How the COVID-19 Pandemic Affected Student Learning in Ohio: Analysis of Spring 2021 Ohio State Tests

Vladimir Kogan
Department of Political Science
The Ohio State University
kogan.1@osu.edu

Stéphane Lavertu
John Glenn College of Public Affairs
The Ohio State University
lavertu.1@osu.edu

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Abstract

We estimate the impact of the COVID-19 pandemic on the achievement of Ohio public school students as of spring 2021. Pandemic-related declines in student achievement (from March 2020 to spring 2021) are roughly equivalent to students missing one half to one full year's worth of learning in math (students in later grades had greater declines) and between one-third and one-half of a year's worth of learning in English language arts (depending on the grade). Students with below-grade-level achievement experienced larger test score declines than students performing at or above grade level—especially in English language arts—which exacerbated existing achievement gaps. Districts with fully remote instruction experienced test scores declines up to three times greater than districts that had in-person instruction for the majority of the school year. To further examine learning dynamics and to confirm the validity of the overall results, we took advantage of the fact that third-grade English language arts assessments were administered in both fall and spring. We find that at least one third of the overall decline in achievement recorded in spring 2021 can be attributed to decreased achievement growth during the 2020-21 school year, with the remainder due to disruptions that took place prior to the fall testing window (including but not limited to school closures in spring 2020). We also confirm that the estimated impact of remote instruction is plausibly causal (reducing achievement growth by approximately one-third) and that disadvantaged students had disproportionate learning declines during the academic year.

I. Overview

The COVID-19 pandemic caused unprecedented disruptions to teaching and learning in Ohio, including school closures, sudden changes to instructional delivery (online and hybrid), economic hardship, and social isolation. In January 2021, we released a report that examined the impact of the pandemic—including the mode of instructional delivery and local unemployment rates—on Ohio students' achievement as measured by the fall 2020 administration of Ohio's third-grade English language arts (ELA) exam.[1] That study documented declines in achievement relative to student performance on the same test in fall 2019. The purpose of this updated report is to estimate how much third-grade students have learned since the fall 2020 administration of the third-grade ELA exam, as well as to estimate total pandemic-related achievement impacts in grades 5-8 and in high school using Ohio State Tests (OSTs) administered in spring of 2021. Specifically, using results from both the fall and spring administrations of the third-grade ELA exam, we examine how student achievement gains during the 2020-21 school year compared to the learning gains of prior third-grade cohorts. For grades 5-8 and high school, we compare students' two-year gains on mathematics and ELA exams—from spring 2019 to spring 2021—to the two-year gains of prior grade cohorts (e.g., 2017 to 2019 and 2016 to 2018).[2] Thus, while our analysis of third-grade scores examines achievement impacts since last fall, the estimates for higher grades capture the impact of the entire pandemic period to date, from March 2020 to spring 2021.

One challenge to comparing student performance on state assessments over time is that the pandemic led to changes in the composition of students who took the annual exams, as test participation rates were lower than in past years (e.g., the U.S. Department of Education waived minimum test participation requirements for the spring of 2021) and some students exited their districts altogether to pursue different educational options.[3] In particular, because students with missing 2021 test scores were more likely to be disadvantaged and, thus, adversely impacted by the pandemic, basic comparisons in test score changes could understate actual declines in student achievement. We address this issue by also generating "adjusted" estimates using a statistical model that controls for differences in student characteristics, including prior test scores. In most grades, we also impute missing test scores using observed student characteristics—most importantly, their test scores on past exams—to make sure our estimates are representative of Ohio's entire population of public school students, including those who did not participate in the spring 2021 tests.[4]

When describing changes in student achievement, we focus on two outcomes. First, we calculate changes in the share of students attaining grade-level proficiency—demonstrated by scoring 700 or

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[1] Vladimir Kogan and Stéphane Lavertu, 2021, "The COVID-19 Pandemic and Student Achievement on Ohio's Third-Grade English Language Arts Assessment," http://glenn.osu.edu/educational-governance/reports/reports-attributes/ODE_ThirdGradeELA_KL_1-27-2021.pdf.

[2] Because the state used different tests prior to 2016, we do not extend the analysis to earlier cohorts. We also do not examine third-grade math scores or fourth-grade tests results because there are no prior achievement data for students in those grades, which is necessary to implement the statistical adjustments we describe in this section. While we focus primarily on fall-to-spring growth for third-grade ELA below, Section IV provides detailed information on third-grade ELA performance in spring 2021 compared to earlier years to facilitate comparison with our earlier report.

[3] The focus of this analysis is on students attending traditional school districts because information on mode of learning is not available for charter schools (called "community schools" in Ohio). In additional analyses, described in the appendix, we also examined students attending charter schools and obtained very similar results.

[4] We did not impute scores for high-school exams in mathematics. In high school, students enrolled in the same grade may take different math classes, so we do not know which test students were supposed to take if they did not participate in exams at all. This should have minimal impact on our estimates of student learning using scaled scores but may cause us to underestimate the impacts on proficiency levels for the Algebra and Geometry exams.

higher on the relevant OST. One limitation of this metric, however, is that it captures changes in achievement among a relatively narrow subset of students who were likely to be near the proficiency threshold. Our second (and preferred) measure examines changes in standardized scale scores. This is reported in student "standard deviation" units and captures learning impacts across a much broader range of baseline achievement. Unlike proficiency rates, however, standardized scale scores are less intuitive and harder to interpret. To aid interpretation, we compare these effect sizes to typical annual achievement growth nationwide in the relevant grade and subject.[5] This comparison is what enables us to equate learning declines to a typical year's worth of learning in a grade and subject. Because the amount of typical growth varies considerably across grades and subjects, we caution against directly comparing the numerical estimates below across grades or subjects. Instead, we encourage the reader to consider how the numeric estimates (in standard deviations) compare to typical nationwide annual achievement growth in that grade and subject.

Here are the main findings for third-grade ELA achievement growth from November to April of the 2020-21 school year:

- Third-grade students learned roughly 20 percent less on average between November 2020 and April 2021 (between the fall and spring administration of the ELA exam) as compared to students in prior years.

- These learning declines were larger for lower-achieving, economically disadvantaged, and minority student subgroups and among districts that spent the majority of the year in fully remote instruction. Students who performed in the highest quartile of achievement in the fall learned as much between fall and spring of the 2020-21 school year as they did during the same span in years prior to the pandemic.

- At least one third of the total pandemic-related achievement decline observed as of spring 2021 is due to decreased growth during the 2020-21 academic year, with the remainder due to declines that took place prior to the fall testing window (including but not limited to school closures in spring 2020).

- The third-grade ELA fall and spring tests enable us to generate plausibly causal estimates of the impact of mode of learning. We find that each additional week of remote learning in a district between the fall and spring reduced third-grade student ELA achievement by 0.01 standard deviations. The decline in achievement attributable to remote learning is approximately a third of typical achievement growth for this grade and subject. Hybrid instruction led to a decline in achievement of approximately one-tenth of typical growth for this grade and subject.[6]

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[5] These benchmarks are based on national tests, but our estimates for November-to-April achievement growth in third-grade ELA are quite similar in magnitude. That suggests that the national benchmarks provide useful points of comparison for interpreting the effect sizes we report below.

[6] We should note that the definition of "hybrid" learning varied across districts, complicating interpretation. In some schools, this meant that all students attended in-person classes part time. In others, it meant that some (lower) grades had fully in-person instruction while other (higher) grades remained fully remote.

