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Early Math Competencies and Later Math Achievement in an Urban Low Income Sample

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With thanks to (Current study) Kerry Hofer, CoPI
(Original study)
Mark Lipsey, CoPI
Doug Clements and Julie Sarama,
University of Denver

Original Building Blocks Scale-Up Study

- The *Building Blocks for Math Pre-K Curriculum* (Clements & Sarama, 2007) was designed to help young children learn math

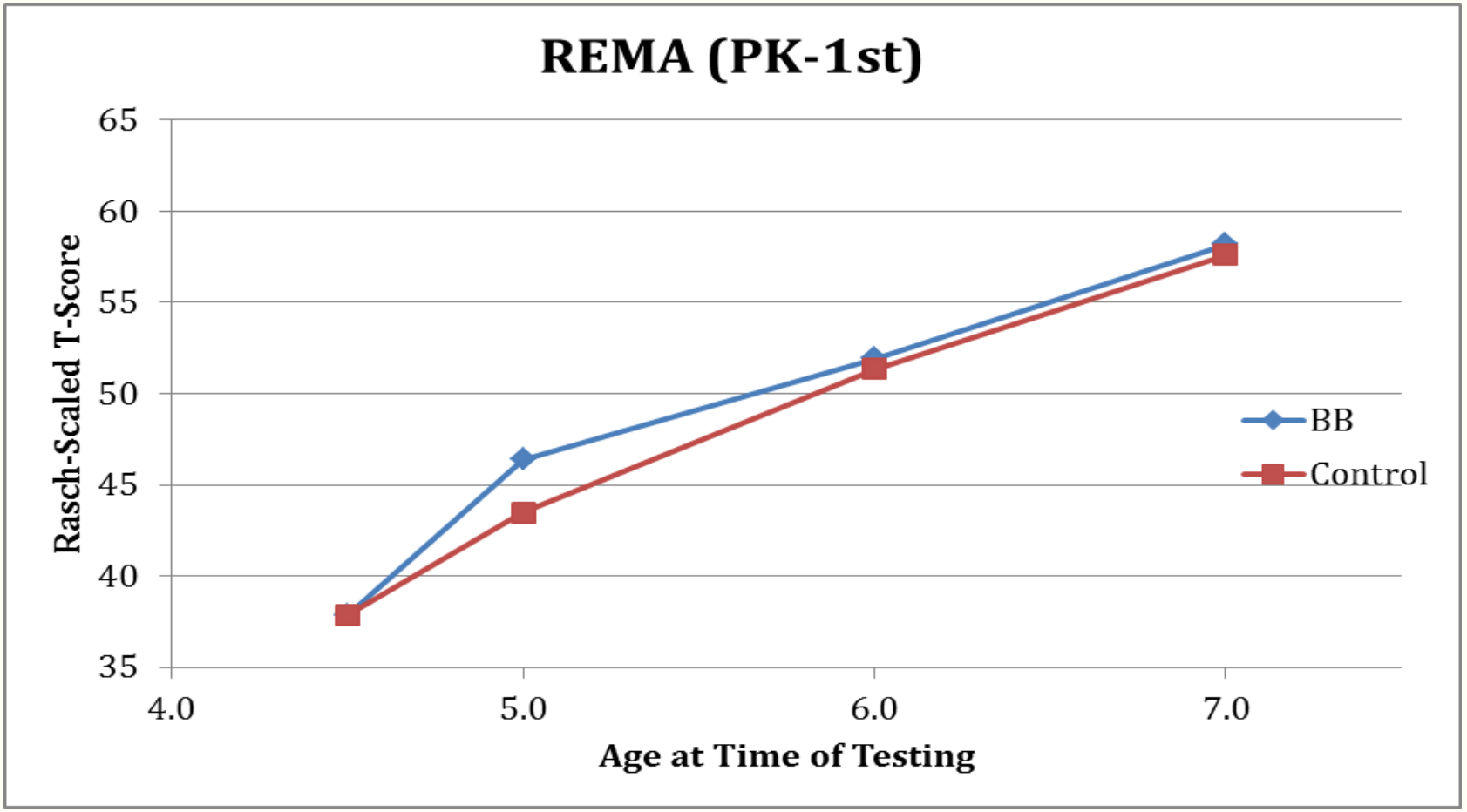
- Nashville was 1 location of a multi-site scale-up study
  - 2006-2007 Training year for teachers
  - 2007-2008 Children attended Pre-K, Full Implementation

