RESEARCH BRIEF

for the Houston Independent School District

Equality of Pre-Kindergarten Educational Opportunities: The Relationship between Pre-k Quality and Student Outcomes (Part 2)

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This study is the second of a two-part series examining the equality of student pre-kindergarten experiences in HISD, examining variations in outcomes occurring at the end of pre-k for students who were enrolled in HISD pre-k programs. Part 1 of this series found that there were disparities in enrollment in pre-k programs of differing qualities, with Hispanic and Asian students and students with limited English proficiency (LEP) enrolling in programs determined to reach fewer National Institute for Early Education Research quality benchmarks. Part 2 of this series (this brief) finds that, on average, there appears to be no direct association between the total number of quality benchmarks attained by a student's school and the student's average CIRCLE assessment score at the end of pre-k. For some groups, however, quality is positively associated with academic outcomes at the end of pre-k. Compared to their peers, non-economically disadvantaged students, students who have limited English proficiency, or are in bilingual programs, exhibit higher CIRCLE scores when enrolled in programs with a higher number of quality benchmarks. Of the individual quality benchmarks, teacher professional development and specialized training in early childhood education appear to be associated with higher CIRCLE scores.

BACKGROUND

This is the second part of a two-part study aiming to understand the equality of educational opportunity and the equality of educational outcomes for the youngest students in the Houston Independent School District (HISD). The quality of Educational Opportunity Study (1966), or the "Coleman report" as it became known, resulted from a call in the Civil Rights Act of 1964 to better understand whether public schools were offering all students equal educational opportunities. Coleman and colleagues examined both inputs to education and student outcomes, concluding that a relationship existed between school resources and student outcomes, but this relationship did not fully explain the differences observed between students of different sociodemographic backgrounds (Coleman et. al., 1966).

Disparities in student outcomes can be observed at the start of formal schooling for many students (see Booth and Crouter (eds.), 2008; Baumgartner, 2017b; Loeb and Bassok, 2007; Rouse, Brooks-Gunn, and McLanahan, 2005). This suggests that disparities observed later in students' educational careers, from grade retention, to drop out rates, to academic achievement, can be traced back to early childhood (Alexander, Entwisle, and Olson, 2007; Duncan, et. al., 2007).

One strategy to try to reduce these disparities is to offer high-quality early learning opportunities to students who are at risk of being unprepared at school entry. The first brief of this series found that there are significant differences with regards to which students are enrolled in pre-kindergarten programs that have attained the greatest number of National Institute for Early Education Research (NIEER) quality benchmarks. Notably,

Hispanic and Asian students are less likely than White or Black students to be enrolled in programs with a higher number of quality benchmarks. Limited English proficiency students are also more likely to be in programs with fewer quality benchmarks than their peers. Students from economically disadvantaged backgrounds are more likely than non-economically disadvantaged students to be enrolled in both the highest and the lowest quality programs, which could suggest that some families are able to differentiate between pre-k programs and choose higher quality options, while other families may not have the resources available (e.g., transportation, knowledge of quality indicators, knowledge of options throughout the district) to enroll their children in different programs (Baumgartner, 2017a).

Utilizing the NIEER quality benchmarks assessed in Part 1 of this study, this brief (Part 2) examines the relationship between these quality benchmarks and student academic achievement at the end of pre-k. Additionally, this study includes a focus on assessing whether and how this relationship may vary for students with different background characteristics, to address whether quality matters in the same way for all students.

RESEARCH QUESTIONS
Specifically, there are two questions Part 2 of this study aims to address:
1) To what extent is the quality of a pre-k program associated with student academic outcomes, controlling for prior student achievement?
2) How does the relationship between pre-k quality and student academic outcomes vary for students of different social and demographic groups?