Here are the main findings for grades 5-8 and high-school end-of-course exams:

- Average achievement on the OST declined significantly in spring 2021 compared to prior years, with larger absolute impacts in math (average declines of approximately 0.3 standard deviations across grades 5-8) than in ELA (average declines ranged between 0.1 and 0.2 standard deviations, depending on the grade level). These declines are roughly equivalent to between one-half and a whole year's worth of learning in math and between one-third and one-half of a year's worth of learning in ELA, depending on the grade.[7] In most grades, ELA proficiency rates decreased by about 8 percentage points and math proficiency decreased by approximately 15 percentage points.

- Compared to their peers, historically underserved student subgroups (measured by race, income, homelessness, disability, and English-learner status) generally experienced test score declines that were 1.5-2 times larger in ELA compared to their peers. Differences among student subgroups were less pronounced on math assessments in the lower grades. In some higher grades, more advantaged student subgroups experienced larger declines in math.

- Differences in impacts across student subgroups look more pronounced when measured in terms of standardized scale scores as opposed to proficiency rates, especially in ELA. One reason is that the pandemic appears to have caused greater disruption among lower-achieving students who were already less likely to demonstrate proficiency (i.e., students below the proficiency threshold before the pandemic fell further below that threshold).

- In contrast to recent analyses that examine achievement on district-administered assessments,[8] we find only limited evidence that achievement fell more in lower grades. Indeed, relative to typical achievement growth in each grade, students in upper middle school and high school grades appear to have fallen behind more than students in lower middle school and elementary grades.

- Students in districts that spent the majority of the academic year using fully in-person instruction experienced smaller achievement declines than students in districts using either hybrid or virtual learning.[9] These differences were somewhat more pronounced in lower grades (compared to higher grades) and in ELA (compared to math). In ELA, fully remote districts recorded test score declines of 0.2-0.3 standard deviations, 2-3 times larger (depending on the grade) than districts that spent the majority of their year fully in-person.

The remainder of this report provides more details about each of these headline findings. Readers should note that the figures and statistics presented below will not be comparable to other publicly available data or information reported on official state report cards because the analysis does not incorporate the full set of business rules used to determine which students are exempt from testing requirements, whose test scores are included for accountability purposes, and how individual students are linked to school buildings and districts.

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[7] See Carolyn J. Hill, Howard S. Bloom, Alison Rebeck Black, and Mark W. Lipsey, 2008, "Empirical Benchmarks for Interpreting Effect Sizes in Research," *Child Development Perspectives* 2(3): pp. 172-177.

[8] Center for Reinventing Public Education, 2021, "How Much Have Students Missed Academically Because of the Pandemic? A Review of Evidence to Date," https://www.crpe.org/sites/default/files/8_5_final_academic_impacts_report_2021.pdf.

[9] Note that district mode of instruction was correlated with student demographics, including student race. Thus, differences in mode of instruction may be one reason for why some student subgroups experienced larger losses, as we note above.

II. Full Results

This section reviews the detailed results. We order the presentation of findings according to the questions that the Ohio Department of Education (ODE) posed (italicized and in bold). After answering these questions in bullet form, we present figures that summarize what we consider to be central take-home points as well as tables that include a fuller set of results. Due to the number of grades and subjects we examine, we focus on selected grades and student subgroups in the interest of space. We also present additional results in tables included in Section IV, which follows the methodological appendix.

1. Based on results from the fall and spring administrations of the third-grade English language arts (ELA) exam, have school districts made progress in addressing and ultimately reversing the negative pandemic learning impacts observed in fall 2020?

- Achievement declines continued during the 2020-21 school year. As our previous report indicated, third-grade ELA scores during the fall 2020 administration were 0.23 standard deviations lower than those during the fall 2019 administration, before the pandemic. The decline increased to 0.32 standard deviations by the spring of 2021, equivalent to roughly half a year of learning, compared to student performance on this exam in previous springs.

- Based on the subset of students who took both fall and spring assessments, students learned roughly 20 percent less on average between November 2020 and April 2021 than earlier cohorts of third-graders did between November and April.[10] The fall-to-spring achievement declines were larger for lower-achieving, disadvantaged, and minority student subgroups and among districts that spent the majority of the year in fully remote instruction.

- For third-grade ELA, we estimate that at least one third of the overall decline in achievement recorded in spring 2021 (as compared to prior springs) can be attributed to decreased growth during the academic year, with the remainder due to disruptions that took place prior to the fall testing window (including but not limited to school closures in spring 2020). We caution against generalizing this finding to other grades and subjects, however.

- Decreased learning over the course of the academic year was concentrated among lower-achieving students (those in the bottom achievement quartile according to fall test scores). These students, who began third grade academically most behind, typically record the largest gains between the fall and spring assessments, but they made up considerably less ground than usual during the 2020-21 academic year. By contrast, students in the highest quartile of achievement in the fall learned as much between fall and spring of the 2020-21 school year as they did prior to the pandemic. As a result, the achievement gaps between lower- and higher-performing students have increased.

- The unusual structure of the third-grade ELA exams—with achievement observed at two points in time for each student during the year—provides a unique opportunity to more cleanly isolate the causal effect of mode of instruction from other factors (e.g., local politics and intensity of COVID spread) that may have influenced both the amount of in-person instruction available to students
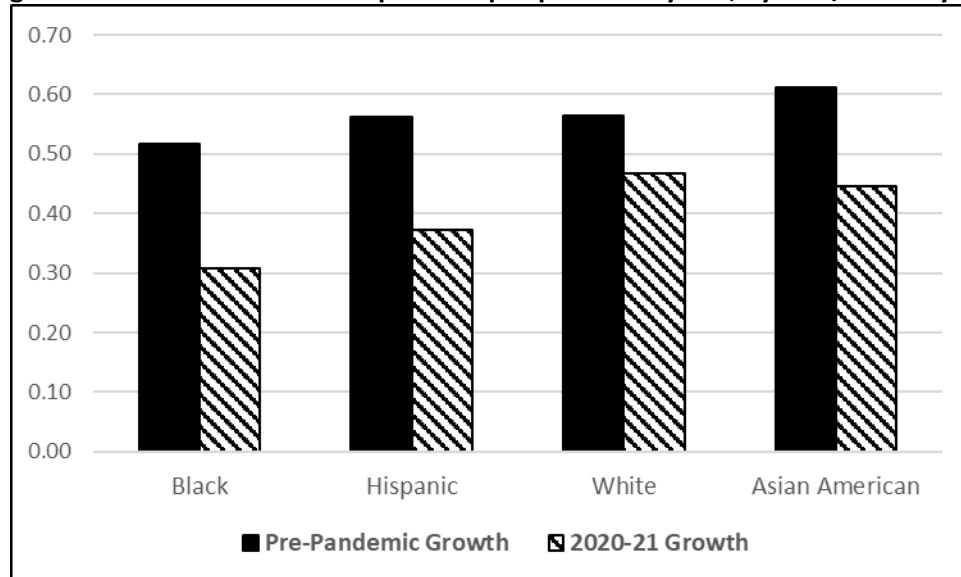
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[10] For convenience, we refer to the "November-to-April" period in the remainder of this report, even though the precise timing of the fall and spring testing windows varies somewhat across years.

and the trajectory of their learning. We observe mode of instruction weekly and find that the number of weeks of in-person instruction offered between November and April strongly predicts how much students learned during this period. (The mode of learning available in September and October does not predict November-to-April achievement growth, however—a placebo test that validates our estimates.) Specifically, we estimate that each additional week of remote learning students experienced between fall 2020 and spring 2021 reduced third-grade student ELA achievement by 0.01 standard deviations. This is approximately a third of typical achievement growth for this grade and subject.[11] Learning among students exposed to hybrid instruction is roughly one-tenth smaller than usual and not statistically significant (p=0.09).

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[11] Prior to the pandemic, we estimate that student achievement increased by 0.57 standard deviations during the roughly 20-week period of instruction between the fall and spring testing windows. This translates to approximately 0.03 standard deviations of growth per week of regular, in-person instruction.

