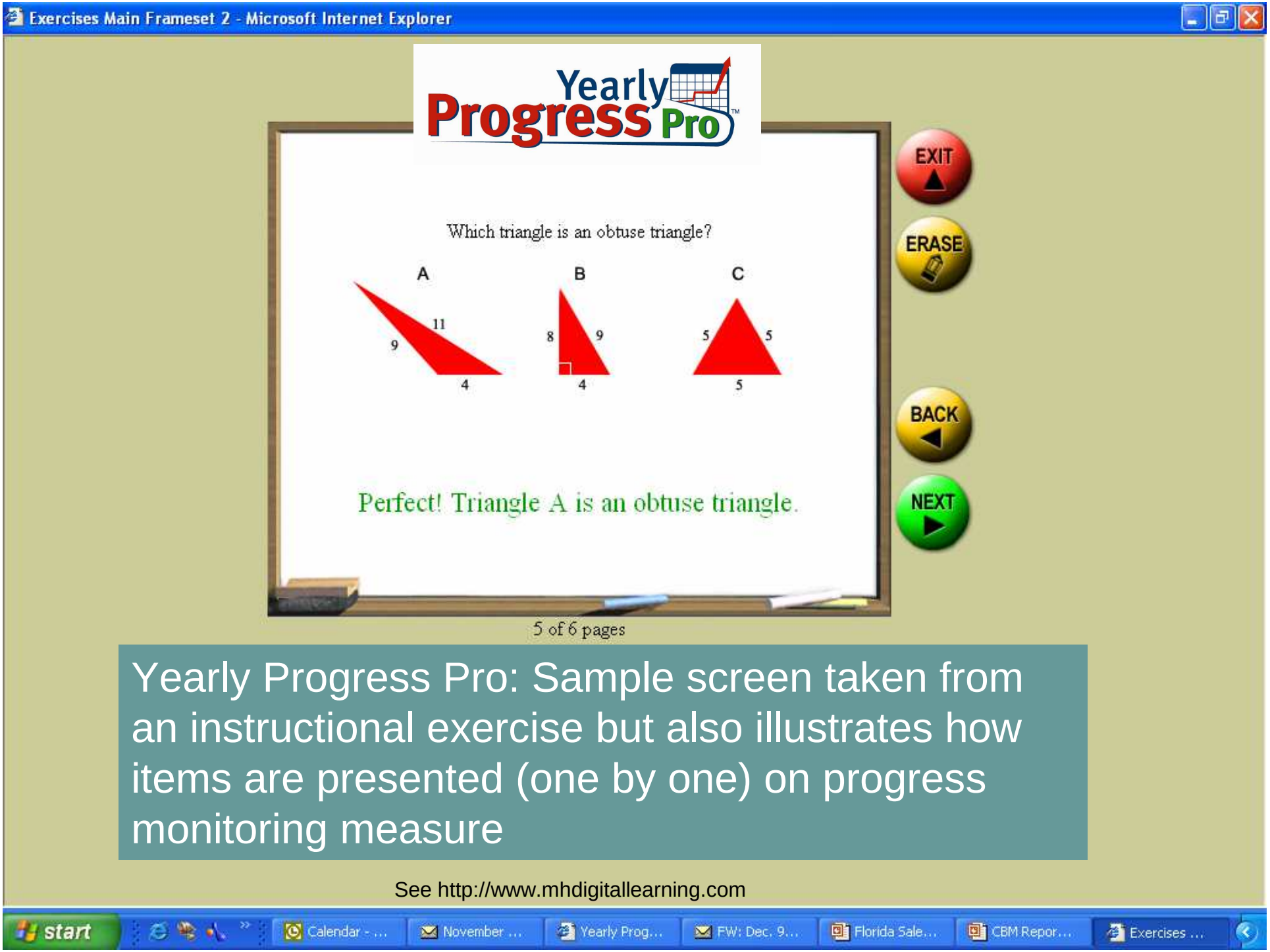
Yearly Progress Pro™

- 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™

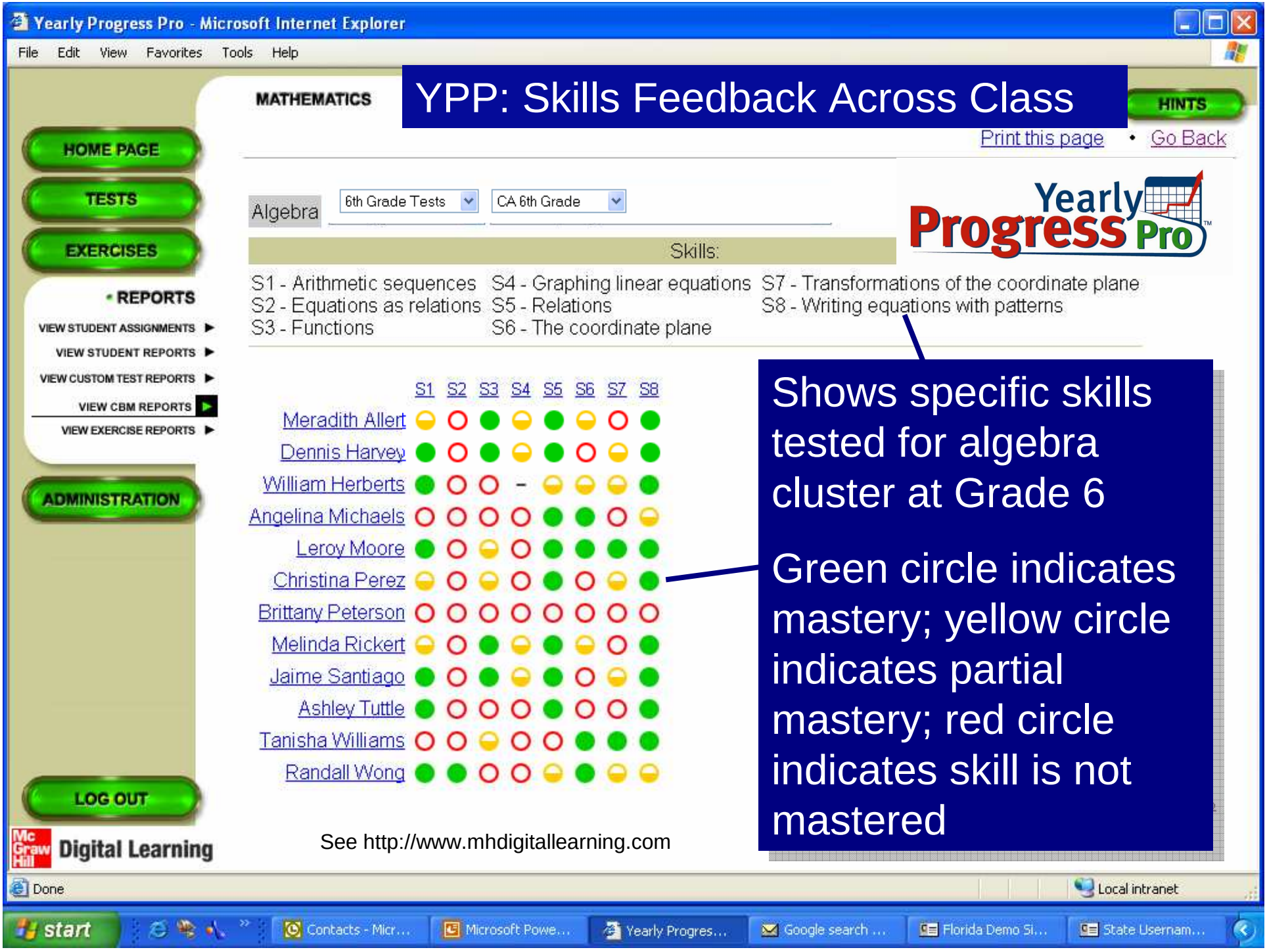
- Scored as number of problems correct (out of a total of 30)
- Provides skills analyses for class and individual students
- Program also contains instructional exercises by skill

