TECHNICAL BRIEF

Technical appendix for: Unequal Access to 8th-Grade Algebra: How School Offerings and Placement Practices Limit Opportunity

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Introduction

The purpose of this technical appendix is to describe the sample and methods used to create the brief: **Unequal Access to 8th-Grade Algebra: How School Offerings and Placement Practices Limit Opportunity**

This brief adds a recent, national-scale, student-level perspective to our understanding of current inequities in 8th-grade Algebra[1] access. This study uses a unique dataset collected by NWEA of 162 thousand students in 22 states that combines 2023-24 math 8th-grade course enrollment information with student demographic characteristics and prior achievement.

Research Questions

This brief examines three sets of questions:

1. First, what is the percentage of schools that offer 8th-grade Algebra or higher in the 2023-24 school year? What are the characteristics of schools that offer 8th-grade Algebra or higher?
2. Second, what are the overall disparities in student enrollment in 8th-grade Algebra or higher by race/ethnicity, school poverty, and urbanicity among schools that offer 8th-grade Algebra or higher?
3. Finally, what are the enrollment disparities in 8th-grade Algebra or higher for high-achieving students among schools that offer 8th-grade Algebra or higher?

Data Sources

This study uses three sources of data: (1) student roster data shared with NWEA by participating districts, (2) NWEA MAP achievement data and student race/ethnicity data, and (3) school characteristics from the Common Core Data.

Course Roster Data

Before the start of testing each term, school data administrators submit rosters to NWEA, which include one or more course enrollments for each student. Among other data points, these rosters include a required free-text field for the class name of each of the students' reported enrollments (e.g., Santiago 8th Grade Math, Geometry - Grade 9, etc.). Due to the

[1] Our analyses focused on whether schools offered Algebra or higher in 8th grade. A school that had any 8th grade courses flagged as Algebra 1, Algebra 2, Geometry, Calculus, or pre-Calculus were considered to have offered 8th-grade Algebra.

flexibility allowed by this field, there is a degree of heterogeneity across schools with respect to the information that can be extracted from these course names. However, schools are incentivized to report complete and accurate rostering data during this process, as assessment results are reported back to teachers at the classroom level based on these data.

School districts provided NWEA with course roster data from the Clever automated course rostering system. The Clever system is an electronic database that districts use to record and track student course enrollments. This system enables us to systematically gather roster data directly from school districts, using a single, standardized format that eliminates the need for districts to upload their roster data from various local data sets. The Clever system also assigns general categories to courses, such as Math or Language Arts classes.

Measure of Achievement

The achievement and student race/ethnicity data for this study are from the NWEA anonymized longitudinal student achievement database. School districts use NWEA® MAP® Growth™ assessments to monitor elementary and secondary students' reading and math achievement and gains, with assessments typically administered in the fall (usually between August and November), winter (usually December to March), and spring (late March through June).

MAP Growth is a computer-adaptive test that precisely measures achievement, even for students above or below grade level, and is vertically scaled to allow for the estimation of gains across time. MAP Growth assessments are typically administered three times a year (fall, winter, and spring) and are aligned to state content standards. Test scores are reported on the RIT (Rasch unIT) scale, which is a linear transformation of the logit scale units from the Rasch item response theory model. For more details on the MAP Growth assessment, see NWEA (2019).

The NWEA data also include demographic information, including student race/ethnicity, gender, and age at assessment. An indicator of student-level socioeconomic status is not available.

Common Core of Data

A set of school-level characteristics, including enrollment, racial/ethnic distribution, and the percentage of students eligible for free or reduced-price lunch (FRPL), was obtained from the 2023-24 school-level Common Core of Data (CCD) files from the National Center for Education Statistics. The proportion of students eligible for free and reduced lunch is calculated based on CCD's total student enrollment and FRPL eligibility counts within a

school. The FRPL counts from the CCD include direct measures of FRPL and district-level measures of student poverty for schools that participate in the Community Eligibility Provision (CEP) program. Thirty-eight percent of schools participate in CEP.

The CEP, which began in 2013, is a program that provides free lunch to all students when a school has more than 40% of its students eligible for income-based food or medical assistance. In these schools, since all students receive a free lunch, schools do not need to collect income data from individual families to determine free and reduced-price lunches. However, many districts track economically disadvantaged students by identifying them through alternative means, such as eligibility for government assistance programs, such as food assistance (e.g., SNAP) or medical assistance (e.g., Medicaid).

