Building Strength in Numbers: How Do Early Interventions in Math Instruction Add Up?

Congressional Briefing

Friday, September 25, 2015
Introductory Remarks

Deborah Phillips, Ph.D., Georgetown University
Welcome. You are in for a treat. At the outset, huge thanks are due to the Friends of the Institute of Education Sciences for sponsoring today’s briefing. The Friends of IES is a diverse coalition of scientific associations and institutions, research and practitioner organizations, and other groups that works to advance the mission of IES. Among the Friends of IES, today’s briefing was principally co-sponsored by the American Educational Research Association, the American Psychological Association, the Society for Research in Child Development, and WestEd.

Additional co-sponsors include the American Sociological Association, the Federation of Associations in Behavioral and Brain Sciences, and Knowledge Alliance.

As you consider expansions in access to early education, we want to call your attention to recent findings from IES-funded research on teaching math to our youngest learners. As I am sure you are aware, a young child’s developing brain is designed to eagerly recruit information from his or her surroundings and experiences – whether beneficial or not – to shape its emerging connections, biochemistry, and thus propensities for behavior and capacities to learn. Crafting policies that affect children’s earliest environments is a very high stakes enterprise. It is against this scientific backdrop that today’s briefing takes place.
Introductory Remarks (cont.)

First, a word about IES, for which I am very honored to be a member of the National Board for Education Sciences.

IES is to education science as NIH is to health science.

Established by Congress in 2002, IES is charged with supporting rigorous, scientifically valid research that is relevant to education practice and policy. To meet this charge, IES has established long-term programs of research that focus on topics of importance to education practitioners and leaders (e.g., reading, teacher quality, education systems, math), rely on clearly specified methodological requirements for scientific research, and that employ a rigorous scientific peer review system for reviewing grant proposals.

IES funds are provided for 4 types of research:

1) Exploratory research examines the relations between education outcomes and malleable factors (i.e., factors that can be changed, such as teacher practices and school management strategies to inform the development of new education interventions or identify those interventions that are associated with better education outcomes and should be rigorously evaluated.
2) Development and innovation projects are intended to create potent and robust interventions that may be effective (eventually at scale) for improving education outcomes.

3) In addition to developing interventions, IES supports research to develop and validate measurement instruments, including screening tools, progress monitoring instruments, measures of child outcomes, and assessments of teachers’ and administrators’ knowledge and skills.

4) The fourth component of IES research is rigorous evaluation of the impact of programs, practices, and policies on education outcomes to determine which interventions appear to be effective in achieving their intended goals, which need more work to become more potent or more robust, and which appear ineffective and should perhaps be discarded.

Soon after it was founded, IES launched a broad range of research programs to:

1) better understand the links between early childhood education, early intervention, and children’s learning and development;
2) develop more powerful early interventions for improving child outcomes;
3) rigorously test the impact of programs, practices, and policies on child outcomes; and
4) develop and validate assessment measures for use with young children.

Today, you will hear examples of the highest-quality research on early math instruction and learning that touch on each of these issues.

Why early math? The preamble to the 2009 National Research Council report on Mathematics Learning in Early Childhood (for which Dr. Clements served as a committee member and Dr. Taniesha Woods as Study Director) states, “Mathematics education has risen to the top of the national policy agenda as part of the need to improve the technical and scientific literacy of the American Public. The new demands of international competition in the 21st century require a workforce that is competent in and comfortable with mathematics” (pg. 1).

Yet, striking disparities emerge in the earliest years of life, before school entry, in the mathematics performance of children growing up on under conditions of adversity.
Early math skills predict future math skills but, surprisingly, also predict future literacy and reading skills. Some evidence even suggests that the prediction of math to later literacy skills is greater than the prediction from early literacy skills.

We also know that all young children have the capability and eagerness to learn and become competent in math.

Our responsibility as adults – whether researchers, parents or decision-makers – is to deploy whatever tools are available to us to ensure that the foundation of all children’s early math skills and knowledge is sturdy and firm and thus capable of supporting their continued learning and interest in math.

