Efficacy Study of the Frog Street Pre-K Curriculum in Guilford County Schools

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EXECUTIVE SUMMARY

This quantitative study evaluated the impact of Frog Street Pre-K: a comprehensive, research-based curriculum that integrates instruction across developmental domains and is aligned to state and national standards. We assessed impacts in Guilford County Schools (GCS, in North Carolina) during the 2023-24 school year on students' kindergarten performance the following year.

Study Sample and Methodology

- The study used a retrospective quasi-experimental design (QED) to examine the impact of the Frog Street Pre-K Curriculum on students' kindergarten performance.
- We followed 223 students who attended Frog Street Pre-K in GCS (across 9 schools) in 2023-24 and enrolled in GCS kindergarten in 2024-25. Their performance was compared to 641 students in the "business-as-usual" comparison group (across 36 schools) that used the Creative Curriculum for pre-K.
- Data sources for assessing student performance in kindergarten included the North Carolina Early Learning Inventory and DIBELS.
- Main analyses used multi-level modeling to account for the clustering of students in schools and inverse probability weighting to adjust for differences between groups in background characteristics.

Findings

- We found a large, significant, positive impact of the Frog Street Pre-K Curriculum on kindergarten readiness: Frog Street students scored 0.37 points higher on the Fall 2024 NC-ELI composite than comparison students (effect size = +0.26).
- An effect of this size applied to a normal distribution of scores would equal a +10-point percentile gain. In other words, participating in the Frog Street Pre-K Curriculum would move an average student (at the 50th percentile) to the 60th percentile.
- Significant subgroup impacts were highest for ELLs, with an average advantage for Frog Street ELL students over comparison students of +0.62 standard deviations. Further research is recommended to explore the replicability of these strong impacts with large samples across diverse school districts.
- No significant differences between groups were found on the DIBELS assessment of early literacy skills, however, most students had minimal early literacy skills at kindergarten entry, which limited our ability to determine impacts.
- Exploratory contrasts with students who did not attend pre-K or attended pre-K outside of GCS suggested that Frog Street students were more kindergarten ready and had stronger early literacy skills. Compared to students who attended pre-K outside of GCS, students in Frog Street Pre-K demonstrated higher

kindergarten readiness (+0.9 points) and early literacy scores (+22.8 points). However, because there were large background differences between Frog Street Pre-K students and these comparison groups, further research is encouraged to substantiate these promising results.

INTRODUCTION

Overview of the Frog Street Pre-K Curriculum

Frog Street Pre-K is a comprehensive, research-based curriculum that integrates instruction across all developmental domains and is aligned to state and national early learning standards. The program is rooted in theories of child and brain science, ensuring that every instructional decision is grounded in how young children learn and grow. Frog Street Pre-K uses a blended pedagogical approach through both intentional teaching and child-led discovery. The Frog Street Pre-K Curriculum embeds explicit instruction, clear modeling, rich language, and scaffolded practice as children build foundational skills in ways that are engaging, purposeful, and developmentally responsive.

The Frog Street Pre-K Curriculum addresses the full range of early learning; social and emotional development; language and literacy; cognition; perceptual, physical & motor; creative arts expression; and literacy, mathematics, science, and social studies knowledge and skills. The program is organized around five cornerstones:

- Integration of Themes, Disciplines and Learning Domains
- Social and Emotional Development
- Differentiated Instruction
- Equity of English and Spanish Instruction and Materials
- Child-Centered Approaches toward Learning

According to Frog Street, the curriculum is designed to meet the needs of diverse learners while celebrating the joy of learning for each child. It includes tools and features that help teachers prepare children for kindergarten, such as social-emotional learning, thematic teacher guides, integrated STEAM (science, technology, engineering, arts, mathematics) projects, and a suite of digital products to support kindergarten readiness across all developmental domains.

Overview of the Evaluation

Frog Street contracted with the Center for Research and Reform in Education (CRRE) to evaluate their pre-K curriculum as it was implemented in Guilford Country Schools (GCS, in North Carolina) during the 2023-24 school year. This report presents findings from this retrospective quasi-experimental design (QED) study examining the impact of the Frog Street Pre-K Curriculum on students' academic performance in kindergarten. The primary comparison was between students who had attended GCS pre-K classrooms using Frog Street and similar GCS students who had attended pre-K in schools using the Creative Curriculum that represented the school's or the associated district's "business-as-usual" model. Supplementary analyses also compared Frog Street Pre-K students to students on other pre-K paths, but these analyses were considered more descriptive and exploratory.

The study examined the following specific research questions:

1. What is the impact of the Frog Street Pre-K Curriculum on students' kindergarten readiness compared to children in similar GCS pre-Ks?
2. What is the impact of the Frog Street Pre-K Curriculum on students' early literacy skills compared to children in similar GCS pre-Ks?
3. Do Frog Street Pre-K Curriculum impacts differ for students from different backgrounds (e.g., gender, race/ethnicity, home neighborhood, English language status, special education status)?
4. How did students in schools with the Frog Street Pre-K Curriculum perform in kindergarten readiness compared to children who:
    a. Did not attend pre-K?
    b. Attended non-GCS pre-K?

METHOD

Research Design

During the 2023-24 school year, Guilford County Schools (GCS) expanded the number of pre-K classrooms using the Frog Street Pre-K curriculum. To evaluate the impact of the Frog Street Pre-K Curriculum, the study compared outcomes for former pre-K students when they entered kindergarten in 2024-25 on: (a) kindergarten readiness across multiple domains (measured by the North Carolina Early Learning Inventory, NC-ELI) and (b) early literacy skills (measured by DIBELS).

This retrospective QED was designed to meet ESSA Tier 3 (promising evidence) criteria. From 4,882 students enrolled in GCS kindergarten in 2024-25, 223 students who had attended GCS pre-K classrooms using Frog Street in 2023–24 were included as the "treatment" group. They were then compared to 641 students who had attended GCS pre-K classrooms using the Creative Curriculum, labeled here as the "comparison" group. We selected this comparison group from all GCS kindergarten students because they (a) attended an alternative pre-K program and (b) were similar to the Frog Street students on background characteristics, which we confirmed by analyzing demographics and prior developmental ratings on the Ages and Stages Questionnaire (ASQ).[1] We used inverse probability weighting to further balance the treatment and comparison groups on observed characteristics, which allowed us to fairly compare groups by emphasizing students based on their likelihood to be in treatment and thus reflect what would happen if everyone had the same chance of being in the treatment group.

