



Early Mathematics Assessment

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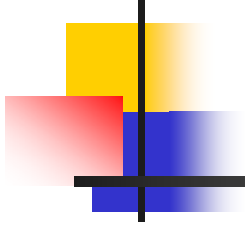
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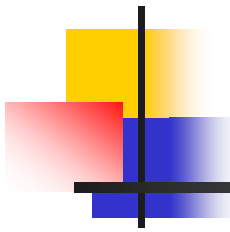
Early Mathematics Assessment



Ben Clarke
& Russell Gersten

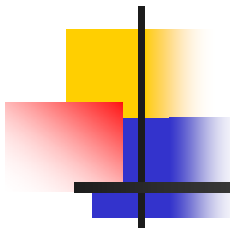
Center on Instruction
Mathematics Strand

November 13, 2006



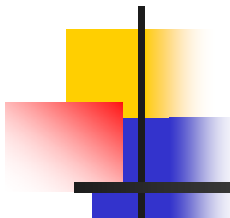
A lesson from reading: Perhaps?

- The trajectory of reading development led to a focus on prevention efforts
- Preventing the establishment of reading problems is now accepted practice dependent on...
 - Early identification assessments
 - Effective early literacy interventions
- Does the same pattern hold true for mathematics?



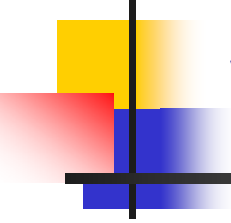
What about math?

- Does math develop in the same way as reading? That is, does it make “sense” to prevent math problems?
 - Less knowledge about long term trajectories
 - Emerging databases may help to answer this question (ECCLES, Jordan, Fuchs)
 - Emerging evidence suggests difficulty in math is relatively stable over time



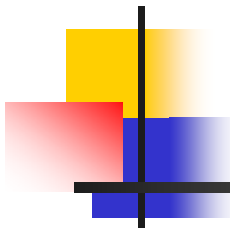
What about math?

- We do know that math knowledge develops across multiple domains (e.g. number, geometry)
 - Students may be on-track in one area and at-risk in another
 - How these domains develop and interact continues to be researched
 - The importance of a logical scope and sequence is paramount



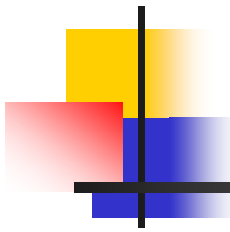
Characteristics of students with mathematics difficulties

- Different profile types exist for students with mathematics difficulties
- Students with mathematics difficulties often have
 - difficulty with quick and accurate retrieval of basic facts (Hasselbring, 88)
 - Working memory deficits (Geary, 94)
 - Difficulty in abstracting mathematical meaning from symbols



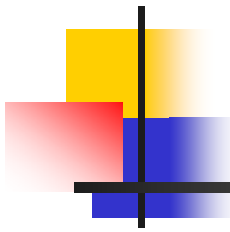
Types of Assessment

- Screening
- Diagnostic
- Progress Monitoring
- Each type of assessment requires measures with certain characteristics



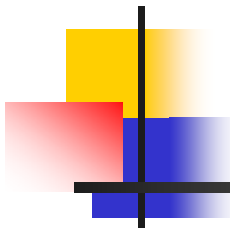
Early Screening

- Brief screening measures
 - Used with all students to screen for risk status
 - Use with all students drives the design and construction of screening measures
 - Measures are of short duration and may be timed



Early Screening Cont.

- Goal is to maximize the amount of information collected in the minimum amount of time
- Predictive validity is critical (e.g. a low score in the Fall predicts difficulty at the end of the year)
- Predictive validity is to a broad measure of mathematics. That is we are predicting general outcomes.
- Screening instruments have been developed by a number of researchers and focus primarily on critical aspects of numerical proficiency and number sense

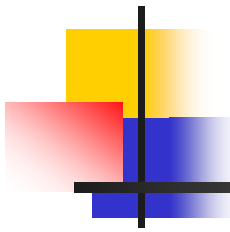


Number Sense

- Critical early mathematical skills may be centered around the concept of number sense.
- Number sense has been defined as:

