Utilizing Core Instruction to Address the Mathematics Learning Needs of ELs in Kindergarten

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Promising Math Conference

Need for Mathematical Knowledge

- “For people to participate fully in society, they must know basic mathematics. Citizens who cannot reason mathematically are cut off from whole realms of human endeavor. Innumeracy deprives them not only of opportunity but also of competence in everyday tasks.” (Kilpatrick, Swafford, & Findell, *Adding It Up*, 2001)

Case for the Research - General

- Increased expectations and rigor for all students as operationalized in the Common Core State Standards (CCSS, 2010; NMAP, 2009) including engagement with the academic language of mathematics

- Many students, particularly students from economically and educationally disadvantaged backgrounds, are at an elevated risk for mathematics difficulties early in their education (Clarke et al., 2011; Griffin, 1994; National Mathematics Advisory Panel, 2008)

Case for the Research - General

- Mathematics achievement trajectories are established early and are difficult to change (Bodvoski & Farkas, 2007; Duncan et al, 2007; Morgan, Farkas, & Wu, 2009)

- The prevention of early mathematics difficulties and effective early intervention should be a primary focus of educational research and practice (Gersten & Chard 2005)

Case for the Research - ELs

- Rapid increase of ELs in the U.S. with Spanish-speaking students the fastest growing sub-group among ELs (70%)

- Many Spanish-speaking ELs from Mexico and countries in Central America, similar to their at-risk US peers, tend to come from educationally and economically disadvantaged backgrounds.

- As a result of these SES obstacles and the inherent challenges associated with learning a new language, these ELs in particular are at greatest risk for facing mathematics difficulties.

Goldenberg, 2008

Case for the Research - ELs

- Achievement levels are concerning
  - 86% of 4th grade ELs scored below proficient on the 2015 NAEP; no change since 2009.
- Gaps between ELs and their peers appear early and remain stable over time (Reardon & Galindo, 2009)

Case for the Research - ELs

- Academic achievement of ELs is linked to the use of disciplinary language.
  - Math achievement is linked to student math verbalizations
- Relatively few rigorous studies of math interventions for ELs.
  - A research base exists on effective instructional design frameworks for at-risk learners.

Case for the Research - ELs

- Kindergarten presents unique challenges in the area of mathematics
  - Consider the support provided around beginning reading instruction and the time and financial resources required to provide that support
  - ELs face a double demand to acquire proficiency in English and math (Baker et al., 2014)

It is likely that the totality of a EL's mathematics experience in K will be delivered through the core curriculum

Instructional Practice Recommendations for Math Instruction with Els (Doabler et al., 2016)

- Design mathematics instruction to promote student success
- Model new and complex mathematical content
- Use visual representations to promote conceptual understanding

Instructional Practice Recommendations for Math Instruction with Els (Doabler et al., 2016)

- Provide structured opportunities for learning and using the academic vocabulary of mathematics
- Provide frequent opportunities for students to communicate their mathematical thinking
- Provide timely, specific academic feedback

ELM Background

Initial grant from IES (2003-2006)

- Development of a core kindergarten mathematics program (ELM)

IES grant 2007-2011

- Study the efficacy of ELM

2011-Present

- Development and efficacy trials continue along with dissemination of study results

