Reading Resources and Student Achievement: Evidence from the Michigan Culture of Reading Program

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Abstract

This paper considers the effect of additional reading resources on third-grade student achievement by exploiting a quasi-experimental setting. In 2014, the Michigan Department of Education Culture of Reading campaign gave over 3,000 copies of a storybook, along with reading instructions, to children in 115 elementary schools and early childhood programs. I use student-level data to identify the effect of additional reading resources on third-grade English language arts (ELA) test scores. I find significant, positive effects of additional reading resources on student achievement for students who received books when they were in an early childhood program.

1 Introduction

There is a growing literature that uses experimental or quasi-experimental methods to examine the effect of school resources on student achievement—achievement gains associated with reducing student-teacher ratios (Angrist and Lavy, 1999), with increasing instructional time in the classroom (Hansen, 2007; Marcotte, 2007), and with higher teacher quality (Rivkin et al., 2005), for example.

In terms of books, in particular, there are two studies that identify the role of books and reading on outcomes. First, Holden (2016) finds significant increases in reading-test scores around the implementation of a one-time textbook provision in California, leveraging the school-level qualification for resources in an environment that had sufficient monitoring to be confident that the resources actually increases textbook provision for treated students. Second, and more relevant given that it also considers early readers, Bennett (2020) studies the effect of Dolly Parton's Imagination Library, a program that mails free books to young children, on elementary achievement. Bennett (2020) finds null effects on third- and fourth-grade achievement, suggesting that small capital investments, such as books, are not sufficient to increase achievement on their own.

Beyond these two, and the handful of small-scale and descriptive efforts that inform the sort of experiences children have around reading, little is known about the role of capital-related inputs such as textbooks and other instructional materials in the production of educational achievement. We know even less about how inputs at home, such as parental instruction and material resources, impact student achievement.[1]

In this paper, I estimate the effect of a capital investment in young children on their reading abilities in third grade—their performance on the third-grade student achievement test. Specifically, I analyze Michigan's "Culture of Reading" program, which was implemented in 2014. The state of Michigan received 740 applications for the program. Awards were allocated on the basis of meeting grant criteria, including a commitment to provide the children with evidence-based reading instruction and family engagement activities focused on literacy.[2] The Culture of Reading program gave a storybook and

[1] There are several papers that consider related questions with a focus on the developing world. Hanushek (1995) argues that the provision of capital-related resources can have an effect on achievement in the right settings but schools often use these resources inefficiently. For example, Glewwe et al. (2009) finds negative effects on achievement in a sample of primary schools in Kenya, but in the region where the study took place, the textbooks provided were above the reading levels of the average child. A similar study conducted in Sierra Leone also finds no effect of reading resources on test scores (Sabarwal et al., 2014), but notes that many of the textbooks did not reach students in the program.

[2] Evidence-based reading instruction refers to instructional practices that have been proven by peer reviewed research to lead to predictable gains in reading achievement.

reading instructions for the storybook to students in eligible classrooms; additionally, the teachers in the selected classrooms were intended to use evidence-based reading instruction in their reading curriculum.[3] In total, 3,000 books were given to 115 classrooms—24 early childhood programs, 23 kindergarten classrooms, 23 first-grade classrooms, 21 second-grade classrooms, and 24 third-grade classrooms.

Due to the multifaceted approach of the Culture of Reading program, there are several potential mechanisms through which the storybooks could influence reading achievement. First, having an additional book at home may lead to increased student achievement. For example, Evans et al. (2010) finds that having may books at home is correlated with increased educational attainment. Having physical books in the home at a young age may lead to increased literary development later in students' academic careers (Feng et al., 2014). Additionally, the program aimed to engage parents in the reading process. Parental involvement in education has a large positive effect on achievement that is large relative to the effect of school resources (Houtenville and Conway, 2008). Family learning activities, such as book reading, are shown to improve childrens' literacy and reading achievement (Bus et al., 1995). Additionally, having books around the home may encourage a more positive learning environment and may encourage parents to spend more time reading with their children, which can have positive effects on reading achievement (Bradley et al., 2001; Hood et al., 2008; Yarosz and Barnett, 2001). The program also aimed to engage teachers in the reading progress through implementation of evidence-based reading instruction at school. The literature on evidence-based reading programs is mixed. For example, the Reading First Initiative, implemented in 2002-2003 through the No Child Left Behind Act, is a national program aimed at using evidence-based reading instruction in elementary schools. Some studies find positive effects on reading achievement (Ratcliff et al., 2011), whereas other studies find no difference in reading comprehension scores between students at schools using the Reading First Initiative reading instruction and students at schools using traditional reading instruction (Gamse et al., 2011).