We also include urbanicity data from the CCD. The NCES created a school-level variable for urbanicity that defines a geographic locale as urban, suburban, town, or rural. A school is located in a rural or non-rural area, based on the U.S. Census definition of a rural area, where "rural" refers to an area with a housing density of less than 425 housing units per square mile. Non-rural areas are further divided into urban, suburban, and town areas. Urban refers to a non-rural territory with a population of 50,000 or more located inside a principal city.[2] Suburban refers to a non-rural area with a population of 50,000 or more located outside a principal city. A town refers to a non-rural area with a population of less than 50,000.

Target Population and Sample Characteristics

Target Population

This analysis focuses on access to advanced math among 8th-grade students nationwide. Our results are intended to generalize to the population of students in U.S. public schools (in the 50 states plus the District of Columbia) that are currently operational and serve 8th-grade students. In 2023-24 (the most recent year in which CCD data are available), this population of 8th-grade students is about 3,700,000 in about 23,000 schools. In this analysis, we are focusing on students with NWEA test score data and course enrollment data (about 162,000 students in 1,300 schools)

[2] A principal city is the largest incorporated city greater than 10,000 in a core based statistical area (CBSA), CBSA's used to be called metropolitan areas.

Sample Description

NWEA's MAP Growth tests are non-mandatory assessments that districts can opt to administer. Therefore, the samples of schools used in this analysis are not inherently a nationally representative sample of U.S. public schools (or perfectly representative of any given state) in any given term. Additionally, our sample is further restricted to schools that share their enrollment data through the Clever data system.

In this brief, we examine each of the three research questions using three distinct analytic samples. The first question examines 8th-grade students with spring 2024 MAP, CCD, and course enrollment data, yielding a sample of 164,000 students across 1,300 schools. These data are then averaged to identify the availability of Algebra in 8th grade or higher and school characteristics. For question two, we examine a subset of the students from the sample in question one by restricting our sample to students who have spring 2024 MAP data, CCD data, course enrollment, *and* are in schools that offer 8th-grade Algebra or higher, generating a sample of 123,200 students in 750 schools. The last question examines a subset of students from question 2 by examining students who have 8th-grade enrollment data, 8th-grade NWEA data, are in schools that offer 8th-grade Algebra or higher, *and* 5th-grade MAP Growth test scores (collected in the spring of the 2020-21 school year), generating a sample of 64,000 students in 500 schools.

Table 1 compares the analytic samples with the national population of U.S. schools serving 8th grade. The analytic samples used in this brief have demographic characteristics that are similar to but not identical to the national average. All three samples are slightly poorer, less White, and more urban than the national average. For example, in sample one, students have a 61% rate of school poverty, compared to a 57% national average. Additionally, students in sample two are 42% White, compared to the national average of 48%.

Key Variables and Achievement Metrics

In this study, we develop a measure of 8th-grade Algebra 1 or higher enrollment, described in the next section, and compare the distribution of enrollment by poverty, race/ethnicity, and 5th-grade achievement.

Methods used to identify types of courses

This section describes the strategy we use to code enrollment data from the Clever data system to identify the 8th-grade courses in which a student is enrolled. The clever data system has an indicator of whether a course is a math course and a text string with the course name. We first restricted our analysis to courses that are identified as math courses in the Clever database.

Second, we identified general 8th-Grade Math, pre-Algebra, Algebra, Geometry, Algebra 2, Calculus, Pre-Calculus, and other math classes using the following decision rules:

- A course was pre-Algebra if a course name contained "alg", ALG"," Alg", and "pre"," PRE"," Pre"
- A course was Algebra 2 if a course name contained "alg", “ALG", " Alg", and "2"," II"," two", "TWO", or "Two"
- A course was Algebra 1 if a course name contained "alg", “ALG", " Alg", but not ("pre"," PRE"," Pre") or ("2", " II", " two", "TWO", or "Two")
- A course was Geometry if the course name contained "geo"," GEO", or" Geo"
- A course was Calculus or Pre-Calculus if the course name contained "calc"," CALC"," Calc"
- A course was general 8th-Grade Math if the course name contained "MATH"," math"," Math", but not "geo"," GEO"," Geo", or "alg", ALG"," Alg", or "calc", "Calc", "CALC"
- A course was considered 'Other' if none of the above categories applied.

In this analysis, we calculate the percentage of students enrolled in 8th-grade Algebra or higher-level math, defined as students enrolled in Algebra 1, Algebra 2, Geometry, Calculus, or pre-Calculus.