Structure of ELM

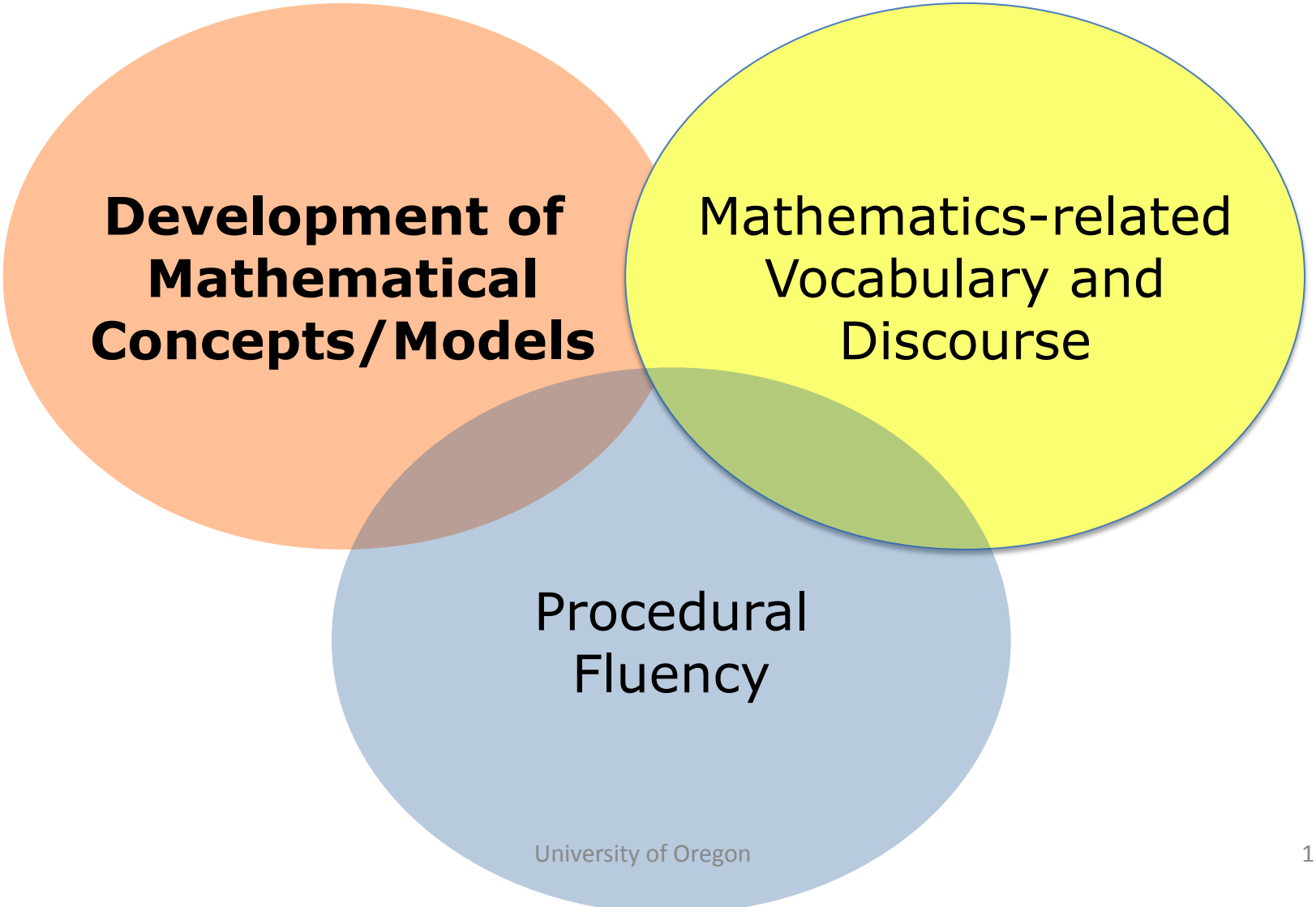
Daily Calendar Lessons

- Daily whole-class calendar time (15 min.)
- Calendar Book contains daily routines and monthly objectives

120 Core Lessons Divided into 4 Quarters

- 45 minutes whole-group math instruction
- Final 15 minutes is guided and independent application using Math Practice sheet
- End of each quarter assessment of progress

ELM Content Conceptual Framework



ELM Instructional Content

National Math Advisory Panel (2008) recommends a focused

coherent progression of mathematics learning with emphasis on proficiency with key topics

Common Core State Standards for Mathematics for K (2010)

- Counting and cardinality
- Operations and algebraic thinking
- Numbers and operations in base ten
- Measurement and data
- Geometry

ELM Objectives

Numbers and Operations

- Proficiency in numeration to 30.
- Count and identify numbers to 100.
  - Including skip counting by 5s and 10s
- Use a variety of ways to model and represent numbers (fingers, tallies, ten frame, number line, hundreds chart, base ten blocks).
- Use multiple strategies to solve simple addition and subtraction problems including story problems.

ELM Objectives
Geometry

- Identify and describe common 2 and 3 dimensional geometric shapes.

- Sort and describe objects by shape, color, size, and other attributes.

- Recognize and extend simple patterns.

ELM Objectives

Measurement

- Compare and order groups of objects with various strategies

  (visually, 1:1 correspondence, counting).
- Identify objects and groups that are more, less, or equal.
- Understand concepts of time, money, and measurement.
- Measure in inches, tell time to the hour, count and compare coins.
- Create and interpret graphs.

