Abstract Title Page

Title: Preventing Preschool Fadeout through Instructional Intervention in Kindergarten and First Grade

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Background / Context: A substantial literature documents the benefits of early childhood education and formal preschool experiences on children's school readiness, with low-income and otherwise disadvantaged children benefitting the most from these programs (Yoshikawa et al., 2013). However, these academic benefits often fade out as children age, and most disappear by the end of kindergarten or first grade (Barnett, 1995; Currie, 2001; Puma, Bell, Cook, & Heid, 2010). A meta-analytic study estimated the magnitude of preschool intervention fadeout at .025 standard deviations per post-treatment year (Leak et al., 2013).

Little research has focused on why short-term gains from preschool may disappear and the conditions under which gains from preschool might be sustained into elementary school (Claessens, Engel, & Curran, 2013). One hypothesis of preschool fade out is that children's elementary school teachers continue to teach content that children already learned during preschool, thus curtailing academic growth. Indeed, recent work suggests that spending too much instructional time on content already mastered by students may temper achievement gains, whereas exposure to more advanced content in kindergarten could bolster new skill development (Engel, Claessens, & Finch, 2013; Magnuson, Ruhm, & Waldfogel, 2007).

In the current study, we investigate two salient approaches available to policymakers that may improve preschool participants' instructional experiences in elementary school. The first involves advanced and challenging instruction in kindergarten and first grade, because children who attend preschool will hypothetically benefit more from advanced content. The other involves some type of professional support in which preschool teachers interact with their kindergarten and first grade counterparts to develop a seamless transition from one grade to the next. We use two experimental studies of preschool interventions and children's elementary school environments to examine whether the quality of instructional content or providing professional development supports to early grade teachers moderate the impacts of two well-known programs on children's cognitive skills: Head Start and Building Blocks.

Research Questions:

1. Does the quality of academic instruction in kindergarten and first grade moderate the magnitude of preschool intervention effects on children's academic skills in kindergarten and first grade?
2. Does a professional development intervention for kindergarten and first grade teachers that provided techniques designed to build upon the preschool program moderate preschool intervention effects on children's academic skills in kindergarten and first grade?

Setting and Intervention: This study is a secondary data analysis of data collected on children participating in two preschool interventions—Head Start and the Building Blocks preschool mathematics intervention. *Head Start* is a comprehensive child development program that provides children with preschool education, health screenings and examinations, and nutritious meals, in a full-day, center-based setting. The Head Start children in our sample participated in the program during their pre-kindergarten year at age 4 at different research sites across the country. The Head Start Impact Study (HSIS) evaluation began in 2002 (described below).

Building Blocks (BB) is a preschool mathematics curriculum that encourages the acquisition of conceptual and procedural knowledge in both numeracy and geometric/spatial reasoning through the emphasis of empirically-supported learning trajectories (see Clements & Sarama, 2008). The TRIAD (Technology-enhanced, Research-based, Assessment, and professional Development) evaluation study was designed to assess the long-run impacts of BB

in 42 public elementary schools operating state preschool programs serving low-income communities in Boston, Massachusetts and Buffalo, New York. Study schools were assigned to one of three conditions: 1) BB preschool curriculum; 2) BB preschool curriculum with follow-through; 3) control (business as usual). Children in schools assigned to the two BB groups received the BB curriculum during preschool (age 4), and preschool teachers attended 13 study-administered pedagogical development (PD) sessions throughout the preschool year. Teachers in schools assigned to the "BB with follow-through" group received additional PD designed to help bridge the gaps between preschool, kindergarten, and first grade. These additional PD sessions brought teachers from all three grades together to discuss what students learn in each grade, and minimize the amount of repeated content.

Population / Participants / Subjects and Data Collection:

Head Start. The Head Start sample comes from the HSIS experiment dataset, which is a nationally representative sample of Head Start participants and a group of comparable non-participants. The full sample includes newly entering 3-and 4-year old Head Start applicants who were randomly assigned to receive the Head Start program or a control group that did not enroll in Head Start where parents either found other available services for their child or the child was cared for at the home. Baseline survey and child assessment data were collected by study investigators (Westat) in the Fall of 2002, at post-treatment child assessments were collected at the end of Head Start in Spring 2003, and during kindergarten and first grade in Spring 2004 and 2005. Our analyses use the 4-year-old cohort (n=1080) so that the children in both of HSIS and BB analyses received the preschool intervention during the same developmental period.

