RESEARCH BRIEF:
MEASURING EDUCATIONAL OPPORTUNITY IN NORTH CAROLINA PUBLIC SCHOOL DISTRICTS

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INTRODUCTION

Measuring educational opportunity is a topic of interest to policymakers and education stakeholders alike. Standardized assessments of student achievement are commonly used to measure educational opportunity in North Carolina and across the nation. This research brief examines two measures of educational opportunity in North Carolina public school districts. Both measures are based on standardized assessments of student achievement. The first measure—*average achievement*—indexes the average level of student achievement at a single point in time.[1] The second measure—*achievement growth*—indexes the rate of growth in student achievement over time. In this research brief, average achievement was measured among third-grade students who were enrolled in North Carolina public school districts in 2014. Achievement growth was measured for this same cohort of students as they progressed from third to eighth grade between 2014 and 2019 (see Figure 1). Correlational analyses were undertaken to examine the validity of these measures. First, the correlation between each measure of educational opportunity and a measure of student economic disadvantage was examined. Second, a weighted composite measure of average achievement and achievement growth was calculated according to the specification used by the North Carolina Department of Public Instruction for the School Performance Grade (i.e., 80% *average achievement* and 20% *achievement growth*). The correlation between this composite measure and the measure of student economic disadvantage was also examined. Finally, alternative weighting specifications for the composite measure and their correlations with student economic disadvantage were considered. The findings and policy implications are discussed below, followed by a technical appendix to further describe the data and analyses.

The North Carolina Department of Public Instruction reports on measures of educational opportunity annually in the School Report Cards. Perhaps most prominently, a "School Performance Grade" is reported, with 80% of this grade being derived from measures of ***average achievement*** and 20% of this grade being derived from measures of ***achievement growth.***

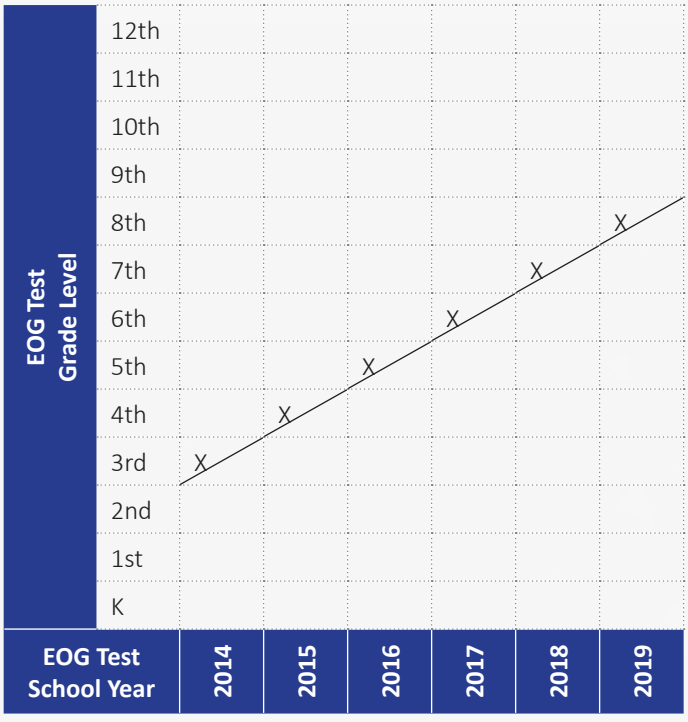
1. Similar to average achievement, educational opportunity is also measured by the percent of students in a school or school district with test scores that surpass a given threshold of "proficiency" at a single point in time.
2. Student achievement was examined beginning in third grade because it was the lowest grade level at which standardized achievement tests were administered in North Carolina.