Original Building Blocks Scale-Up Sample

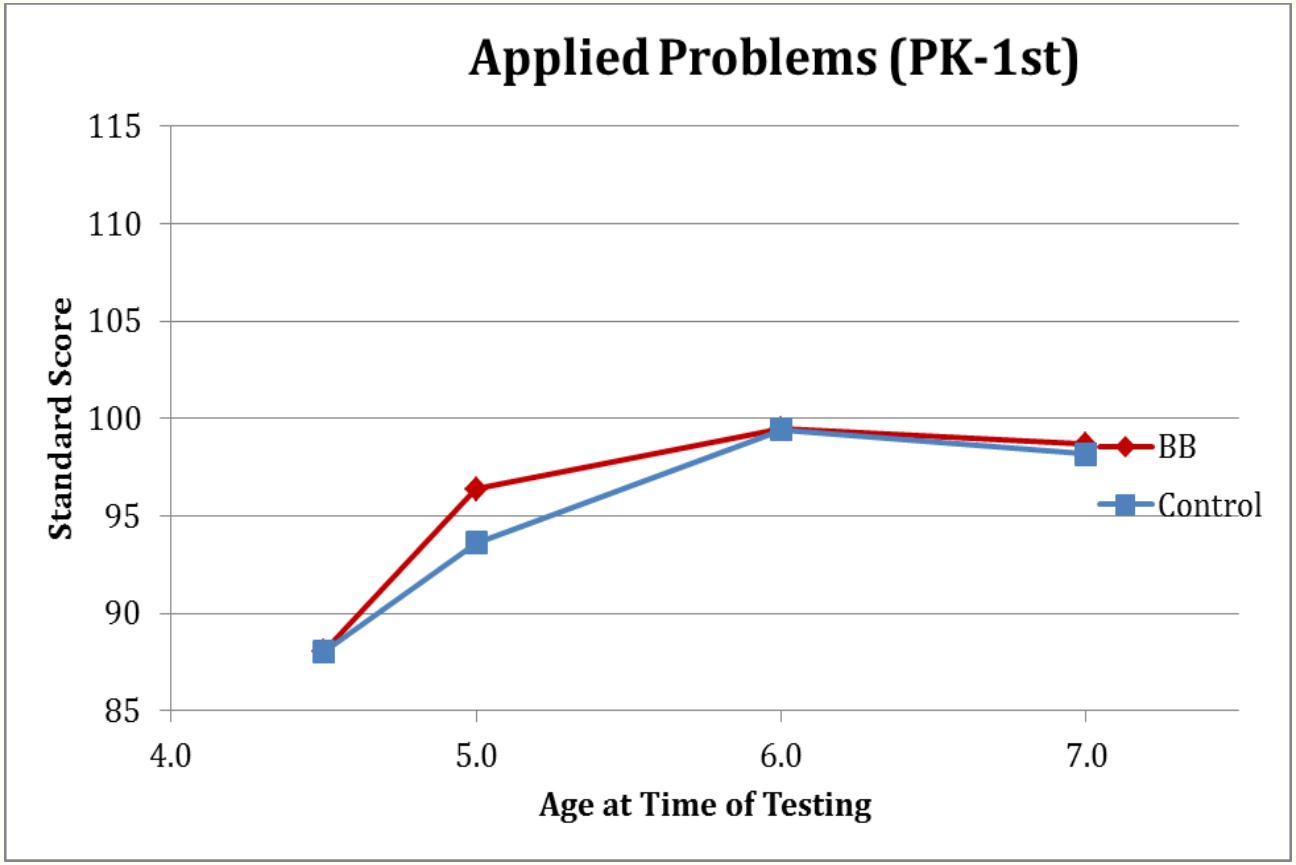
- 20 schools randomly assigned to conditions
  - 16 Metropolitan Public schools
  - 4 Head Start centers
- 57 classrooms
  - 31 treatment classrooms (16 public, 15 Head Start)
  - 26 control classrooms (17 public, 9 Head Start)
- Approximately 680 children with PK pre- and post-data
  - Sample was predominantly Black and from low-income households