Our three speakers will point us toward promising directions for doing just this – indeed, for not only expanding pre-K opportunities for young children but for ensuring that these opportunities enable their developing brains to recruit information from instructional exchanges that will foster strong early math skills and knowledge.
We will hear from:
Dr. Prentice Starkey from WestEd who will tell us about children’s early mathematical development and learning, as well as work he and his colleagues have conducted in collaboration with Drs. Clements an Sarama on the effects of the Pre-K Mathematics Intervention program.

Dr. Douglas Clements (also representing Dr. Julie Sarama) from the University of Denver will be presenting evidence regarding their Building Blocks curriculum and TRIAD Scale-Up Model.

Dr. Hiro Yoshikawa from NYU will then share the results he and his colleagues have found from the Boston Preschool evaluation regarding scale-up use of evidence based curricula, including Building Blocks.

After their presentations, Dr. Taniesha Woods will briefly summarize key takeaway messages from the presentations. We will then take questions from the audience.

Children’s Early Mathematical Development and Learning

Prentice Starkey, Ph.D.
Center for Early Learning, WestEd
The Problem of Two Math Achievement Gaps

1. A cross-national gap
   - Mathematics achievement is lower in American students than in students from several other countries (e.g., Stevenson & Stigler)
   - This gap begins by age 3 and widens over time

2. A cross-socioeconomic gap
   - Mathematics achievement tends to be lower in students from low-income backgrounds than in their middle-class peers
   - This gap begins by age 3 and widens over time
CMA Scores of American Children

Supported by NSF Grant No. 9979974 to P. Starkey & A. Klein
CMA Scores of Chinese Children

Mean Proportion Correct on the CMA

Age

Funded by NSF Grant No. 9979974 to P. Starkey & A. Klein
### Table 2: School-entry Skills and Behaviors Predict Later Achievement

<table>
<thead>
<tr>
<th>School-entry:</th>
<th>Grades 1 to 8:</th>
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<tbody>
<tr>
<td></td>
<td>Math achievement</td>
</tr>
<tr>
<td>Reading</td>
<td>.09*</td>
</tr>
<tr>
<td>Math</td>
<td>.41*</td>
</tr>
<tr>
<td>Attention</td>
<td>.10*</td>
</tr>
<tr>
<td>Externalizing (- expected)</td>
<td>.01 ns</td>
</tr>
<tr>
<td>Internalizing (- expected)</td>
<td>.01 ns</td>
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</tbody>
</table>

* p<.05; n=236 estimated coefficients; Source: Duncan et al. (2007). Meta-analytic estimates control for time to test, test/teacher outcome and study fixed effects; coefficients are weighted by inverse of their variances.
### Effect of Persistent and Intermittent Problems at Ages 6, 8 and 10 on the Probabilities of High School Completion and College Attendance, Full Controls

<table>
<thead>
<tr>
<th>Problem area</th>
<th>Problem frequency</th>
<th>HS completion</th>
<th>College attendance</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>-.03 (.03)</td>
<td>-.13† (.07)</td>
</tr>
<tr>
<td></td>
<td>Intermittent</td>
<td>-.05 (.06)</td>
<td>-.06 (.12)</td>
</tr>
<tr>
<td></td>
<td>Persistent</td>
<td>-.05† (.03)</td>
<td>-.14* (.07)</td>
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<td></td>
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<td>-.13* (.06)</td>
<td>-.29** (.09)</td>
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<tr>
<td>Reading problems</td>
<td>Intermittent</td>
<td>-.07* (.03)</td>
<td>-.10 (.06)</td>
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<td></td>
<td>Persistent</td>
<td>-.10† (.05)</td>
<td>-.24* (.010)</td>
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<td>Math problems</td>
<td>Intermittent</td>
<td>-.01 (.03)</td>
<td>-.09 (.06)</td>
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<tr>
<td></td>
<td>Persistent</td>
<td>.01 (.05)</td>
<td>-.05 (.15)</td>
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<tr>
<td>Anti-social behavior</td>
<td>Intermittent</td>
<td>-.01 (.03)</td>
<td>-.08 (.06)</td>
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<tr>
<td></td>
<td>Persistent</td>
<td>-.03 (.05)</td>
<td>-.18† (.09)</td>
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<tr>
<td>Inattention</td>
<td>Intermittent</td>
<td>.01 (.05)</td>
<td>-.05 (.15)</td>
</tr>
<tr>
<td>Anxiety</td>
<td>Intermittent</td>
<td>-.01 (.03)</td>
<td>-.08 (.06)</td>
</tr>
<tr>
<td></td>
<td>Persistent</td>
<td>-.03 (.05)</td>
<td>-.18† (.09)</td>
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</tbody>
</table>