Math Related Vocabulary and Discourse in ELM

- Basic concepts representing quantitative and relational concepts
  - Before, next, last, after, more, how much
- Vocabulary unique to mathematics
  - Equal, triangle, measure, subtract, pattern
- Teacher scripting for consistency and accuracy of math vocabulary definitions
- Opportunities to engage in classroom discourse using these words

Math Vocabulary and Discourse

Lesson 11 Objectives	Numbers & Operations	One-to-one correspondence; Rational count 1 to 5; Identify and trace numerals 1-5
	Geometry	**Recognize and name triangle**; Review circle and square; Compare shapes
	Measurement	
	Vocabulary	Understand and use the vocabulary words: *shape, circle, square, triangle, straight, round, same, different*
Materials	Teacher	Story Book, Where Are the Triangles? (or other book about triangles); Shape cards (circle, square, and different types of triangles)
	Student	Baggie for each child with 5 triangles. Each baggie should have the same color, but use lots of different colors across bags (can use shape cards, shape blocks, or cut outs from construction paper); Math Practice 11, pencil, and crayons

1. Introduce the concept of triangle; Review and compare shapes (Vocabulary: shape, triangle, circle, square, straight, round, same, different)

- Say, **"We've talked about *circles* and *squares*."** Hold up a circle and square and ask children to tell you the names of the sh

- Say, **"Today, we're going to learn about *triangles*."** Hold up a triangle.

- **"This *shape* is a *triangle*. What's the name of this *shape*, everybody?"** ("A triangle.") **"Yes, this *shape* is a *triangle*."**

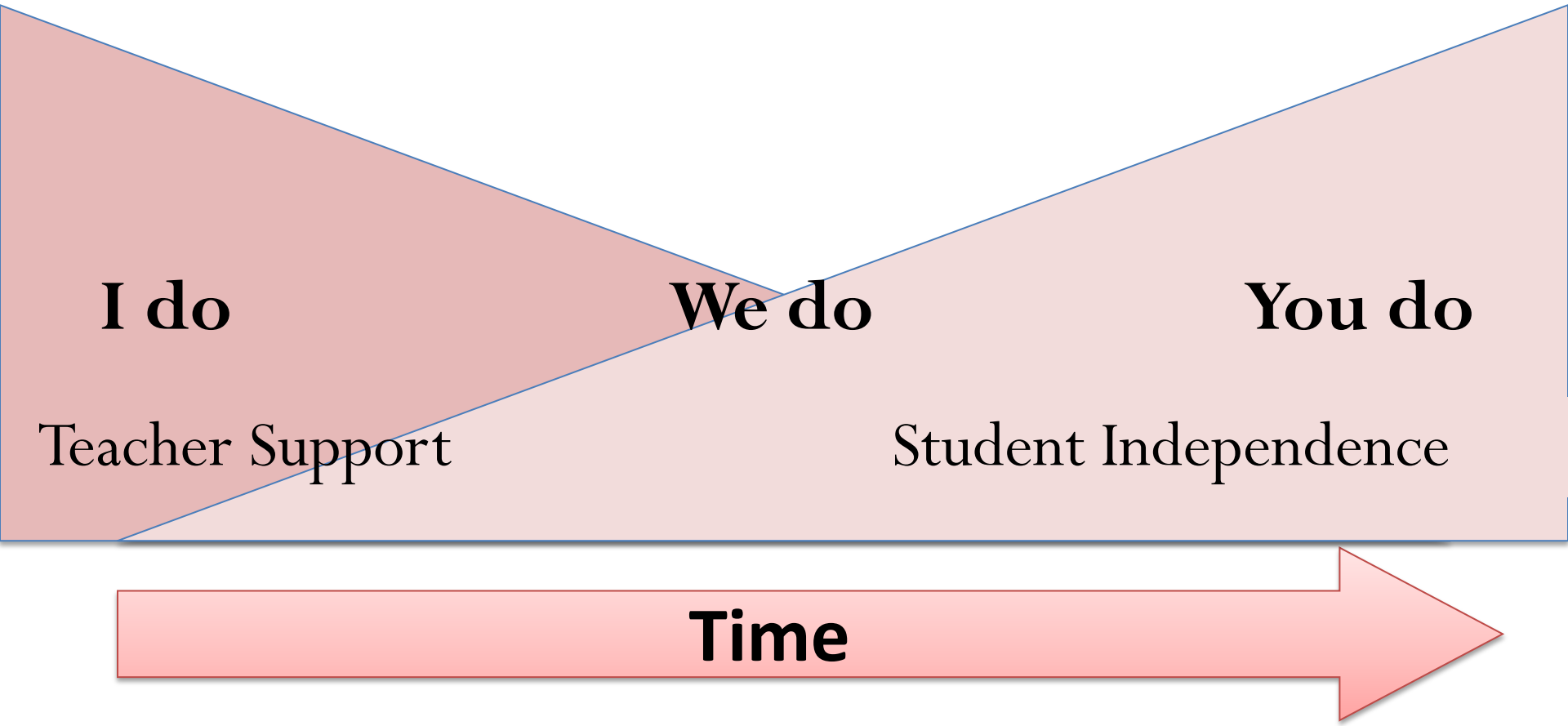
Procedural Fluency and Automaticity in ELM