DATA AND METHODS
Data
The data for this study come from two sources. One source of data is HISD, which provides information regarding student sociodemographic characteristics, enrollment status, teacher certifications, and school-level demographic characteristics for fall and spring of the 2015-2016 school year. This sample was restricted to students who were in HISD pre-k in 2015-2016.[1]

The second source of data comes from a questionnaire distributed to the 164 campuses identified in HISD as containing pre-kindergarten classrooms. This questionnaire is intended to measure various characteristics of pre-kindergarten programs throughout the district (see Part 1 of this series for more information). Fifty-four schools responded to the questionnaire, but only fifty of these schools are included in this analysis, as some were missing data from administrative files regarding teacher certifications. Supplemental analyses find no significant differences between those schools responding and not responding to the questionnaire. The sample is limited to only those students who participated in the pre-k assessment and were in schools that participated in the questionnaire (N=4,033).

Measures
Student academic outcomes are measured at the spring of the pre-k school year using the end of year CIRCLE literacy assessment that was administered in either English or Spanish to students (though some students who spoke English and Spanish participated in both assessments, as campuses were able to decide the language of administration for each student). This study uses two measures of academic achievement: the continuous CIRCLE score and a dichotomous measure that evaluates whether students are performing on grade level at the time of assessment. In other words, the dichotomous measure serves as an indicator of whether students are school ready at the end of pre-k.

Quality pre-kindergarten is a continuous measure that demonstrates the overall level of quality of pre-kindergarten programs within a school. This number is a composite score

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[1] In the state of Texas, only students who are identified in one or more risk groups are eligible for access to free, state-funded public pre-k, including: unable to speak and comprehend English, educationally disadvantaged, homeless, child of a member of the armed forces who is in active duty or who was killed or injured while serving, or has ever been in the care of the Department of Family and Protective Services (Texas Education Code §29.153).

| Table 1. Descriptive characteristics of students in sample (N=4,033).				
		Assessment language		
		English Only	Spanish Only	Both
	All students (N=4.033)	(N=2,134)	(N=1.701)	(N=198)
	Mean/proportion (SD)	Mean/proportion (SD)	Mean/proportion (SD)	Mean/proportion (SD)
Female	0.498	0.500	0.496	0.495
Race/ethnicity				
White	0.032	0.057	0.005	0.000
Black	0.269	0.500	0.008	0.020
Hispanic	0.665	0.382	0.984	0.975
Asian	0.026	0.047	0.001	0.005
Other	0.008	0.014	0.002	0.000
Immigrant	0.050	0.032	0.073	0.035
Limited English proficiency	0.504	0.105	0.969	0.813
Bilingual	0.503	0.070	0.991	0.980
Economically disadvantaged	0.931	0.907	0.960	0.949
Age	4.528	4.521	4.537	4.521
Special education	0.016	0.025	0.006	0.000
Attends zoned school	0.490	0.442	0.513	0.813
Attended two years of HISD pre-k	0.107	0.114	0.102	0.066
Number of quality benchmarks	5.163	5.376	4.942	4.758

created through the combination of nine quality benchmarks established by the National Institute of Early Education Research (NIEER). A higher number on this measure is an indicator that a pre-kindergarten program is likely of higher quality. (Further information is included in Appendix A, but also in Part 1 of this series.)

Student-level characteristics include economic disadvantage, race/ethnicity, immigrant status, enrollment in special education, limited English proficiency, age, gender, whether the student attends their zoned school, assessed in both languages, and their fall CIRCLE scores.

Analytic Strategy

This analysis uses OLS, logistic, and multilevel regression models to examine the relationship between the number of NIEER quality benchmarks of a student's pre-k program and their literacy skills at the end of pre-kindergarten, controlling for prior academic performance and a series of background characteristics. Analyses are conducted separately for English and Spanish assessments, with some students included in both analyses because they took assessments in both languages. Figure 1 demonstrates the relationships between variables examined in this study.
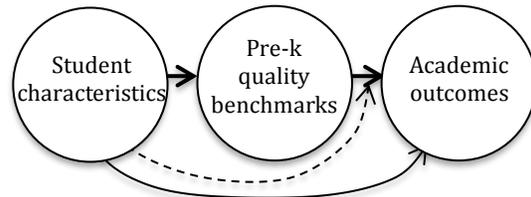
Figure 1. The relationship between student characteristics, pre-k quality benchmarks, and student outcomes.