[1] Additionally, the Creative Curriculum was broadly used across the district in most pre-K classrooms prior to Frog Steet, so this was considered business-as-usual. Several pre-K schools (8) using other unique approaches (such as the Montessori model) or served unique populations (such as the EC schools) were not included in the analysis as part of the comparison group due to their unique approaches and student selection, making them very different from the treatment group and thus difficult for comparison.

Supplementary analyses compared Frog Street students' kindergarten performance to that of students (a) who had not attended any pre-K and (b) who had attended pre-K outside of GCS. These supplementary comparisons were considered exploratory because these groups were not equivalent to Frog Street students on background characteristics.

Procedure

Prior to the 2023-2024 school year, approximately 2,500 pre-k eligible students and their families applied to attend the NC Pre-K program in Guilford County, including programs in Guilford County Schools (GCS) elementary school sites, Head Start sites, and private child care sites. On the application, families could select up to four approved locations; some families listed a GCS school and others did not. When listing their preferred sites, parents were unaware of which curriculum the different GCS schools would be using. Roughly 1200 families listed a GCS school site and were sent the Ages and Stages Questionnaire (ASQ) to complete as a screening tool to help place the applicants in rank order by greatest need. This ASQ score also served as a pre-test measure in the current study.

Once ASQs were received, GCS ranked them in order of greatest need and placed applicants in a classroom, from the greatest need to least, taking into consideration the preferred sites listed on the application. For example, if an applicant's preferred site was full, the next preferred location was considered. This process continued until all available slots at elementary schools were filled. Parents then received their child's placement information and accepted or declined their placement. For those students placed in a GCS elementary school site, students received instruction from a licensed teacher who used either the Frog Street Pre-K curriculum or the Creative Curriculum Preschool curriculum depending on their school. Instructors using Frog Street Pre-K were in their first and second year of implementation while those utilizing Creative Curriculum had been using it for multiple years. Families who were not admitted either enrolled their child in other preschools outside GCS or remained on the waitlist.

At the beginning of the 2024-25 school year, the vast majority of the admitted and non-admitted students returned to GCS as kindergartners. At the time of kindergarten enrollment, parents or caregivers provided information about their child's pre-K enrollment the prior year. For students who attended pre-K in GCS, this information was cross-checked with district enrollment data.

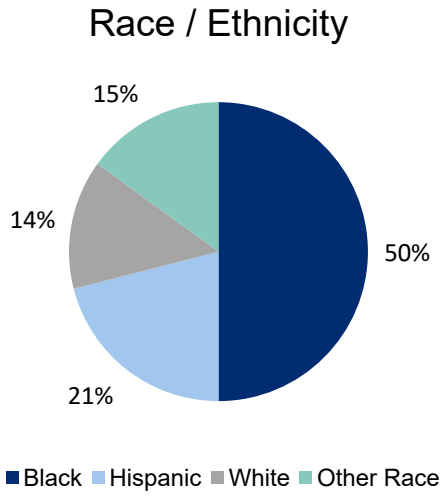
Within the first 60 days of kindergarten, teachers completed the NC-ELI for each child (see description below). Teachers also administered DIBELS at the beginning, middle, and end of the year to measure early literacy skills.

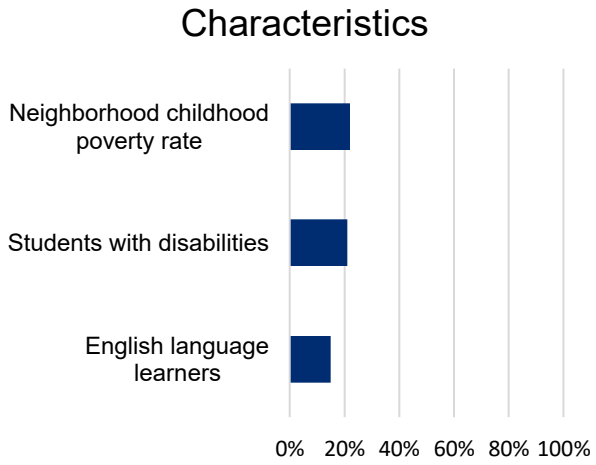
Participants

Details about all study participants are presented below.

	GCS Schools	Teachers (pre-K)	Students (pre-K)
Frog Street Curriculum (treatment)	9	19	223
Creative Curriculum (comparison)	41	56	641[2]
Supplementary comparisons			
No pre-K			916
Non-GCS pre-K			792

Demographic snapshot of all student participants in the primary analytic sample:





The study took place in Guilford County Schools, the third-largest school district in North Carolina, serving about 67,000 students across 124 schools. It focused on the cohort of

[2] Only 623 of these students appear in the analytic sample we discuss below due to 18 students missing post-test scores, demographics, or school information.

students who attended pre-K in 2023-24 and entered kindergarten in 2024-25. Demographic details for the primary analytic sample are presented in Table 1.[3] Demographic details for the other treatment contrasts are provided in Appendix C.

Table 1
Demographics of the Primary Analytic Sample

	Overall %	Treatment % (Frog Street Curriculum)	Comparison % (Creative Curriculum)
Female	50.2	53.2	49.1
Race - Black	49.7	55.4*	47.7
Hispanic	21.4	23.0	20.9
White	14.4	9.0	16.3**
Other/Multi	14.4	12.6	15.1
ELL	15.6	13.5	16.4
SPED	20.9	18.5	21.7
Neighborhood child poverty rate	22.4	22.4	22.4
ASQ (score)	210.6	212.9	209.8
n	846	223	623

*Note.*1. ASQ = Ages and Stages Questionnaire. 2. Analytic sample does not include 18 student participants who were missing post-test scores, demographics, or school information. 3. *$p < .05$, **$p < .01$.

The analytic sample included 846 students who had a post-test score and complete school enrollment and demographic information. Pretest (ASQ) scores were missing for 8.6% of these students, so we used regression imputation to fill in those values.[4] This procedure allowed us to retain more students in the analyses and conduct more rigorous contrasts.