Figure 1. Changes in fall-to-spring standardized test score growth on third-grade ELA OST in 2020-21 compared to pre-pandemic years, by race/ethnicity

Note: The figure presents the average fall-to-spring growth of normalized test scores in standard deviation units between pre-pandemic years (2018 and 2019) and 2021. These are regression estimates that compare changes in test scores over time for students who took the same exam in fall and spring of each year.

Figure 2. Changes in fall-to-spring standardized test score growth on third-grade ELA OST in 2020-21 compared to pre-pandemic years, by economic disadvantage

Note: The figure presents the average fall-to-spring growth of normalized test scores in standard deviation units between pre-pandemic years (2018 and 2019) and 2021. These are regression estimates that compare changes in test scores over time for students who took the same exam in fall and spring of each year.
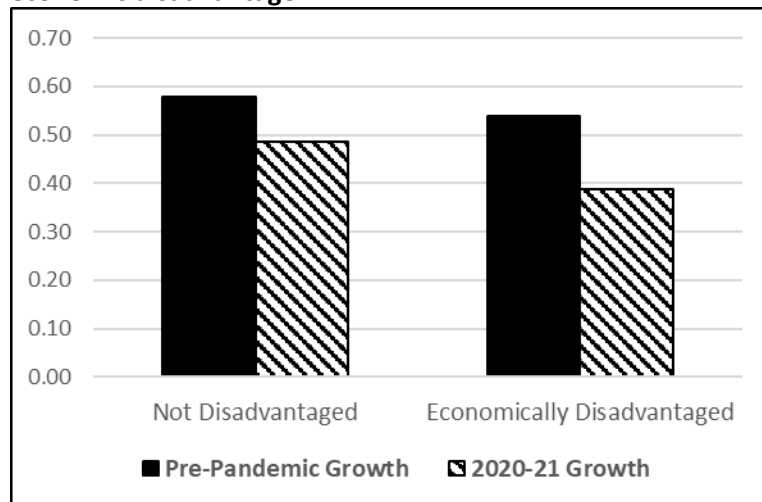
Figure 3. Changes in fall-to-spring standardized test score growth on third-grade ELA OST in 2020-21 compared to pre-pandemic years, by district mode of instruction
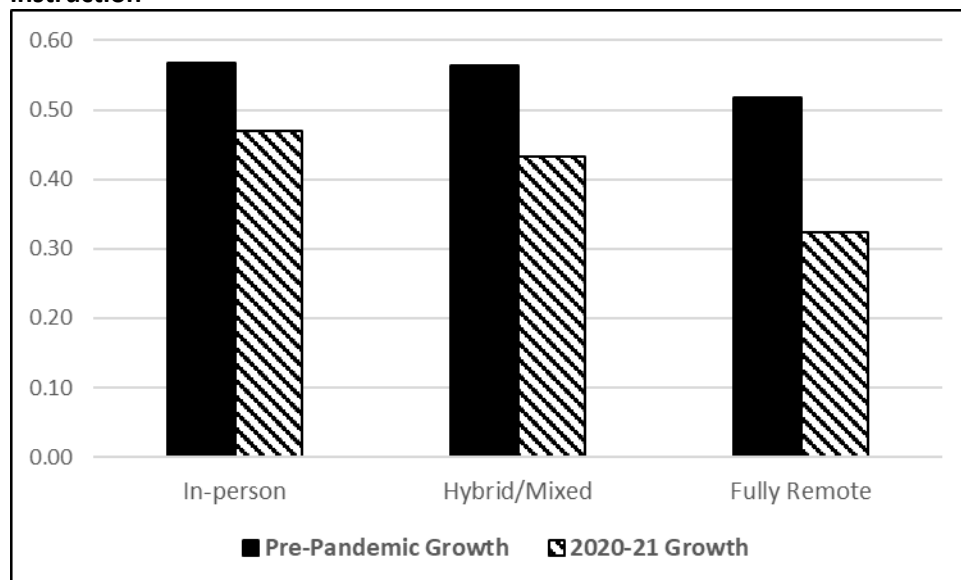

Note: The figure presents the average fall-to-spring growth of normalized test scores in standard deviation units between pre-pandemic years (2018 and 2019) and 2021. These are regression estimates that compare changes in test scores over time for students who took the same exam in fall and spring of each year. Mode of instruction is determined based on weekly data submitted to the Ohio Department of Education for weeks between the fall and spring test administration windows. Due to changes in how mode of instruction was recorded over the course of the year, the "hybrid" category combines districts that offered fully hybrid instruction across all grades and districts that offered at least some in-person instruction for lower grades and remote instruction for older students.

Figure 4. Changes in fall-to-spring standardized test score growth on third-grade ELA OST in 2020-21 compared to pre-pandemic years, by fall achievement quartile
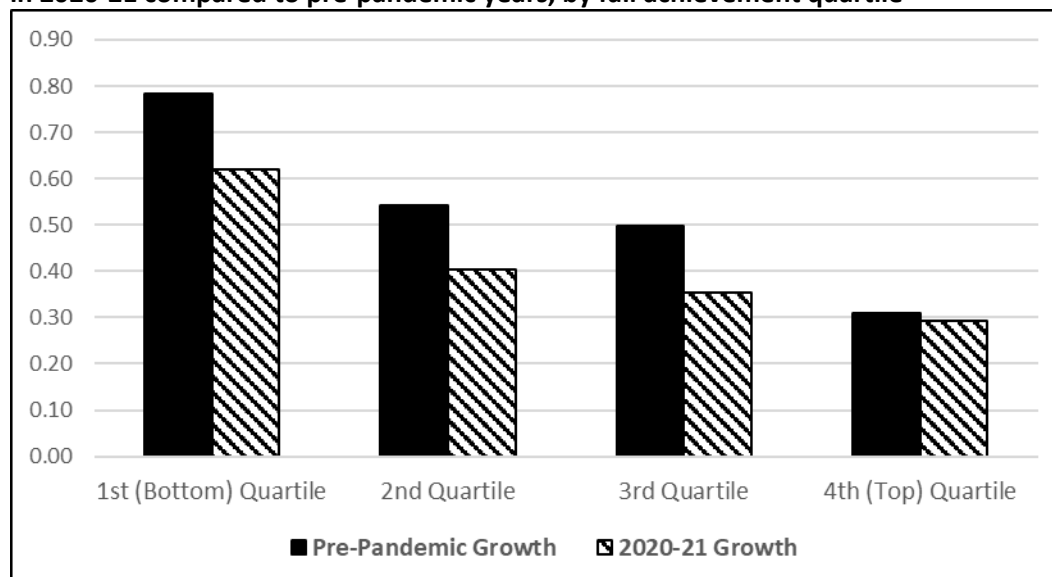

Note: The figure presents the average fall-to-spring growth of normalized test scores in standard deviation units between pre-pandemic years (2018 and 2019) and 2021. These are regression estimates that compare changes in test scores over time for students who took the same exam in fall and spring of each year. Students are grouped into quartiles based on their fall test scores, from lower (quartile 1) to higher (quartile 4) baseline test scores.