Identifying causal impacts of school resources on student achievement is often difficult. For example, if the allocation of school resources is nonrandom we stand to mistakenly credit the existence of resource provision when any omitted variable that co-varies with those resources and ELA test scores could explain observed differences. Difference in local income levels could explain differences

[3] The same storybook, titled "Acoustic Rooster and his Barnyard Band", was given to students in the classrooms that received awards.

in ELA scores, for example, and if resources are systematically available in schools that just happen to serve lower-income families, then we may be identifying a relationship between income and student achievement instead of resources and ELA levels. To retrieve causal estimates of resources' effects—such as books on student achievement—we seek plausibly exogenous variation in the provision of those resources. To do otherwise is to confound the effect of resources on reading achievement with school or household characteristics that may also impact achievement, such as fixed school inputs, the characteristics of peers, or neighborhoods. The Michigan Culture of Reading program yields a quasi-experimental setting in which there is a plausibly exogenous assignment of resources to students. This setting will allow us to estimate the causal impact of receiving books and evidence-based reading instruction on third-grade ELA test scores.

There has yet to be an evaluation of the Culture of Reading program and the potential benefits that may come from such low-cost interventions. I find large and significant gains in third-grade performance among students who were given a free book, family reading activities, and evidence-based reading instruction while enrolled in a Pre-K school. I find no such effects for students who received similar treatment even one year later in kindergarten, or in first or second grades.

In Section 2 I describe my data and empirical methodology. In Section 3 I report the results for the analysis of the Culture of Reading Program on third-grade achievement and explore heterogeneity in the effect for various subgroups. In Section 4 I draw conclusions and a quick cost-benefit analysis.

2 Empirical Design

2.1 Data

The data used in this paper are from public schools in Michigan and is provided by the Michigan Education Research Institute. The data contains yearly records of student-level demographic data for students who were enrolled in Pre-K through third-grade from 2014-2015 through 2018-19. The data also contains yearly records of third grade standardized test scores from 2014-2015 through 2018-2019.

My sample contains information on public school students and therefore I only observe students who attended a public Pre-K program. In 2014-2015, there were 46,114 Pre-K students in enrolled in a Michigan public school. In the following school year, 37,774 of those students stayed enrolled in a Michigan public school—14,391 students continued on to attend kindergarten and 23,198 remained

enrolled in a public Pre-K program. Due to availability of data, the analysis for Pre-K students only include students who were enrolled in a public Pre-K program in 2014-2015 and progressed to third grade in 2018-2019.

I measure student achievement using standardized test scores from Michigan's M-STEP standardized test. The M-STEP test was implemented in 2014-2015 and third-grade public school students in Michigan take the exam in the spring. The test covers English-language arts and mathematics. The Michigan Department of Education reports student-level scaled scores and proficiency levels. I standardize the scale scores within subject and year to a mean of zero and a standard deviation of one. Thus, the estimated effects are in student-level standard deviations and can be interpreted as an effect size; a 1 unit increase in achievement can be interpreted as the average student scoring approximately one standard deviation higher than the reference cohort in that same grade.

Descriptive statistics are reported in Table 1. The table presents average values of student-level demographic variables used for each grade. Column (1) represents the sample of treated observations, column (2) represents the sample of untreated observations, and column (3) represents the difference between the treated sample and untreated sample. As the Culture of Reading program was targeted at low-income schools, we would expect to see that the treated sample is composed of a higher percentage of low-income students. This is the case for each grade in the sample. Students that are able to access the Culture of Reading program are also more likely to be in an at-risk program and are more likely to be African-American/Black.

2.2 Estimating the Effect on Student Achievement

The distribution of books and reading instruction to students was determined by the Michigan Department of Education. Early childhood programs and elementary school classrooms were able to apply for the program. Even though classrooms selected into the application process, the students did not select into the program. Culture of Reading awards were given to 23 kindergarten classrooms; 23 first grade classrooms; 21 second grade classrooms; 24 third grade classrooms; and 24 early childhood programs.[4]

Fundamentally, the design compares a group of treated students (i.e., those who received books) to a group of control students (i.e., those who did not receive books). Thus, I measure the effect

[4] See https://www.michigan.gov/mde/0,4615,7-140-37818˙34785-342225–,00.html for a list of classrooms that received books.

of treatment within cohorts. That is, I identify the treatment effect by comparing second-graders to second-graders, first-graders to first-graders, and etc. As all students in the same grade in the same school were treated (or not treated) by the program, I cannot identify the effect of treatment by comparing students within the same grade at the same school. However, I can compare students within the same grade across different schools. Across these cohorts of students, I consider the potential heterogeneity in performance gains that may relate to how far ahead of the third-grade ELA test students were when they received books.

The program was short-lived, and treatment only occurred in 2014. I restrict the sample to students who did not switch schools in 2014 to avoid mislabeling students as treated when they were not and vice versa because the timing of treatment is not known more precisely than the fall of 2014. For this reason, I also do not estimate treatment effects for students who were in third-grade in 2014-2015.