** p<.01  *p<.05  †p<.10; “problem” is defined as being in the worst quartile of distribution at a given age
Early Mathematics Intervention Research

Can early mathematics intervention
• Reduce the SES-related math gap?
• Or, more generally, help young children reach their learning potential?
• Prepare young children for elementary school mathematics?
A Longitudinal Study of the Effects of Pre-K Mathematics on Low-Income Children’s Mathematical Knowledge

Prentice Starkey & Alice Klein
University of California, Berkeley

Douglas Clements & Julie Sarama
University at Buffalo, SUNY

Supported by a Preschool Curriculum Evaluation Research grant from the Institute of Education Sciences, U.S. Department of Education. The opinions expressed are those of the authors and do not represent views of the U.S. Department of Education.
Components of Pre-K Mathematics Intervention

Classroom component:

*Pre-K Mathematics* small group activities

Enrichment of the classroom learning environment: Math learning center (math materials and math software)

Home component:

*Pre-K Mathematics* home activities

Professional development component

Trainer-of-trainers model

Institute for training of program trainers

Teacher workshops and on-site support and monitoring by program trainers
Central Valley: Computer
Central Valley: Family Engagement

Parent Feedback:

Home Math Activity: Who Has More?

Child’s Name: [Redacted]

How many days did your child do this activity? 3 days
How long did your child do the activity? 10 minutes per day
Did your child enjoy and learn from the activity? Yes

Comments:
We had fun doing the activity.

[Signature]
CMA Scores of Intervention and Control Children in Fall and Spring

Supported by Institute of Education Sciences Grant R305K050004 to P. Starkey & A. Klein
Scaling Up the Implementation of a Pre-Kindergarten Mathematics Curriculum in Public Preschool Programs

Alice Klein and Prentice Starkey
WestEd
Lydia DeFlorio
University of Nevada, Reno
E. Todd Brown
University of Louisville

The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education through Grant R305K050004 to WestEd. The opinions expressed are those of the authors and do not represent views of the U.S. Department of Education.
Scale-Up Study: Effects of *Pre-K Mathematics*
Intervention on 4-Year-Olds’ Mathematical Knowledge

Effect Size = .83 (Main Study) and .70 (Sustainability Study)
Figure 19. Sustainability Study: Growth analysis of TEMA-3 scores from pre-kindergarten entry through kindergarten by condition and type of preschool program.
Treatment teachers use a set of best math practices that helps children engage in mathematical thinking for sustained periods of time. Cognitive change occurs during and after this active cognitive engagement.

Other Findings:
The **Pre-K Mathematics** intervention has a causal impact on
- Children’s understanding of verbal directions
- Children’s persistence in completing a task
The Pre-K Mathematics intervention significantly enhanced low-SES children’s mathematical knowledge (Starkey & Klein, 2013). The 1-year, pre-k intervention, however, did not completely close the SES-related gap in informal mathematical knowledge.
CLOSING THE SES-RELATED GAP IN EARLY MATHEMATICAL KNOWLEDGE

Alice Klein & Prentice Starkey
WestEd
Lydia DeFlorio
University of Nevada, Reno
Paul Swank
University of Texas, Houston

The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education through Grant R305A080697 to WestEd. The opinions expressed are those of the authors and do not represent views of the U.S. Department of Education.
To evaluate the efficacy of a math curriculum for 3-year-olds, *Pre-Pre-K Mathematics*, implemented in the first year of preschool.