Tables with complete results:

Table 1. Changes in fall-to-spring standardized test score growth on third-grade ELA OST in 2020-21 compared to pre-pandemic years

	Pre-Covid Growth	2020-21 SY Growth	Difference
Statewide Average	*0.56*	*0.44*	*-0.12*
Race/ethnicity			
Black	0.52	0.31	-0.21
Hispanic	0.56	0.37	-0.19
White	0.56	0.47	-0.10
Asian American	0.61	0.45	-0.17
Economic disadvantage			
Not Disadvantaged	0.58	0.49	-0.09
Economically Disadvantaged	0.54	0.39	-0.15
Disability			
Not Disabled	0.57	0.46	-0.11
Disabled	0.48	0.32	-0.15
English Learner			
Not English Learner	0.56	0.45	-0.11
English Learner	0.59	0.33	-0.26
Homelessness			
Not Homeless	0.56	0.44	-0.12
Homeless	0.49	0.37	-0.12
District mode of learning in 2020-21			
In-person	0.57	0.47	-0.10
Hybrid/mixed	0.56	0.43	-0.13
Remote	0.52	0.32	-0.19
Fall achievement quartile			
1st Quartile	0.78	0.62	-0.17
2nd Quartile	0.54	0.40	-0.14
3rd Quartile	0.50	0.35	-0.14
4th Quartile	0.31	0.27	-0.04

Note: The table summarizes the average fall-to-spring growth in normalized test scores in standard deviation units between pre-pandemic years (2018 and 2019) and 2021. These are regression estimates that compare changes in test scores over time for students who took the same exam in fall and spring of each year. Mode of instruction is determined based on weekly data submitted to the Ohio Department of Education for weeks between the fall and spring test administration windows. Due to changes in how mode of instruction was recorded over the course of the year, the "hybrid" category combines districts that offered fully hybrid instruction across all grades and districts that offered at least some in-person instruction for lower grades and remote instruction for older students. In the bottom panel, students are grouped into quartiles based on their fall test scores, from lower (quartile 1) to higher (quartile 4) baseline test scores.

2. How has the pandemic impacted student achievement in math and ELA in Ohio in grades 5-8 and on high school end-of-course exams?

Summary of results:

- Average student achievement on state exams administered in spring 2021 declined significantly in every grade and subject. In absolute terms, students experienced larger declines in math (roughly 0.3 standard deviations) than in ELA (ranging from 0.1 to 0.2 standard deviations). Nationally, average year-to-year student achievement gains are larger in math than in reading. The decline of 0.3 standard deviations in math is roughly equivalent to one-half of a year's worth of learning in fifth grade and approximately a full year's worth of learning in middle and high school. A decline of 0.1 to 0.2 standard deviations in ELA translates to between one-third and one-half of a year's worth of learning, depending on the grade level.

- In most grades, the decline in the proficiency rate is approximately 8 percentages points in ELA and 15 percentage points in math.

Figure:

Figure 5. Changes in standardized scaled scores in 2020-21 compared to pre-pandemic years, by grade and subject

Note: The figure presents the average differences in normalized test scores in standard deviation units between pre-pandemic years (spring 2018 and 2019) and spring 2021. These are regression-adjusted estimates intended to partially account for differences in student test participation in 2021, which we generated using the methods described in the technical appendix. See Table A1 in Section IV for the typical growth benchmark for each grade and subject. Grade 10 scores are based on the ELA II and Geometry end-of-course exams, which are not taken by all tenth graders. We also exclude scores from students who took these exams in other grades.

Tables with complete results:

Table 2. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years, grades 5-8

	ELA			Math		
	Pre-Covid	2020-21 SY	Diff.	Pre-Covid	2020-21 SY	Diff.
Grade 5						
Participation Rate	96.4	90.3	-6.1	94.6	88.5	-6.1
Test score (SDs, unadjusted)	0.03	-0.06	-0.09	0.04	-0.27	-0.31
Proficient (unadjusted)	72.2%	70.1%	-2.1%	66.2%	55.8%	-10.4%
Test score (SDs, adjusted)	--	--	*-0.15*	--	--	*-0.34*
Proficient (adjusted)	--	--	*-6.8%*	--	--	*-15.6%*
Grade 6						
Participation Rate	96.2	89.9	-6.3	93.1	86.8	-6.3
Test score (SDs, unadjusted)	0.03	-0.08	-0.11	0.04	-0.25	-0.30
Proficient (unadjusted)	60.7%	58.4%	-2.2%	63.7%	54.3%	-9.4%
Test score (SDs, adjusted)	--	--	*-0.18*	--	--	*-0.35*
Proficient (adjusted)	--	--	*-8.2%*	--	--	*-16.2%*
Grade 7						
Participation Rate	95.9	89.9	-6.0	89.4	82.5	-6.9
Test score (SDs, unadjusted)	0.03	-0.06	-0.09	0.04	-0.23	-0.27
Proficient (unadjusted)	68.3%	65.1%	-3.2%	63.3%	54.3%	-9.0%
Test score (SDs, adjusted)	--	--	*-0.15*	--	--	*-0.31*
Proficient (adjusted)	--	--	*-8.2%*	--	--	*-14.9%*
Grade 8						
Participation Rate	94.7	90.2	-4.6	89.5	83.9	-5.7
Test score (SDs, unadjusted)	0.03	-0.06	-0.09	0.04	-0.23	-0.27
Proficient (unadjusted)	59.5%	58.7%	-0.8%	59.8%	50.7%	-9.1%
Test score (SDs, adjusted)	--	--	*-0.08*	--	--	*-0.28*
Proficient (adjusted)	--	--	*-3.3%*	--	--	*-14.7%*

Note: We calculated participation rates using student enrollment in each grade (excluding those repeating a grade), including students with disabilities who are not required to take the standard Ohio State Tests. Thus, although changes in participation rates over time should be accurate, participation rates for each year are likely lower than official participation rates that districts might report. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 in Section IV for the typical growth benchmark for each grade and subject.

Table 3. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years, high school

	Pre-Covid	2020-21 SY	Diff.
Algebra			
Participation Rate	58.8	60.5	+1.7
Test score (SDs, unadjusted)	0.03	-0.20	-0.23
Proficient (unadjusted)	74.0%	65.6%	-8.4%
Test score (SDs, adjusted)			*-0.29*
Proficient (adjusted)			*-9.5%*
Geometry			
Participation Rate	56.0	53.4	-2.6
Test score (SDs, unadjusted)	0.03	-0.19	-0.22
Proficient (unadjusted)	67.7%	64.1%	-3.7%
Test score (SDs, adjusted)			*-0.29*
Proficient (adjusted)			*-4.0%*
English II			
Participation Rate	91.6	86.3	-5.3
Test score (SDs, unadjusted)	0.02	0.06	0.03
Proficient (unadjusted)	71.6%	72.2%	+0.6%
Test score (SDs, adjusted)			*-0.08*
Proficient (adjusted)			*-5.6%*

Note: We calculated participation rates using student enrollment in grades 9 (for Algebra) and 10 (for Geometry and English II), excluding students repeating these grades. Some students may take these assessments in earlier or later grades, and we exclude these students from each year's testing sample. However, the participation rates above include students with disabilities who are not required to take the state assessments. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores (except in math) and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 in Section IV for the typical growth benchmark for each grade and subject.