The children and families in the sample are all very low income and have the following characteristics: 45% Hispanic, 39% white and 15% Black, 42% of parents have less than a high school degree, 23% are recent immigrants, 16% are teenage mothers and a majority (84%) live in an urban area. Information on children's elementary school experiences were collected from kindergarten and first grade teachers through a teacher survey in the spring of 2004 and 2005. Literacy skills were measured with the Peabody Picture Vocabulary Test (Dunn & Dunn, 1997) and Letter Word and Spelling standard scores from the Woodcock-Johnson Psycho-Educational Battery-Revised III (Woodcock, McGrew, & Mather, 2001). We created a literacy assessment composite measure to use as the dependent variable by standardizing all three measures to mean 0 and standard deviation of 1, averaging across the three, and then restandardizing the measure.

Building Blocks. TRIAD study participants (n=1375) were randomly selected from study schools at the beginning of the preschool year (2006-2007). The current study sample (n= 965) consists of students who had valid achievement data in preschool, kindergarten, and first grade, and at least one non-missing classroom observational measure in kindergarten or first grade. In the study sample, 35% of students were assigned to the BB group and 36% were assigned to the BB with follow-through group. The majority of students qualified for free or reduced price lunch (79%); 58% identify as African American and 20% as Hispanic. Math achievement was assessed at preschool entry, and at the end of the preschool, kindergarten and first grade year via the Research Based Early Mathematics Assessment (REMA; Clements, Sarama, & Liu, 2008).

Research Design and Data Analysis:

Variables of interest. We identified two key instructional characteristics in both studies to operationalize the quality of elementary school exposure to literacy content (HSIS) and math content (BB). In the HSIS, teachers were asked how many times in the past week their class did

a given literacy activity. We coded each activity into basic or advanced based on grade level (available in Appendix A). We converted each basic and advanced activity into times per month by taking the mean value of the answer category (e.g., Never=0, 1-2 times per week=1.5), multiplied by 4, and then standardized this measure to have a mean of 0 and standard deviation of 1. Instructional quality during the first grade year is a cumulative measure of quality from both Kindergarten and first grade, averaged across the two years.

In the TRIAD evaluation of BB, teachers' instructional practices were evaluated via the Classroom Observation of Early Mathematics Environment and Teaching (COEMET; see Clements, Sarama, Spitler, Lange, & Wolfe, 2011). The COEMET is composed of 28 Likert-scaled items. Assessors, who were blind to treatment group, rated classrooms for teaching practices known to support early math development, such as the use of engaging small group activities and emphasizing cognitively demanding concepts and strategies. For the kindergarten year, we took the average of these 28 items and then standardized scores. As with the HSIS, our measure of first grade instructional quality is the standardized average of a child's kindergarten and first grade COEMET scores. We also included the number of mathematical activities observed during each COEMET period in our analysis as an indicator of the amount of time spent on mathematics in the class.

Analysis: We use multivariate regression to estimate the effect of instructional experiences on the magnitude of preschool treatment effects in children's kindergarten and first grade year. Both preschool interventions were randomly assigned, so treatment effects estimated during the pre-k year and after are unbiased. In the HSIS models, we focus on literacy outcomes as the dependent variable, and in BB models, we focus on mathematics. In all models, we regressed achievement measures (taken at either end of preschool, kindergarten, or first grade) on treatment status, fixed effects for unit of random assignment, baseline assessment scores, and a set of control variables, varying slightly between BB and HSIS (see Tables 1 and 2 for details). We then add measures of classroom instruction as covariates to see how much of the treatment effect is explained by high-quality instructional practices. Finally, we add models in which treatment is interacted with classroom instruction. If high-quality instruction in kindergarten and first grade helps reduce fade-out, then these interactions should be positive and significant.

Findings / Results:

Table 1 presents the results for models estimating end of kindergarten effects, and Table 2 presents end of first grade effects. All variables except the treatment indicator are scaled in standard deviation units to facilitate their interpretation as effect sizes.

Kindergarten

Head Start. Models 1-4 in Table 1 are for the HSIS where the dependent variable is a composite of three literacy and language assessments. Model 1 shows the end of Head Start year treatment effect, which is significant with an effect size of .16. However, this effect becomes negative and insignificant by the end of Kindergarten (Model 2). When we add the instructional quality variables (basic and advanced literacy instruction) in model 3, the treatment effect remains unchanged though the coefficient on advanced literacy activities is .38 and significant, and the coefficient on basic literacy activities is -.28 and significant. Model 4 adds the interactions between instructional quality and treatment. Neither term was statistically significant, suggesting that advanced literacy instruction is unable to sustain the gains of the Head Start treatment group children through the kindergarten year.

