

Cluster Randomized Trial of the Efficacy of Early Childhood Science Education with Low-Income Children – Years 1–3

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Purpose

Test the efficacy of an early childhood science education curriculum (Head Start on Science; HSOS) and professional development program in improving teacher science practice and child school readiness.

- *Taking Science to School* documented importance of science education prior to kindergarten
- Low-income children have few opportunities for high-quality early science experiences
- Few efficacy studies of early childhood science education are available
- HSOS is widely available but has not been tested for efficacy

Expected Impacts

Compared to controls, the HSOS group will show:

Teachers

- More science efficacy
- More value placed on science education for young children
- Higher-quality science education practices (instructional quality with children; integration of science with literacy and math; science addressed throughout day)
- More science materials and activities accessible
- Better general classroom environment (exploratory)

Children

- Better expressive and receptive language and literacy
- Higher levels of math achievement
- More scientific reasoning and process understanding
- More curiosity
- More positive approaches to learning
- Better social skills and emotion regulation

Parents

- More value placed on science for preschoolers
- More opportunities for science exposure outside classroom

Research Design

Cluster randomized design with two 2-year cohorts

Intervention

Head Start on Science Curriculum

- 89 activities that address 7 areas: The Senses, Weather, Physical Science, Critters, Water and Water Mixtures, Seeds, and Nature Walks
- Provides guides for process skills targeted, materials needed, introducing the activity, framing questions, closure, and follow-up activities
- Tied to Head Start performance indicators
- Links to literacy and art centers
- Family activity handouts in English/Spanish

Teacher Training

- Focus on hands-on practice with activities, science processes, field trips, family activities, integration into literacy and math, and use of technology
- Receive computer, video camera
- Receive kit of science materials, HSOS curriculum guide (control teachers also receive)

Distance Coaching

- Teachers upload monthly videos of science activities
- Expert coaches provide feedback using Teachscape system
- Coaching on instructional practice, integration of literacy and math into science activity, and incorporating science learning goals
- 2 in-class visits for relationship-building and technology support
- Science Activity Planning form promotes intentionality behind science education

Wonder Wall

- Virtual bulletin board for posting science questions

Field Trips

- One field trip per year, facilitated to help apply learning about how to integrate science learning

Implementation

Class recruitment and randomization was completed for both cohorts. Intervention and data collection are complete for Cohort 1 and in process for Cohort 2.

- 75 classrooms were recruited, 71 were randomized; 32 classrooms for Cohort 1 completed the study, 30 are currently in Cohort 2.
- 124 teachers participated.
- All HSOS teachers completed training. On average, teachers participated in about 65% of coaching opportunities.
- Ratings of the intervention are very positive, although technology is challenging for some teachers. Participation depends on technology ability and administrator support.

Sample

Teachers and Classrooms, Cohorts 1 and 2

	HSOS	Control	Total
Classrooms	N = 39 (52%)	N = 36 (48%)	N = 75
Teachers	N = 66 (53%)	N = 58 (47%)	N = 124
Lead teacher (vs teaching assistant)	59%	62%	61%
Gender (female)	100%	99%	99%
Race			
African American	12%	12%	12%
White	77%	79%	77%
Other	11%	9%	11%
Education			
Bachelor's Degree and Above	52%	52%	52%
Years experience in early childhood programs (M, (SD))	6.4 (5.2)	6.6 (6.2)	6.6 (5.6)

Children, Cohort 1

	HSOS	Control	Total
Children	N = 134 (51%)	N = 131 (49%)	N = 265
Gender (female)	53%	48%	51%
Race			
African American	20%	8%	14%
Bi-Racial	10%	7%	8%
White	35%	38%	37%
Other	25%	37%	31%
Missing	10%	11%	11%
Language: English (vs Spanish)	87%	76%	81%
Age (months, M (SD))	50.0 (6.7)	50.3 (5.4)	50.2 (6.1)

Measurement Development

Teacher science practices

Coded from videos of teacher implementing one of three science activities. Codes: Context Setting, Exploration, Observation, Prediction, Experimentation, Explanation Generation, Comparison, Categorization, Recording, Summary, Transfer, Information, Vocabulary, Curiosity. Each is also coded as Modeling or Facilitation.

Child science processes

Coded from audiotapes of children observing videos of scientific phenomena (e.g., sink and float, rolling). Codes: Prediction, Comparison, Categorization, Explanation Generation, Pattern-Finding, Curiosity. New hands-on activity in Cohort 2 will provide Experimentation.

"A lot of children are starting to do science and set up experiments by themselves."