3. How much do these learning disruptions vary across grade levels, student subgroups, and modes of learning used by districts during the 2020-21 academic year?
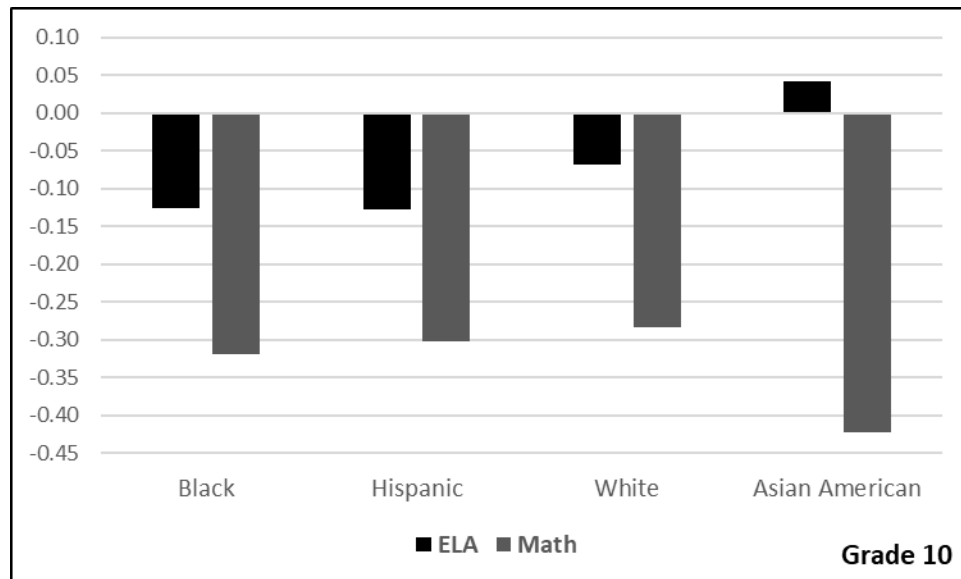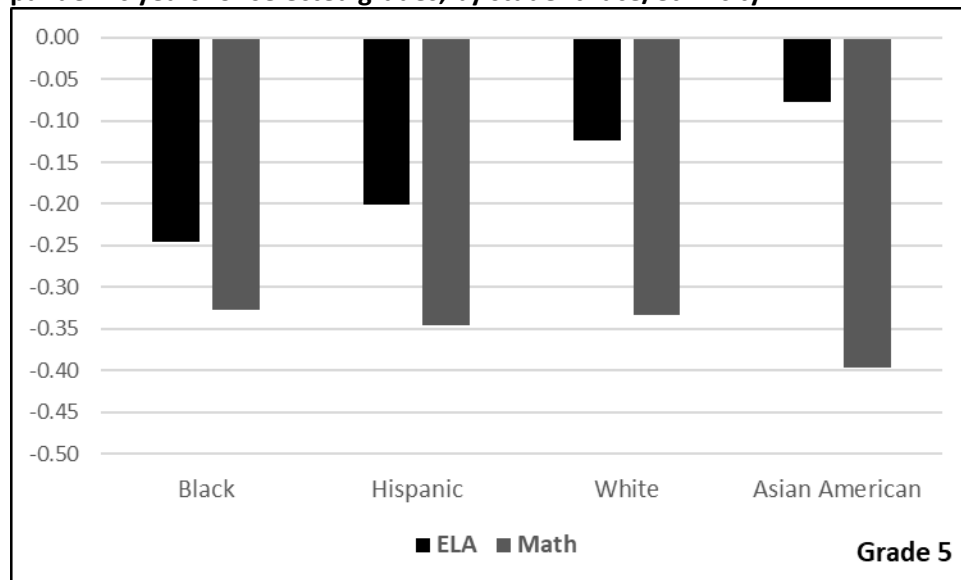
- In absolute terms, the declines in test scores were more pronounced for ELA in lower grades but were largely similar across all grades in math. However, national data suggest students typically experience larger achievement gains in lower grades (see Table A1 in section IV). If one compares the estimated declines (in standard deviation units) to the nationwide benchmarks by grade and subject, it turns out that both the ELA and math results imply larger achievement declines for student in higher grades.

- In terms of student subgroups, we found larger differences in ELA scores than in math scores. In ELA, Black students saw their test scores decrease 2-3 times more than white students in most grades, while Hispanic students experienced declines that were typically twice as large as those of white students. Similarly, economically disadvantaged, homeless, and disabled students and English learners experienced ELA test score declines that were generally 2-3 times larger than declines among students not identified as such, with some important differences in these gaps across grade levels. In math, score declines were roughly similar across the various subgroups in most grades, although Asian American students recorded consistently larger test score declines in math than other racial and ethnic subgroups.[12]

- Districts that spent the majority of the academic year using fully in-person instruction generally experienced smaller test score declines than districts relying on either hybrid or remote instruction, with important differences between subjects. In ELA, fully remote districts recorded test score declines on the order of 0.2 to 0.3 standard deviations, 2-3 times larger (depending on the grade) than districts that spent the majority of their year fully in person. Achievement declines in districts that used some form of hybrid instruction were typically between the two. In math, gaps across modes of instruction were more muted.[13] Differences by mode of instruction were also somewhat less pronounced in higher grades compared to lower grades. The latter finding may partly reflect how "hybrid" learning was defined in district-reported data, which may have included fully remote instruction for older students.

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[12] The Asian American category does not include students who identify as Pacific Islander.
[13] For math, we found larger decreases in achievement in districts that utilized hybrid instruction than those operating fully remotely in some grades.

Figures:

Figure 6. Changes in standardized scaled scores in 2020-21 compared to pre-pandemic years for selected grades, by student race/ethnicity

Note: The figure presents the average differences in normalized test scores in standard deviation units between pre-pandemic years (spring 2018 and 2019) and spring 2021. These are regression-adjusted estimates intended to partially account for differences in student test participation in 2021, which we generated using the methods described in the technical appendix. See Table A1 in Section IV for the typical growth benchmark for each grade and subject. Grade 10 scores are based on the ELA II and geometry end-of-course exams, which are not taken by all tenth graders. We also exclude scores from students who took these exams in other grades.
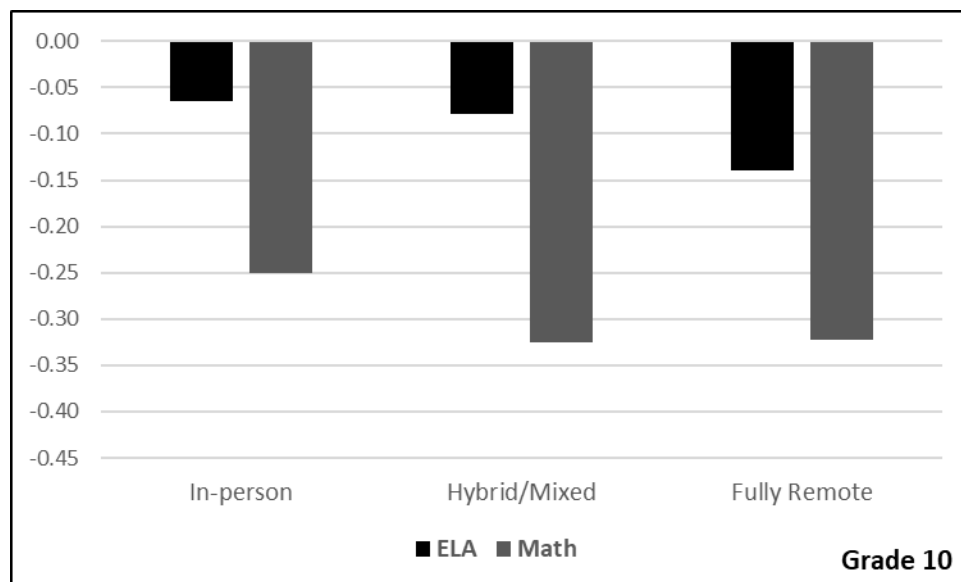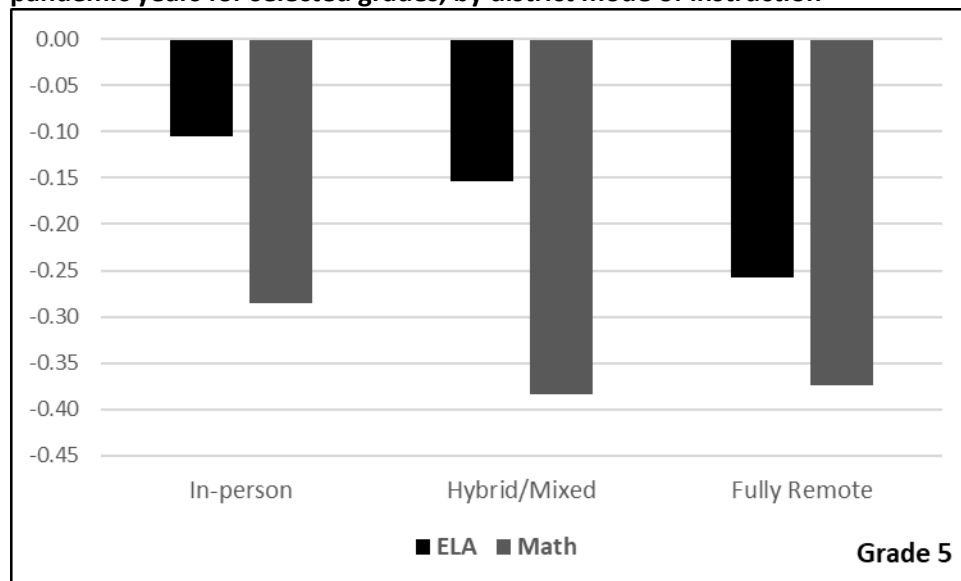
Figure 7. Changes in standardized scaled scores in 2020-21 compared to pre-pandemic years for selected grades, by district mode of instruction