See http://www.mhdigitallearning.com



Yearly Progress Pro: Sample screen taken from an instructional exercise but also illustrates how items are presented (one by one) on progress monitoring measure

See http://www.mhdigitallearning.com


Yearly Progress Pro - Microsoft Internet Explorer
File Edit View Favorites Tools Help
MATHEMATICS
YPP: Skills Feedback Across Class
HINTS
Print this page • Go Back
HOME PAGE
TESTS
EXERCISES
REPORTS
VIEW STUDENT ASSIGNMENTS
VIEW STUDENT REPORTS
VIEW CUSTOM TEST REPORTS
VIEW CBM REPORTS
VIEW EXERCISE REPORTS
ADMINISTRATION
LOG OUT
Algebra
6th Grade Tests
CA 6th Grade
Yearly Progress Pro
Skills:
S1 - Arithmetic sequences
S2 - Equations as relations
S3 - Functions
S4 - Graphing linear equations
S5 - Relations
S6 - The coordinate plane
S7 - Transformations of the coordinate plane
S8 - Writing equations with patterns
S1 S2 S3 S4 S5 S6 S7 S8
Meradith Allert
Dennis Harvey
William Herberts
Angelina Michaels
Leroy Moore
Christina Perez
Brittany Peterson
Melinda Rickert
Jaime Santiago
Ashley Tuttle
Tanisha Williams
Randall Wong
Mc Graw Hill Digital Learning
See http://www.mhdigitallearning.com
Shows specific skills tested for algebra cluster at Grade 6
Green circle indicates mastery; yellow circle indicates partial mastery; red circle indicates skill is not mastered
Done
Local intranet
start
Contacts - Micr...
Microsoft Powe...
Yearly Progres...
Google search ...
Florida Demo Si...
State Usernam...

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

See http://www.edcheckup.com

EdCheckup: Cloze Math

Assessment Info

Student: **gret, hansen** Test Type: **Screening**

Period: **Spring** Probe: **Probe 1**

edcheckup

Probe 1

2 x 6 = 12	45 ÷ 9 = 5	8 + 6 = 14	___ x 9 = 0
3 x ___ = 18	16 ÷ 4 = ___	___ - 1 = 2	64 ÷ ___ = 8
0 + 1 = ___	___ + 5 = 7	4 x ___ = 8	6 + 7 = ___
___ + 7 = 16	4 x ___ = 36	0 ÷ 6 = ___	___ - 9 = 5
9 x ___ = 9	1 - 0 = ___	___ + 7 = 14	27 ÷ ___ = 9
0 ÷ 8 = ___	___ x 5 = 45	2 + ___ = 5	1 x 4 = ___