The outcome variable of interest is third-grade ELA standardized test scores. I control for school-level characteristics and student demographic characteristics to ensure the comparison between the treated and untreated group are confounded with as little outside variation as possible. Specifically, to examine whether the Culture of Reading Program led to significant improvements in third-grade test scores, I estimate for each grade level in 2014 (the year of the program):

$$T_{ics} = \alpha + \beta \mathbb{1}(Treated_{ics}) + X_i\gamma + K_s\delta + \varepsilon_{ics} \ ,$$

where T_{ics} is student i's test score, having been in class c in school s in 2014. Recalling that treatment fell at the classroom level within schools, $\mathbb{1}(Treated_{ics})$ equals one if student i was in a classroom that received books as part of the Culture of Reading Program. In X_i I include student level demographic controls (i.e., gender, race, and indicators for whether student i qualified for free or reduced-price lunch, was an English-second language learner). I also control for whether students ever switch schools between Kindergarten and grade three, or repeat a grade.[5] In K_{sy} I include school-level controls (i.e., enrollment, the percent of students who are white, Black or Hispanic/Latino, the percent who receive free or reduced-price lunch, and the percent of students who are English-language learners).

[5] I do not include a switch from Pre-K to K as a switch because very few elementary schools include an early childhood program.

3 Results

I begin with estimates for the full sample of students, regardless of their racial or socioeconomic composition. I consider two main outcome variables: third grade English-language Arts and third grade mathematics standardized test scores. The outcome variables are standardized within school year to a mean of zero and standard deviation of one.

In Figure 1, I plot the effect sizes of treatment on ELA test scores for each grade. The last four estimate bars represent the model with the full set of demographic and school controls. I find no evidence that having access to the Culture of Reading Program had significant effects on third-grade test scores for students who were in kindergarten, first, or second grade in 2014-2015, as these effects are estimated as a precise zero. For those students enrolled in Pre-K in 2014-2015 and took the third-grade standardized test in 2018-19, I find an .17 standard deviation increase in ELA achievement associated with receiving the book

As higher ELA achievement is known to correlate with higher mathematics achievement (Martin and Mullis, 2013; Shin et al., 2013; Thurber et al., 2002), I also consider the potential for mathematics scores to vary systematically with treatment. In Figure 3, I plot the effect sizes of treatment on mathematics scores for each grade. Similar to ELA achievement, having access to the Culture of Reading Program has a null effect for students who were in kindergarten, first grade, or second grade in 2014-2015. For students who were enrolled in Pre-K in 2014-15, I find a significant and positive effect ($.15\sigma$).

3.1 Pre-K

In Figure 2, I restrict the analysis to Pre-K students in 2014-2015 who took the standardized test in 2018-2019. I systematically drop the students who switched in each grade. The effect size is robust to dropping students who switch schools. In Figure 4, I repeat this procedure with mathematics scores and I also find that the effect size is robust to excluding students who switch schools. These findings indicate that the result is not being driven by students who switch schools.

One concern is the selection out of public Pre-K options and into private Pre-K. The demographic characteristics of Pre-K students enrolled in Michigan public schools in 2014 is similar to the demographic characteristics of kindergarten through third-grade students enrolled in public schools in 2014. Therefore, based on observable characterstics of students, there is not sufficient evidence of

large seleciton out of public Pre-K in favor of private options. However, the treatment group for Pre-K consists of more low-income and more African-American students than the rest of the sample. Because income and test scores are positively correlated, the Pre-K coefficient estimates represent a lower-bound on the treatment effect.

3.2 Heterogeneity

The Culture of Reading program gives a free book, family reading instructions, and access to evidence-based reading instruction to all eligible students, regardless of family income. However, one might expect students from low-income families to benefit greater from participation in the program, as these families may have less access to books and other reading programs due to financial constraints. To estimate the effects across income status, I estimate the effect of receiving access to the program on ELA achievement scores for students who are eligible for free and reduced priced lunch and for students who are not, for each grade in the sample. Figure 5 presents the results on third grade test scores. I find null effects for students who were in kindergarten, first grade, or second grade at the time of treatment. For Pre-K students, I find a large, positive effects for students in both income groups. The average treatment effect for free/reduced lunch students is .16 standard deviations (p = .009). For Pre-K students who are not eligible for free/reduced price lunch, I find an effect size of .24 standard deviations (p = .007).

Next, I assess how the Culture of Reading program affects students of different races or ethnicities. I find that the positive effect of treatment on ELA achievement in Pre-K is largely driven by the effect of the program on African-American/Black students. The effect of the program on ELA achievement is .23 standard deviations for Black students in Pre-K in 2014. I find a slight positive effect for white Pre-K students (.14σ, p = .058) and null effect for Hispanic Pre-K students. I find null effects for all races/ethnicities in kindergarteners, first graders, and second graders.