Grade 5

Grade 10

Note: The figure presents the average differences in normalized test scores in standard deviation units between pre-pandemic years (spring 2018 and 2019) and spring 2021. These are regression-adjusted estimates intended to partially account for differences in student test participation in 2021, which we generated using the methods described in the technical appendix. Mode of instruction is determined based on weekly data submitted to the Ohio Department of Education. Due to changes in how mode of instruction was recorded over the course of the year, the "hybrid" category combines districts that offered fully hybrid instruction across all grades and districts that offered at least some in-person instruction for lower grades and remote instruction for older students. See Table A1 in Section IV for the typical growth benchmark for each grade and subject. Grade 10 scores are based on the ELA II and geometry end-of-course exams, which are not taken by all tenth graders. We also exclude scores from students who took these exams in other grades.

III. Methodological Appendix

The analysis estimates the impact of the COVID-19 pandemic on student achievement by examining changes in student participation and performance on the spring administration of the Ohio State Tests (OSTs). Specifically, for grades 5-8 and high school, we compare test participation and scores in spring 2021 (holding constant student demographic characteristics and test scores from two years prior) to participation and scores in spring 2018 and 2019 (again, holding constant student demographic characteristics and test scores from two years prior). For third-grade ELA, we compare November-to-April changes in student test scores during the 2020-21 school year to fall-to-spring changes in student test scores during the 2018-19 and 2017-18 school years.

We present two sets of estimates: "unadjusted" and "adjusted." The "unadjusted" estimates capture raw differences in test participation rates and student test scores for each assessed grade and subject. The "adjusted" estimates are based on statistical models that account for changes in the characteristics of students tested across years—to estimate what changes in test scores would have looked like if the composition of test-takers in 2021 looked similar to prior years. For most grades and subjects, our "adjusted" estimates impute scores for students who did not participate in the exams. As we show above, aggregate decreases in test participation came disproportionately from lower-achieving student subgroups, resulting in compositional changes among tested students that mask some of the pandemic-related learning disruptions in the raw data. We do not impute missing test scores for high school math exams (Algebra and Geometry) because we cannot identify which exam each student was expected to take.

Unadjusted Estimates

The analysis employs Education Management Information System (EMIS) data on students who were enrolled for the first-time in each tested grade during each academic year, to establish the baseline population of students. Test scores for pre-pandemic years also come from the EMIS database, whereas scores from the pandemic period are from ODE test vendor files. We pre-processed the data to remove potentially problematic values (e.g., recoding scores as missing if they are below the minimum reported in the OST Annual Technical Reports). The participation rates we report above represent the proportion of students in each grade attendance file who have a valid test score in the EMIS records or vendor file, depending on the school year. For earlier years, the EMIS records indicate the accountable district for each student. For spring 2021, we use the "attending" district as recorded in the vendor file. For pre-pandemic years, we assign students with missing scores to the district in which a student spent the most time according to attendance records. For spring 2021, we assign students to the district they attended most recently, prior to the beginning of the spring testing window. Our preferred estimates focus only on students enrolled in traditional public schools. In some robustness checks, described below, we include all students and assign them to their district of residence (rather than district of attendance or the district in which they took the exam according to the vendor file).

Adjusted Estimates

Based on each grade's respective attendance file, we estimate that the statewide participation rate on spring assessments declined from over 95 percent in pre-pandemic years to approximately 85-90 percent in spring 2021. The drop in test participation was largest for economically disadvantaged, homeless, and minority students and in districts that relied primarily on fully remote instruction. These patterns strongly suggest that the 2020-21 test score declines of students who did not participate in the examination would have been greater than the statewide average. Thus, raw differences in observed test scores likely understate actual changes in student achievement between 2018-2019 and spring 2021.

To address this sample selection bias, we first impute missing test scores where possible and use a statistical model to adjust the raw estimates for differences in student composition over time. Our imputation model includes student demographic characteristics (measured the year before each exam), a third-order polynomial of prior math and ELA test scores, and district of attendance. We then substituted these estimated scores for students who did not take the exam, creating a complete dataset for each grade, subject, and year.

In the final analysis, we combine scores (including imputations) from spring 2018, 2019, and 2021 into a separate pooled dataset for each grade and subject and estimate the following Ordinary Least Squares (OLS) model:

$$y_{idt} = \alpha_d + X'_{idt}\theta + \beta 2021_{idt} + \epsilon_{idt} \qquad \text{(A1)}$$

where y_{idt} is a test score (or proficiency indicator) for student i in district of attendance d and school year t. The model includes fixed effects for students' district of attendance (α_d). We also control for a vector of student demographic characteristics observed in the previous year and a third-order polynomial of lagged test scores in both ELA and math from two years prior (X_{idt}).[14] The control variables also include indicators for students with missing demographic and prior test score data.[15] For third-grade ELA, we do not observe prior test scores. Instead, similar to our earlier report, we include an indicator variable for whether each student was assessed to be "on track" to attain proficiency in reading based on district-administered diagnostic assessments completed in fall of second grade.

The variable (2021_{it}) indicates whether the test score is from spring 2021 or from one of the two pre-pandemic years. Thus, the parameter β captures the difference between the average test score in spring 2021 and the average test score in the two pre-pandemic years, holding constant observable students' demographics and pre-pandemic achievement levels. Standard errors are clustered by school district of attendance, though this does not affect our inferences given the large sample sizes we use in our analyses. We estimate the model above separately for each grade and subject, and we normalize the test scores to have a mean zero and standard deviation of one based on the distribution of pre-pandemic scores in each grade and subject.[16]

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[14] We use lagged scores from two years earlier because the cancelation of spring 2020 exams means that we do not observe one-year-lagged scores for the spring 2021 testing cohort.

[15] For students with missing prior scores, we fill in the missing values with zero, corresponding to the statewide average. Note, however, that we estimate a separate missing test score effect.

[16] Note that we include all students, including those not attending traditional public schools, when standardizing.

For third-grade ELA, we observe both fall and spring test scores for students who participated in both rounds of assessment. When analyzing fall-to-spring growth, we estimate the following difference-in-differences model:

$$y_{it} = \alpha_i + \gamma SPRING_{it} + \beta SPRING_{it} * PANDEMIC_{it} + \epsilon_{it} \qquad \text{(A2)}$$

where y_{it} is a test score for student i in assessment cycle t. The model includes fixed effects for each student (α_i). Note that this absorbs time-invariant student characteristics, including demographics and prior achievement. The coefficient γ captures the average growth in scores between the fall and spring assessment cycles in pre-pandemic years. The parameter β captures the change in fall-to-spring growth in 2021 compared to the pre-pandemic years.[17] We again use standard errors clustered by school district of attendance when assessing the statistical significance of the estimates.