Preliminary Results for Change in Intervention vs Control Children

Child Cognitive Outcomes

Measure	Intervention		Control		Time x Group F
	Pre	Post	Pre	Post	
Language and Literacy					
Peabody Picture Vocabulary Test (PPVT)	91.76 (23.81)	96.69 (22.14)	85.49 (29.06)	90.37 (25.88)	1.27
Expressive Vocabulary Test (EVT)	93.36 (23.04)	99.78 (21.31)	81.60 (31.99)	87.70 (29.39)	.17
Phonological Awareness Literacy Screening (PALS)					
Upper Alphabet Recognition Score	7.58 (9.00)	12.37 (9.59)	5.78 (7.68)	11.09 (9.61)	.08
Sound Awareness Score	3.40 (3.84)	5.12 (4.02)	3.41 (3.73)	4.76 (4.04)	.52
Name Writing Score	3.21 (2.24)	4.70 (1.87)	3.16 (2.03)	4.89 (1.76)	.18
Spelling Score	.47 (1.58)	1.10 (2.48)	1.04 (2.77)	1.23 (2.37)	3.92*
Math					
Test of Early Mathematics Ability (TEMA)	89.39 (14.48)	93.02 (14.92)	87.56 (15.36)	90.62 (16.94)	.28
Science					
Mouse House	42.77 (19.81)	45.10 (19.88)	42.60 (18.57)	40.00 (20.70)	1.80
Causal Sequence	9.99 (3.61)	10.26 (4.34)	10.25 (4.16)	11.45 (4.49)	1.02
Conditional Reasoning	40.05 (19.55)	43.28 (19.20)	38.78 (16.88)	43.88 (20.33)	.12
Curiosity	4.95 (1.89)	4.76 (1.80)	4.94 (1.91)	4.73 (1.70)	.72

Notes. Does not account for nested data in classrooms. Cohort 1 only. *p < .05.

Child Socioemotional Outcomes

Measure	Rater	Intervention		Control		Time x Group F
		Pre	Post	Pre	Post	
Social Skills Improvement System						
Total Social Skills	Teacher	95.89 (15.17)	103.33 (16.02)	101.60 (17.81)	102.25 (18.11)	9.10**
	Parent	103.43 (11.97)	72.10 (11.78)	107.29 (11.83)	75.87 (11.89)	.00
Total Problem Behaviors	Teacher	106.56 (18.10)	104.10 (19.33)	98.55 (16.23)	98.56 (17.55)	1.40
	Parent	109.21 (14.94)	87.07 (8.15)	103.95 (11.92)	85.26 (8.21)	3.26*
Preschool Learning Behaviors Scale						
Competence Motivation	Teacher	18.54 (3.78)	19.24 (4.09)	19.69 (3.70)	19.44 (4.61)	2.66
	Parent	17.63 (3.42)	18.12 (3.04)	18.34 (3.14)	18.18 (3.05)	.81
Attention/Persistence	Teacher	17.63 (4.89)	18.74 (4.45)	19.40 (4.50)	19.06 (4.82)	5.93*
	Parent	18.22 (3.80)	18.61 (3.76)	18.84 (3.67)	18.79 (4.05)	.44
Learning Strategy	Teacher	12.63 (2.90)	12.84 (2.83)	13.61 (2.44)	13.35 (3.04)	6.23
	Parent	9.80 (2.59)	10.11 (2.57)	10.79 (3.00)	10.11 (2.57)	3.05*
Emotion Regulation Checklist						
Negative/Lability	Teacher	1.82 (0.59)	1.71 (0.62)	1.58 (0.49)	1.60 (0.57)	4.29*
	Parent	1.86 (0.45)	1.83 (0.42)	1.68 (0.38)	1.73 (0.48)	1.14
Emotion Regulation	Teacher	3.05 (0.49)	3.22 (0.50)	3.28 (0.54)	3.36 (0.51)	1.53
	Parent	3.54 (0.32)	3.53 (0.36)	3.54 (0.34)	3.53 (0.32)	.00

Notes. Does not account for nested data. Cohort 1 only. Teacher Ns range from 198–201, Parent Ns range from 77–80. **p < .01. *p < .05. †p < .10.

Summary of Years 1–3 Implementation

The intervention is very well-received. Technology is a challenge due to upload speeds and the platform provider lack of responsiveness. Teacher participation varies from moderate to very high. Participation is affected by administrator support and technology experience.

Results

One of two cohorts is complete. Analyses do not yet take into account the multilevel (nested) nature of children participating within classrooms. Direct measures of science outcomes (teacher science practices, child science process) are still in development. Preliminary results indicate that HSOS children improve more in socioemotional outcomes than control children. They also improve more in spelling. Scientific reasoning outcomes look promising, but analyses are not complete. Cohort 2 data are necessary for stable analyses on children and teacher outcomes.

"Children are really excited. You might call 2–3 over to do the science activity and you end up with 17 because they all want to do it and they want to do it now."