SUMMARY OF EFFECTS ON DIRECT ASSESSMENTS, NASHVILLE ONLY

REMA – Rasch-scaled T-scores

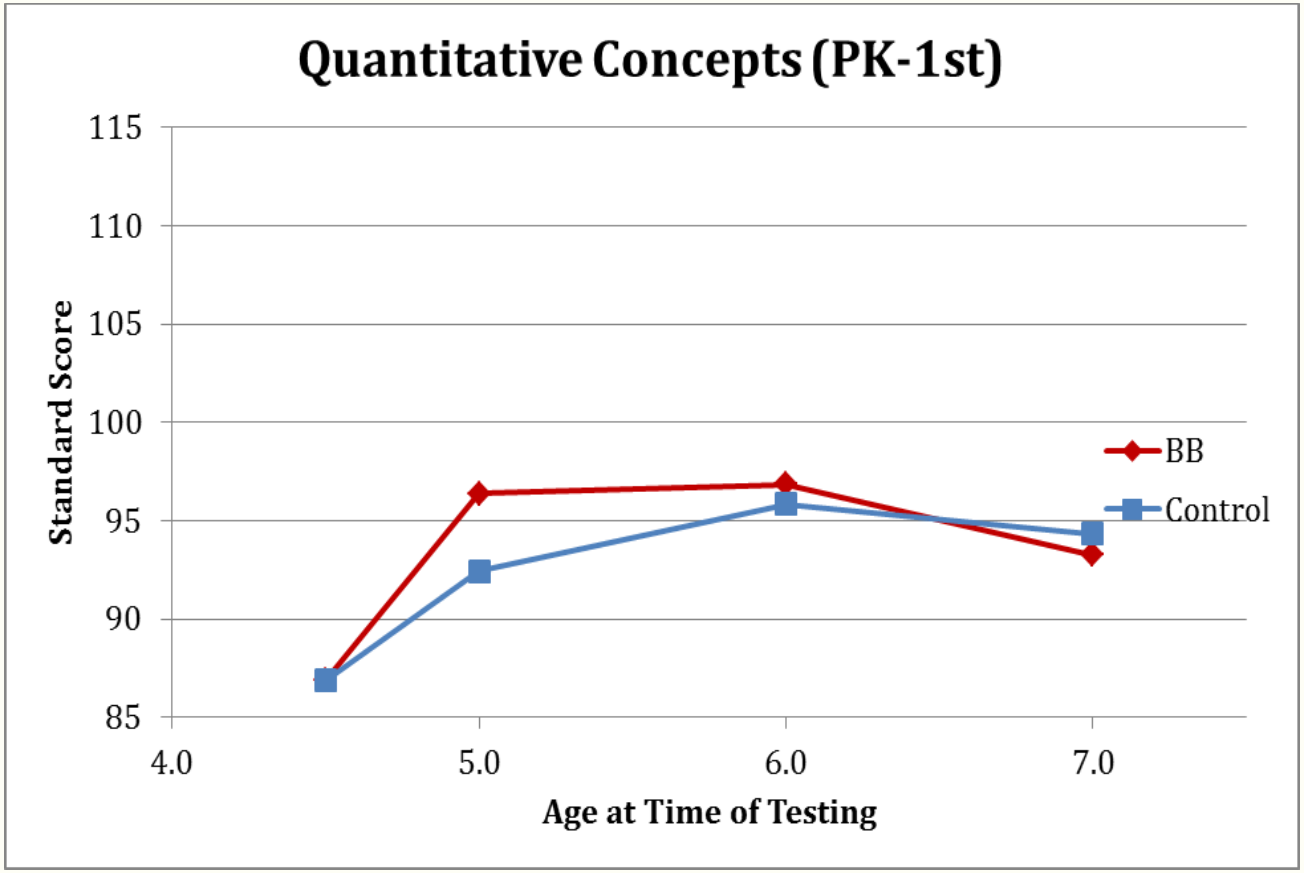


WJ Applied Problems*



*Covariate Adjusted Scores

WJ Quantitative Concepts*

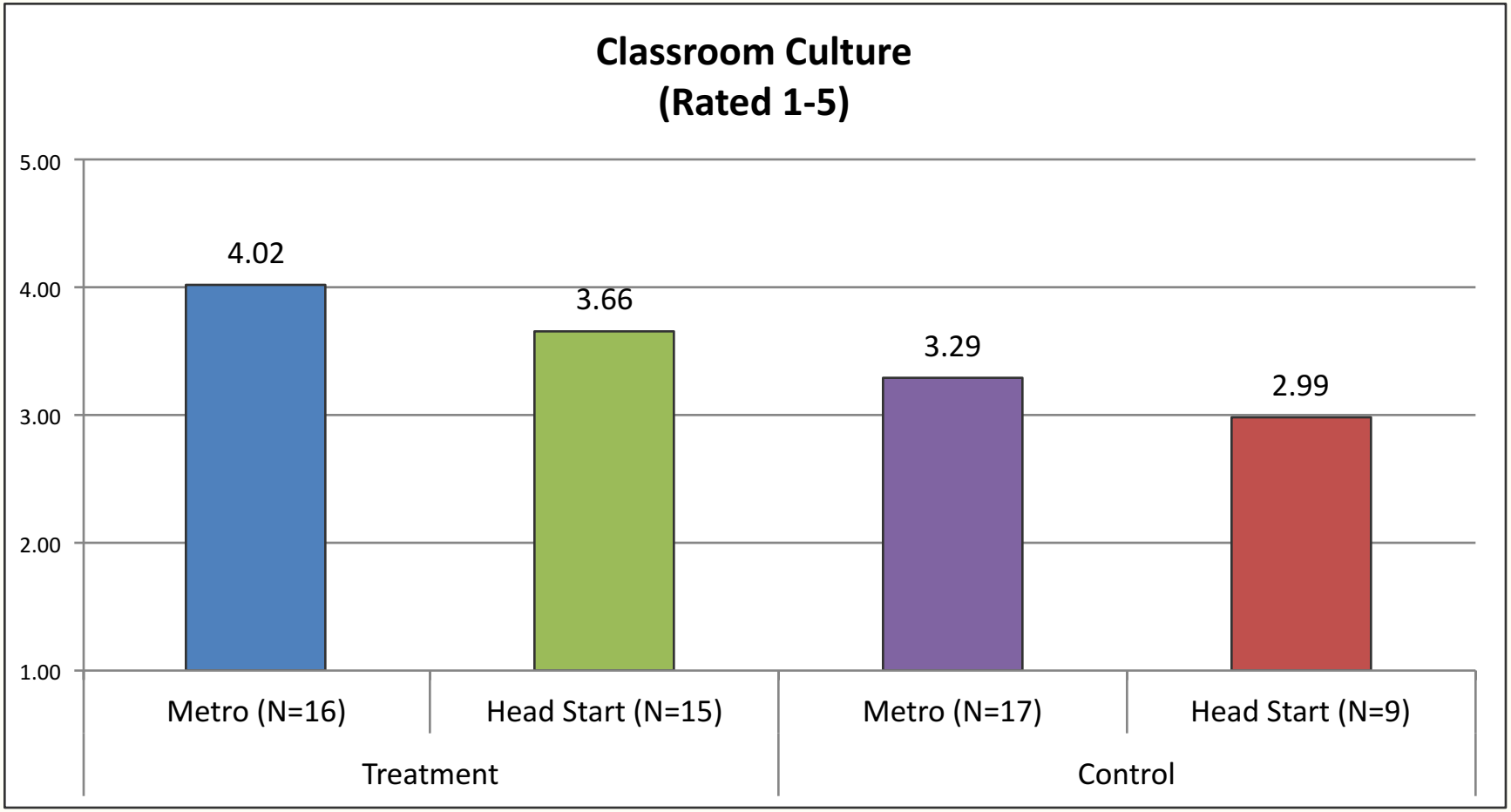


*Covariate Adjusted Scores

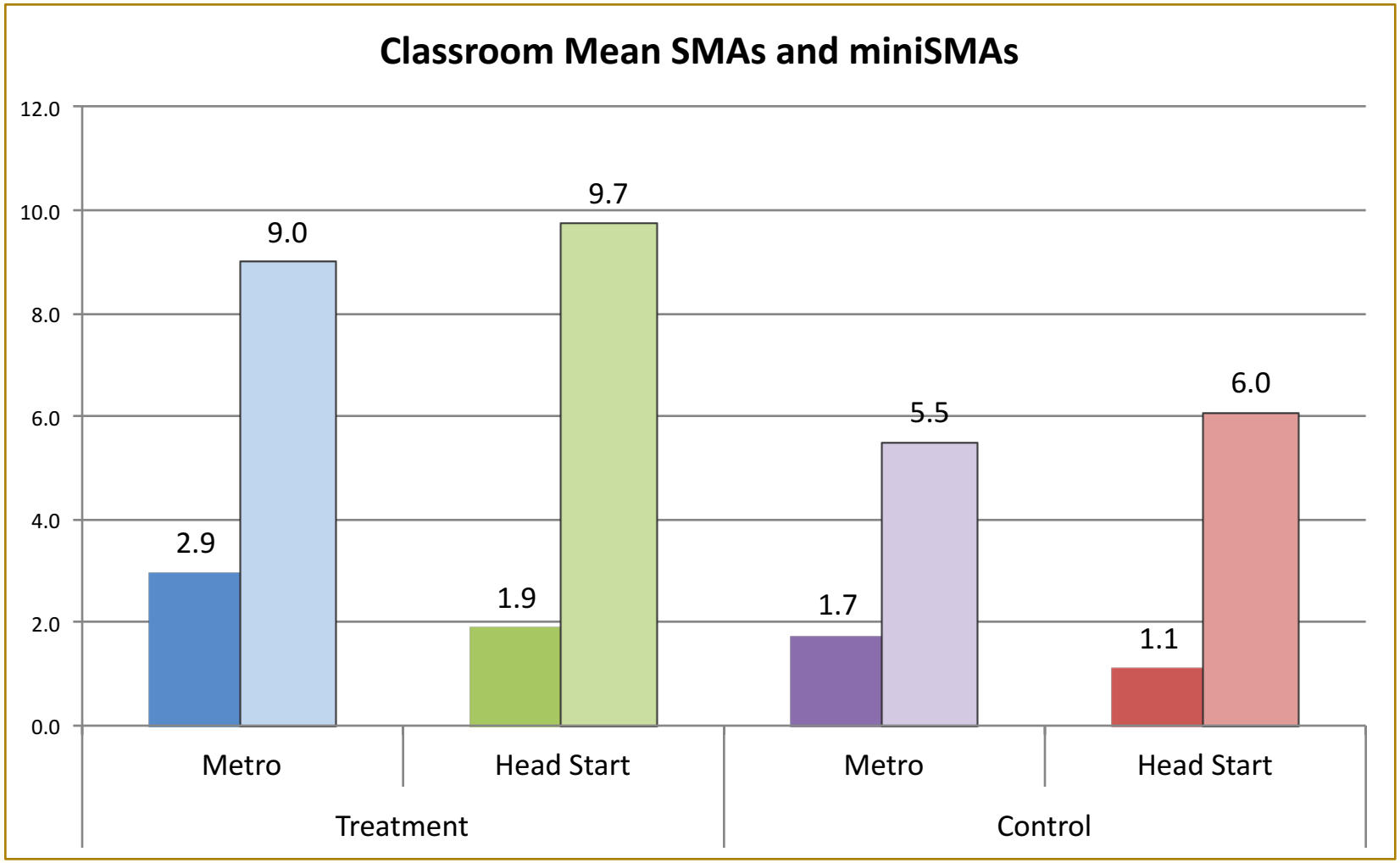
Fidelity

- Measured in Treatment and Control Classrooms
  - COEMET (*Classroom Observation of Early Mathematics—Environment and Teaching;* Sarama & Clements, 2007)
    - Classroom Culture
    - Specific Math Activities (SMA's)
    - Miniature Specific Math Activities (miniSMA's)