Achievement Metrics

The students in our analytic sample, which consisted of 8th-grade students from the 2023-24 school year, were in 5th grade during the 2020-21 school year. We used the 5th grade math test scores from Spring 2021 to group students into five groups: (a) bottom 20% of test scores in 5th grade, (b) 20-40th percentile achievement, (c) 40-60th percentile achievement, (d) 60-80th percentile achievement, and (e) top 20% of test scores in 5th grade.

Methods

Below, we describe the methods used to answer the three research questions.

Question 1

To calculate the percentage of schools that offer Algebra or higher in 8th grade, we used the course data described above. A school that had any 8th grade courses flagged as Algebra 1, Algebra 2, Geometry, Calculus, or pre-Calculus were considered to have offered 8th-grade Algebra.

We merged the school-level flag of offering Algebra with NWEA data on race/ethnicity and school-level CCD data on urbanicity and percentage of students in poverty. We averaged these variables by school to generate a dataset that consisted of the following variables: whether the school offered Algebra in 8th grade, the percentage of Black and Latino students, the percentage of students receiving free or reduced-price lunch (FRPL), and whether the school was located in an urban, town, suburban, or rural region.

To facilitate comparisons, the percentages of Black and Latino students were combined into two variables for schools with varying racial and ethnic compositions. We also simplified comparisons of school poverty by focusing solely on schools with a FRPL percentage below 25% and those with a FRPL percentage above 75%.

To examine differences in access by school characteristics, we calculated the percent of schools that offered 8th-grade Algebra based on the following school characteristics (C):

- High Poverty (School %FRPL>75)
- Low Poverty (School %FRPL<25)
- Greater than 75% Black or Latino (% Black or Latino >75%)
- Less than 25% Black or Latino (% Black or Latino <25%)
- School is in a rural area
- School is in a suburban area
- School is in an urban area

We also created a variable P_{jk} which is an indicator of whether a school j with a school characteristic k offers Algebra in 8th grade. P_{jk} = 1 if the proportion of students in a school enrolled in Algebra 1 or higher in an 8th-grade or higher math class is greater than zero. P_{jk}=0 if the proportion of students in the school enrolled in Algebra in 8th grade or higher is zero.

For question 1, we estimated the proportion of schools (P) that offer 8th-grade Algebra or higher for different school characteristics (C).

$$\overline{(P|\ C = k)} = \frac{\sum_j^n (P_j|\ C = k)}{n}$$

These results can be seen in Figure 1 in the brief.

Question 2

Next, we examine the student-level differences in Algebra or higher access among racial ethnic subgroups (g). For this analysis, we shift our focus to students rather than schools and examine the percentage of students (Y) enrolled in Algebra. We focus only on schools that offer Algebra 1 or higher. Among schools that offer Algebra 1 or higher in 8th-grade, we calculated the percentage of students by race/ethnicity enrolled in Algebra 1 or higher $\overline{(Y_g|}\ Pj = 1)$.

$$\overline{(Y_g|}\ Pj = 1) = \frac{\sum_i^n (Y_{ijg}|\ P_j = 1)}{n}$$

These results are shown in Figure 2 in the main brief and Figure 1 in the technical appendix.

Question 3

Finally, we examined the proportion of students who are enrolled in algebra who are in the top 20th percentile in 5th grade. We focused on 5th-grade prior achievement to replicate the analysis conducted by the E3 Alliance to examine inequalities in algebra access among high-achieving students. Students are divided into five quintiles (Q) based on the observed data on fifth-grade math achievement, with the highest achieving quintile (Q=1) (i.e., the top 20th percent) and the bottom quintile (Q=5) (i.e., the bottom 20th percent). The equation below shows the calculations used to estimate the percentage of the top 20% who were enrolled in 8th-grade algebra by racial and ethnic subgroup.

$$\overline{(Y_g|}\ P_j = 1, Q = 1) = 1/n(\sum_i^n (Y_{ijg}|\ P_j = 1, Q = 1))$$

We also did a supplemental analysis that examines these disparities in access across all achievement groups (see Figure 2).

Limitations

Our analysis aims to provide insight into national trends in 8th-grade Algebra enrollment. While we have a large sample size (over 160k students), we are examining only 4% of 8th-grade students nationwide in 22 of 50 states. Additionally, the schools that use the NWEA MAP tests and share course data through the Clever database are not a random sample of schools. Our analytic sample is similar to the national sample, although not identical to it.