Student characteristics were similar across treatment and comparison groups (see Table 1). The only significant difference between groups was student race. The treatment group (55.4%) had a slightly larger share of Black students than did the comparison group (47.7%) and the comparison group had a slightly larger share of White students (16.3% vs. 9.0%).

Although the groups were comparable overall, we still chose to employ propensity-score weighting to balance the groups, due to the non-random selection of students into the Frog Street Pre-K schools as documented above. Our weighting procedure, which balanced treatment and comparison groups on prior achievement and demographic

[3] Demographics of the weighted sample are provided in Appendix A.

[4] Our regression imputation approach estimated a regression equation predicting values on the ASQ for students missing this based on the other variables in our model, including student demographics and neighborhood poverty levels. This produced plausible, case-specific replacements that reflected relationships in the observed data. This approach also maintained the mean and standard deviation values for the ASQ from before imputation.

variables (described in more detail below), ensured the most precise and unbiased estimates of the Frog Street Pre-K Curriculum's impact.

Measures

To address the research questions, the study team obtained and analyzed data from GCS about students' developmental skills, kindergarten performance, school enrollment, and demographic background.

Ages & Stages Questionnaires (ASQ, Squires & Bricker, 2009). Parents completed the ASQ in spring or summer 2023 as part of the GCS pre-K application. The ASQ is a widely used screening tool for children between birth and 66 months that measures development across five domains—communication, gross motor, fine motor, problem solving, and personal-social. It can be completed by teachers or parents. Based on behavioral observation of the child, the reporter indicates whether a child has mastered age-appropriate skills; scores are summed to produce domain and composite scores. GCS uses the ASQ as a preschool admission screening tool, and we used the composite ASQ scores as the pretest measure of children's development prior to pre-K. As indicated by the quick completion times, parent-reported ASQ scores may have limited sensitivity and reliability due to parents' lack of familiarity with or attentiveness to assessment procedures.

North Carolina Early Learning Inventory (NC-ELI). Kindergarten teachers completed the NC-ELI within the first 60 days of kindergarten to assess children's kindergarten readiness across multiple domains: language and literacy, mathematics, approaches to learning, social and emotional development, and physical well-being and motor development. The NC-ELI is an observation-based, formative assessment aligned to state early learning standards and based on the Teaching Strategies GOLD® assessment. Teachers rated each child's skills and behaviors based on observation and documentation to produce domain and summary scores. NC-ELI scores in our analytic sample ranged from 1.0–10.8 on the composite and were approximately normally distributed.

Dynamic Indicators of Basic Early Literacy Skills (DIBELS, Good et al., 2004). The DIBELS assessments are brief, teacher-administered measures of students' early literacy skills that are predictive of later reading outcomes. DIBELS is used in grades K-5; we analyzed composite scores and scores on the five kindergarten subtests: letter naming fluency (LNF), phonemic segmentation fluency (PSF), word reading fluency (WRF), and two nonsense word fluency (NWF) subtests: (a) correct letter sounds (CLS), and (b) words recoded correctly (WRC). We analyzed DIBELS scores at kindergarten entry (fall 2024) and again at the end of the kindergarten year (spring 2025). DIBELS scores at entry were heavily skewed toward very low values (with many students having scores near zero), indicating a floor effect that reduced the measure's ability to distinguish between students' achievement. (See Appendix B for more descriptive analyses of the DIBELS scores.) This is not surprising given students are just beginning to develop literacy skills when they enter kindergarten. Scores at

the end of kindergarten were more normally distributed but still positively skewed. As this data characteristic violates one of the core assumptions of multiple regression and multilevel modeling, we treated DIBELS as a secondary outcome and interpreted those results cautiously.

School enrollment and demographic data. GCS provided school enrollment and demographic data for students who were enrolled in GCS pre-K in 2023-24 or kindergarten in 2024-25. School enrollment data were used to identify the treatment and comparison groups (based on their pre-K school enrollment). Demographic data were more complete for the 2024-25 year, so we used values from this year in analyses. Demographic variables included gender, race/ethnicity, special education status, and English-learner status.

Neighborhood data. GCS also provided each student's census tract and the tract-level child poverty rate. We included neighborhood poverty in weighting and analyses to improve comparability between groups due to our limited pretest measures and lack of other prior academic performance data.

Analytical Approach

Kindergarten readiness data for students in 2024-25 were analyzed in Stata (v 18.0). After examining descriptive patterns, the main analysis employed Hierarchical Linear Modeling (HLM) with students nested within schools to determine the impacts of the Frog Street Pre-K Curriculum on NC-ELI scores in fall 2024. Models adjusted for children's prior development (ASQ pretest scores in spring/summer 2023) and for student background (race/ethnicity, gender, ELL status, disability status, and neighborhood poverty). Continuous variables were grand-mean centered to generate an interpretable adjusted comparison group mean. We first estimated the impacts on the composite scores and then on the individual domain scores.

Because students were not randomly assigned to Frog Street classrooms, we used inverse probability weighting (IPW) to reduce selection bias by creating comparable groups of treatment and comparison students, while also keeping as many students as possible in the analytic sample. We estimated the probability that each student had attended Frog Street based on ASQ scores and the demographic variables listed above. Treatment students were given a weight of 1.0; comparison students received weights proportional to how similar they appeared to treatment students on the ASQ and demographic variables, i.e., the inverse of their probability of being in the treatment group. Comparison weights were within an acceptable range from 0.12 to 1.0, where more similar students have higher weight value and are thus weighted more heavily in the impact estimates and vice versa for less similar students. For example, a comparison student with a low ASQ score of 150 from a neighborhood with a very high child poverty rate of 60% would have a low weight closer to 0.12 because they are dissimilar from the typical Frog Street student who had an ASQ score of 213 and poverty rate of 22%. With this low weight, their results on the post-test would not affect the average treatment effect as much as a student with a higher weight closer to 1.