To implement a 2-year preschool math intervention (PPK and PK years) with low SES children, and evaluate its impact on the growth of early mathematical knowledge.
Results: Pre-Pre-Kindergarten TEMA-3

Effects of the Intervention on the TEMA-3 Raw Scores
Over the Pre-Pre-Kindergarten Year

TEMA Raw Score

- I-2
- I-1
- Control

Time of Assessment

Fall (Wave 1)       Spring (Wave 2)
The *Pre-Pre-K Mathematics and Pre-K Mathematics* interventions significantly enhanced low-SES children’s mathematical knowledge (Starkey & Klein, 2013). The SES-related gap in informal mathematical knowledge was technically ($p=.0505$) closed but it re-opened in grade K.
A Randomized Trial of A Tutor-Based Mathematics and Attention Intervention for Low-Performing Preschoolers at Risk for Mathematical Difficulties in School

Marcia A. Barnes
University of Texas at Austin

Alice Klein, Prentice Starkey
WestEd

Bruce McCandliss
Stanford University

The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education through a grant to UT, Austin. The opinions expressed are those of the authors and do not represent views of the U.S. Department of Education
Some children show low response to an effective Tier 1 Math curriculum

Figure 2. CMA Scores of Intervention and Control Children by Quartile (1Q-4Q) in Scale-Up Study

- 1Q Intervention
- 2Q-4Q Intervention
- 1Q Control
- 2Q-4Q Control
1. Does an intensive early math intervention significantly improve the math knowledge of low-performing Pre-K children?

2. Does attention training improve the attention abilities of these Pre-K children?

3. Does attention training combined with an intensive early math intervention improve the math knowledge of these children?
Results: Impact on the Child Math Assessment

Effects of the PKMT Intervention on Child Math Assessment Scores at Post-test

- TX
- CA

Math and Attention  Math Only  Control
Conclusions

Closing the early math gaps – or, more generally, helping young children reach their learning potential in math – is a tractable problem.

Addressing this problem should be a priority for educational research and policy.
The Building Blocks Curriculum and TRIAD Scale-up Model

Douglas H. Clements & Julie Sarama, University of Denver

Math’s Predictive Power

Large-scale research, predicting school success (Duncan et al., 2007)

Learning Trajectories: 3 Parts

1. Goal
2. Developmental Progression
3. Instructional Activities
Present day, research on mathematics goals contributes to standards (red line) and so forth, but... disconnected.
Small-Scale Summative Evaluation


Geometry

TRIAD: Part 2 of Intervention

TRIAD means...

13

6. Provide professional development that is
- multifaceted,
- extensive, ongoing,
- reflective,
- focused on children’s thinking,
- grounded in particular curriculum,
- situated in the classroom.

Most Important: Professional Development

14

Teachers’ Representations of Learning Trajectories

15

Pizza Game 1

16

- Each player has a copy of the Pizza Game activity sheet.
- Player 1 rolls a die and puts that many “toppings” (counters) on her “plate.”
- Player 2 must agree that she is correct.
- If so, player 1 moves the toppings from the plate to her pizza.
- Players take turns until they have decorated their pizza completely.

(Note: See “How to Introduce a Game” in the Appendix.)

Scaffolding Strategies:
- More help: Make a

Tools

- Related development:
  - Count (Small Numbers)
  - Perceptual Subitizer to 5

Pizza Game 1—Partners help!

The child rolls a die and places a chip on their plate. Then he asks his partner “Is right?” This checking is important! First, it keeps the children “focused” and so mathematically accurate. Second, it leaves them interacting. Here, the first child has to get the second child’s attention, but usually having
TRIAD II: Large-Scale Evaluation

Control

Rasch scores

p < .0001

ES = .72
Language and Literacy Do Not Suffer

- No difference on letter naming or 3 expressive language measures.