I then explore heterogenous treatment effects across gender. Figure 7 presents the results. Similar to the previous analyses, I find null effects for kindergarteners, first graders and second graders. I find that male students in Pre-K benefit more from the Culture of Reading program than female students in Pre-K. I estimate an effect size of .22 standard deviations (p = .002)for males and .12 standard devations (p = .082) for females.

3.3 Matching

Students who had access to books and additional reading instructions through the Culture of Reading Program are more likely to be low-income, more likely to be African-American/Black, and are more likely to be in an at-risk program. As these are observable attributes, in the analysis above I control for any systematic variation in outcomes by these student characteristics. However, due to the imbalance in treatment and control groups, one can imagine that other unobservable attributes also differ across treatment and control groups. In the absence of randomization, effects can be estimated by comparing two individuals who have the same attributes, one who is treated and one who is not.

One method of matching involves pairing a treated student to an untreated student using all observable characterstics available. However, as the number of covariates gets large, it becomes increasingly more difficult to find an exact match, leading to a decreased sample size and increased susceptibility to bias. When exact matching on all characteristics is not possible, we can use propensity score matching to identify the treatment effect. This method matches treated and untreated observations using the conditional probability of being treated. In this case, the propensity score is the conditional probability of receiving access to the Culture of Reading Program. Propensity score matching will allow me to identify the effect of having received access to the Culture of Reading Program on third-grade standardized test scores.

I perform propensity score matching for each grade separately and use exact matching on income and gender. I then match propensity scores using nearest-neighbor matching. Nearest-neighbor matching matches one treated student to one untreated student with a similar propensity scores.[6] In other words, I match one 2nd grade, low-income, female student who received access to the Culture of Reading Program to one 2nd grade, low-income, female student who has a similar propensity score but did not receive access to the program, for example. One consequence of this method is that my sample size decreases significantly because a treated student must be matched to an untreated student of the same income status and gender, with a similar propensity score. The final matched sample includes 874 Pre-K students, 1,806 kindergartners, 3,178 first-graders, and 1,832 second-graders.

Using the nearest-neighbor matching approach, I have pairs of students who have similar propensities to have received access to the Culture of Reading Program in 2014, one treated and one untreated. This method allows me to estimate the effect of having received access to the program on third-grade

[6] I use the MatchIt R package (Ho et al., 2018) to perform the propensity score matching.

ELA scores. Results from matching are given in Table 3. I find that for Pre-K students, the effect of being eligible for the Culture of Reading program increases third-grade ELA test scores by .196 standard deviations. Propensity score matching yields null results for kindergarteners and second graders. I find a negative estimate of -.086 standard deviations for first graders.

4 Conclusion

In this paper, I identify the effect of a capital investment in young children on their reading abilities in third grade. I exploit a quasi-experimental setting through Michigan's Culture of Reading Program. My findings suggest that receiving access to a storybook, family reading activities, and evidence-based reading instruction in Pre-K has significant, positive effects on both ELA and mathematics achievement. I also find that access to the Culture of Reading program has particularly large effects for African-American/Black Pre-K students.

My findings suggest that programs such as the Culture of Reading program that engage students, families, and teachers in the reading process is a cost-effective way to increase student achievement. My estimates indicate that having access to this program increased third-grade ELA achievement by .17 standard deviations, on average, for students who were treated in Pre-K and back-of-the-envelope calculations suggest that this program costs approximately $46,000. The Culture of Reading program is much more cost effective than other interventions, such as class size reductions. The estimates from Krueger (1999) suggest that reducing class size leads to a 0.2 standard deviation improvement in elementary student achievement; this reduction in class-size cost approximately $3,501 per year for each student (Krueger, 2003). Jepsen and Rivkin (2009) estimate the effect of a class size reduction program in California, findging that a ten-student reduction in class size improved reading scores by .10 standard deviations in the school distribution. In 1997-1998, the state spent approximately $1.5 billion (or $1,024 per pupil) on the California class size reduction program (Brewer et al., 1999). In terms of capital-investments, Holden (2016) estimates a .2 standard deviation increase in achievement at the school-level for a program that costs $138 million (or $96.90 per pupil).

The purpose of this paper, however, is not to discourage other interventions such as class-sized reductoins. Instead, this paper offers a low-cost way to induce greater primary school achievement through a reading program that offers a free storybook, family reading instructions, and evidence-based reading curriculum to young students. Due to program limitations, this paper does not speak

to the complementarities of these three components. Understanding which features of a program – capital inputs, parental time, classroom curriculum, or a combination of the these – would be valuable to the policymakers designing and implementing early childhood interventions to promote literacy at a young age.