RESULTS

Student characteristics

Across a number of demographic characteristics, students who took the CIRCLE assessment in different languages are very similar (Table 1). Not unexpectedly, student gender and age are similar across groups. And because such a large proportion of the overall school district is economically disadvantaged and that economic disadvantage is one of the ways that students qualify for free pre-k through HISD, it is not surprising that a large proportion of students in this sample are economically disadvantaged, across assessment languages.

In a few areas, students who took only the Spanish assessment or took both assessments appear to be different than students who took only the English assessment. As expected, the students who took Spanish assessments or assessments in both languages were more likely to have limited English proficiency and be enrolled in bilingual programs.

In some ways, students who took both assessments were different than their peers who took an assessment in only one language. The students who took both assessments were the most likely to attend their zoned school when compared to students who took either the English or Spanish only assessments. Shown in the last row of this table, students who participated in only the English assessment were on campuses that attained a higher number of NIEER quality benchmarks than students who participated in only the Spanish assessment or took both assessments.

In Table 2, additional descriptive statistics are presented for the outcome variables in this study, showing how students who took end of the year pre-k assessments in different languages varied with respect to their total score and the proportion of students who were performing at grade level at the end of pre-k.

As you can see in rows 2 and 4 in Table 2, students who participated in both assessments had lower total scores and a lower proportion of students who performed at grade level, when compared to either the students who took only an English or Spanish assessment.

Although the scores for students who participated in both assessments are significantly lower than their peers who took a single assessment, in the regression analyses that follow, the inclusion of English scores for students who took both assessments in the English CIRCLE analysis (and similarly for the Spanish CIRCLE analysis) did not change the results presented here.

Association between quality benchmarks and student achievement
The first research question asked to what extent the number of total quality benchmarks achieved by a pre-k program in HISD is associated with student academic outcomes at

Table 2. Average CIRCLE assessment score, by language of assessment (N=4,033).

	Assessment language		
	English	Spanish	Both
Total score (English)	105.81	--	67.40
% at grade level (English)	70%	--	17%
Total score (Spanish)	--	103.43	79.53
% at grade level (Spanish)	--	84%	53%

Note: English and Spanish assessments are NOT on the same scale, thus, scores cannot be directly compared.
In this sample, overall mean(SD) by assessment language: English 102.55 (25.34), Spanish 100.94(24.28).

the end of the pre-k year. As demonstrated in Table 3, *there appears to be no significant relationship between the number of quality benchmarks and student CIRCLE scores*, on either the English or Spanish assessments.

The models presented here include a series of student-level control variables, but the relationship between quality and pre-k assessment was also non-significant in simplified models which only included quality and CIRCLE scores.
To understand whether the continuous version of the benchmarks indicator was sensitive enough to any relationship between quality and student outcomes, this study also examined two dichotomous versions of the quality variable in separate analyses: a high number of quality

Table 3. Multilevel regression model predicting CIRCLE score, by language

	Assessment language	
	English	Spanish
	Coeff. (SE)	Coeff. (SE)
Total quality benchmarks	-0.100[n.s.] (0.956)	0.931[n.s.] (1.918)
Student controls	x	x
Constant	59.407 (7.779)	58.618 (13.882)
% variance at school-level	26.2%	50.3%

*** $p<0.001$ ** $p<0.01$ * $p<0.05$ [n.s.] non-significant
Models include control variables: race/ethnicity, gender, economic disadvantage, age, immigrant status, LEP status, bilingual program, special education, enrolled in 2 years of HISD pre-k, attended zoned school, and a flag for those who were assessed in 2 languages.
Full table available upon request.

indicators (6 or more) and a low number of quality indicators (3 or fewer). These tests found similar results to those presented for the continuous version of this measure. Additionally, to test the sensitivity of the outcome measure, a continuous indicator of CIRCLE assessment score, supplemental analyses also tested a dichotomous version of this variable which indicated whether a student was performing "at grade level" in the spring of pre-k. Again, results from these analyses were similar to those presented above, so they are not included in this brief.