FINDINGS

Based on correlational analyses, ***average achievement*** was found to be highly correlated with student economic disadvantage—suggesting that ***average achievement*** may reflect a broad range educational opportunities available to students based on the socioeconomic status of the community where their school district was located (reading: $r = -0.80$; math: $r = -0.72$) (see Figure 2 for the reading correlation). Alternatively, ***achievement growth*** showed a much smaller correlation with student economic disadvantage (reading: $r = 0.00$; math: $r = -0.21$) (see Figure 3 for the reading correlation). These findings suggest that ***achievement growth*** may better index the unique contribution of schools toward promoting student learning and achievement. Moreover, these findings confirm prior research by Reardon (2019) based on analyses of data on all public school districts in the United States.

FIGURE 1

North Carolina Third to Eighth Grade Growth Cohort between 2014 and 2019



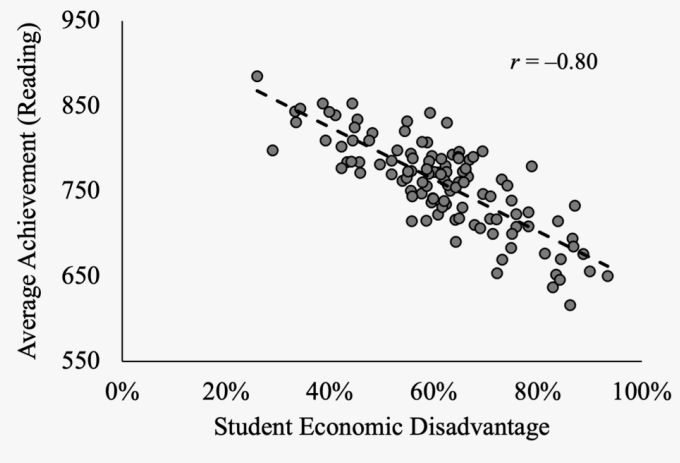
A composite measure of educational opportunity was created by calculating a weighted average of the ***average achievement*** and ***achievement growth*** scores. This composite measure first followed the weighting specification used by the North Carolina Department of Public Instruction to calculate the School Performance Grade, with 80% of the composite measure derived from the ***average achievement*** score and 20% derived from the ***achievement growth*** score.

For example, a school district in eastern North Carolina demonstrated the lowest level of average reading achievement among third grade students in 2014. This school district was also situated in a community with one of the highest rates of student economic disadvantage in North Carolina (at the 95th percentile for student economic disadvantage among all North Carolina public school districts). Nonetheless, the cohort of students in this school defied expectations and demonstrated one of the highest rates of growth in reading achievement through eighth grade (at the 92nd percentile for reading achievement growth among all North Carolina public school districts).

While the low level of average reading achievement in this school district may lead policymakers and educational stakeholders to judge the quality of educational opportunity as low in this school district, the high rate of reading achievement growth should lead us to judge this school district as providing high-quality educational opportunity to students.

FIGURE 2

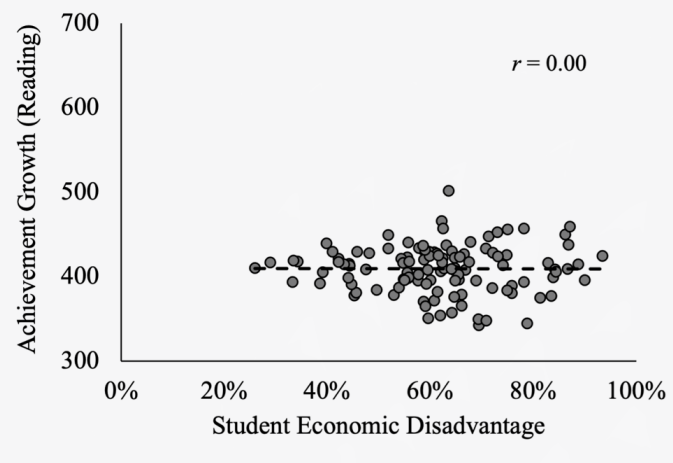
The Correlation between Third-Grade Average Achievement in Reading and Student Economic Disadvantage



Note. All 115 school districts displayed with trend line.