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Table 1: Descriptive Statistics

	Treatment	Control	Difference
Pre-Kindergarten			
Low-Income	.789	.608	.178
Male	.519	.582	-.063
English Learner	.039	.065	-.026
At-Risk Program	.615	.530	.085
African-American/Black	.435	.178	.257
White	.351	.660	-.309
Hispanic/Latino	.134	.088	.046
School Locale - City	.367	.222	.145
School Locale - Rural	.059	.223	-.164
Kindergarten			
Low-Income	.633	.524	.109
Male	.519	.517	.002
English Learner	.042	.089	-.047
At-Risk Program	.514	.472	.042
African-American/Black	.163	.158	.006
White	.731	.679	.052
Hispanic/Latino	.054	.081	-.027
School Locale - City	.165	.228	-.063
School Locale - Rural	.391	.208	.183
Grade 1			
Low-Income	.653	.514	.139
Male	.511	.511	.000
English Learner	.139	.097	.042
At-Risk Program	.475	.432	.043
African-American/Black	.163	.166	-.008
White	.708	.670	.038
Hispanic/Latino	.070	.082	-.012
School Locale - City	.279	.241	.038
School Locale - Rural	.280	.201	.079
Grade 2			
Low-Income	.723	.508	.215
Male	.503	.509	.006
English Learner	.161	.090	.071
At-Risk Program	.560	.418	.142
African-American/Black	.284	.159	.125
White	.529	.678	-.149
Hispanic/Latino	.135	.082	.053
School Locale - City	.540	.233	.307
School Locale - Rural	.335	.204	.131

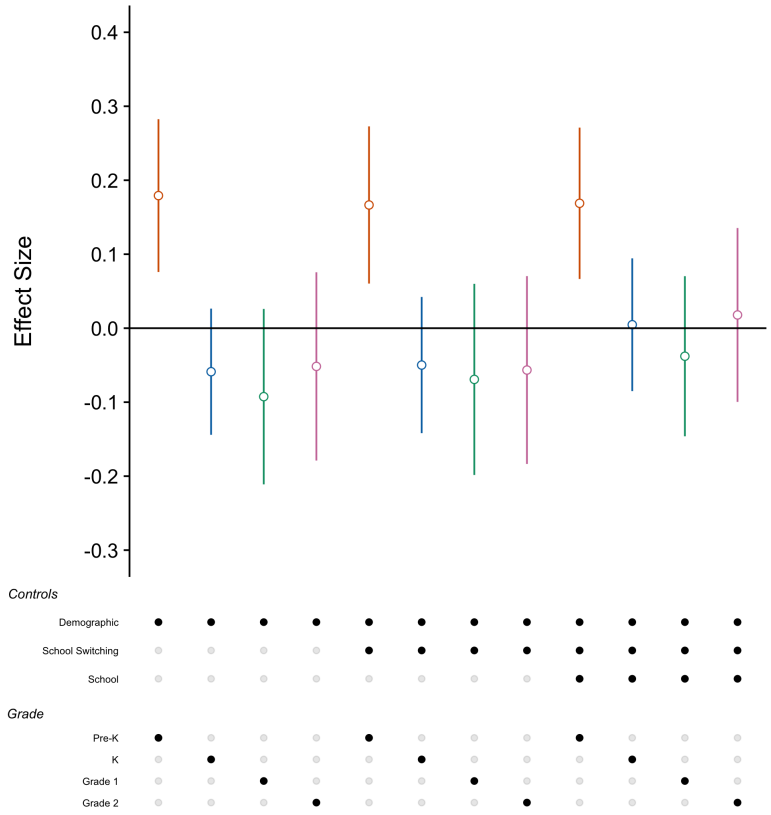
Table 2: Demographic Characteristics

	Pre-K			K through 2nd grade		
	Treatment	Control	Full	Treatment	Control	Full
Low-Income	80.6	54.7	55.9	65.5	51.7	51.2
White	35.1	66.0	64.5	68.8	67.6	67.6
African-American	43.5	17.8	19.0	18.0	16.2	16.2
Hispanic/Latino	13.4	8.9	9.1	7.9	8.1	8.1
Female	48.3	41.8	42.1	49.2	49.0	49.0
ESL	0	1.9	1.8	11.0	8.9	8.9