*Variations in quality/assessment relationship by student characteristics*
Although the previous results show no relationship between pre-k program quality benchmarks and student CIRCLE assessment score, it assumes that all students would benefit from higher pre-k quality in the same way.

The next step of this analysis, and second research question, examines how the relationship between quality and student CIRCLE scores in the spring of pre-k varies for students of different socio-demographic groups. All groups described in Table 1 were analyzed, but only significant results are presented here.

Economically disadvantaged students
For students who took either the English or Spanish versions of the CIRCLE assessment, the relationship between the number of pre-k quality benchmarks and student assessment scores vary for students from economically disadvantaged backgrounds versus those who do not. To better understand these relationships, predicted values are presented in Figure 2 (table of results can be found in Appendix B).

Students who are economically disadvantaged do not appear to be benefiting from being on campuses with a higher number of quality benchmarks (as shown by the flat, dotted gray lines), but non-economically disadvantaged students do appear to experience a positive relationship between quality benchmarks and their predicted CIRCLE assessment score (as shown by the upward-sloping, black line).

English assessment

Spanish assessment
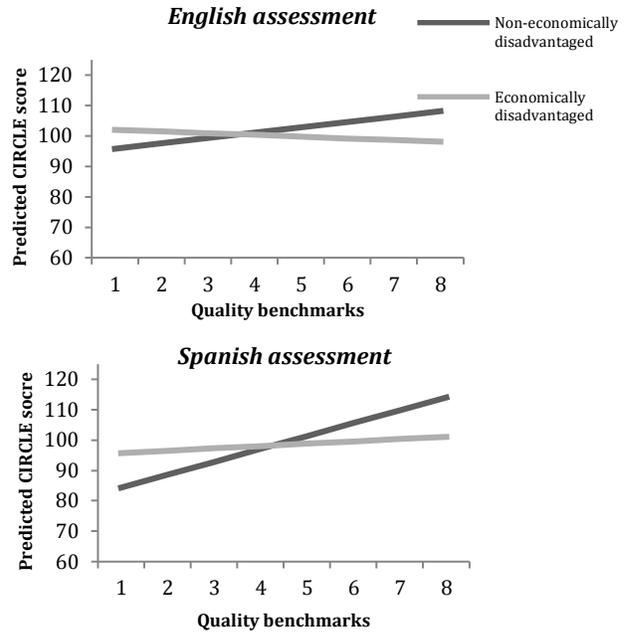
Figure 2. Predicted values for CIRCLE for economically and non-economically disadvantaged students.

One way to interpret this finding might be that students who are already more advantaged may be gaining additional advantage by being in a program that has attained a higher number of quality benchmarks.

Language minority students
When examining the relationship between English language CIRCLE scores and quality benchmarks for students classified as limited English proficiency (LEP) or who participated in bilingual programs, we also observe significant differences between groups.

In both instances, as shown in Figure 3, the analysis suggests that *LEP students and those enrolled in bilingual programs find greater benefit from enrollment in programs with higher quality benchmarks than non-LEP or students who are not in bilingual programs*. This finding emphasizes the importance of high quality early learning opportunities for students who are language minorities.

In a supplemental analysis, this study also considered whether students who were both LEP *and* in bilingual programs experienced any particular benefit from enrollment in programs