FIGURE 3

The Correlation between Third-Grade to Eighth-Grade Achievement Growth in Reading and Student Economic Disadvantage



Note. All 115 school districts displayed with trend line.

Using this weighting specification, the composite measure was highly correlated with student economic disadvantage (reading: $r = -0.81$; math: $r = -0.75$) (see Table 2). Alternative weighting specifications were considered by increasing the weight applied to the *achievement growth* score in calculating the composite measure. The magnitude of the correlation decreases as the weight applied to the *achievement growth* score was increased to 50% (reading: $r = -0.75$; math: $r = -0.69$) and 80% (reading: $r = -0.36$; math: $r = -0.40$).

TABLE 2

Correlations between Composite Measures of Average Achievement & Growth and Student Economic Disadvantage (N = 115)

Composite Measure: Average Achievement & Achievement Growth	Reading	Math
100% AA	-0.80	-0.72
80% AA & 20% AG *	-0.81	-0.75
50% AA & 50% AG	-0.75	-0.69
20% AA & 80% AG	-0.36	-0.40
100% AG	0.00	-0.20

Note. Average achievement in reading/math (i.e., the intercept) was estimated at third grade and achievement growth in reading/math (i.e., the linear slope) was estimated from third to eighth grade. Student economic disadvantage is the percent of economically disadvantaged students in the school district (i.e., the percent of students in the school district who qualified for free- or reduced-price lunch). All correlations ≥ |0.20| were statistically significant beyond the $p < .05$ value. * This composite measure follows the weighting specification used by the North Carolina Department of Public Instruction to calculate the School Performance Grade.

POLICY IMPLICATIONS

Two measures of educational opportunity were examined in this research brief: *average achievement* and *achievement growth*. These measures appear to index distinct dimensions of educational opportunity in North Carolina public schools. While *average achievement* appears to index the broad range of educational opportunities available to students in their communities and schools, *achievement growth* may provide a better index of the unique contribution of schools toward promoting student learning and achievement. Support for this conclusion was evidenced by large correlations between *average achievement* and student economic disadvantage, but not *achievement growth*.

The North Carolina Department of Public Instruction reports a School Performance Grade, with 80% of the grade derived from measures of *average achievement* and 20% derived from measures of *achievement growth*. In this research brief, a composite measure of educational opportunity was calculated based on this same weighting specification, and the composite measure was found to be highly correlated with student economic disadvantage. When alternative weighting specifications were used to calculate the composite score, the magnitude of the correlation was reduced as greater weight was attributed to the *achievement growth* score.

Based on these findings, a recommendation is made to place greater emphasis on measures of *achievement growth* for educational accountability and quality improvement. This recommendation is consistent with recommendations outlined

in a 2019 action plan to ensure *a sound basic education* for all students in North Carolina: "North Carolina's accountability system should be structured to reward growth in school performance," (e.g., WestEd, Learning Policy Institute, & Friday Institute for Educational Innovation at North Carolina State University, 2019; p. 121). Although measures of average achievement are commonly used to index educational opportunity, education stakeholders have raised concerns about this practice for high-stakes accountability and quality monitoring purposes (e.g., WestEd, Learning Policy Institute, & Friday Institute for Educational Innovation at North Carolina State University, 2019). Instead, they argue for the use of *achievement growth* in order to better judge the contributions of schooling to student learning.

There a several ways to measure *achievement growth*. First—as presented in this research brief—*achievement growth* can be measured for cohorts of students in school districts as they progress from third to eighth grade. Although individual schools within school districts may vary in their rate of *achievement growth*, many schools do not span the third to eighth grade range and, therefore, measures of *achievement growth* for this grade range may not be available for all schools. Alternatively, *achievement growth* can be measured for cohorts of students during a single grade (e.g., from third to fourth grade). Such single-grade measurement of *achievement growth* could be produced for both schools and school districts. Finally, yearly *achievement growth* can be measured for all students in each grade during a single school year (e.g., for all students in third, fourth, fifth, sixth, seventh, and eighth grade in a school district in 2019). This type of multi-grade, single year measurement of *achievement growth* could be produced for both schools and school districts.