Table 3: Propensity Score Matching Estimation Results

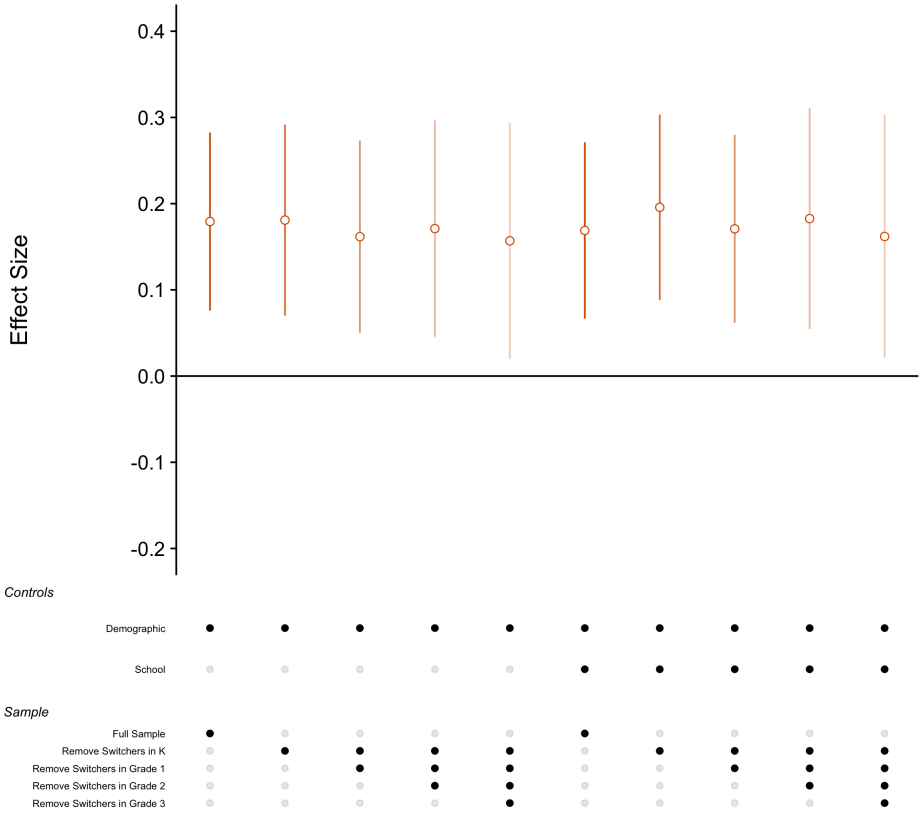
	Normalized ELA Score			
	Pre-K	K	Grade 1	Grade 2
	(1)	(2)	(3)	(4)
Effect Size	0.196^{***}	-0.032	-0.086^{***}	-0.031
	(0.062)	(0.043)	(0.031)	(0.044)
Observations	874	1,806	3,178	1,832
Note:				*p<0.1; **p<0.05; ***p<0.01

Figure 1: Effect of Treatment on Third Grade ELA Scores



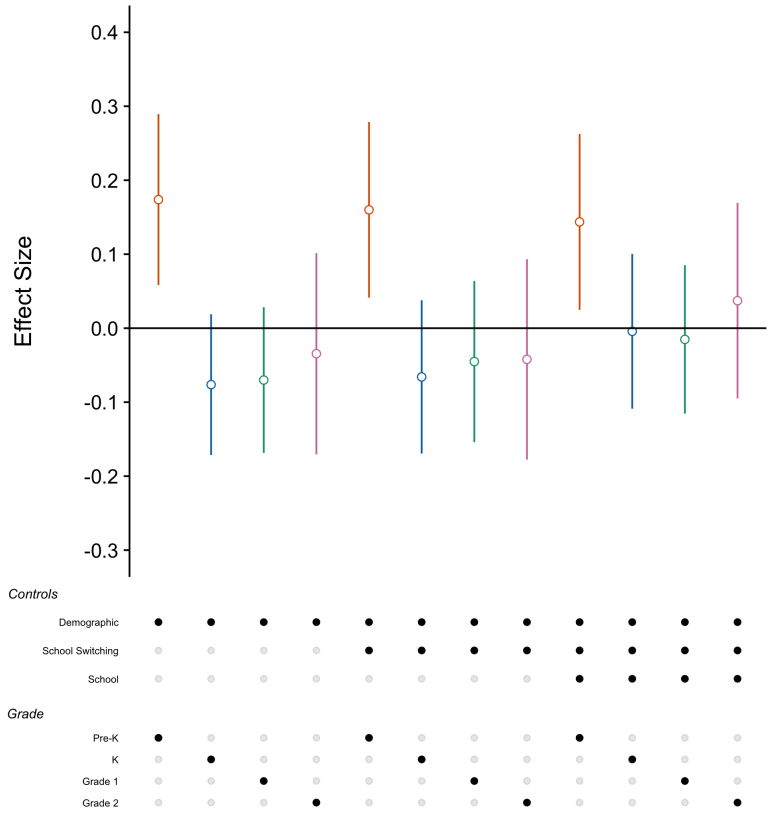
Note: Each bar represents the average effect of the Culture of Reading program on third-grade ELA test scores. Each effect size is estimated from a linear regression. Standard errors are clustered at the school-level.