Building Blocks. In Table 1, Models 5-10 display the impacts of BB on kindergarten

mathematics achievement. Model 5 shows the BB treatment effect at the end of the preschool year with an effect size of .67. At Kindergarten (model 6) the effect drops to .34 and remains significant. When we add the instructional quality variables (COEMET and number of math activities) in model 7, the treatment effect remains unchanged, and the coefficient on the number of math activities is .13 and significant. Model 8 adds the interactions between instructional quality and treatment, but neither term was significant.

Models 9 and 10 take a different look at sustaining pre-K gains. Rather than classroom quality, they examine a kindergarten teacher PD focused directly on sustaining the BB preschool gains. Unlike our measures of teacher-driven classroom instructional quality, teachers were randomly assigned to engage in additional PD. The treatment effect for students in the "BB with follow-through" was .37 and significant, but it was not significantly different from the end of kindergarten impact for students who received BB without follow-through PD (.33). All told, there is no evidence that either instructional quality or focused PD is able to sustain pre-K gains through the end of kindergarten.

First Grade

Head Start. Models 1-3 in Table 2 show the effect of Head Start on our literacy composite at the end of first grade. In each model, the treatment effect is not significant. Including the instructional quality variables does not change the significance of the coefficients, though adding the interaction terms in model 3 increases the treatment coefficient to .11. Neither the instructional variables nor the interactions with treatment were significant. Again, there is no evidence that high-quality instruction can sustain Head Start gains through the first-grade year.

Building Blocks. Models 4-7 show the effect of BB on math scores at the end of first grade. Models 4-6 show the BB only treatment effect at the end of first grade, which falls to .17 (from .33 in kindergarten) but remains significant. When we add the instructional quality variables in model 5, the BB only treatment effect falls from significance and there is a significant main effect of .17 for the number of math activities. Adding the interaction with treatment in model 6 produces a similar pattern, where the BB only treatment effect is not significant at the .05 level, but there is a .22 significant effect size for the number of math activities. The interaction between instructional quality and treatment was not significant. Thus, yet another test shows no evidence that high-quality instruction sustains pre-K gains.

As with the final models in Table 1, model 7 in Table 2 focuses on a PD approach to sustaining gains. A comparison of treatment effects for both the BB only and the BB plus follow-up group shows that the effect size for the follow-up group is .31 and significant, compared with a .18 effect size for the BB only group. The .31 coefficient is only slightly smaller than the .37 coefficient found on the PD group at the end of kindergarten, suggesting very little fadeout during first grade. In other words, two years of PD may be able to help sustain gains, although a comparison of the two effect sizes revealed that the follow-through group effect is not quite statistically significantly larger than the preschool only effect ($F= 2.57$; $p = .11$).

Conclusions: We did not find any evidence to support the hypothesis that better instructional quality mitigates the fadeout of preschool treatment effects during elementary school. However, we did find some evidence that when the BB intervention was coupled with teacher professional supports in kindergarten and first grade, this all but eliminated the fadeout of effects observed between kindergarten and first grade. However, both the focused PD and high instructional quality could not reduce fadeout effects between preschool and kindergarten.

Appendix A. References

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Appendix B. Tables and Figures

Table 1. Head Start and Building Blocks treatment effects at the end of pre-k and Kindergarten

	Head Start Impact Study (Age 4 cohort)				Building Blocks					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Literacy Composite Score				Math Achievement					
	End of Pre-k	End of Kindergarten			End of Pre-k	End of Kindergarten			End of Pre-k	End of K
Preschool Treatment										
Head Start Treatment Group	0.16*	-0.14	-0.15	-0.11						
	(0.08)	(0.10)	(0.10)	(0.20)						
Building Blocks Preschool Treatment Only					0.67**	0.34**	0.33**	0.33**	0.68**	0.33**
					(0.08)	(0.07)	(0.08)	(0.08)	(0.08)	(0.07)
Building Blocks Preschool Treatment with K and 1st Grade PD Extension					NI	NI	NI	NI	0.63**	0.37**
									(0.10)	(0.08)
Instructional Quality										
Total advanced literacy activities in K (times per month; standardized)			0.38**	0.43*						
			(0.13)	(0.20)						
Total basic literacy activities in K (times per month; standardized)			-0.28*	-0.29						
			(0.13)	(0.25)						
COEMET (Good Instruction)							0.04	0.03		
							(0.04)	(0.06)		
Number of Math Activities							0.13**	0.14+		
							(0.05)	(0.07)		
Treatment Interactions										
Head Start Treat * Advanced literacy activities				-0.10						
				(0.22)						
Head Start Treat * Basic literacy activities				0.03						
				(0.31)						
Building Blocks Treat * COEMET								0.04		
								(0.08)		
Building Blocks Treat * Number of Math Activities								-0.01		
								(0.08)		
Controls	x	x	x	x	x	x	x	x	x	x
Fixed effects for Random Assignment Block	x	x	x	x	x	x	x	x	x	x
Observations	1624	1067	1067	1067	564	564	555	555	884	884

**p<.01, * p< .05, + p< .10

NI= Group not included in model.