Robustness Checks

In addition to models above, we estimate several more specifications to verify the robustness of the findings. First, to address potential disenrollment and non-random selection into charter schools or open-enrollment districts (for example, in response to home district mode of learning available during the pandemic) we include charter school students and replace district-of-attendance with district-of-residence fixed effects. Mode of instruction is coded based on district of residence (rather than attendance) in these specifications. Second, we also drop observations from spring 2018 and use only spring 2019 as our pre-pandemic baseline. The results from each of these alternative specifications are similar to our preferred estimates reported above.

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[17] We exclude students who repeat third grade, so the main effect of the pandemic is absorbed in the student-level fixed effects.

IV. Additional Tables

Table A1. Average annual growth in national standardized test scores, by grade and subject

	Reading	Math
Grade 3	0.60	0.89
Grade 4	0.36	0.52
Grade 5	0.40	0.56
Grade 6	0.32	0.41
Grade 7	0.23	0.30
Grade 8	0.26	0.32
Grade 9	0.24	0.22
Grade 10	0.19	0.25

Source: Carolyn J. Hill, Howard S. Bloom, Alison Rebeck Black, and Mark W. Lipsey, 2008, "Empirical Benchmarks for Interpreting Effect Sizes in Research," *Child Development Perspectives* 2(3): pp. 172-177.
Note: The estimates represent average spring-to-spring growth in standardized test scores in each grade based on national norming samples from half a dozen major standardized tests in each subject. The estimates include learning in school, growth due to experiences outside of school, and typical summer learning loss between grades.

Table A2. Differences in participation rates and test scores in 2020-21 on third-grade ELA OST compared to pre-pandemic years

	Pre-Covid	2020-21	Difference
Participation	97.4	88.7	-8.7
Test score (standardized, unadjusted)	0.03	-0.33	-0.37
Proficient (unadjusted)	67.9%	57.1%	-10.8%
Test score (standardized, adjusted)			*-0.32*
Proficient (adjusted)			*-12.8%*

Note: We calculated participation rates using third-grade enrollment (excluding those repeating third grade), including students with disabilities who are not required to take the standard Ohio State Tests. Thus, although changes in participation rates over time should be accurate, participation rates for each year are likely lower than official participation rates that districts might report. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores and control for students' demographic characteristics and pre-pandemic reading diagnostic performance, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 in Section IV for the typical growth benchmark for each grade and subject.

Table A3. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in grades 5-8, by race

	ELA				Math			
	White	Black	Hispanic	Asian American	White	Black	Hispanic	Asian American
Grade 5								
Participation	-4.8%	-10.6%	-7.8%	-10.4%	-4.6%	-11.1%	-8.4%	-7.8%
Test score (SDs, adjusted)	-0.12	-0.25	-0.20	-0.08	-0.33	-0.33	-0.35	-0.40
Proficient (adjusted)	-5.8%	-11.5%	-8.6%	-4.5%	-14.9%	-17.3%	-18.8%	-11.2%
Grade 6								
Participation	-4.9%	-11.6%	-8.1%	-9.6%	-4.9%	-12.0%	-7.7%	-6.4%
Test score (SDs, adjusted)	-0.14	-0.32	-0.26	-0.15	-0.35	-0.35	-0.38	-0.45
Proficient (adjusted)	-7.4%	-10.8%	-10.5%	-8.1%	-15.8%	-16.7%	-19.0%	-14.0%
Grade 7								
Participation	-4.4%	-12.0%	-8.2%	-8.5%	-5.5%	-12.1%	-8.4%	-10.2%
Test score (SDs, adjusted)	-0.15	-0.15	-0.16	-0.12	-0.33	-0.20	-0.27	-0.41
Proficient (adjusted)	-7.9%	-9.9%	-9.8%	-5.9%	-14.7%	-14.4%	-17.0%	-12.5%
Grade 8								
Participation	-2.8%	-10.5%	-8.0%	-7.8%	-4.0%	-10.8%	-8.8%	-7.9%
Test score (SDs, adjusted)	-0.06	-0.15	-0.14	-0.06	-0.30	-0.19	-0.28	-0.44
Proficient (adjusted)	-2.6%	-5.6%	-5.8%	-3.9%	-14.5%	-14.0%	-17.0%	-15.9%

Note: We calculated participation rates using student enrollment in each grade (excluding those repeating a grade), including students with disabilities who are not required to take the standard Ohio State Tests. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject.

Table A4. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in high school, by race

	White	Black	Hispanic	Asian American
Algebra				
Participation	+1.7%	+2.0%	-0.7%	+3.2%
Test score (SDs, adjusted)	-0.29	-0.32	-0.29	-0.36
Proficient (adjusted)	-9.0%	-7.3%	-7.9%	-6.9%
Geometry				
Participation	-2.1%	-3.5%	-5.5%	-0.4%
Test score (SDs, adjusted)	-0.28	-0.32	-0.30	-0.42
Proficient (adjusted)	-5.2%	+2.0%	-2.2%	-5.5%
English II				
Participation	-4.3%	-8.5%	-7.2%	-4.3%
Test score (SDs, adjusted)	-0.07	-0.13	-0.13	0.04
Proficient (adjusted)	-5.1%	-7.3%	-9.1%	-2.6%

Note: We calculated participation rates using student enrollment in grades 9 (for Algebra) and 10 (for Geometry and English II), excluding students repeating these grades. Some students may take these assessments in earlier or later grades, and we exclude these students from each year's testing sample. However, the participation rates above include students with disabilities who are not required to take the state assessments. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores (except in math) and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject.

Table A5. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in grades 5-8, by economic disadvantage

	ELA		Math	
	Not Disadvantaged	Economically Disadvantaged	Not Disadvantaged	Economically Disadvantaged
Grade 5				
Participation	-5.3%	-7.1%	-4.9%	-7.2%
Test score (SDs, adjusted)	-0.08	-0.21	-0.33	-0.35
Proficient (adjusted)	-4.0%	-9.8%	-12.2%	-18.3%
Grade 6				
Participation	-5.2%	-7.5%	-5.0%	-7.6%
Test score (SDs, adjusted)	-0.09	-0.26	-0.36	-0.36
Proficient (adjusted)	-6.4%	-9.9%	-13.9%	-18.0%
Grade 7				
Participation	-4.4%	-7.7%	-5.9%	-8.0%
Test score (SDs, adjusted)	-0.12	-0.19	-0.36	-0.26
Proficient (adjusted)	-6.1%	-10.9%	-13.6%	-16.6%
Grade 8				
Participation	-2.7%	-6.7%	-3.8%	-7.5%
Test score (SDs, adjusted)	-0.04	-0.13	-0.34	-0.25
Proficient (adjusted)	-1.7%	-5.1%	-14.3%	-15.4%

Note: We calculated participation rates using student enrollment in each grade (excluding those repeating a grade), including students with disabilities who are not required to take the standard Ohio State Tests. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject.