- Automatic and effortless recall of basic math concepts frees up cognitive resources needed to focus on more complex problems
- Multiple strand instruction provides daily practice across lessons
- Children are given frequent opportunities to respond in whole class, partner, and written math practice activities
- Teacher checks for understanding integrated into lessons

Explicit Instruction

Key Math Principles and Concepts	• Explicitly modeled • Scaffolded student application • Responsive teacher feedback
Opportunities for Students to Verbalize	• Essential mathematical concepts • Mathematical thinking and reasoning
Engage in Essential Practice	• Key mathematical concepts • Rich and frequent opportunities • Push toward generalization of skills

Scaffolding Instruction for Success in ELM



Study Design

4-year project

2 Randomized Controlled Trials

Study 1: Purpose

Measure the efficacy of a Tier-1 kindergarten mathematics curriculum

Oregon (2008-09)

Texas (2009-10)

Study 1: Research Design

K-classrooms randomly assigned to treatment or control conditions.

Treatment classrooms implemented ELM curriculum

Control classrooms (business as usual) used a host of commercially-available math curricula, including Everyday Math, Houghton Mifflin

Research Question 1

What is the immediate impact of ELM taught in general education kindergarten classrooms on mathematics achievement compared to standard district practice and does impact depend on student initial achievement?

Participants

	ELM	Control
Classrooms	68	61
Students	1401	1197

N = 129 classrooms and 2598 students

Post Test: Student Measures of Impact

Test of Early Mathematics Ability (TEMA)