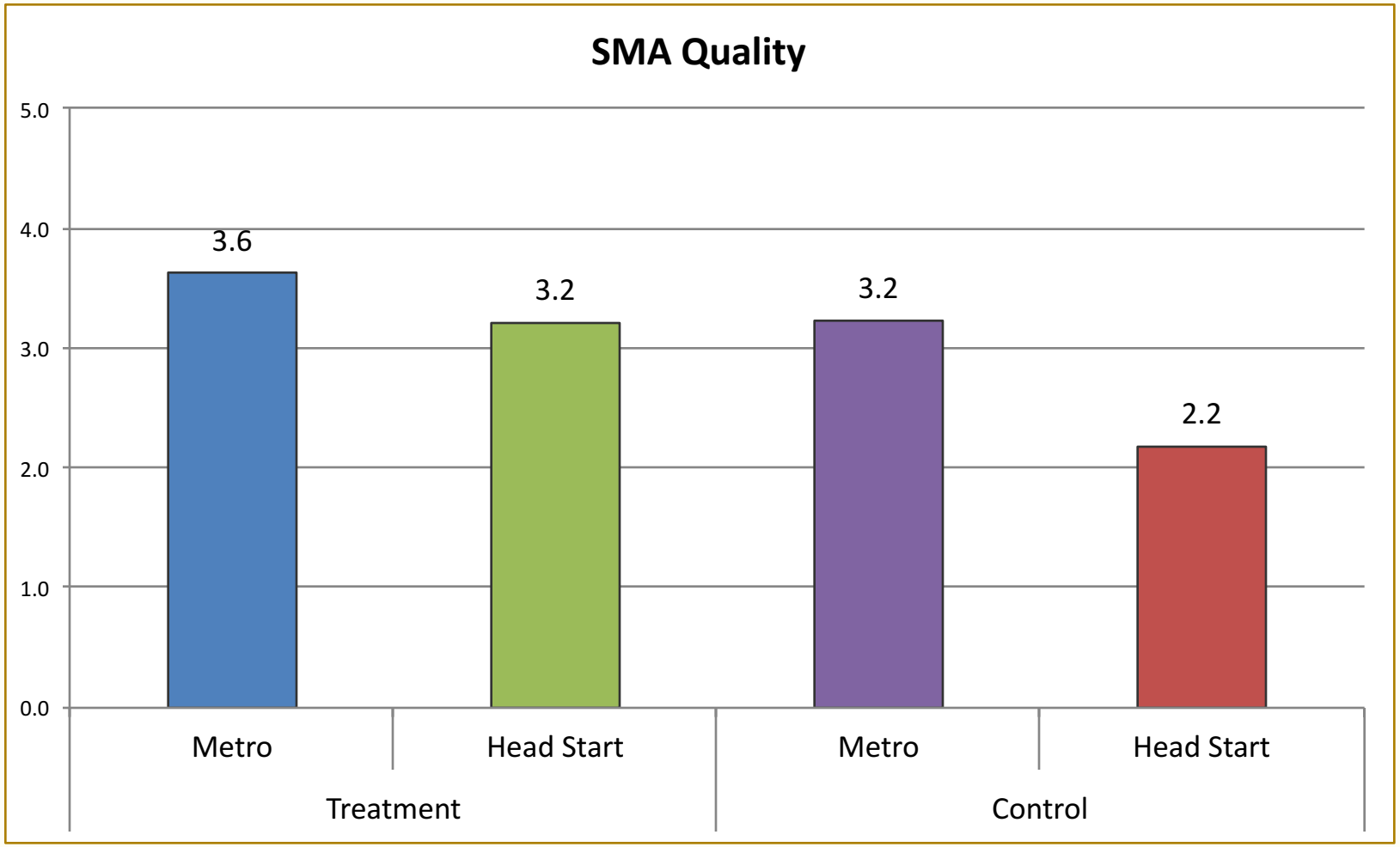
Classroom Culture (COEMET)

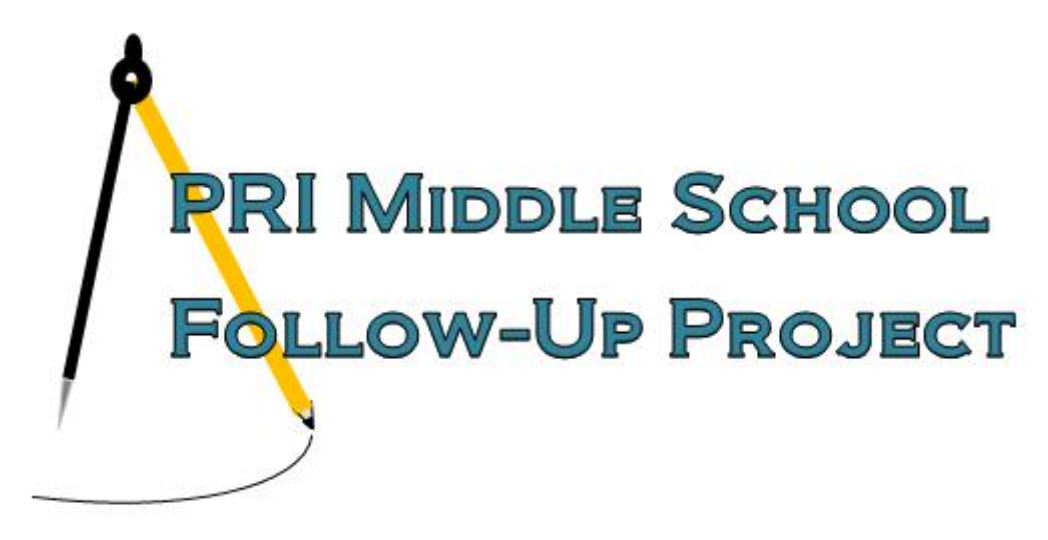


SMA Numbers (COEMET)



SMA Quality (COEMET)





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Dale Farran and Kerry Hofer, Co-PI's
Bethany Rittle-Johnson, Gavin Price and Bruce McCandliss, Investigators

Follow Up Sample

- 771 consented students originally
  - 16 withdrew in 1st grade
  - 29 no longer in Tennessee
  - 45 students not located in state data base
  - 53 in Tennessee but not in Nashville
  - **34 students' Nashville parents declined**
  - 72 students located but never responded (backpacks!)