Sig. higher for TRIAD on:
- Information
- Complexity
- Independence
- Inferential Questions

Follow Through

Control
TRIAD
TRIAD Follow Through

We need this…
To do better than this…
Persistence of Effects: To the 7th Year

- Treatment ended for TRIAD group at end of pre-K and for the TRIAD-FT group 1st grade.
- Effects maintained, especially for African-American students.

Math and math + scaffolded play interventions: Analyses of main effects on development of executive function
Better Early Math

1. Early math is surprising important.
2. Use of learning trajectories is a particularly promising path
3. Follow through is essential, especially for vulnerable groups

4. Building Blocks and TRIAD successful at both sustainability and persistence
5. Three for the price of one: mathematics, language, and executive function
6. Rethink fade out!
Thanks!

Julie.Sarama@du.edu
Douglas.Clements@du.edu

References


Achieving High-Quality Math Instruction in Preschool at City-Wide Scale: The Boston Preschool Program

Hirokazu Yoshikawa, NYU
Christina Weiland, University of Michigan
Jason Sachs, Boston Public Schools
Monica Yudron, Harvard Graduate School of Education

U.S. Department of Education and Congressional Briefings, Sept 2015
What are Effective Approaches to High Preschool Instructional Quality? 
(Yoshikawa, Weiland, et al., 2013)

- Most promising recent evidence: Combination of
  - 1) Developmentally focused instruction / curricula (focused on particular set of skills – e.g., language / literacy; math; socio-emotional skills)
  - 2) Intensive on-site or video-based professional development (mentoring / coaching; often with frequency of as much as 2X a month)
  - 3) Regular monitoring of child progress that is not high stakes, but to inform teachers’ practice – adjust content and approach based on how individual children are doing

- Strong set of recent examples, including in the area of math curricula and instruction (Clements & Sarama, 2008; Klein, Starkey, DeFlorio, & Brown, 2012)
Part 1
Impacts of the Boston Public Schools Preschool program
Study details

• Rigorous regression discontinuity design
• 2,018 children included
• 85% of district schools and 70% of students in those schools
• Diverse student population
  – 11% Asian, 27% Black, 41% Hispanic, 3% Other, 18% White
  – Home language: 50% English, 27% Spanish, 22% Other
  – 69% receive free/reduced lunch, 9% students with disabilities
• Counterfactual: Majority of control group children were enrolled in other preschool programs
Boston Public Schools Preschool Program as Evaluated in the Impact Study

- Evidence-based language and math curricula (Building Blocks; Clements & Sarama, 2008 and Opening the World of Learning, or OWL; Schickedanz & Dickinson) implemented district-wide [in 79 elementary schools]
- 5 days training prior to year; 6 days training during year
- In-classroom coaching supports (one set of coaches supporting 2 curricula); on average 1 coach per 10 classrooms [cost about $550 per child]
- Coaches: Average 8.8 years of teaching early childhood; average 3.3 years of coaching ECE
- In addition, NAEYC accreditation processes in 20+ schools
- Low-stakes, formative literacy assessments from preK to 2nd grade
- Professional development supports for principals in early childhood
Largest effects on language and math of public preK studies to date in the US
(Weiland & Yoshikawa, 2013, Child Development)

<table>
<thead>
<tr>
<th>Test Measure</th>
<th>Effect Size</th>
</tr>
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<tbody>
<tr>
<td>PPVT-III (vocabulary)</td>
<td>0.44***</td>
</tr>
<tr>
<td>W-J LW (early reading)</td>
<td>0.62***</td>
</tr>
<tr>
<td>W-J AP (numeracy)</td>
<td>0.59***</td>
</tr>
<tr>
<td>REMA Short (numeracy, geometry)</td>
<td>0.50***</td>
</tr>
</tbody>
</table>
Positive Effects on All Three Dimensions of Executive Function Skills

(Weiland & Yoshikawa, 2013, Child Development)
Effects on Disparities at Kindergarten Entry: Summary

