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EdData II
Education Data for Decision Making

Development and Rationale of the Early Grade Math Assessment

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About the Presentation

- This presentation was prepared for use in a one-day workshop titled "Understanding the Early Grade Reading and Math Assessments: From Development to Data Analysis," led by RTI International at the annual conference of the Comparative and International Education Society (CIES) in San Juan, Puerto Rico, April 22, 2012.

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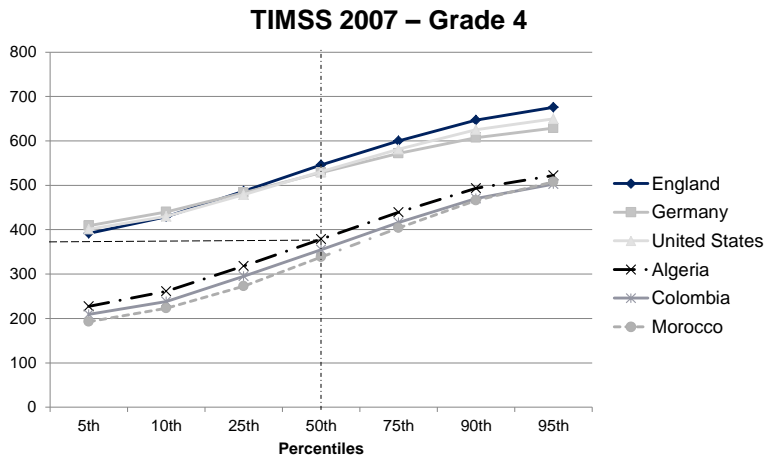
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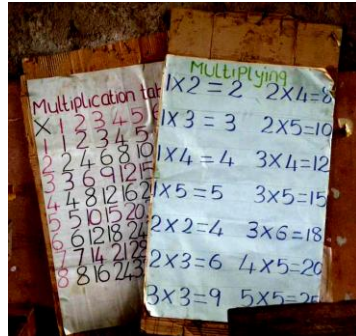
Why Math?

Why Math?

- Being able to access information through understanding and manipulating numbers can have a positive impact on an individual's day-to-day life
- Early grade mathematics forms the foundation for skills in higher-level mathematics, as well as in science, technology, and engineering (STEM)
- Recent meta-analyses of longitudinal data show that early math skills have the greatest predictive power of later academic achievement (Duncan et al., 2007; Romano et al., 2010)

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., et al. (2007). School readiness and later achievement. *Developmental Psychology*, *43* (6), 1428-1446 and correction, 44(1), 232.
Romano, E., Babchishin, L., Pagani, L. S., & Kohen, D. (2010). School readiness and later achievement: Replication and extension using a nationwide Canadian survey. *Developmental Psychology, 46*(5), 995–007.

Why EGMA?

TIMSS 2007 – Grade 4

Legend:
- England
- Germany
- United States
- Algeria
- Colombia
- Morocco

X-axis (Percentiles): 5th, 10th, 25th, 50th, 75th, 90th, 95th
Y-axis: 0, 100, 200, 300, 400, 500, 600, 700, 800

TIMSS = Trends in International Mathematics and Science Study (international achievement assessments)

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EGMA Development Process

1. Conduct extensive literature review, establish conceptual framework (based on review of research conducted over the past 60 years)
2. Contact experts in the field who had done similar work in the U.S. and beyond
3. Develop draft tasks
4. Convene an expert panel to discuss skills and tasks to be included in the EGMA
5. Pilot EGMA
6. Review pilot, revise instrument
7. Apply EGMA
8. Expert panel review and recommendations – refine instruction and item specifications

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EGMA Development Process

EGMA applications to date

- Kenya
- Liberia
- Malawi
- DR Congo
- Mali
- Rwanda

- East Timor
- Zambia
- Morocco
- Iraq
- Jordan

EGMA Specifications

- Overall instrument features
  - Quick administration, easy to score
  - High face validity
  - Oral administration
  - Feasible to administer in developing-country contexts, including context-specific adaptations as needed

EGMA Specifications

- subtasks – Criteria for inclusion
  - Represent a progression of foundational skills that support proficiency in mathematics
  - Research indicates predictive power
  - Include measures of both conceptual understanding and procedural fluency/automaticity
  - Common in many curricula for early grades
  - Teachable

EGMA Subtasks

Number Identification (Timed)

- Allows children to use knowledge which they have gained through auditory means (their ears) and connect this with printed numbers, like 4.
- Numbers serve to describe set sizes and measurements
  - Quantity
    - Six children
  - Length/Distance
    - Five miles or 2 days
  - Area
    - Ten square miles
- Students need to be able to identify numbers with automaticity.