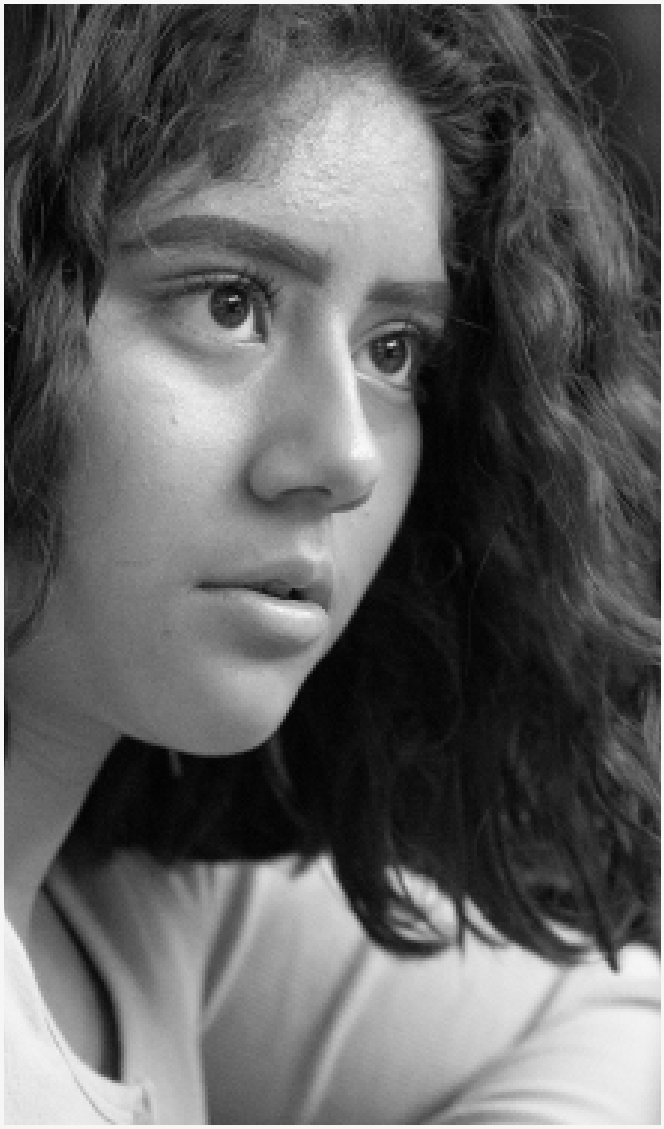
TECHNICAL APPENDIX

Measures *Student Achievement in Reading and Mathematics*

Standardized assessments of reading and mathematics achievement were administered to students in North Carolina public schools by school administrators at the end of each grade between third grade and eighth grade. These analyses utilized scores from these end-of-grade (EOG) tests administered during all school years between 2014 and 2019.[3] These data were obtained from the North Carolina Education Research Data Center at Duke University. The EOG tests are state-mandated, standardized assessments that adhere to guidance and requirements from the U.S. Department of Education.

Scores from the EOG reading scale (Edition 4) and EOG math scale (Editions 4 & 5) were transformed into Lexile scores for reading and Quantile scores for mathematics (www.metametricsinc.com).[4] The Lexile and Quantile scales provide developmental

3. The test scores of students who took alternative assessments designed for students with disabilities were excluded from these analyses because those test scales were not equated with the EOG scale.



scores based on Rasch-based measurement models that are vertically scaled across grade levels and appropriate for investigating student growth in academic achievement (Williamson, 2018).