English assessment

English assessment
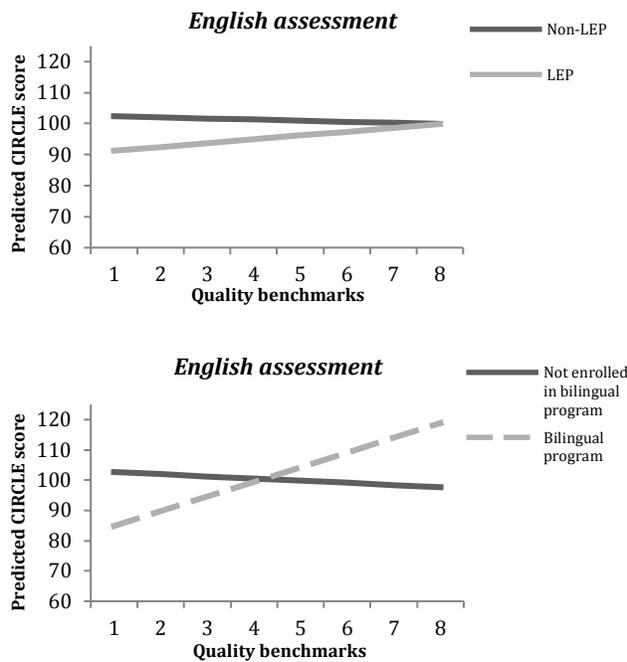
Figure 3. Predicted values for CIRCLE for LEP and bilingual program students.

with higher quality benchmarks. The results indicate that *students who are both LEP and in bilingual programs experience greater benefit on the English-language CIRCLE assessment when enrolled in higher quality programs than their peers who are LEP and not in bilingual programs, or versus any non-LEP students* (see Appendix C). Again, this finding reinforces the need for high quality early education programs for students who may have the greatest improvement to make in English literacy skills.

Are any specific pre-k quality benchmarks associated with student achievement?
For students who took the English CIRCLE assessment, there is a significant, positive relationship between being on a campus where *teachers are receiving at least 15 hours of professional development* and student CIRCLE scores.

Similarly, for students who took the Spanish CIRCLE assessment, being on a campus that has met the professional development benchmark of at least 15 hours is associated with higher CIRCLE scores. In addition, students who are on *campuses where all pre-k teachers have*

specialized training in early childhood learning standards or pre-k education have higher scores on the CIRCLE assessment than students on campuses that have not reached this benchmark.

DISCUSSION AND RECOMMENDATIONS
The goals of this study were to understand, 1) the relationship between pre-k quality indicators and student academic skills at the end of pre-k, and 2) how this relationship may vary for students of different social and demographic backgrounds.

On average, it appears that being on a campus which has achieved a higher number of quality benchmarks is not associated with student CIRCLE scores.

One reason why there may be no observed relationship between total number of NIEER quality benchmarks and student assessment scores, on average, is that these benchmarks are treated as *minimum requirements* for a high quality state-funded pre-k program. Notably, this study is only able to measure 9 out of 10 of the indicators because of data limitations. If the training/certification of teaching assistants and aides in the district is strongly related to student outcomes, this study may be missing an important piece of the quality measure. Additionally, perhaps the NIEER quality benchmarks are not enough for students in HISD. Considering the special needs of this student body and their families with respect to English proficiency, a measure of pre-k quality may need to include an indicator of early language services to capture the needs of this population.

When examining whether *any* students benefit from these higher quality programs, the results show that non-economically disadvantaged students find a benefit from enrollment in higher quality programs versus their economically disadvantaged peers on the English CIRCLE assessment. Bearing in mind the already higher average performance of non-economically disadvantaged students compared to their peers, this finding suggests that the pre-k programs in HISD may be exacerbating

differences between students by providing a greater boost to those students who area already more advantaged. In supplemental analyses, results show that non-economically disadvantaged students have a greater likelihood than economically disadvantaged students of being enrolled in a program reaching the highest number of quality benchmarks (8), which may further explain this finding.

Conversely, students who are language minorities, either considered "limited English proficiency" by the district, or who are enrolled in bilingual programs, find a greater benefit from being in a program with a higher number of quality benchmarks on the English assessment. This means that students who may need the most support in developing English literacy skills may benefit most from being in programs with the highest number of quality benchmarks.

