Abstract

Title: Do pre-k quality benchmarks influence children's third grade academic achievement?

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Background
Quality benchmarks in state pre-k programs measure the overall quality of prekindergarten programs. The quality benchmark includes ten quality standards: comprehensive early learning and development, curriculum support, teacher degree, teacher specialized training in pre-k, assistant teacher with degree related to child development, staff professional development plan, maximum class size of no more than 20, staff-child ratio (1:10 or lower), screening and referral (vision, hearing, and health), and continuous quality improvement systems (Barnett et al., 2017). States that meet only one of the standards receive a score of one, while states with more standards will have higher scores, up to a maximum of 10. Some states have changed their scores over time. Connecticut, for example, had a benchmark of 5 in 2004, meeting the standards of early learning and development, curriculum support, teacher specialized training, maximum class size, and staff-child ratio, but in 2005, changed the benchmark to 6 with the addition of the screening and referral quality.

Promising effects of pre-k are often found when programs have one of the three following components: evidence-based curricula, integrated professional development and coaching, and organized and engaging classrooms (Duncan & Magnuson, 2013; Phillips et al., 2017; Weiland & Yoshikawa, 2013). These impacts are larger for racial minority groups (Phillips et al., 2017; Gormley, 2007). However, there is less empirical support for the effects of pre-k on children's academic achievement regarding the combined quality components on a large scale and over a longer period of time. Thus, examining the changes in quality benchmarks on children's later academic outcomes for all children and children in different racial groups is important to extending this knowledge.

Objective
The study investigates the effect of pre-k quality benchmarks on children's math and English Language Art (ELA) outcomes at third grade.

Setting
This study focuses on states with pre-k quality benchmarks, which has been collected by the National Institute for Early Education and Research (NIEER) from 2001 to present. Linking the benchmark with the state average student achievement at third grade from the Stanford Educational Data Archive (SEDA), the study examines the association between pre-k quality and student academic outcomes.

Subjects
The full sample consists of 50 states, of which forty had pre-k benchmarks in place between 2005 and 2011. The analysis sample includes all of these forty states with benchmarks, adequate enrollments and expenditures in pre-k, and corresponding student achievement scores at third grade. Descriptive statistics for the sample are presented in Table 1.

Research Design
The study uses a state-by-year fixed effects model to exploit the variation in pre-k quality benchmarks on children's achievement. As not all states with quality benchmarks in later years had benchmarks in early years, states without benchmarks in early years can serve counterfactual to those with benchmarks later. The variation in benchmarks between 2005 and 2011 allows for further examination on student achievement.

The quality benchmark collected by NIEER is used to examine the changes in student academic achievement at third grade from SEDA. Applying the state-by-year fixed effects model to absorb time-

invariant characteristics of states helps to address the potential for endogeneity of pre-k benchmark changes and control for possible trends in student outcomes or state policies. State-by-year covariates are also controlled to account for the time-varying characteristics of states (e.g., pre-k enrollment rate for 3 and 4 years old & per-pupil pre-k educational expenditures). Estimations with and without these covariates will be explored to verify how their inclusion affects the results. In all analysis models, the potential for serial correlation in within-state achievement over time is considered by clustering errors at the state level.

Data Collection and Analysis

This study relies on two primary sources of data. The quality benchmark data is from NIEER-collected data on quality standards, enrollment, and expenditures for pre-k in all states since 2001 (Table 1). The pre-k benchmark is matched by state between 2005 and 2011 to third grade test scores from SEDA in 2009 and 2015.

The SEDA includes estimates of average math and English Language Art (ELA) scores by state, grade, year, subject, race, and ethnicity of students in the United States between 2009 and 2015 (Reardon, Kalogrides, and Ho, 2017). The National Assessment of Educational Progress (NAEP) math and ELA scale scores over seven years are used in the study. The seven years of test scores correspond to four academic years after pre-k benchmarks. Particularly, the seven years of test scores are defined as four years after the benchmarks of each state. For example, the 2005 states with benchmarks will appear in the SEDA data from third grade in 2009.

An analysis of the data is constructed by combining state benchmarks, enrollment rates for three and four years old, and expenditures per pupil with math and ELA outcomes by state and year for all students and racial groups.