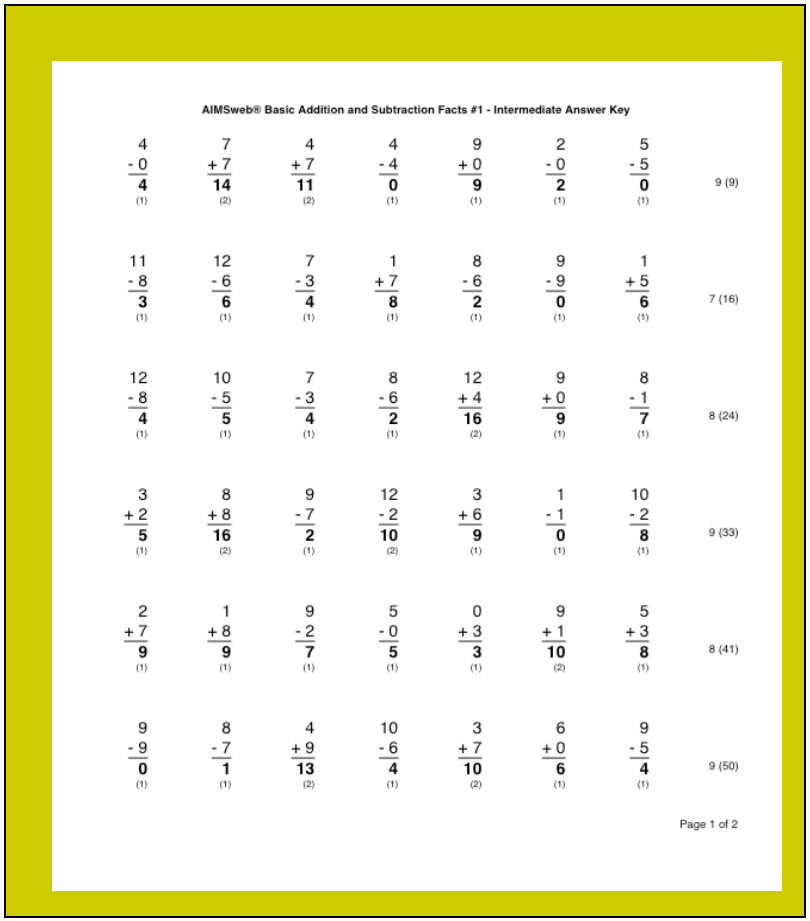
Taken from http://www.edcheckup.com

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

See http://www.aimsweb.com

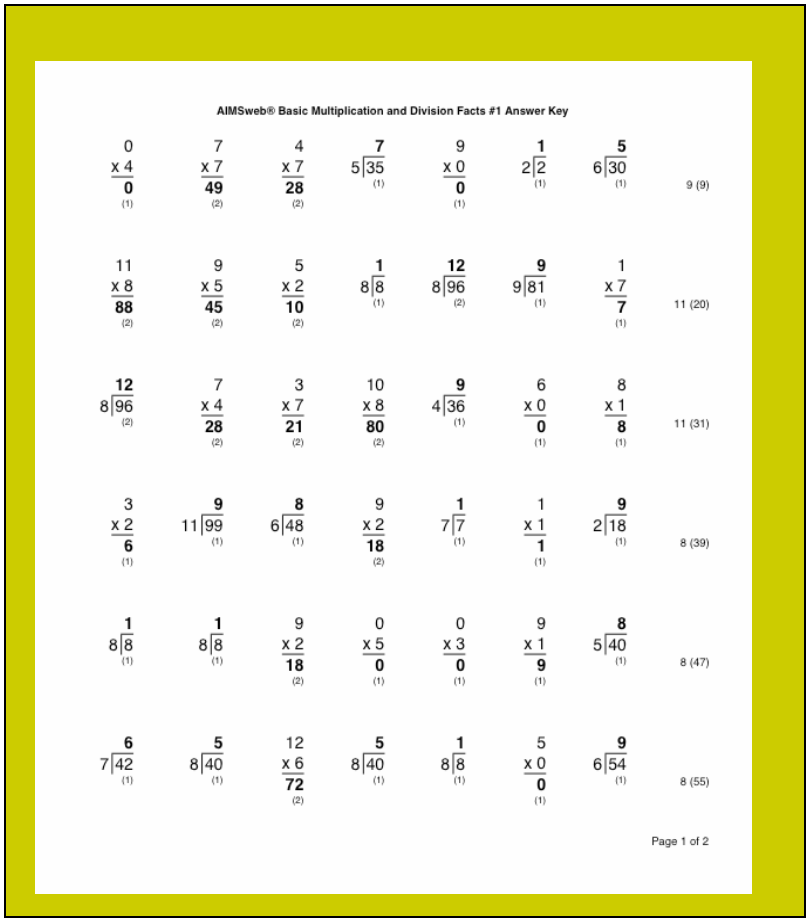
Sample AIMSweb Basic Facts Measures



AIMSweb® Basic Addition and Subtraction Facts #1 - Intermediate Answer Key

4 - 0 = **4** (1)	7 + 7 = **14** (2)	4 + 7 = **11** (2)	4 - 4 = **0** (1)	9 + 0 = **9** (1)	2 - 0 = **2** (1)	5 - 5 = **0** (1)	9 (9)
11 - 8 = **3** (1)	12 - 6 = **6** (1)	7 - 3 = **4** (1)	1 + 7 = **8** (1)	8 - 6 = **2** (1)	9 - 9 = **0** (1)	1 + 5 = **6** (1)	7 (16)
12 - 8 = **4** (1)	10 - 5 = **5** (1)	7 - 3 = **4** (1)	8 - 6 = **2** (1)	12 + 4 = **16** (2)	9 + 0 = **9** (1)	8 - 1 = **7** (1)	8 (24)
3 + 2 = **5** (1)	8 + 8 = **16** (2)	9 - 7 = **2** (1)	12 - 2 = **10** (2)	3 + 6 = **9** (1)	1 - 1 = **0** (1)	10 - 2 = **8** (1)	9 (33)
2 + 7 = **9** (1)	1 + 8 = **9** (1)	9 - 2 = **7** (1)	5 - 0 = **5** (1)	0 + 3 = **3** (1)	9 + 1 = **10** (2)	5 + 3 = **8** (1)	8 (41)
9 - 9 = **0** (1)	8 - 7 = **1** (1)	4 + 9 = **13** (2)	10 - 6 = **4** (1)	3 + 7 = **10** (2)	6 + 0 = **6** (1)	9 - 5 = **4** (1)	9 (50)

Page 1 of 2