As mentioned above, our analytic sample is more urban, slightly poorer, and less White than the nation as a whole.

We also checked our Algebra enrollment estimates with national survey data from the NAEP. In the 2023-24 NAEP survey of students, about 23% were enrolled in 8th-grade Algebra or higher. Our estimates of algebra enrollment or higher are 22.6%.

Given the large sample size and the similarity with national survey estimates of Algebra enrollment, these data provide a good approximation of national trends. However, there might be some bias because our sample is slightly poorer and less white than the nation as a whole. Given that most studies find an advantage for non-poor versus poor students and white students compared to Black and Latino students, any finding of under-representation in our slightly poorer and slightly less White sample of students might be an under-estimate of disparities in access to 8th-grade Algebra.

Last, our findings about racial/ethnic disparities in placement policies apply primarily to high-achieving students (i.e., those in the top 20% of the achievement distribution). Academic achievement, not placement policy, is the primary barrier to access to 8th-grade Algebra among the bottom 60% of students in the achievement distribution. Given the well-known disparities in academic achievement, academic supports to prepare all students for advanced math are crucial. In a supplemental analysis, our analytic data show achievement disparities by race/ethnicity (see Table 2), consistent with other research on the educational opportunity gap and educational debt. The barriers to access are threefold: (1) stemming from the availability of 8th-grade algebra in the school, (2) achievement disparities, and (3) inequalities in placement among high-achieving students. This research brief focuses on the first and third barriers. Future research will investigate achievement disparities and identify additional steps to enhance students' preparation for Algebra 1 or higher.

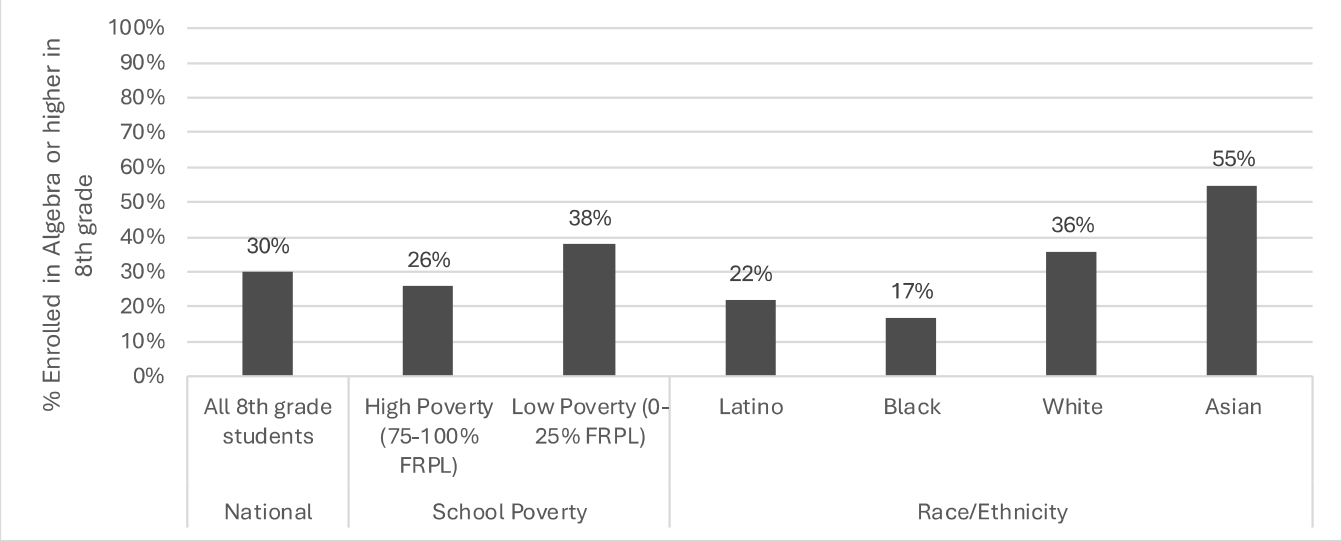
Conclusion

This analysis provides new estimates of the barriers to access to 8th-grade Algebra by race/ethnicity, urbanicity, and school poverty. This analysis reveals disparities in the schools that offer 8th-grade Algebra and inequalities in placement policies for high-achieving students. This research suggests that educators and policymakers can help improve access to Algebra 1 or higher by increasing the number of schools that offer Algebra in 8th grade, enhancing academic support in math to prepare more students for Algebra 1 or higher, and addressing placement policies that create barriers to equity among high-achieving students.