Early Numeracy – CBM

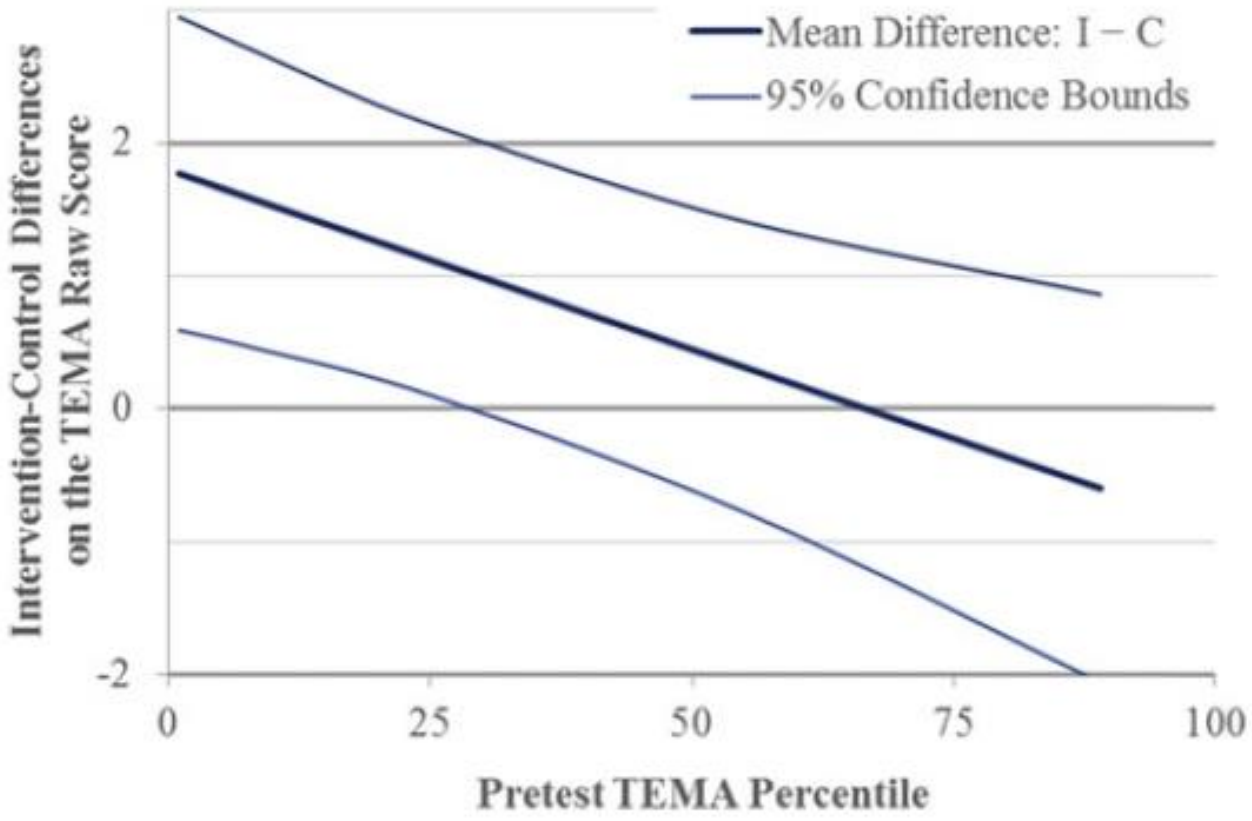
- Oral Counting
- Number Identification
- Quantity Discrimination
- Missing Number

Results: Effect Sizes (Hedges' *g*)

Measure	All Students	At Risk
TEMA Raw Score	+0.11	+0.18*
EN-CBM Total	+0.10	+0.13

Note. 65% of the sample was classified as at-risk (below the 40th percentile).

Moderation: Initial Achievement



Study 2 Objectives

2

- What is the effect of the ELM curriculum on the math achievement of Spanish Speaking (SS)-ELs?

2a

- Do math skills at the beginning of K predict differential response to the ELM curriculum amongst SS-ELs?

2b

- Do the number of SS-ELs in classrooms predict differential response to the ELM curriculum? Does the frequency of math discourse predict differential response to the ELM curriculum?

Participants

- Subsample of previous study

	ELM	Control
Classrooms	35	31
Students	328	228

Research Question 2

- What is the effect of the ELM curriculum on the math achievement of SS-ELs?

Measure	Hedges G	P value
TEMA Raw Score	+0.30	.04*
EN-CBM Total	+0.18	.17

Research Question 2a-2c

Do math skills at the beginning of K predict differential response to the ELM curriculum amongst SS-ELs? NO

Do the number of SS-Els in classrooms predict differential response to the ELM curriculum? NO

Does the frequency of math discourse predict differential response to the ELM curriculum? NO

Results Summary

- ELM showed a similar benefit for ELs as had been documented in previous work (Clarke et al., 2011 and 2016)
- In contrast to those studies, impact did not differ by initial skill status.
- Variables associated with ELM implementation and other factors did not predict differential response.

Discussion

- Tier 1 core instruction can serve as an effective preventive mechanism for students at-risk in mathematics
  - Role of initial skill status warrants further investigation (in particular for ELs leaners)
  - Differential response is still critical to consider and investigate
- Gains faded by first grade
  - Common result (Starkey & Klein, 2008)
  - But why and what does that imply for our work
- The counterfactual and study conditions matter
  - All students received core
  - Efficacy versus evaluation

Discussion cont.

- Greater information on ELs proficiency level and more specific observational and testing approaches
- Development and exploration of modifications to ELM/curricula to support the specific learning needs of ELs and their families.
- Continued need to replicate findings with diverse populations and to build systematic programs of research in the area of mathematics

Our understanding of how best to teach and assess mathematics is rapidly expanding - Stay connected and be flexible in your approach to supporting mathematics achievement!

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A Few ELM References

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