Baseline equivalence between groups before and after weighting is shown in Table 2. Before weighting, the standardized mean difference between groups on the pretest (ASQ in 2023) was 0.05 standard deviations; after weighting it fell to 0.02, indicating improved and good balance.[5]

Table 2
Baseline Equivalence on ASQ (Pretest) in 2023 for Treatment and Comparison Students, Before and After Weighting

	All students	Treatment			Comparison			Standardized mean difference
	n	*n*	*M*	*SD*	*n*	*M*	*SD*	*M*
Before weights	846	223	212.93	55.23	623	209.79	52.96	0.052
After weights	846	223	212.93	55.23	623	213.43	53.00	0.018

To answer research question 2 about students' early literacy skills as assessed on the DIBELS, we followed the same modeling, covariates, and IPW approach. However, we estimated a new set of weights because the DIBELS samples were slightly smaller (DIBELS beginning-of-year: 203 treatment, 588 comparison; end-of-year: 209 treatment, 598 comparison). We estimated impacts on both the composite scores and the subtests. Descriptive analyses of these outcomes at kindergarten entry (fall 2024) confirmed that weight distributions and baseline balance were similar in these post-test samples (see Appendix B).

Subgroup impacts. To answer research question 3 and test whether impacts differed by student characteristics, we re-ran the same models described above but added an interaction term between the treatment indicator and student-level covariates of interest. We ran a separate model for each student-level covariate interaction. The interaction term indicated whether there was a differential benefit of the treatment for each subgroup (compared to the other groups on that demographic). The combination of treatment impact with interaction terms then identified the treatment impact for each subgroup, estimating whether treatment students with particular characteristics outperformed similar peers with those characteristics in the comparison group.

Supplementary analyses of other comparison groups. To answer research question 4, we ran additional exploratory analyses comparing the performance of Frog Street Pre-K students to that of (a) students who did not attend any pre-K and (b) students

[5] Balance was also improved on other student background characteristics. We also restricted the sample to students who were on "common support" or had a likelihood of being in treatment that was present in the other study group. This ensures that students are only included who have a comparable student in the other group. Only a few students were dropped due to common support (varying from 0 to 21 students per sample, representing 0.8 to 6% of the sample). The difference in the sample size in the impact tables reflects the dropping of these cases.

who attended non-GCS pre-K. These analyses used the same modeling and IPW procedures as above but used unique comparison groups, resulting in different sample sizes and contrasts. Initial baseline differences for these contrasts on the ASQ were substantially larger (standardized differences of 0.46 and 0.31). Although weighting improved balance, meaningful differences remained across covariates. Because of this residual imbalance, we treated these contrasts as exploratory and interpreted the results with more caution. Baseline equivalence tables for these analyses are provided in Appendix C.

RESULTS

This section of the report begins with the primary findings related to Frog Street Pre-K's impacts on students' kindergarten readiness, followed by secondary impacts on early literacy skills. We then examine subgroup impacts. We conclude with supplementary comparisons between Frog Street Pre-K and other pre-K pathways.

Impacts on Kindergarten Readiness

What is the impact of the Frog Street Pre-K Curriculum on students' kindergarten readiness compared to children in similar GCS pre-Ks?

Key Findings

- Frog Street Pre-K students scored significantly higher in kindergarten readiness on the NC-ELI assessment (ES = +0.26), than similar comparison students.
- This represents a +10 percentile gain where a student at the 50th percentile in the comparison group would move to the 60th percentile if they had attended Frog Street Pre-K.
- In analyses of NC-ELI domain scores, Frog Street Pre-K students scored significantly higher (ES = +0.31) than comparison students in the Physical domain and scored higher in directionality across all domains.

The main analysis examined the impact of Frog Street Pre-K Curriculum on students' kindergarten readiness in fall 2024 on the NC-ELI composite score compared to students in schools using the Creative Curriculum. Table 3 shows the results from multilevel models, adjusting for the clustering of students in schools and incorporating weights to adjust for treatment-comparison group differences. Effect sizes are experimental minus comparison means divided by the comparison group standard deviation.

Table 3
Impact of Frog Street Pre-K Curriculum on Fall 2024 NC-ELI Composite Scores

Outcome	N	Adjusted comparison mean	Adjusted treatment mean	Impact estimate (SE)	*p*-value	Effect size
NC-ELI	829	5.62	5.99	0.37* (.18)	.039	0.26

Note. 1. 50 schools. 2. NC-ELI = North Carolina Early Learning Inventory. SE = Standard Error. 3. * = significant at the .05 level.

On the NC-ELI composite score (across all subjects), when students entered kindergarten in fall 2024, Frog Street Pre-K students (M = 5.99) outperformed the comparison students in Creative Curriculum schools (M = 5.62) by 0.37 points (see Impact Estimate). This difference was statistically significant ($p < .05$) and corresponded to an effect size of +0.26 standard deviations. Based on Kraft's (2020) research, an effect size of that magnitude would represent a large, educationally meaningful impact. An effect of this size applied to a normal distribution of scores would equal a +10-point percentile gain. In other words, participating in the Frog Street Pre-K Curriculum would move an average student (at the 50th percentile) to the 60th percentile.

We also estimated impacts of Frog Street Pre-K on each of the five NC-ELI domain scores. Table 4 presents these results, where the impact estimate is the difference between the adjusted comparison and treatment group means.

Table 4
Impact of Frog Street Pre-K Curriculum on Fall 2024 NC-ELI Domain Scores

Outcome	N	Adjusted comparison mean	Adjusted treatment mean	Impact estimate (SE)	*p*-value	Effect size
Social	827	5.64	5.91	0.27 (.18)	.128	0.16
Literacy	829	4.86	5.13	0.27 (.17)	.117	0.18
Math	823	5.17	5.49	0.31 (.21)	.138	0.21
Cognitive	826	5.47	5.80	0.34 (.22)	.129	0.18
Physical	826	6.96	7.68	0.72 (.26)**	.006	0.31