• Subgroups: All children benefitted, but impacts particularly impressive and larger for children from lower-income families and Latino children.
  – Closed the school readiness gap among poor and non-poor children in mathematics
  – Eliminated the school readiness gap between Latino and White children in early reading and mathematics
  – Narrowed school readiness gaps between White and Asians and between White and Black students.
Fidelity and Quality

- Studies of curriculum fidelity and classroom quality provide background on the instructional context under which impacts on children were obtained:

- **Fidelity 2008-2009**: Curricula moderately to highly well implemented  
  (Weiland, Eidelman, & Yoshikawa, 2011)

- **Quality in 2009-2010** (Weiland, Ulvestad, Sachs, & Yoshikawa, 2013)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Range (Min-Max)</th>
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<tbody>
<tr>
<td>ECERS Interactions</td>
<td>5.54</td>
<td>1.21</td>
<td>2.20-7.00</td>
</tr>
<tr>
<td>CLASS Emotional Support</td>
<td>5.63</td>
<td>0.60</td>
<td>4.00-6.83</td>
</tr>
<tr>
<td>CLASS Instructional Support</td>
<td>4.30</td>
<td>0.84</td>
<td>2.22-5.67</td>
</tr>
<tr>
<td>CLASS Organization</td>
<td>5.10</td>
<td>0.68</td>
<td>2.75-6.22</td>
</tr>
</tbody>
</table>

More typical means (sd) in the literature:

- 2.04 (0.84)  
  Burchinal et al., 2010

- 2.47 (1.10)  
  Pianta et al., 2005
Part 2
The Boston Public Schools Preschool Model and Its Scaling “Up and Out” Across Grades and to Community Providers
Boston Preschool System History

• 2005: Then-Mayor Menino launches pre-k for 3 and 4 year olds in BPS—always been a leader in ECE

• BPS creates the Department of Early Childhood

• 2006-2009: focus on quality improvement-through PD and structural changes; instituting evidence-based curricula and coaching system; NAEYC accreditation processes; principal training in early childhood; formative child assessments; “taking the pulse” of observed quality through random subsamples

• 2010-Present: Scaling “up and out” (up across grade levels; out to community providers and Head Start) in context of Mayor Walsh’s plan to double coverage in BPS preschool system to two thirds of city’s 4 year olds by 2018
Current BPS Pre-K (K1) Program

- 2,400 seats for 4 year olds
- $12,000 per pupil ($500 per pupil coaching)* —$180K start up year.
- In 85% of BPS’s 78 elementary schools
- Free for parents (Lottery)
- 6 hour day
- 22:2—one teacher and 1 paraprofessional
- Teachers on same pay scale as K-12 system with same educational requirements

*There are other related school costs not factored in as the school is already running. A next step in our evaluation efforts is to conduct a more rigorous cost study.
Current Expansion “Out” to Community Providers

Doubling Boston prekindergarten capacity by 2018 through a mixed-auspice approach but a single program model.

• **Pilot of Expansion of the Model to Community Providers:**
  • Instructional materials and support to integrate the BPS language, literacy, and mathematics curricula (*Opening the World of Learning* and *Building Blocks*, respectively) and assessments into the classroom;
  • Professional development alongside BPS early childhood teachers;
  • Bimonthly one-on-one coaching focused on the language, literacy, and mathematics curricula to translate new knowledge into practice in the classroom;
  • Monthly cross-site meetings of directors and instructional leaders;
  • Supplementation to their salary and benefits as requested by center directors

• Modify curriculum for extended day and to improve alignment with K-2nd grade efforts
Findings from Community Provider “K1DS” Pilot Study
(Yudron & Weiland, 2015)