EGMA Subtasks

Number identification (timed)

2	9	0	12	30
22	45	39	23	48
91	33	74	87	65
108	245	587	731	989

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EGMA Subtasks

Number Discrimination (Comparison)

- In order to be able to discriminate between two different quantities (numbers) children must understand:
  - Number order
  - Place value
- If children cannot discriminate between two numbers, they will not be able to do higher mathematics like addition, subtraction, multiplication, and division.

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EGMA Subtasks

Number Discrimination (Comparison)

7	5	_7_	1	0	94	78	_94_	1	0
11	24	_24_	1	0	146	153	_153_	1	0
39	23	_39_	1	0	287	534	_534_	1	0
58	49	_58_	1	0	623	632	_632_	1	0
65	67	_67_	1	0	867	965	_965_	1	0

EGMA Subtasks

Missing Number (Patterns)
- Recognizing patterns is fundamental in mathematics
- Leads to beginning of multiplication
  - 2, 4, 6, is one way of figuring out 2 x 3
- Supports problem-solving and foundations of algebra
- Facilitates flexibility and efficiency in mathematical thinking
  - 1, 2, 3, 4, 5, 6, 7
  - 10, 20, 30, 40, 50, 60, 70
  - 25, 50, 75, 100, 125, 150, 175

Missing Number (Patterns)

1						6					
5	6	7	(8)	1	0	348	349	(350)	351	1	0

2						7					
14	15	(16)	17	1	0	28	(26)	24	22	1	0

3						8					
20	(30)	40	50	1	0	30	35	40	45	1	0

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Addition and Subtraction – Level 1 (Timed)

- Addition and subtraction are the basis for many later mathematical skills
  - Multiplication
  - Division
  - Algebra
  - Geometry
- If students do not master the most basic addition and subtraction problems with automaticity, they will struggle with even more complicated addition and subtraction, much less multiplication, division, etc.

EGMA Subtasks

Addition – Level 1 (Timed)

1 + 3 = (4)	7 + 8 = (15)
2 + 3 = (5)	4 + 7 = (11)
6 + 2 = (8)	7 + 5 = (12)
4 + 5 = (9)	8 + 6 = (14)
3 + 3 = (6)	9 + 8 = (17)
8 + 1 = (9)	6 + 7 = (13)

EGMA Subtasks

Subtraction – Level 1 (Timed)

4 – 3 = (1)	15 – 8 = (7)
5 – 3 = (2)	11 – 7 = (4)
8 – 2 = (6)	12 – 5 = (7)
9 – 5 = (4)	14 – 6 = (8)
6 – 3 = (3)	17 – 8 = (9)
9 – 1 = (8)	13 – 7 = (6)

Addition and Subtraction – Level 2

- More difficult problems – allows for better capture of a range of abilities
- Extends principles and procedures of addition and subtraction to include place value:
  - 2 + 4 =
  - 12 + 4 =
  - 12 + 24 =

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Addition – Level 2 (Timed)

13 + 6 = (19) | 1 | | 0 |

18 + 7 = (25) | 1 | | 0 |

12 + 14 = (26) | 1 | | 0 |

22 + 37 = (59) | 1 | | 0 |

38 + 26 = (64) | 1 | | 0 |

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EGMA Subtasks

Subtraction – Level 2 (Timed)

19 − 6 = (13) | 1 | 0 |

25 − 7 = (18) | 1 | 0 |

26 − 14 = (12) | 1 | 0 |

59 − 37 = (22) | 1 | 0 |

64 − 26 = (38) | 1 | 0 |

EGMA Subtasks

Word Problems

- "Problem solving means engaging in a task for which the solution method is not known in advance." (NCTM, 2000)
- The word problems reflect the different "types" of addition and subtraction problems (join, separate, part-part-whole, compare or equalize), as well as basic principles of multiplication, and show whether a child can work conceptually through real-life problems to figure out the answer (minimizing procedural factors)

National Council of Teachers of Mathematics (NCTM) [USA]. (2000). *Principles and standards for school mathematics.* Reston, Virginia: NCTM.