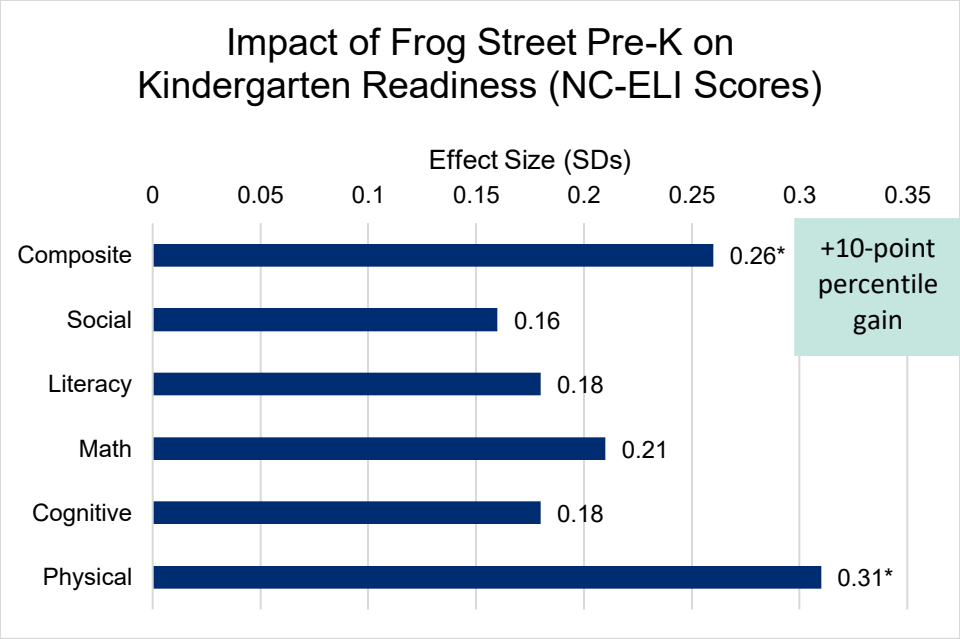
Note. 1. 50 schools. 2. NC-ELI = North Carolina Early Learning Inventory. SE = Standard Error. 3. ** = significant at the .01 level.

Similar to the results on the composite score, all impacts on the subject-specific domain scores were positive in direction with small effect sizes. The largest and only statistically significant ($p < .05$) domain impact was on Physical Development; Frog Street Pre-K students scored 0.72 points higher than comparison students. Applied to a normal distribution of scores, the associated effect size of +0.31 would equal a +11-point percentile gain. That is, participating in the Frog Street Pre-K Curriculum would move an average student (at the 50th percentile) to the 61st percentile.

The effect sizes of the impacts of Frog Street Pre-K on NC-ELI scores, including the composite and domains, are presented together in Figure 1. The two significant impacts

(on the Composite score and Physical Development domain) are indicated with an asterisk. Additionally, the figure includes a text box highlighting the percentile point gain equivalent to the impact on the composite score.

Figure 1



Note. * $p < .05$

Impacts on Early Literacy

What is the impact of the Frog Street Pre-K Curriculum on students' early literacy skills compared to children in similar GCS pre-Ks?

Key Findings

- There were no significant differences between Frog Street Pre-K students and comparison students on the DIBELS composite or subtest scores.

We next examined Frog Street Pre-K's impact on early literacy skills, as measured by the DIBELS assessment. Because many children had very limited literacy skills at kindergarten entry, we treated DIBELS as a secondary outcome to NC-ELI. Descriptive analyses of Fall 2024 DIBELS scores in this sample (see Appendix B) confirmed that they were highly skewed towards low values across both groups, i.e., many students had similar and very low scores (a floor effect), making it difficult for this assessment to fully capture student development at this time point. Spring 2025 scores, though more normally distributed, would have been influenced by other factors from kindergarten and

thus reflect less of the impact of the Frog Street Pre-K Curriculum directly. Despite these limitations, we thought it was still valuable to determine whether any meaningful achievement patterns emerged, given the importance of early literacy as an educational outcome. Table 5 shows the impact of Frog Street Pre-K Curriculum on DIBELS composite scores at kindergarten entry (Fall 2024) and at the end of the kindergarten year (Spring 2025).

Table 5

Impact of Frog Street Pre-K Curriculum on 2024-25 DIBELS Composite Scores

Outcome	N	Adjusted comparison mean	Adjusted treatment mean	Impact estimate (SE)	*p*-value	Effect size
DIBELS Fall 2024	779	304.49	303.84	-0.65 (3.04)	.832	-0.01
DIBELS Spring 2025	785	453.30	449.10	-4.19 (3.56)	.239	-0.09

Note. 1. 50 schools. 2. SE = Standard Error.

At kindergarten entry in fall 2024, there was no significant difference between Frog Street Pre-K and comparison students on the DIBELS composite score. In the fall, the Frog Street and comparison students had almost identical means, whereas in the spring, the comparison group had a nonsignificant advantage of 4.19 points.

We also examined the impacts of Frog Street Pre-K on the five DIBELS subtests administered in kindergarten: Letter Naming Fluency (LNF), Phonemic Segmentation Fluency (PSF), Word Reading Fluency (WRF), and two Nonsense Word Fluency (NWF) — Correct Letter Sounds (CLS) and Words Recoded Correctly (WRC). These results are shown in Tables 6 (for fall 2024) and 7 (for spring 2025). The subtest scores were also positively skewed, like the composite scores, and the impact estimates on the scores should be interpreted with caution.

Table 6

Impact of Frog Street Pre-K Curriculum on Fall 2024 DIBELS Subtests

Outcome	N	Adjusted comparison mean	Adjusted treatment mean	Impact estimate (SE)	*p*-value	Effect size
LNF	779	22.70	22.85	0.14 (1.15)	.901	0.01
PSF	779	4.28	3.99	-0.29 (.50)	.561	-0.04
WRF	779	3.48	3.20	-0.28 (.55)	.613	-0.03
NWF-CLS	779	8.57	7.80	-0.78 (.75)	.302	-0.06
NWF-WRC	779	0.77	0.55	-0.22 (.23)	.333	-0.06

Note. 1. 50 schools. 2. SE = Standard Error.

Table 7

Impact of Frog Street Pre-K Curriculum on Spring 2025 DIBELS Subtests

Outcome	N	Adjusted comparison mean	Adjusted treatment mean	Impact estimate (SE)	*p*-value	Effect size
LNF	785	54.18	52.46	-1.72 (1.44)	.233	-0.09
PSF	785	47.48	46.51	-0.97 (1.71)	.570	-0.05
WRF	785	19.01	16.75	-2.26 (1.32)	.087	-0.12
NWF-CLS	785	51.42	49.43	-2.00 (2.36)	.397	-0.06
NWF-WRC	785	13.78	12.59	-1.19 (.92)	.197	-0.10

Note. 1. 50 schools. 2. SE = Standard Error.

Impacts on the DIBELS subtests mirrored the composite score findings: there were no significant differences between the groups at either time point. Differences between groups were close to zero at both time points.

Subgroup impacts

Do Frog Street Pre-K Curriculum impacts differ for students from different backgrounds (e.g., gender, race/ethnicity, home neighborhood, English language status, special education status)?