Student Economic Disadvantage

The percent of economically disadvantaged students in the school district was indexed based on the percent of students in the school district who qualified for free- or reduced-price lunch during the 2014 school year.[5]

ANALYSES

Analyses were undertaken in two phases. In the first phase, ***average achievement*** and ***achievement growth*** were measured among students in school districts from third to eighth grade using a growth curve model approach. Based on the resulting measures of achievement status and growth, correlates of these measures were examined in the second phase of analyses. All analyses were completed in SAS® version 9.4.

Phase I: Measuring School-District Achievement Status and Growth

School-district ***average achievement*** and ***achievement growth*** was measured for the cohort of students who progressed from third to eighth grade between 2014 and 2019 in each of North Carolina's 115 public school districts (see Figure 1).[6] The reading and math scores of individual students were used. Cohorts were defined as all students who took the third-grade through eighth-grade reading and/or math assessments during this six-year period. Specifically, all students who took the third-grade reading and/or math assessment in 2014, the fourth-grade assessment in 2015, the fifth-grade assessment in 2016, the sixth-grade assessment in 2017, the seventh-grade assessment in 2018, and/or the eighth-grade assessment in 2019.

A multi-level growth curve model was estimated, with separate models estimated for reading and math scores (2 models total). The generalized equation for the model is displayed in Figure 4. In this three-level model, repeated assessments of students' reading or mathematics skills over time (*t*; Level-1) were nested within students (*i*; Level-2) and students were nested within school districts (*j*; Level-3) (see Figure 3). Time was coded as 0 at third grade, 1 at fourth grade, 2 at fifth grade, 3 at sixth grade, 4 at seventh grade, and 5 at eighth grade. Test scores (Y_{tij}) were modeled as a function of (1) an intercept term centered at

4. The EOG Math tests changed from Edition 4 to Edition 5 in 2018. EOG Math scores from Editions 4 and 5 were directly linked to the Quantile framework and converted into Quantile scores based on each respective link. A number of advanced eighth grade students were not assessed with the EOG Math test in 2019, but were assessed using the end-of-course (EOC) test instead. For these analyses, EOG and EOC scores for eighth grade students in 2019 were converted into Quantile scores based on the separate linking studies to were conducted to directly link these test scores to Quantile scores.

the third-grade assessment score to represent the expected achievement level for student *i* in school district *j* in third grade (π_{0ij}) and the expected achievement level for students in school district *j* in third grade (β_{00j}) as well as (2) a linear slope term to represent the expected ***achievement growth*** for student *i* in school district *j* during each grade between third and eighth grade (π_{1ij}) and the expected ***achievement growth*** for students in school district *j* during each grade between third and eighth grade (β_{10j}). The intercept term was allowed to vary randomly between students (r_{0ij}) and school districts (u_{00j}), and the slope term was allowed to vary randomly between students (r_{1ij}) and school districts (u_{10j}). All of the variance terms were parameterized to be normally distributed random variables with a mean of zero. An unstructured covariance matrix was specified to allow the random intercepts and slopes and their variances to be correlated with one another at Level-2 and at Level-3 in order to allow for a systematic relation between achievement level and growth. Restricted maximum likelihood (REML) was used to estimate the variance components. Students with at least one test score were included in these analyses and maximum likelihood was used to handle missing data. No covariates were included in these analyses in order to calculate unconditional estimates of the intercepts and slopes. Based on the results of this model, estimates of ***average achievement*** (i.e., intercept; β_{00j}) and ***achievement growth*** in reading/math (i.e., slope; β_{00j}) were derived for each of the 115 school-districts for use in the subsequent analyses.[7] Specifically, the empirical best linear unbiased predictions (EBLUPs) were derived for the realizations of the random intercept, slope, and nested errors. The scores of students who

TABLE 1
Descriptive Statistics and Correlations (N = 115)