90 Students unrecoverable

- 522 students re-consented – all from Metro Nashville Public Schools (MNPS) (77% retained; 5% declined)
  - 521 assessed this past spring
    - 317 BB treatment children (70% of original group)
    - 205 Control children (64% of original group)

76 Schools

- 31 elementary schools
  - 15% retained
  - 2.4 students assessed per school
- 27 Middle schools
  - 10.3 students assessed per school
- 18 Izone or Charter schools
  - Izone – independent schools grouped because they were failing
  - Charter – Nashville new and resistant to charters. Must serve low income students in areas where schools are failing
  - 9.7 students assessed per school

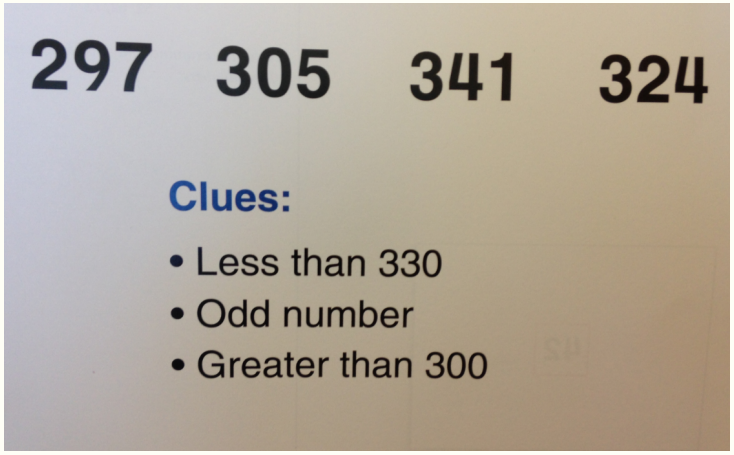
Demographics

	N	Min	Max	Mean	SD
Age at Time of Testing (in years)	521	10.4	12.5	11.05	0.325
PK Treatment Condition	316	10.4	12.5	11.0	.320
PK Control Condition	205	10.4	12.3	11.1	.327

	Overall		PK Treatment		PK Control	
	Freq	Pct	Freq	Pct	Freq	Pct
Ethnicity						
Black	411	79%	259	82%	152	74%
White	46	9%	23	7%	23	11%
Hispanic	42	8%	20	6%	22	11%
Other	22	4%	15	5%	7	4%
Gender						
Male	228	44%	140	44%	88	43%
Female	293	56%	176	56%	117	57%
Pre-K School System*						
MAC	210	40%	152	48%	58	28%
MNPS	311	60%	164	52%	147	72%

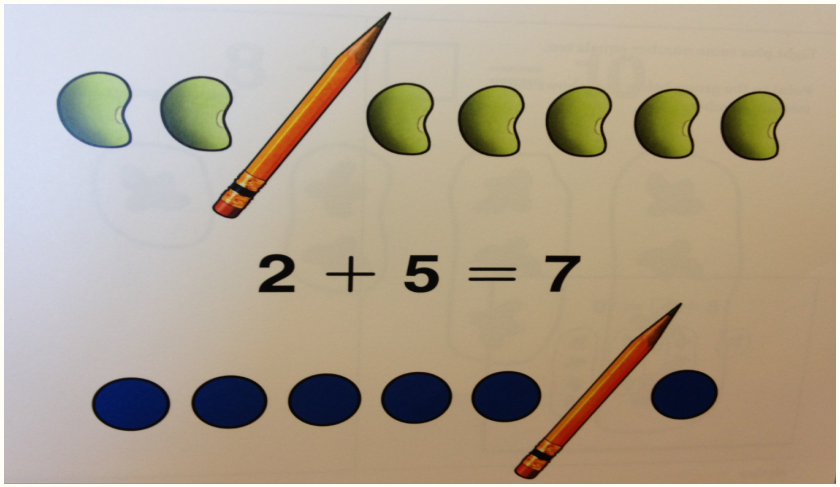
Assessments: KeyMath 3 Diagnostic As

- *Numeration* - The Numeration subtest measures an individual's understanding of whole and rational numbers.
- Example: **Use the clues to find which number I am thinking about. It's less than three hundred thirty, it's an odd number, and it's greater than three hundred. Which number am I thinking about?**



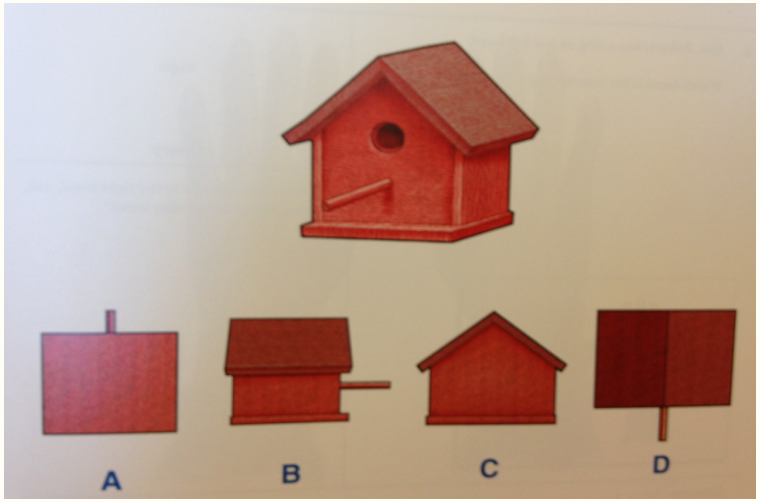
- *(Answer: 305)*

- ***Algebra*** - The Algebra subtest measures an individual's understanding of pre-algebraic and algebraic concepts.
- Example: **The pencil separates the row of seven beans to show the addition sentence two and five equals seven. Here is a row of blue dots. What is the new addition sentence?**