Key Findings

- ELL students benefited significantly more (+0.6 points) from Frog Street Pre-K in their kindergarten readiness than non-ELL students in Frog Street Pre-K.

We also tested whether the impacts of the Frog Street Pre-K Curriculum varied by student background characteristics, including gender, race/ethnicity, English learner status, and special education status. We conducted these analyses separately for each subgroup, adding an interaction (product) term between treatment status and the subgroup indicator into our analytic model. In Table 8, we report the subgroup-specific treatment impact estimates on the fall 2024 NC-ELI composite scores, which is calculated as the main treatment effect for the base group and by adding the interaction term to this main effect for the other subgroups. We also report the difference in impacts, taken from the interaction term, which calculates the difference between the impact estimates (far right column) for each subgroup in a particular demographic. For example, on gender, this outcome shows whether the impact of treatment on female students was significantly different from the impact on male students.

Table 8
Impact of Frog Street Pre-K Curriculum on Fall 2024 NC-ELI Composite scores, by Student Subgroup

Subgroup	n (subgroup)	Impact estimate (SE)	*p* value	Effect size	Difference in impact (SE)
Gender					
Male	410	0.24 (.21)	.266	0.17	
Female	419	0.48 (.18)**	.007	0.34	0.25 (.16)
Race/Ethnicity					
Black	416	0.33 (.21)	.120	.24	
White	176	0.56 (.16)**	.001	.40	0.12 (.29)
Hispanic	115	0.33 (.20)	.088	.24	0.00 (.21)
Other	122	0.42 (.44)	.339	.30	0.09 (.38)
ELL					
Non-ELL	617	0.29 (.18)	.104	0.21	
ELL	212	0.87 (.22)**	.000	0.62	0.58 (.19)**
SPED					
Non-SPED	617	0.33 (.19)	.075	0.24	
SPED	212	0.52 (.29)	.076	0.37	0.19 (.29)

Note. 1. *n* = 829 overall. 2. ** = significant at the .01 level.

Overall, Frog Street Pre-K Curriculum impacts were positive for all subgroups. Three student subgroups experienced a positive impact of Frog Street Pre-K on kindergarten readiness relative to their peers in the comparison group: female students (+0.48 points), White students (+0.56 points), and ELL students (+0.87 points).

The only significant ($p < .05$) differential impact identified was for English Language Learners (ELLs): the treatment effect was significantly higher for ELL students compared to the treatment effect for non-ELL students. The impact of Frog Street Pre-K on ELL students (+0.87 points) was 0.58 points higher on the NC-ELI composite than the treatment impact on non-ELL students (+0.3 points).The Frog Street ELL subgroup was small (n = 29) but still represents a meaningful impact with a +0.58 SDs effect size that is over double the size of the main impact we saw on NC-ELI scores across the sample as a whole.

Similar analyses of DIBELS scores showed no significant subgroup impacts. The full results from these models appear in Appendix B.

Exploratory Contrasts with Other Pre-K Paths

How did students in schools with the Frog Street Pre-K Curriculum perform in kindergarten readiness compared to children who:

(a) Did not attend pre-K? or

(b) Attended non-GCS pre-K?

Key Findings

- Students in Frog Street Pre-K demonstrated higher kindergarten readiness (+0.4 points) and early literacy scores (+11.8 points) at kindergarten entry than their peers who did not attend pre-K.
- Students in Frog Street Pre-K demonstrated higher kindergarten readiness (+0.9 points) and early literacy scores (+22.8 points) at kindergarten entry than their peers who attended pre-K programs outside of GCS.
- Sampling inequivalence in both sets of analysis necessitate caution in interpreting these outcomes.

In our final set of analyses, we compared Frog Street Pre-K students' performance to two other student groups who entered GCS kindergarten at the same time: (a) students who did not attend any pre-K, and (b) students who attended pre-K outside of GCS (for example, Head Start or community-based daycares). Tables 9 and 10 present the results from these analyses, which use the same weighting and multilevel analytic approach as our main analyses, but with unique comparison groups. These results are considered exploratory because both comparison groups differed substantially from Frog Street students on the ASQ (pretest) and certain demographics. Weighting adjustments reduced but did not eliminate those differences. See Appendix C for more information on these samples and their differences.

Table 9

Frog Street Pre-K Students' Performance in Kindergarten Compared to Students Who Did Not Attend Pre-K

Outcome	N	Adjusted comparison mean	Adjusted treatment mean	Impact estimate (SE)	*p*-value	Effect size
NC-ELI	969	5.33	5.76	0.44 (.13)**	.001	0.30
DIBELS Fall 2024	929	293.30	305.12	11.82 (3.49)**	.001	0.26
DIBELS Spring 2025	914	443.06	446.89	3.83 (4.30)	.374	0.07

Note. 1. 50 schools. 2. NC-ELI = North Carolina Early Learning Inventory. SE = Standard Error. 3. ** = significant at the .01 level.

Compared to children who did not attend pre-K, Frog Street Pre-K students scored significantly higher on both the NC-ELI and the fall 2024 DIBELS, with effect sizes of +0.30 and +0.26, respectively. No differences were found on the spring 2025 DIBELS.

Compared to children who attended pre-K outside of GCS (Table 10), Frog Street Pre-K students scored significantly higher on both kindergarten performance measures and at both time points. Again, entry-level differences were larger, with large effect sizes for NC-ELI (+0.57) and fall DIBELS (+0.51). As in the prior analysis (Table 9), the large background differences between Frog Street and comparison samples could partially or mostly explain these effects.

Table 10
Frog Street Pre-K Students' Performance in Kindergarten Compared to Students Who Attended Non-GCS Pre-K

Outcome	N	Adjusted comparison mean	Adjusted treatment mean	Impact estimate (SE)	*p*-value	Effect size
NC-ELI	1,050	5.01	5.86	0.85 (.13)***	<.001	0.57
DIBELS Fall 2024	1,005	282.79	305.55	22.75 (3.26)***	<.001	0.51
DIBELS Spring 2025	986	440.48	448.08	7.60 (3.14)*	.015	0.15

Note. 1. 50 schools. 2. NC-ELI = North Carolina Early Learning Inventory. SE = Standard Error. 3. * = significant at the .05 level; *** = significant at the .001 level.