Descriptive Statistics						Correlations				
	Variable	Mean	SD	Min	Max	1.	2.	3.	4.	5.
1.	Economic Disadvantage (%)	61.81	13.93	26	93	1.00				
2.	Average Achievement Reading	758.46	53.08	616	885	-0.80	1.00			
3.	Achievement Growth Reading	409.28	27.96	342	501	0.00	-0.11	1.00		
4.	Average Achievement Math	612.64	49.22	495	738	-0.72	0.88	-0.06	1.00	
5.	Achievement Growth Math	442.58	42.05	322	545	-0.20	0.16	0.59	-0.04	1.00

Note. Average achievement in reading/math (i.e., the intercept) was estimated at third grade and achievement growth in reading/math (i.e., the linear slope) was estimated from third to eighth grade. Student economic disadvantage is the percent of economically disadvantaged students in the school district (i.e., the percent of students in the school district who qualified for free- or reduced-price lunch). All correlations ≥ |0.20| were statistically significant beyond the $p < .05$ value.

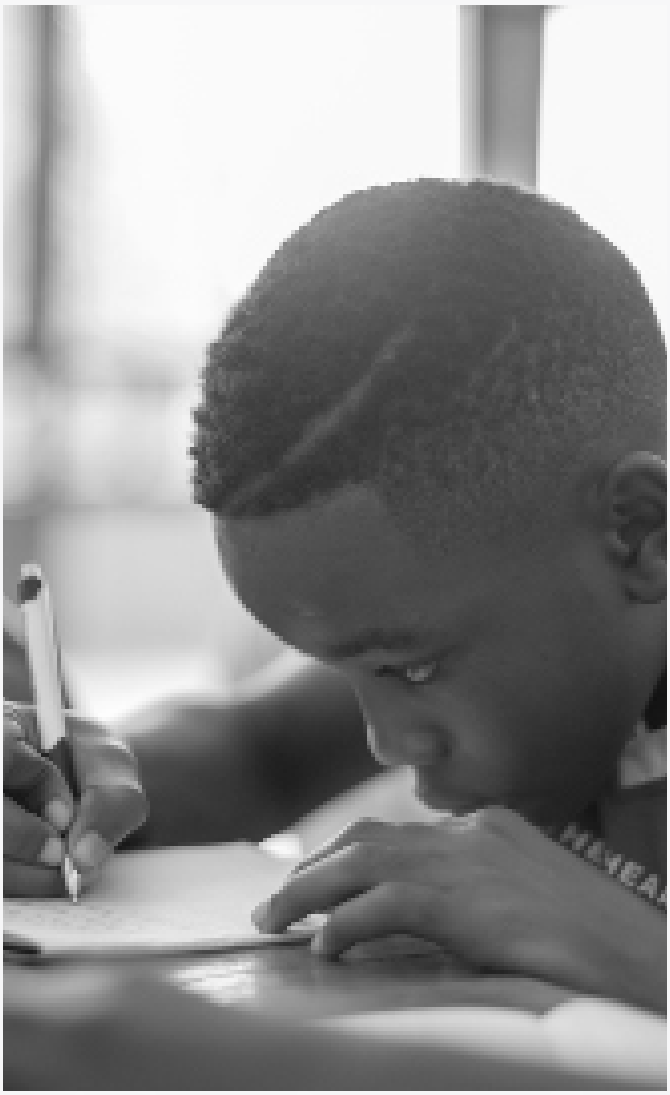
5. The Community Eligibility Provision (CEP) for free- or reduced-price lunch was not adopted by North Carolina Public Schools until the 2016 school year.
6. Students in the North Carolina Schools for the Blind and Deaf and following were excluded from these analyses because this school district were not comparable to the other 115 traditional public-school districts.

changed school districts were included in each respective school district (e.g., the scores for a student who took the third- through fifth-grade assessments in school district A were nested withing school district A, and the scores for that same student who took the six- through eighth-grade assessments in school district B were nested within school district B). This model was conceptually similar to model 8.15–8.17 described by Bryk and Raudenbush (1992).