(Answer: 5 + 1 = 6 or 1 + 5 = 6)

- ***Geometry*** - The Geometry subtest measures an individual's ability to analyze, describe, compare, and classify two- and three-dimensional shapes. It also covers topics such as spatial relationships and reasoning, coordinates, symmetry, and geometric modeling.
- Example: **Here is a birdhouse. Below are different views of the birdhouse. Which view is the back of the birdhouse?**



(Answer: C)

Woodcock Johnson Achievement Battery III: Quantitative Concepts Subtest (carryover from original)

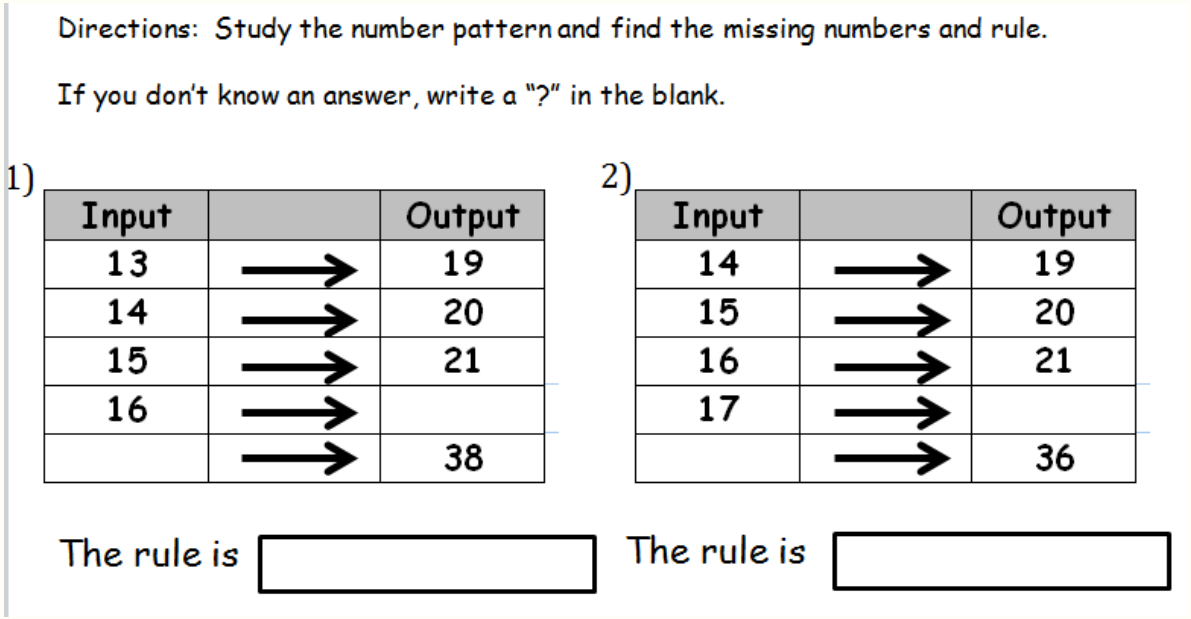
- Assesses students' knowledge of mathematical concepts, symbols, and vocabulary, including numbers, shapes, and sequences; it measures aspects of quantitative math knowledge and recognition of patterns in a series of numbers.
- Examples (Part A):
  - *What does a decimal point look like?*
  - *What does this abbreviation mean?* **Oz**
- Example (Part B):
  - *For each problem, tell me the number that goes in the blank space.*

    ____ *5 6 7*

Pre-Algebra Task (Functional Thinking)

Developed by Bethany Rittle-Johnson this task consists of 6 'tables' in which the student has to fill in the missing Input number, Output number, and Rule. The maximum possible score is 18 (3 points per table).

Examples:



Directions: Study the number pattern and find the missing numbers and rule.

If you don't know an answer, write a "?" in the blank.

1)

Input		Output
13	→	19
14	→	20
15	→	21
16	→	
	→	38

The rule is _____

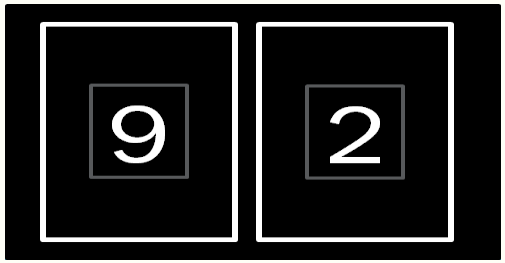
2)

Input		Output
14	→	19
15	→	20
16	→	21
17	→	
	→	36

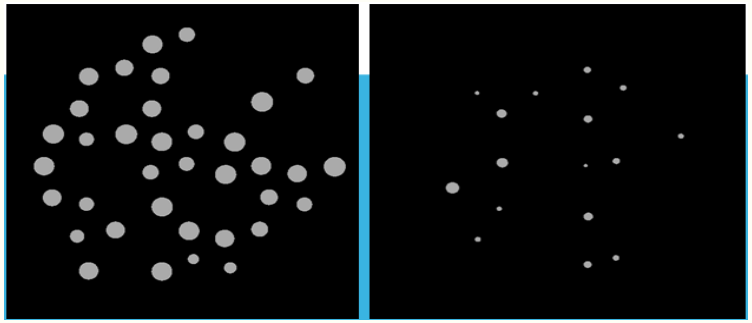
The rule is _____

Math-Specific Neurocognitive Measures

1. ***Symbolic Number Comparison Task.*** This task assesses children's symbolic Approximate Number System (ANS) acuity through the presentation of two single digits simultaneously.