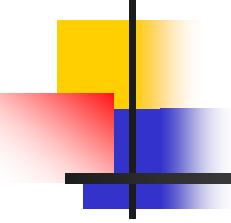
“a child’s fluidity and flexibility with numbers, the sense of what numbers mean, and an ability to perform mental mathematics and to look at the world and make comparisons”

(Gersten & Chard, 1999)



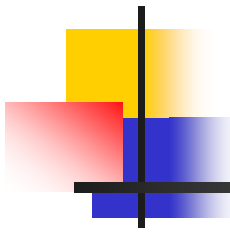
Number Sense (Case, 98)

- ✓ Fluent, accurate estimation and judgment of magnitude comparisons.
- ✓ Flexibility when mentally computing.
- ✓ Ability to recognize unreasonable results.
- ✓ Ability to move among different representations and to use the most appropriate representation.



Numerical proficiency skills for early screening

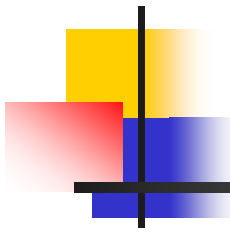
- Strategic counting
- Magnitude comparison
- Number combinations
- Word problems
- Number identification (gateway skill)
- Sequence Counting (gateway skill)



Examples of Screening Measures

- Research line by Clarke and colleagues
- Four measures for K and 1st grade
 - EN-CBM Oral Counting measure
 - Students orally count for one minute. No student materials.
 - EN-CBM Number Identification measure

13	1	12	4	8	17	11	6
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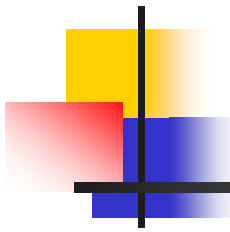
Early Numeracy CBM

- EN-CBM Quantity Discrimination measure
(Magnitude Comparison)

12	3	4	1	5	11	9	4
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- EN-CBM Missing Number measure
(strategic counting)

—	13	14	6	—	8	3	4	—
---	----	----	---	---	---	---	---	---



Examples Cont. - CBM

- Fuchs and Colleagues
- CBM - Computation
- CBM - Concepts/Applications
- Also experimented with Number Combinations and Number Counting/Identification

Test 1

Computation 1

Name: _____

Date: _____

A $\begin{array}{r} 0 \\ + 3 \\ \hline \end{array}$	B $\begin{array}{r} 9 \\ - 7 \\ \hline \end{array}$	C $\begin{array}{r} 0 \\ + 7 \\ \hline \end{array}$	D $\begin{array}{r} 54 \\ + 33 \\ \hline \end{array}$	E $\begin{array}{r} 7 \\ + 3 \\ \hline \end{array}$
F $\begin{array}{r} 10 \\ - 0 \\ \hline \end{array}$	G $\begin{array}{r} 8 \\ + 1 \\ \hline \end{array}$	H $\begin{array}{r} 2 \\ + 5 \\ \hline \end{array}$	I $\begin{array}{r} 6 \\ - 3 \\ \hline \end{array}$	J $\begin{array}{r} 8 \\ - 5 \\ \hline \end{array}$
K $\begin{array}{r} 11 \\ - 1 \\ \hline \end{array}$	L $\begin{array}{r} 8 \\ - 1 \\ \hline \end{array}$	M $\begin{array}{r} 10 \\ - 7 \\ \hline \end{array}$	N $\begin{array}{r} 2 \\ 6 \\ + 1 \\ \hline \end{array}$	O $\begin{array}{r} 6 \\ - 2 \\ \hline \end{array}$
P $\begin{array}{r} 65 \\ + 23 \\ \hline \end{array}$	Q $\begin{array}{r} 45 \\ - 4 \\ \hline \end{array}$	R $\begin{array}{r} 5 \\ + 1 \\ \hline \end{array}$	S $\begin{array}{r} 8 \\ 1 \\ + 1 \\ \hline \end{array}$	T $\begin{array}{r} 7 \\ - 5 \\ \hline \end{array}$
U $\begin{array}{r} 8 \\ + 1 \\ \hline \end{array}$	V $\begin{array}{r} 99 \\ - 8 \\ \hline \end{array}$	W $\begin{array}{r} 10 \\ - 3 \\ \hline \end{array}$	X $\begin{array}{r} 7 \\ + 3 \\ \hline \end{array}$	Y $\begin{array}{r} 9 \\ + 1 \\ \hline \end{array}$

Column A

Applications 1

Column B

(1)

Tickets SoldJenny Antonio Alex Krystal = 1 ticketHow 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.