Figure 2: Effect of Treatment on Third Grade ELA Scores for Pre-K Students



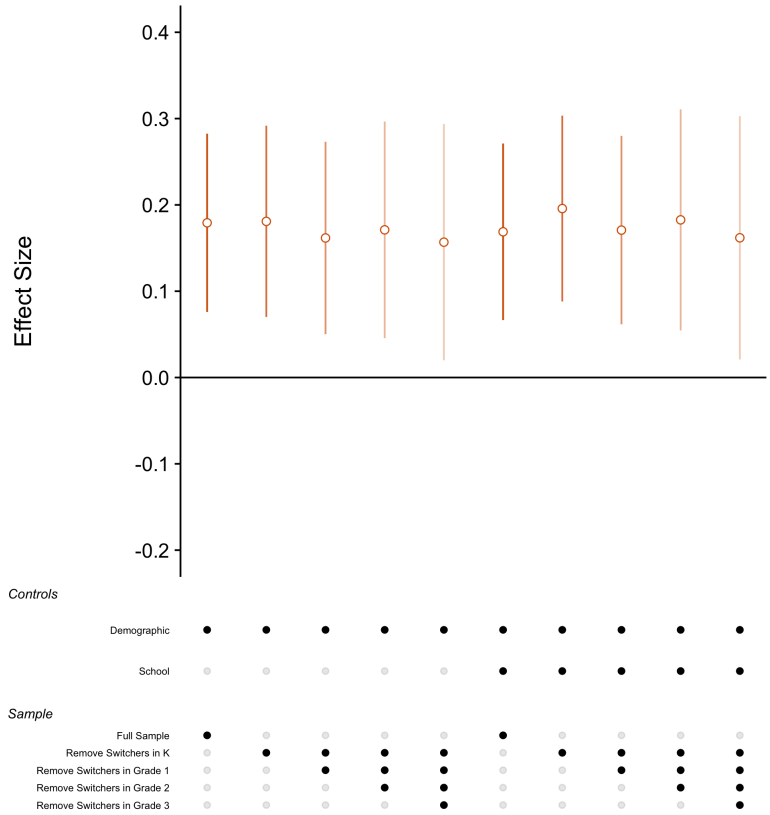
Note: Each bar represents the average effect of the Culture of Reading program on third-grade ELA test scores. Each effect size is estimated from a linear regression. Standard errors are clustered at the school-level.

Figure 3: Effect of Treatment on Third Grade Mathematics Scores



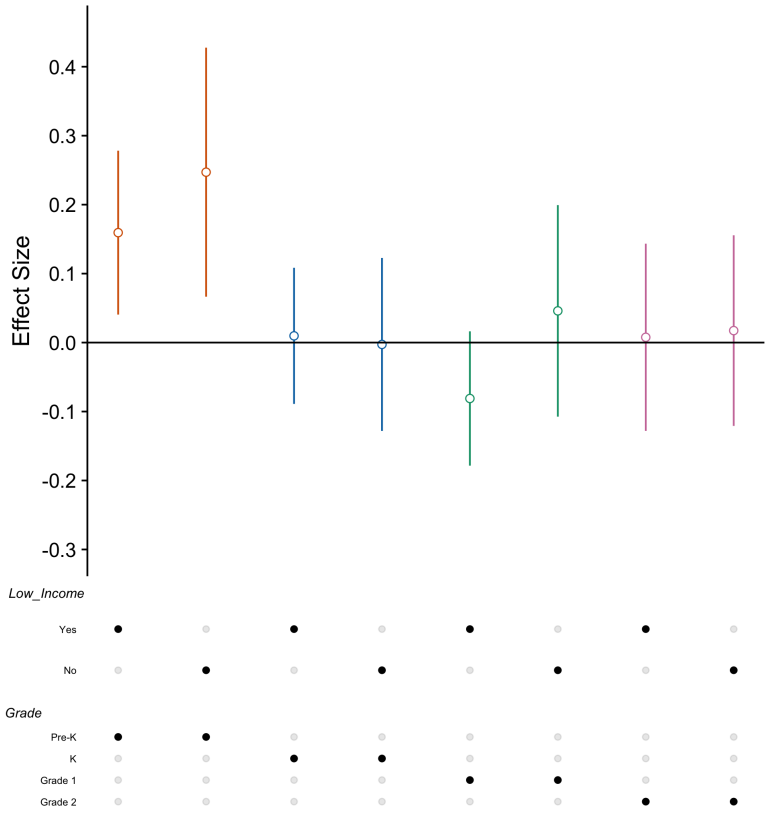
Note: Each bar represents the average effect of the Culture of Reading program on third-grade mathematics test scores. Each effect size is estimated from a linear regression. Standard errors are clustered at the school-level.