There are a number of important implications of these findings, beginning with the need for all campuses to attain a greater number of pre-k quality benchmarks associated with providing high quality early learning opportunities for students. While it may be particularly beneficial for LEP students or those in bilingual programs to be on campuses of high quality*, increasing the quality of pre-k for all campuses would ensure that these students have access to a strong early educational experience, regardless of which HISD campus they attend*.

Another implication of this study is to emphasize the importance of having highly trained teachers in pre-k classrooms. Of the quality indicators assessed in this study, teacher professional development and specialized teacher training/certifications in pre-k/early childhood were the most significant predictors of student performance at the end of pre-k.

One of the limitations of this study is that only approximately one-third of HISD campuses with pre-k programs responded to the questionnaire used to measure the number of quality benchmarks achieved. As a result, over 100 campuses and their students were not included in this analysis. Although the demographic characteristics of campuses that responded are similar to those that did not, it is unknown how these campuses might compare to each other with respect to the number of NIEER quality benchmarks attained. In addition, a small proportion of students ($\sim$7%) were missing CIRCLE scores which led to their omission from the sample. This may lead to an under or overestimation of the relationships observed in this study.

The findings from this study suggest the importance of continued research on the quality of pre-k programs in HISD. In particular, there are three areas that would benefit from future research: 1) collect data from more campuses regarding indicators of high quality early education, 2) capture information about the training and certification of teaching assistants and teaching aides who serve pre-k classrooms, and, 3) add indicators of developmentally appropriate language services to future measures of program quality. Capturing data in these areas, on an ongoing basis, can play a significant role in the district's understanding of the services offered through their pre-k programs and how well these programs are serving students. Given what is known about the importance of early learning opportunities and the relationship between early academic skills and later outcomes, investments of time and resources in these early years is likely to have significant dividends.

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Appendix A: Information about NIEER Quality Benchmarks

The National Institute for Early Education Research has developed a list of 10 research-based quality standards benchmarks, which they feel are the minimum requirements for a high quality early education program. Though these standards cover a wide range of program characteristics, they are not intended to be a complete list of qualities associated with high quality learning environments. These indicators have generally been used to examine whether state policies require the level of the benchmark that is associated with high quality. This study examines whether these characteristics are observed in practice in campuses throughout HISD through the use of the questionnaire outlined in Appendix A and administrative data.

Quality	Benchmark
Early learning standards	Comprehensive
Teacher degree	BA
Teacher specialized training	Specialization in pre-k
Assistant teacher degree [a]	*CDA or equivalent*
Teacher in-service	At least 15 hours/year
Maximum class size	20 or lower
Staff-child ratio	1:10 or better
Screening/referral and support services	Vision, hearing, health; and at least one support service
Meals	At least one meal/day
Monitoring	Site visits at least every five years
From *The State of Preschool 2015: State Preschool Yearbook*. (Barnett, et al., 2016) **[a] Note: This indicator could not be assessed in this analysis, as HISD does not track the teaching or professional certifications of assistant teachers/teacher aides.**	

Appendix B: Multilevel regression models predicting CIRCLE score, by language of assessment

	Economic disadvantage		Limited English proficiency		Bilingual program
	Assessment language		Assessment language		Assessment language
	English	Spanish	English	Spanish	English
	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)	Coeff. (SE)
Total quality benchmarks	1.764	4.237	-0.352	5.941	-0.716
Economically disadvantaged	10.831	18.290			
Economically disadvantaged x total quality benchmarks	-2.317*	-3.474*			
Limited English proficiency			-14.263***	37.708**	
Limited English proficiency x total quality benchmarks			1.577*	-5.104*	
Enrolled in bilingual program					-28.951***
Enrolled in bilingual program x total quality benchmarks					5.570***

*** p<0.001 ** p<0.01 *p<0.05
Models include control variables: race/ethnicity, gender, economic disadvantage, age, immigrant status, LEP status, bilingual program, special education, enrolled in 2 years of HISD pre-k, attended zoned school, and a flag for those who were assessed in 2 languages. Full table available upon request.

Appendix C: Interaction between LEP status and bilingual program enrollment