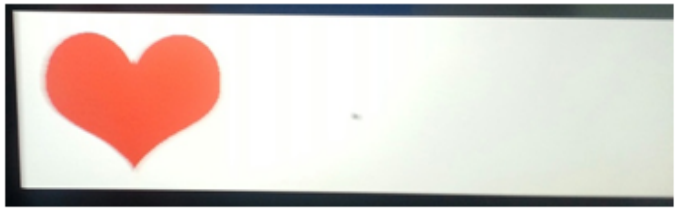
2. ***Non-symbolic Number Comparison (ANS).*** Student must decide which side of the screen contains more dots.



Domain General: Executive Function and Visuospatial Skill

1. ***Working Memory (Backward Corsi Blocks).*** Different numbers of squares light up in a sequence; the student must tap the squares in the reverse. The task consists of 16 total trials made up of 8 2-trial items. The sequence length of squares increases from 2 to 8.
2. ***Attention Shifting.*** Hearts and Flowers (HAF) task tests a student's ability to use attention shifting and inhibitory control by tapping congruent or incongruent sides of the screen based on different stimuli + rule combinations. The task consists of 12 congruent trials, 12 incongruent trials, and 48 mixed trials.

Congruent Trials (student presses the button that corresponds to the SAME side the heart appears on)



Incongruent Trials (student presses the button that corresponds to the OPPOSITE side the flower appears on)

Other Measures

1. End of Grade State Test Scores (TCAP): Math and Reading
2. Course Grades: Reading (Language Arts) and Math
3. Student Survey: *Feelings about Math*
4. Teacher Survey
   - Classroom Characteristics
   - Student Performance
   - Student Motivation and Work Effort

Key Math Descriptives: Full Sample

		Mean	SD
KM: NUMERATION			
	AGE EQUIVALENT	9.21	2.03
	GRADE EQUIVALENT	4.20	1.97
KM: ALGEBRA			
	AGE EQUIVALENT	9.15	1.96
	GRADE EQUIVALENT	4.31	1.84
KM: GEOMETRY			
	AGE EQUIVALENT	8.62	1.98
	GRADE EQUIVALENT	3.91	1.96

Intercorrelations Among Assessments of Traditional Math

	KM NUMBER	KM ALGEBRA	KM GEOMETRY	QUANT CONCEPTS
KM NUMBER	--			
KM ALGEBRA	.83	--		
KM GEOMETRY	.69	.66	--	
QUANT. CONCEPTS	.68	.68	.54	--
FUNCTIONS	.66	.66	.45	.60

Correlations between Traditional Math and Neurocognitive Assessments

	KM NUMBER	KM ALGEBRA	KM GEOMETRY	QUANT CONCEPTS	FUNCTIONS
SYM NUMBER	.33	.36	.27	.34	.31
ANS ACCURACY	.16	.17	.17	.15	.18
HAF INCONG.	.23	.22	.20	.23	.19
HAF MIXED	.29	.27	.25	.32	.28
BACKWARD SPAN	.35	.31	.31	.35	.27

Very Below Average Students (61) Compared to Average Students (460)

DESCRIPTIVE STATISTICS ON 460 VERSUS 61				
	At or Above 3rd Grade on KM		Below 3rd Grade on All KM	
	Mean	SD	Mean	SD
Quant Concepts (Std)	93.2	10.9	70.6	13.7
Functions Total (18)	7.5	4.6	2.0	2.0
S. Number Accuracy	.96	.04	.90	.06
S. Number RT	736.4	199.5	769.2	187.3
ANS Accuracy	.61	.10	.55	.18
ANS RT	832.9	226.9	744.1	129.9
HAF Mixed Accuracy	.67	.14	.57	.11
HAF Mixed RT	576.9	81.2	532.4	106.8
Backwards Span	4.6	1.4	3.2	1.6

Summing Up Performance

- This group of 521 urban students from poor families are scoring 1 ½ to 2 years behind in math knowledge, the worst being fundamentals to Geometry.
- Ending the 5th grade (for most), they have skills comparable to beginning 4th graders or those finishing 3rd grade.
- In other words, from their 6 years of schooling, they are making 2/3 the progress.
- 12% of them are even further behind
- The neurocognitive assessments behave somewhat differently for these children.
  - They don't "see" number quickly
  - They respond too quickly to non-symbolic assessments, making more errors.

One possibility is that these low scoring children have math dyscalculia and could have been identified earlier and provided a different kind of math instruction.

PREDICTING LATER OUTCOMES FROM EARLIER MATH SKILLS

Preliminary Results

- Scores at the end of 1st grade on Quantitative Concepts and the REMA correlate .40 to .50 for the 460 who were at or above 3rd grade.
  - The strongest predictors were between measures of Number knowledge early and later
  - Geometry correlations are weaker
- Correlations for those below 3rd grade on all KeyMath outcomes between early and later skills are .30 or lower
  - The correlations between their pretest pre-k scores and later outcomes are 0.
- So far, little in our data suggests early identification as a solution

Other Interesting (unexplored) Findings

- Correlations between how children feel about math and how they rate their skills in math and their actual performance are all below .20.

- Correlations between teachers' ratings of children's math competencies and their actual skills average .55.

- Neither the students nor the teachers seem to be truly aware of how much the students have learned.

THANK YOU!
QUESTIONS?