- **Findings of first 18 months of implementation** (Yudron & Weiland, 2015):
- Before intervention, none of the classrooms met Boston quality benchmarks for language, literacy, and mathematics instruction.
- Language / literacy instructional quality (ELLCO; Smith, Dickinson et al 2002) and math instructional quality (COEMET; Sarama & Clements, 2009) on average 1SD below levels in BPS PreK classrooms in schools in same neighborhoods
- Tailoring model to meet new context.
  - PD differentiated—much more site-based.
  - Second year: Increased focus on math content and instruction.
  - High attendance at group training sessions, but on average, coaching occurred monthly not bimonthly
  - Providing more training for center directors on high-quality early childhood instruction vs. support provided to principals in BPS.
After 18 months of implementation:

• Improvements in observed math and language / literacy instructional quality after 18 months of implementation

• Gap in observed quality reduced between community providers and school-based model

• Math instruction broadens beyond very basic counting and shapes to wider range of reasoning and skills

• Currently – scaling further to Boston’s Head Start programs and larger range of community providers—(BPS is a recipient of federal Preschool Expansion Grant)
Current Challenges and Future Directions in Scaling “Out” to Community Providers

• Less stable staffing in community providers
• More intensive training of directors, who often do not serve as instructional leaders
• Lack of common planning time
• 3 year olds in some classrooms with 4 year olds (Building Blocks not designed for 3 year olds)
• Transition between prior curricula and OWL / BB often not smooth
• Preschool Expansion Grant incentivizes segregating low-income students into one classroom as funding is based on percentage of eligible students.
Key Lessons from Boston and Implications for Policy

- High quality math instruction can be achieved at scale
- Key: Curricula based on developmental evidence and in-classroom coaching supports together with program-level supports for leadership
- Quality of coaches is also key; studies suggest importance of 1) early childhood experience; 2) knowledge of the curriculum; 3) rapport, mentoring and consultation skills (e.g., Lloyd & Modlin, 2012; Zaslow et al., 2010)
- Challenges and heterogeneity of community provider implementation must be addressed in staffing stability; other curricular requirements; coverage to facilitate coaching meetings;
- Need funding mechanisms to support mixed income classrooms
Acknowledgements

The US DOE Institute for Educational Sciences (funder of original Boston PreK Evaluation and current third-grade follow-up study (PI Weiland; Co-PIs Unterman, Yoshikawa)

2008-2010 impact evaluation:
Participating families, teachers, principals, early childhood coaches, Jason Sachs and the BPS Department of Early Childhood, the BPS Office of Research, Assessment and Evaluation, Carolyn Layzer and Abt Associates
Co-PI's: Nonie Lesaux, Richard Murnane, and John Willett
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K1DS pilot implementation study:
K1DS: Monica Yudron, Bonnie McIntosh, Abby Morales, Michelle High-McKinnon, Mayra Cuevas, Brian Gold, Boston Public Schools and Thrive in Five; CBO participating centers and teachers; Participating BPS prekindergarten teachers
References


Mathematical thinking starts early— even before children enter formal programs (e.g., preschool, kindergarten); young children are ready and enjoy learning mathematics.

High-quality prekindergarten mathematics programming can have a positive effect on young children’s mathematics learning outcomes.

Math knowledge is a predictor of other learning outcomes:
- Mathematics
- Literacy
- Language development
- Executive Function

Educators of young children may be less confident about teaching mathematics.

Effective professional development is critical to supporting teachers’ mathematics instructional practices.
IES funded research shows effective teacher professional development includes:
- Mathematics content
- Pedagogy/Instructional practices
- Child development; Children’s mathematical development
- Formative assessment (teacher assesses child and adjusts instruction based on child’s needs)
- Connected to an evidence-based curriculum (e.g., *Pre-K Mathematics, Building Blocks*)
- Coaching; Relationship
- On-going (i.e., beyond an initial training)

Positive effect for all children; High-quality early childhood mathematics education can reduce and eliminate disparities in mathematics learning outcomes (i.e., racial, ethnic, ELL, and socioeconomic status)

Children who have received high-quality early mathematics instruction continue to show effects in elementary school. But, high-quality mathematics instruction in both the early years and early grades is needed to fully eliminate disparities across children’s development.
Moderated Q&A

Deborah Phillips, Ph.D., Georgetown University