DISCUSSION

This retrospective quasi-experimental study examined the impact of the Frog Street Pre-K Curriculum on students' kindergarten performance in Guilford County Schools. We followed children who attended Frog Street Pre-K in 2023-24 into GCS kindergarten in 2024–25 and compared them to similar GCS students who attended pre-Ks using the Creative Curriculum (the "business-as-usual" programming). We used school-level hierarchical models, adjusted for prior development (ASQ) and demographics, and applied weighting to rebalance the comparison group so it looked more like the treatment group. Supplementary, exploratory contrasts compared Frog Street students to children with no pre-K and to children who attended non-GCS pre-K programs. Below, we summarize the key findings and address the study's limitations and suggestions for future research.

Impacts of Frog Street Pre-K on Kindergarten Performance

The Frog Street Pre-K Curriculum had a large positive impact on students' overall kindergarten readiness. On the NC-ELI composite score in fall 2024, Frog Street Pre-K

students scored significantly higher (0.37 points, $p < .05$) than their comparison condition counterparts (effect size = +0.26). Practically, this effect size corresponds to an estimated percentile growth of 10%, moving an average student from the 50th to the 60th percentile. Impacts on all NC-ELI domain impacts were directionally positive, but the only statistically significant domain effect was for physical development (+0.72 points; $p < .01$).

DIBELS was treated as a secondary outcome because many children demonstrated minimal literacy skills at kindergarten entry, producing a floor effect. Both groups made gains from fall to spring, but we found no statistically significant difference between Frog Street Pre-K and comparison students on the DIBELS composite or any subtests at kindergarten entry and at the end of kindergarten.

Subgroup Impacts of Frog Street Pre-K on Kindergarten Readiness

Frog Street Pre-K had positive impacts across subgroups, which were significant for female, White, and ELL students. The greatest differential benefit was for ELL students compared to the impact for non-ELL students. Frog Street ELLs scored 0.9 points higher on NC-ELI than ELLs in the comparison group (effect size = +0.62, $p < .05$) compared to only a 0.3-point effect for non-ELL students. This result is suggestive of particularly strong program benefits for ELLs. Further research is recommended to explore the replicability of these strong impacts with large samples across diverse school districts.

Impacts of Frog Street Pre-K Relative to Other Pre-K Paths

In comparison to students who did not attend pre-K or attended pre-K outside of GCS, Frog Street students scored significantly higher in their kindergarten readiness and early literacy skills at kindergarten entry. Frog Street students scored 0.4 points higher on the NC-ELI than students who did not attend pre-K, and 0.9 points higher than students who attended non-GCS pre-K programs. Although small in points, these differences represent effect sizes of 0.3 and 0.6 SDs, which are both considered large impacts relative to average program impacts in education. In early literacy skills, Frog Street student scores were 11.8 points higher on DIBELS than students who did not attend pre-K, and 22.8 points higher than students who attended pre-K outside of GCS.

We consider these contrasts as exploratory because the Frog Street and comparison groups were substantively different in prior skills' assessment scores and some demographic characteristics. Our weighting analysis reduced some of these differences, but not sufficiently to rule out systematic bias due to sampling inequivalence. Still, our results suggest that Frog Street Pre-K students appear to have a jump start at the beginning of kindergarten over their peers from these other pathways.

Limitations

Although the evidence from the present study supported the effectiveness of Frog Street Pre-K Curriculum on students' kindergarten readiness, several limitations should be considered. Because students were not randomly assigned to Frog Street Pre-K, selection bias resulting in Frog Street students having higher propensity for success in kindergarten cannot be ruled out. In the main analyses, however, we were able to achieve high similarity between the Frog Street and comparison samples by using inverse probability weighting, adjusting for scores on a pre-k development assessment (the ASQ) and demographics.

Second, the ASQ, while providing a useful baseline measure, was limited by measuring only some developmental skills relevant to kindergarten readiness but most critically, by being completed by parents who were not trained on how to complete it. It seems highly likely that there were inconsistencies and bias in how parents completed the assessment, potentially reducing the validity of these scores. Additionally, the DIBELS measure showed strong floor effects at kindergarten entry, limiting its usefulness as an outcome for differentiating between the literacy skills of treatment groups at that point.

Third, the study was conducted within a specific school district in one US state that is large and ethnically diverse, which may limit the generalizability of the findings to other contexts, including smaller school districts or regions with different demographic profiles. Future research replicating these findings in other geographic settings could provide further evidence of the Frog Street Pre-K Curriculum's efficacy and understand how local context may influence program effectiveness.

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APPENDIX A: Descriptive Tables

Table A1

Demographics of the Primary Analytic Sample – After Weighting

	Overall %	Treatment % (Frog Street Curriculum)	Comparison % (Creative Curriculum)
Female	50.2	53.2	53.4
Race - Black	49.7	55.4	55.1
Hispanic	21.4	23.0	22.8
White	14.4	9.0	9.0
Other/Multi	14.4	12.6	13.2
ELL	15.6	13.5	13.7
SPED	20.9	18.5	18.4
Neighborhood child poverty rate	22.4	22.4	22.4
ASQ (score)	210.6	212.9	213.4
n	846	223	623

*Note.*1. ASQ = Ages and Stages Questionnaire.