Based on the Lexile scale for reading, the average school district had a third-grade reading status of 758.46 (*SD* = 53.08) and grew 409.28 Lexile score points between third and eighth grade (*SD* = 27.96) (see Table 1). Based on the Quantile scale for mathematics, the average school district had a third-grade math status of 612.64 (*SD* = 49.22) and grew 442.58 Quantile score points between third and eighth grade (*SD* = 42.05). Additionally, on average, 61.81% of students within school districts qualified as economically disadvantaged based on free- or reduced-price lunch status (*SD* = 13.93).

Phase II: Correlates of School-District Average Achievement and Achievement Growth

Based on results of the phase I analyses, correlates of school-district achievement status and growth for the sample of 115 school districts were calculated. First, achievement status and growth were not reliably correlated (reading: $r = -0.11$, $p = .22$; math: $r = -0.04$, $p = .63$). These findings suggest that ***average achievement*** and ***achievement growth*** measure distinct dimensions of educational opportunity in North Carolina public schools. Second, achievement status was highly, negatively correlated with student economic disadvantage (reading: $r = -0.80$, $p = < .001$; math: $r = -0.72$, $p = < .001$) (see Figure 2 for the reading correlation). These findings suggest that school districts with higher percentages of economic disadvantage among students had lower levels of ***average achievement***. Finally, ***achievement growth*** in reading was not reliably correlated with student economic disadvantage ($r = 0.00$, $p = .99$) while ***achievement growth*** in math was modestly, negatively correlated with student economic disadvantage ($r = -0.20$, $p = .03$) (see Figure 3 for the reading correlation). These findings suggest that ***achievement growth*** and student economic disadvantage were not reliably related in the case of reading achievement, and not strongly related in the case of math achievement.



7. Values for school-district ***achievement growth*** were rescaled to represent the rate of growth from third to eighth grade by multiplying the yearly rate of growth produced in the Phase I analyses by a value of 5.

FIGURE 3

A Generalized Equation for the Multi-Level Growth Curve Model to Measure School-District Achievement Level and Growth

Level-1 (time; t):

$$Y_{tij} = \pi_{0ij} + \pi_{1ij} time_{tij} + e_{tij}$$

Level-2 (students; i):

$$\pi_{0ij} = \beta_{00j} + r_{0ij}$$
$$\pi_{1ij} = \beta_{10j} + r_{1ij}$$

Level-3 (school districts; j):

$$\boldsymbol{\beta_{00j}} = \gamma_{000} + u_{00j}$$
$$\boldsymbol{\beta_{10j}} = \gamma_{100} + u_{10j}$$

Variance Components:

$$e_{tij} \sim N(0, \sigma_{tij})$$
$$r_{0ij} \sim N(0, \sigma_{0ij})$$
$$r_{1ij} \sim N(0, \sigma_{1ij})$$
$$u_{00j} \sim N(0, \sigma_{00j})$$
$$u_{10j} \sim N(0, \sigma_{10j})$$

$\boldsymbol{Y_{tij}}$ are the test scores (separate models were calculated for reading and mathematics scores) at time t (grade) for student i in school district j; $time_{tij}$ is coded as 0 at third grade, 1 at fourth grade, 2 at fifth grade, 3 at sixth grade, 4 at seventh grade, and 5 at eighth grade

$\boldsymbol{\pi_{0ij}}$ is the expected achievement level (i.e., intercept) for student ij in third grade

$\boldsymbol{\pi_{1ij}}$ is the expected achievement growth (i.e., linear slope) for student ij during each grade between third and eighth grade

$\boldsymbol{\beta_{00j}}$ is the expected achievement level (i.e., intercept) for school district j in third grade

$\boldsymbol{\beta_{10j}}$ is the expected achievement growth (i.e., linear slope) for school district j during each grade between third and eighth grade

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