Figure 4: Effect of Treatment on Third Grade Mathematics Scores for Pre-K Students



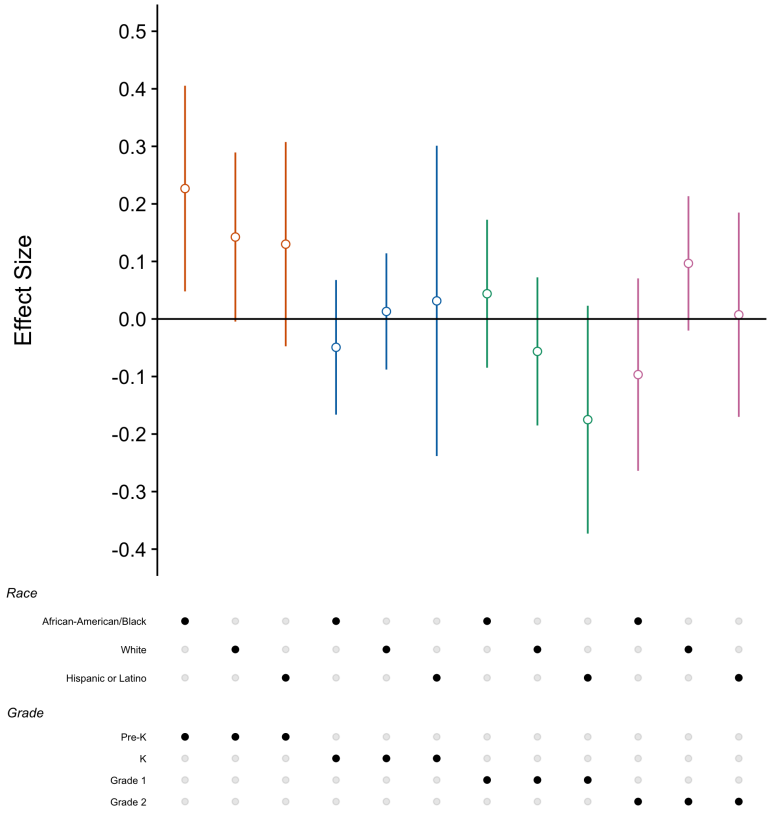
Note: Each bar represents the average effect of the Culture of Reading program on third-grade ELA test scores. Each effect size is estimated from a linear regression. Standard errors are clustered at the school-level.

Figure 5: Effect of Treatment on Third Grade ELA Scores by Income Status



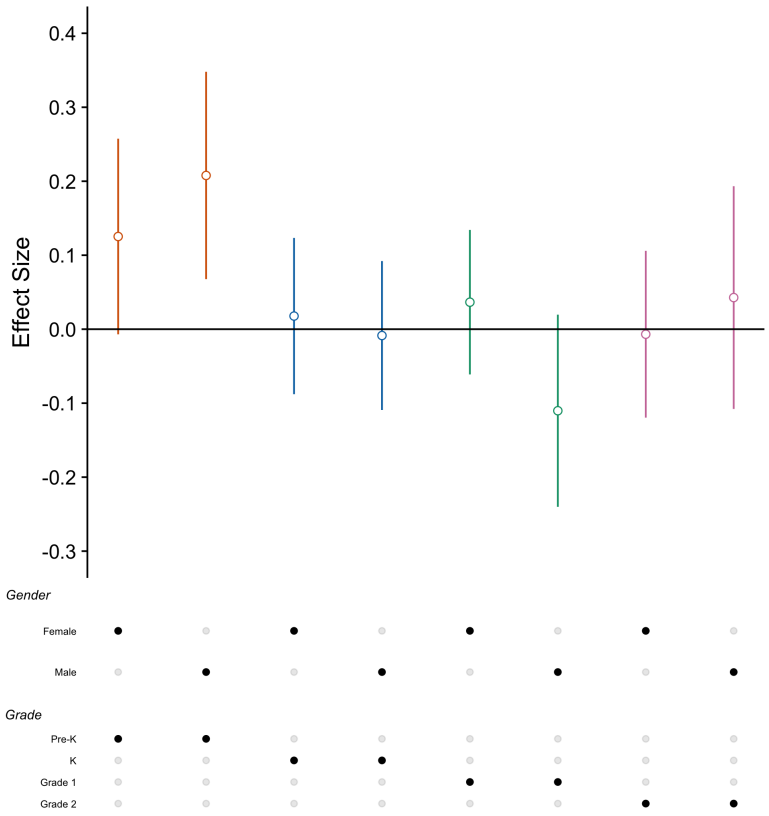
Note: Income status refers to whether or not the student qualifies for free/reduced priced lunch. Each bar represents the average effect of the Culture of Reading program on third-grade ELA test scores. Each effect size is estimated from a linear regression with controls for student demographics and school characteristics. Standard errors are clustered at the school-level.

Figure 6: Effect of Treatment on Third Grade ELA Scores by Race/Ethnicity



Note: Each bar represents the average effect of the Culture of Reading program on third-grade ELA test scores. Each effect size is estimated from a linear regression with controls for student demographics and school characteristics. Standard errors are clustered at the school-level.

Figure 7: Effect of Treatment on Third Grade ELA Scores by Gender



Note: Each bar represents the average effect of the Culture of Reading program on third-grade ELA test scores. Each effect size is estimated from a linear regression with controls for student demographics and school characteristics. Standard errors are clustered at the school-level.