EGMA Subtasks

Word Problems

Exercise		
Exercise 1 🔊 2 children are on the bus. [*pause and check*] 3 more children get on. [*pause and check*] How many children are on the bus altogether?	✓✗ Correct answer: 5 \[1\] \[0\]	
Exercise 2 🔊 There are 6 children on the bus. [*pause and check*] 2 are boys. The others are girls. [*pause and check*] How many girls are there on the bus?	✓✗ Correct answer: 4 \[1\] \[0\]	
Exercise 3 🔊 There are 2 children on John's bus. [*pause and check*] There are 8 children on Mary's bus. [*pause and check*] How many more children must join John's bus so that it has the same number of children as Mary's bus?	✓✗ Correct answer: 6 \[1\] \[0\]	

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EGMA – Future Steps

- Addition of two additional subtasks recommended by expert panel:
  - *Relational Reasoning*: Being able to consider numerical and/or spatial relationships, particularly for solving problems (i.e., 5 + 2 = 2 + ___ or 52 + 3 – 3 = ___)
  - *Spatial Reasoning*: Being able to visualize spatial patterns and mentally manipulate them
- Development of EGMA toolkit

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Uses of EGRA/EGMA – General Guidelines

- What EGRA/EGMA can do:
  - Target EARLY competencies – can show how students are doing in mastering those early skills
  - Help to identify specific weaknesses/strengths and relationships with supporting factors
- EGRA/EGMA can be used:
  - To give a "snapshot" of performance, based on random sample
  - To help determine areas of focus for improvement
  - In impact and program evaluation – to help show how policy and instructional changes are working
  - At the school/classroom level (with some adaptation)
- EGRA/EGMA can/should NOT be used:
  - For targeting higher-level skills
  - On a census-level basis (cannot test all students)
  - For high-stakes accountability

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Matching Approach to Purpose

Types of EGRA Surveys, According to Purpose	
If you are interested in….	EGRA can be used as a…
• Obtaining a rough estimate or picture of students' reading ability in a particular population	Reading "Snapshot": Using all or selected EGRA subtasks, the assessment can quickly determine reading levels to raise awareness about reading challenges and motivate policy makers, ministry staff, donors, and civil society to take action.
• Ascertaining students' reading ability throughout the country • Identifying differences in student literacy development across regions, languages, types of schools, and sex • Determining the effect of language policy on students' reading development	National or System-Level Diagnostic: Using all subtasks relevant to the curriculum and language, EGRA can thoroughly examine gaps in reading competencies to help improve policy, curriculum, and pre-service and professional development programs for teachers.

From RTI International & International Rescue Committee (IRC). (2011, July). *Guidance notes for planning and implementing EGRA.* Available from https://www.eddataglobal.org/reading/index.cfm?fuseaction=pubDetail&id=318

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Matching Approach to Purpose

Types of EGRA Surveys, According to Purpose	
If you are interested in….	EGRA can be used as a…
• Knowing whether a particular reading intervention is effective in improving children's reading performance • Comparing the effectiveness of different programs aimed at improving reading outcomes	Impact Evaluation: Using relevant subtasks, an EGRA survey can be used to detect change over time in student performance resulting from an intervention aimed at improving reading instruction and learning outcomes.
• Identifying whether students in a particular classroom are developing reading skills with current interventions • Identifying whether instruction needs to be differentiated for students in a classroom • Monitoring student progress	Classroom Assessment: Using selected subtasks relevant to classroom instruction, teachers can apply EGRA to conduct a mastery check of a whole class or to monitor progress of particular students against norms and benchmarks for the grade in order to inform instruction at the classroom level.

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More Information

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