_____ : _____

VanDerheyden: K-CBM

Draw Circle

4



Scored as number
of correct circled
answers / minute

Circle Number

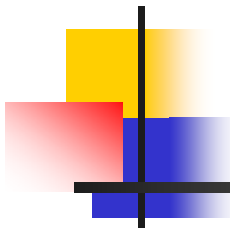


Scored as
numbers circled
correctly / minute

Write number

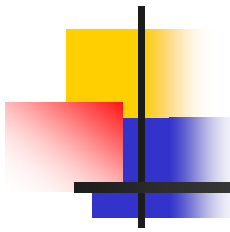


Scored as
numbers written
correctly / minute



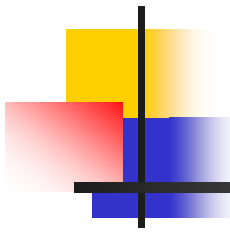
Examples with Key Variables

- Simple word problems (Jordan, 05)
 - Jill has two pennies. Jim gives her one more penny. How many pennies does Jill have now?
 - Mark has three cookies. Colleen takes away one of his cookies. How many cookies does Mark have now?
- Magnitude comparison/Number Identification (Mazzocco, 05)
 - Four items that predicted 3rd grade performance (also included number constancy and mental addition)



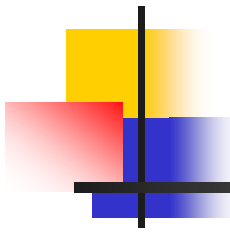
Diagnostic Measures

- In-depth measures
 - May not be used with all students
 - Provides greater information about student performance within a domain (e.g. number, geometry, measurement) or across multiple domains
 - Purpose is to provide diagnostic information about a student's strength and weakness and guide the development of appropriate instructional plans



Example: Number Knowledge Test

- Developed by Case, Okamoto, and Griffin
- Contains four levels
- Students advance to the next level if they score above a criterion at the previous level
- Each level introduces new problems but also repeats problems with larger numbers



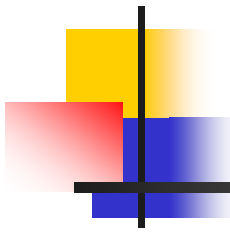
Number Knowledge Test: Cont.

- Level 0

- Here are some circles and triangles.
Count just the triangles and tell me how many there are.

- 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?



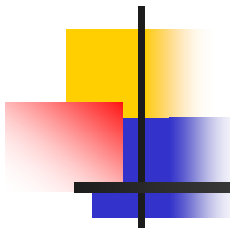
Number Knowledge Test: Cont.

- Level 2

- Which is bigger: 19 or 21?
- What number comes 4 numbers before 17?

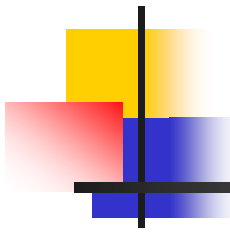
- Level 3

- What number comes 9 numbers after 999?
- Which difference is smaller: the difference between 48 and 36 or the difference between 84 and 73?



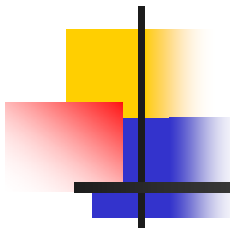
Progress Monitoring Measures

- Progress monitoring measures
 - Some early screening measures have features that also enable them to be used in progress monitoring (e.g. Fuchs - CBM computation)
 - Other screening measures do not have features to enable progress monitoring (e.g. Mazzocco)



Considerations

- Timed measures vs. Untimed measures
- Skill specific measures vs. Multiple skill measures
- Domain specific or across domains
- Long term-predictive validity



Future Research

- Examine and develop longitudinal databases
- Construct analysis of early mathematics measures (what are we really measuring)
- Investigate sensitivity of measures to model growth