Figures

Figure 1

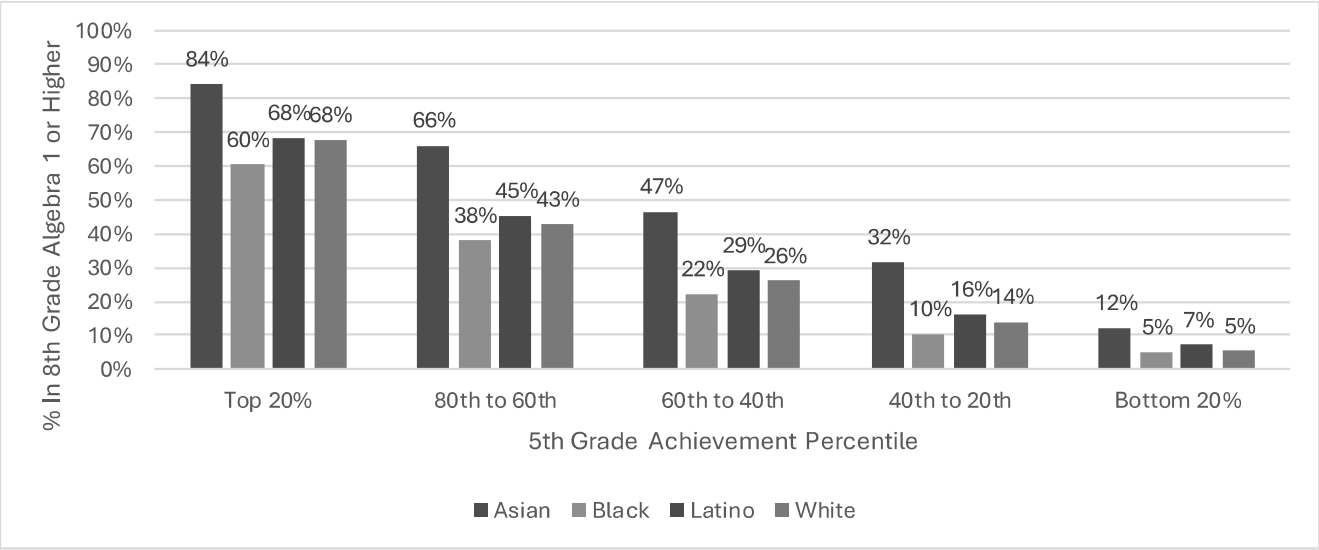
Inequalities in Algebra Access by Demographic Groups and School Poverty Among Students in Schools that Offer 8th-Grade Algebra



(N= 123,000 students)

Figure 2

Percent in 8th-grade Algebra or Higher by Achievement and Demographics in schools that offer Algebra 1 or higher



Note: N= 64,000. Due to the small sample size of some demographic groups, generally, only differences greater than 2% are statistically significant. For example, among students in the 60th to 80th percentiles, the

difference between White students (43%) and Latino students (45%) is not statistically significant and could have occurred by chance.

Tables

Table 1

Comparison of School Poverty and Race/Ethnicity for National Population Data and Analytic Samples

	National Population	Q1 Sample: Students in 8th-grade students	Q2 Sample: Students in 8th grade in schools with Algebra 1 or higher	Q3 Sample: Students in 8th grade who are in schools with Algebra 1 or higher and have data from the 5th grade Math MAP test
% FRPL in the School	57%	61%	59%	59%
% Black	15%	17%	17%	14%
% Latino	26%	27%	24%	23%
% White	48%	42%	44%	48%
% Asian	4%	5%	5%	5%
% Urban	29%	36%	36%	36%
% Rural	29%	21%	20%	23%
N Students	3,700,000	162,000	123,200	64,000
N Schools	23,000	1,300	750	500

Table 2

Percent of students in each math achievement quintile by race/ethnicity among 5th-grade students in the Spring of 2021

	Asian	White	Latino	Black
Lowest 20% in 5th-grade math achievement	12%	12%	33%	35%
21st to 40th percentile in math	16%	16%	24%	25%
41st to 60th percentile in math	19%	22%	21%	20%
61st to 80th percentile of math	21%	22%	12%	12%
Highest 20% in 5th-grade math achievement	32%	26%	8%	6%