HSIS Notes. Standard errors clustered by unit of random assignment (in parentheses). Controls: Head Start entry assessment scores, gender, race, teen mom, parents education, immigration status, parent age, urbanicity, treatment 'no-show', treatment 'crossover', random assignment block.

BB Notes. Standard errors clustered at the preschool teacher level (in parentheses). Controls: preschool entry math score, gender, race, age at preschool entry, mother's education level, free/reduced price lunch status, whether limited English proficient, random assignment block.

Table 2. Head Start and Building Blocks treatment effects at the end of First Grade

	Head Start Impact Study (Age 4 Cohort)			Building Blocks			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Literacy Composite Score			Math Achievement			
Preschool Treatment							
Head Start Treatment Group	-0.00	-0.00	0.11				
	(0.07)	(0.07)	(0.16)				
Building Blocks Preschool Treatment Only				0.17*	0.13+	0.12	0.18*
				(0.08)	(0.08)	(0.08)	(0.08)
Building Blocks Preschool Treatment with K and 1st Grade PD Extension				NI	NI	NI	0.31**
							(0.07)
Instructional Quality							
Total advanced literacy activities in K and G1 combined (times per month; standardized)		0.02	0.04				
		(0.15)	(0.22)				
Total basic literacy activities in K and G1 combined (times per month; standardized)		-0.12	-0.04				
		(0.15)	(0.21)				
COEMET (Good Instruction)					0.03	0.03	
					(0.04)	(0.06)	
Number of Math Activities					0.16**	0.22**	
					(0.04)	(0.08)	
Treatment Interactions							
Head Start Treat * Advanced literacy activities			-0.04				
			(0.25)				
Head Start Treat * Basic literacy activities			-0.14				
Building Blocks Treat * COEMET						0.02	
						(0.09)	
Building Blocks Treat * Number of Math Activities						-0.09	
						(0.09)	
Controls	x	x	x	x	x	x	x
Fixed effects for Random Assignment Block	x	x	x	x	x	x	x
Observations	1056	1056	1056	564	561	561	884

**p<.01, * p< .05, + p< .10

NI= Group not included in model.

HSIS Notes. Standard errors clustered by unit of random assignment (in parentheses). Controls: Head Start entry assessment scores, gender, race, teen mom, parents education, immigration status, parent age, urbanicity, treatment 'no-show', treatment 'crossover', random assignment block.

BB Notes. Standard errors clustered at the preschool teacher level (in parentheses). Controls: preschool entry math score, gender, race, age at preschool entry, mother's education level, free/reduced price lunch status, whether limited English proficient, random assignment block.

Table Appendix A. Coding scheme for instructional quality of literacy activities in the Head Start Impact Study

Kindergarten literacy activities		First grade literacy activities	
Listen to stories with no print	basic	Activity related to book	basic
Show child how to read a book	basic	Write letters of alphabet	basic
Write own name	basic	Learn names of letters	basic
Teach directional words like over and up	basic	Have children tell you a story	basic
Write letters of the alphabet	basic	Practice sounds letters make	basic
Learn the names of letters	basic	Listen to stories w. print	basic
		Read books chosen by child	basic
		Read text w controlled vocab	basic
		Read text w strong phonemic pattern	basic
		Read patterned or predictable text	basic
		Hear storytellers	basic
Discuss new words	advanced	Language activities in mixed achievement groups	advanced
Have children tell you a story	advanced	Discuss new words	advanced
Practice the sounds that letters make	advanced	Read aloud	advanced
Listen to stories with print	advanced	Read silently	advanced
Rhyming words and families	advanced	Work in reading workbook	advanced
		Write words from dictation	advanced
		Use invented spellings	advanced
		Read thematic text	advanced
		Compose stories or reports	advanced
		Publish child's writing	advanced
		Perform plays/skits	advanced
		Write stories in journal	advanced