APPENDIX B: Secondary Outcome (DIBELS) Analyses

Figure B1

DIBELS Score Distribution

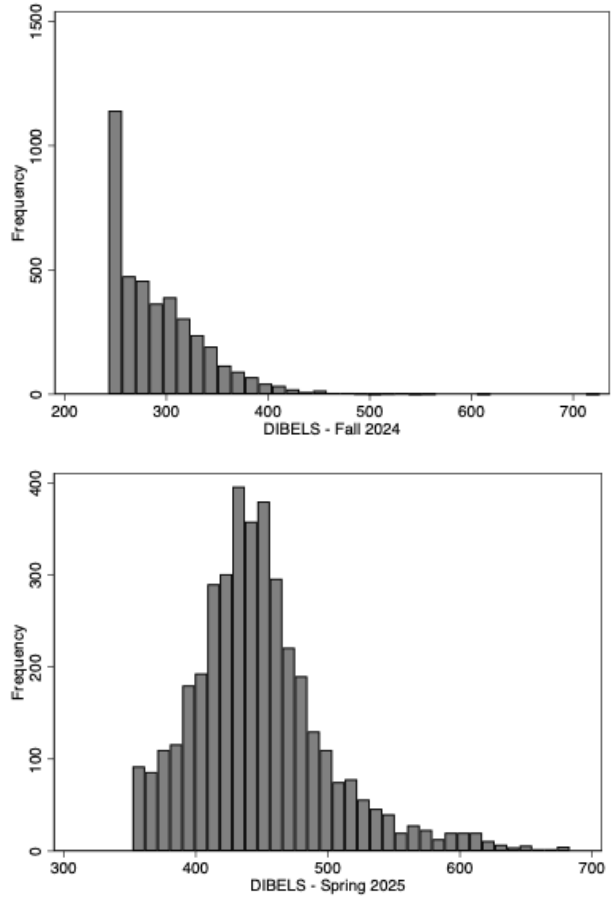

Table B1

Baseline Equivalence on ASQ (Pretest) in 2023 for Treatment and Comparison Students in DIBELS Fall 2024 Sample, Before and After Weighting

	All students	Treatment			Comparison			Standardized mean difference
	n	*n*	*M*	*SD*	*n*	*M*	*SD*	*M*
Before weights	790	219	212.64	55.47	571	209.73	51.95	0.058
After weights	790	219	212.64	55.47	571	214.70	51.08	-0.046

Note. Weights ranged from 0.12 to 1 in the comparison group.

Table B2

Baseline Equivalence on ASQ (Pretest) in 2023 for Treatment and Comparison Students in DIBELS Spring 2025 Sample, Before and After Weighting

	All students	Treatment			Comparison			Standardized mean difference
	n	*n*	*M*	*SD*	*n*	*M*	*SD*	*M*
Before weights	789	219	212.64	55.47	570	209.73	52.04	0.022
After weights	789	219	212.64	55.47	570	213.11	51.91	-0.016

Note. Weights ranged from 0.12 to 1 in the comparison group.

Table B3

Impact of Frog Street Pre-K Curriculum on Fall 2024 DIBELS Composite Scores, by Student Subgroup

Subgroup	n (subgroup)	Impact estimate (SE)	*p* value	Effect size	Difference in impact (SE)
Gender					
Male	380	-4.71 (4.21)	.264	-0.10	
Female	399	3.01 (5.21)	.564	0.07	7.72 (7.41)
Race/Ethnicity					
Black	393	-3.21 (3.40)	.346	-0.07	
White	97	-6.57 (9.39)	.484	-0.15	-3.36 (8.74)
Hispanic	173	3.44 (8.99)	.702	0.08	6.66 (10.40)
Other	116	6.43 (6.19)	.299	0.14	9.64 (7.31)
ELL					
Non-ELL	661	-3.30 (3.09)	.285	-0.07	
ELL	118	16.41 (5.61)**	.003	0.36	19.71 (5.33)
SPED					
Non-SPED	624	2.32 (3.74)	.534	0.05	
SPED	155	-14.33 (7.55)	.058	-0.32	-16.65 (9.29)

Note. 1. *n* = 779 overall. 2. Significance was determined using Wald tests on each simple effect. ** *p* < .01.

Table B4

Impact of Frog Street Pre-K Curriculum on Spring 2025 DIBELS Composite Scores, by Student Subgroup

Subgroup	n (subgroup)	Impact estimate (SE)	*p* value	Effect size	Difference in impact (SE)
Gender					
Male	376	-5.75 (4.37)	.188	-0.11	
Female	401	-3.04 (4.63)	.511	-0.06	2.71 (5.66)
Race/Ethnicity					
Black	388	-8.74 (6.14)	.155	-0.17	
White	108	-17.31 (7.97)	.030	-0.34	-8.57 (10.08)
Hispanic	171	-2.42 (4.92)	.623	-0.05	6.33 (7.21)
Other	110	19.89 (10.71)	.063	0.40	28.63 (13.86)*
ELL					
Non-ELL	658	-6.28 (3.71)	.090	-0.12	
ELL	119	8.11 (6.83)	.235	0.16	14.39 (7.02)
SPED					
Non-SPED	615	-4.49 (4.47)	.315	-0.09	
SPED	162	-3.50 (7.71)	.650	-0.07	1.00 (9.99)

Note. 1. *n* = 777 overall. 2. Significance was determined using Wald tests on each simple effect. * $p < .05$.

APPENDIX C: Supplementary Analyses of Additional Treatment Contrasts

Table C1

Demographics of the Analytic Samples in Secondary Analyses

	Treatment % (Frog Street)	Comparison 2 % (No Pre-K)	Comparison 3% (Non-GCS Pre-K)
Female	53.2	52.1	53.0
Race - Black	55.4	42.8***	32.7***
Hispanic	23.0	9.7***	29.7*
White	9.0	37.5***	21.7***
Other/Multi	12.6	9.9	15.9
ELL	13.5	7.1**	32.0***
SPED	18.5	12.1*	9.4***
Neighborhood child poverty rate	22.4	18.7*	25.5
ASQ (score)	212.9	230.48***	227.9***
n	223	775	883

*Note.*1. ASQ = Ages and Stages Questionnaire. 2. Significance of differences marked on the comparison group compared to treatment. *$p < .05$, **$p < .01$, ***$p < .001$. 3. Analytic sample includes students with non-missing post-test score, demographics, and school information.

Table C2

Baseline Equivalence on ASQ (Pretest) in 2023 for Treatment and Comparison Students in no Pre-K, Before and After Weighting

	All students	Treatment			Comparison			Standardized mean difference
	n	*n*	*M*	*SD*	*n*	*M*	*SD*	*M*
Before weights	969	212	213.12	56.25	757	230.43	32.32	0.463
After weights	969	212	213.12	56.25	757	217.77	45.57	0.153

Note. This only includes students on common support.

Table C3

Baseline Equivalence on ASQ (Pretest) in 2023 for Treatment and Comparison Students in Non-GCS Pre-K, Before and After Weighting

	All students	Treatment			Comparison			Standardized mean difference
	n	*n*	*M*	*SD*	*n*	*M*	*SD*	*M*
Before weights	1,050	206	217.61	50.26	844	227.75	24.80	0.317
After weights	1,050	206	217.61	50.26	844	219.37	34.27	0.059

Note. This only includes students on common support.