Findings

Table 2 summarizes the results on the effects of state pre-k benchmarks on average math and MLA scores. The results include math and ELA achievement measures for all students and different racial groups. There is no relationship found between benchmark changes and math for all students' math achievement at third grade. However, Asian, Hispanic, and black students are found to benefit on math scores at the third grade from the increase of quality benchmarks in pre-k. The largest effect of benchmarks on math is found for Asian students with an increase of math achievement scale score by 1.13, followed by Hispanic students with 0.77 and black students with 0.40. Most results are robust while controlling state spending and enrollment rates. The association between pre-k benchmarks and ELA achievement for all students and racial groups is not statistically significant.

Conclusion

The current study expands our understanding of state pre-k program quality on average achievement at a large scale. The findings show that, on average, pre-k programs produce positive gains in math for all racial group children except for white students at third grade. The results imply that increasing pre-k quality overall will improve most children's math outcomes. Although there is no association between the higher quality of pre-k and ELA, this does not mean that the development of children's ELA skills is not relevant to pre-k quality. Given that most studies found that children need to develop math skills before advancing other skills (Nguyen et al., 2016), the present findings of quality benchmark on math seem valid.

Appendices

Appendix A: References

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Appendix B: Tables and Figures

Table 1. Descriptive Statistics for the Analysis Sample

	N	Mean	SD	*N*	Mean	SD
Independent Variable						
Pre-K Quality Benchmark	254	6.81	2.14			
Dependent Variables						
		Math			**English Language Art**	
Average Achievement for All Students	323	228.70	5.85	327	207.30	7.55
Average Achievement for Asian Students	314	240.78	8.29	307	218.75	10.93
Average Achievement for Black Students	319	216.23	4.84	320	192.65	6.23
Average Achievement for Hispanic Students	317	221.38	5.00	321	195.99	7.12
Average Achievement for White Students	318	233.04	5.03	323	213.71	6.02
Average Achievement for Hispanic Students	323	25.38	1.71	327	35.41	2.46
State by Year Covariates						
State +TANF Expenditure Per Pupil	323	3894.88	3091.72			
Pre-K enrollment rate for 3 years old	321	.03	.05			
Pre-K enrollment rate for 4 years old	322	.19	.19			
Observations	323			327		

Note. The descriptive statistics include all the variables used in the study. The pre-k quality benchmark is a continuous variable, ranged from 1 to 10 from 2005 to 2011. All outcome measures are in NAEP scale score points. Performance estimates are standardized so that different states have estimates on the common NAEP scale, so that estimates in this metric are comparable to state and national test score performance estimates in the NAEP. These estimates are also comparable across grades and years, but not subjects (Reardon, Kalogrides, and Ho, 2017). State-by-year covariates include pre-k expenditure per pupil and enrollment rates for three and four years old. Pre-k expenditure is adjusted to 2015 dollars. Enrollment rates for three and four years old are divided by the total population of three and four-year olds respectively. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 2. Regression Results of Benchmarks on Average Math and ELA Achievement at Third Grade

	Math				English Language Art			
	Model 1		Model 2		Model 1		Model 2	
Average Achievement for All Students	0.151	(0.145)	0.123	(0.174)	0.089	(0.172)	0.052	(0.136)
Average Achievement for Asian Students	1.055**	(0.332)	1.129*	(0.425)	0.101	(0.409)	0.004	(0.485)
Average Achievement for Black Students	0.304	(0.186)	0.400*	(0.188)	-0.05	(0.312)	-0.102	(0.355)
Average Achievement for Hispanic Students	0.667*	(0.249)	0.767*	(0.317)	0.464	(0.332)	0.505	(0.367)
Average Achievement for White Students	0.135	(0.156)	0.127	(0.157)	0.258	(0.214)	0.221	(0.198)
Average Achievement for Hispanic Students	0.174	(0.115)	0.095	(0.097)	0.147	(0.136)	0.104	(0.154)
State by Year Covariates	no		yes		no		yes	
N	254				257			

Note. Standard errors in parentheses. All models include state by year fixed effects. Standard errors are clustered at the state level. State by year covariates include pre-k expenditure per pupil and enrollment rates for three and four years old. Pre-k expenditure is adjusted to 2015 dollars. Enrollment rates for three and four years old are divided by the total population of three and four-year olds respectively. All outcome measures are scale standardized scores * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.