AIMSweb® Basic Multiplication and Division Facts #1 Answer Key

0 x 4 = **0** (1)	7 x 7 = **49** (2)	4 x 7 = **28** (2)	**7** ÷ 5 | 35 (1)	9 x 0 = **0** (1)	**1** ÷ 2 | 2 (1)	**5** ÷ 6 | 30 (1)	9 (9)
11 x 8 = **88** (2)	9 x 5 = **45** (2)	5 x 2 = **10** (2)	**1** ÷ 8 | 8 (1)	**12** ÷ 8 | 96 (2)	**9** ÷ 9 | 81 (1)	1 x 7 = **7** (1)	11 (20)
12 ÷ 8 | 96 (2)	7 x 4 = **28** (2)	3 x 7 = **21** (2)	10 x 8 = **80** (2)	**9** ÷ 4 | 36 (1)	6 x 0 = **0** (1)	8 x 1 = **8** (1)	11 (31)
3 x 2 = **6** (1)	**9** ÷ 11 | 99 (1)	**8** ÷ 6 | 48 (1)	9 x 2 = **18** (2)	**1** ÷ 7 | 7 (1)	1 x 1 = **1** (1)	**9** ÷ 2 | 18 (1)	8 (39)
1 ÷ 8 | 8 (1)	**1** ÷ 8 | 8 (1)	9 x 2 = **18** (2)	0 x 5 = **0** (1)	0 x 3 = **0** (1)	9 x 1 = **9** (1)	**8** ÷ 5 | 40 (1)	8 (47)
6 ÷ 7 | 42 (1)	**5** ÷ 8 | 40 (1)	12 x 6 = **72** (2)	**5** ÷ 8 | 40 (1)	**1** ÷ 8 | 8 (1)	5 x 0 = **0** (1)	**9** ÷ 6 | 54 (1)	8 (55)

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Taken from http://www.aimsweb.com

Additional Resources

Progress Monitoring Measures

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

Additional Resources

National Centers

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