Table A6. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in high school, by economic disadvantage

	Not Disadvantaged	Economically Disadvantaged
Algebra		
Participation	+2.2%	+0.8%
Test score (SDs, adjusted)	-0.31	-0.29
Proficient (adjusted)	-9.2%	-8.5%
Geometry		
Participation	-1.4%	-4.1%
Test score (SDs, adjusted)	-0.29	-0.28
Proficient (adjusted)	-6.0%	-1.4%
English II		
Participation	-4.0%	-7.1%
Test score (SDs, adjusted)	-0.03	-0.14
Proficient (adjusted)	-4.1%	-8.7%

Note: We calculated participation rates using student enrollment in grades 9 (for Algebra) and 10 (for Geometry and English II), excluding students repeating these grades. Some students may take these assessments in earlier or later grades, and we exclude these students from each year's testing sample. However, the participation rates above include students with disabilities who are not required to take the state assessments. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores (except in math) and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject.

Table A7. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in grades 5-8, by disability status

	ELA		Math	
	Not Disabled	Disabled	Not Disabled	Disabled
Grade 5				
Participation	-6.5%	-3.3%	-6.4%	-3.5%
Test score (SDs, adjusted)	-0.14	-0.19	-0.36	-0.21
Proficient (adjusted)	-7.1%	-6.8%	-16.1%	-11.3%
Grade 6				
Participation	-6.7%	-3.8%	-6.6%	-3.8%
Test score (SDs, adjusted)	-0.16	-0.30	-0.37	-0.29
Proficient (adjusted)	-9.0%	-5.5%	-17.2%	-10.4%
Grade 7				
Participation	-6.2%	-4.3%	-7.3%	-4.6%
Test score (SDs, adjusted)	-0.15	-0.19	-0.34	-0.14
Proficient (adjusted)	-8.6%	-8.2%	-16.3%	-8.7%
Grade 8				
Participation	-4.7%	-3.4%	-6.1%	-3.6%
Test score (SDs, adjusted)	-0.07	-0.14	-0.34	-0.07
Proficient (adjusted)	-3.6%	-2.0%	-16.6%	-7.1%

Note: We calculated participation rates using student enrollment in each grade (excluding those repeating a grade), including students with disabilities who are not required to take the standard Ohio State Tests. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject.

Table A8. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in high school, by disability status

	Not Disabled	Disabled
Algebra		
Participation	+1.7%	+1.5%
Test score (SDs, adjusted)	-0.31	-0.23
Proficient (adjusted)	-9.7%	-3.7%
Geometry		
Participation	-2.8%	-1.1%
Test score (SDs, adjusted)	-0.30	-0.23
Proficient (adjusted)	-4.8%	+1.3%
English II		
Participation	-5.6%	-3.5%
Test score (SDs, adjusted)	-0.07	-0.13
Proficient (adjusted)	-6.1%	-6.3%

Note: We calculated participation rates using student enrollment in grades 9 (for Algebra) and 10 (for Geometry and English II), excluding students repeating these grades. Some students may take these assessments in earlier or later grades, and we exclude these students from each year's testing sample. However, the participation rates above include students with disabilities who are not required to take the state assessments. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores (except in math) and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject.

Table A9. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in grades 5-8, by English learner status

	ELA		Math	
	Not English Learner	English Learner	Not English Learner	English Learner
Grade 5				
Participation	-6.1%	-7.9%	-6.0%	-7.5%
Test score (SDs, adjusted)	-0.15	-0.29	-0.34	-0.34
Proficient (adjusted)	-6.8%	-13.8%	-15.2%	-19.0%
Grade 6				
Participation	-6.2%	-9.6%	-6.2%	-9.0%
Test score (SDs, adjusted)	-0.17	-0.37	-0.36	-0.33
Proficient (adjusted)	-8.2%	-11.3%	-16.0%	-16.6%
Grade 7				
Participation	-5.9%	-9.4%	-6.8%	-9.1%
Test score (SDs, adjusted)	-0.15	-0.15	-0.32	-0.17
Proficient (adjusted)	-8.4%	-9.2%	-15.1%	-11.9%
Grade 8				
Participation	-4.4%	-10.6%	-5.6%	-10.2%
Test score (SDs, adjusted)	-0.08	-0.16	-0.30	-0.16
Proficient (adjusted)	-3.3%	-4.9%	-14.9%	-12.2%

Note: We calculated participation rates using student enrollment in each grade (excluding those repeating a grade), including students with disabilities who are not required to take the standard Ohio State Tests. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject.

Table A10. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in high school, by English learner status

	Not English Learner	English Learner
Algebra		
Participation	+1.6%	+4.3%
Test score (SDs, adjusted)	-0.30	-0.32
Proficient (adjusted)	-9.0%	-5.9%
Geometry		
Participation	-2.5%	-2.3%
Test score (SDs, adjusted)	-0.29	-0.35
Proficient (adjusted)	-4.1%	+0.3%
English II		
Participation	-5.1%	-8.5%
Test score (SDs, adjusted)	-0.08	-0.07
Proficient (adjusted)	-6.0%	-6.7%

Note: We calculated participation rates using student enrollment in grades 9 (for Algebra) and 10 (for Geometry and English II), excluding students repeating these grades. Some students may take these assessments in earlier or later grades, and we exclude these students from each year's testing sample. However, the participation rates above include students with disabilities who are not required to take the state assessments. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores (except in math) and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject.

Table A11. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in grades 5-8, by homeless status

	ELA		Math	
	Not Homeless	Homeless	Not Homeless	Homeless
Grade 5				
Participation	-6.1%	-11.5%	-6.0%	-12.8%
Test score (SDs, adjusted)	-0.15	-0.20	-0.34	-0.27
Proficient (adjusted)	-7.0%	-10.3%	-15.3%	-14.1%
Grade 6				
Participation	-6.2%	-12.7%	-6.1%	-13.7%
Test score (SDs, adjusted)	-0.18	-0.28	-0.36	-0.26
Proficient (adjusted)	-8.3%	-8.2%	-16.1%	-13.3%
Grade 7				
Participation	-5.9%	-13.4%	-6.8%	-13.4%
Test score (SDs, adjusted)	-0.15	-0.11	-0.31	-0.15
Proficient (adjusted)	-8.4%	-9.8%	-15.1%	-11.6%
Grade 8				
Participation	-4.4%	-14.1%	-5.5%	-14.4%
Test score (SDs, adjusted)	-0.08	-0.15	-0.29	-0.15
Proficient (adjusted)	-3.3%	-5.1%	-14.9%	-12.2%

Note: We calculated participation rates using student enrollment in each grade (excluding those repeating a grade), including students with disabilities who are not required to take the standard Ohio State Tests. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject.

Table A12. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in high school, by homeless status

	Not Homeless	Homeless
Algebra		
Participation	+1.8%	-7.6%
Test score (SDs, adjusted)	-0.30	-0.24
Proficient (adjusted)	-9.0%	+0.4%
Geometry		
Participation	-2.5%	-12.5%
Test score (SDs, adjusted)	-0.29	-0.27
Proficient (adjusted)	-4.1%	+6.2%
English II		
Participation	-5.1%	-16.4%
Test score (SDs, adjusted)	-0.08	-0.09
Proficient (adjusted)	-6.0%	-9.8%

Note: We calculated participation rates using student enrollment in grades 9 (for Algebra) and 10 (for Geometry and English II), excluding students repeating these grades. Some students may take these assessments in earlier or later grades, and we exclude these students from each year's testing sample. However, the participation rates above include students with disabilities who are not required to take the state assessments. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores (except in math) and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject.

Table A13. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in grades 5-8, by mode of instruction

	ELA			Math		
	In-person	Hybrid/Mixed	Fully Remote	In-person	Hybrid/Mixed	Fully Remote
Grade 5						
Participation	-3.9%	-6.1%	-12.0%	-3.8%	-5.7%	-12.4%
Test score (SDs, adjusted)	-0.11	-0.15	-0.26	-0.29	-0.38	-0.37
Proficient (adjusted)	-5.4%	-6.8%	-12.0%	-12.3%	-17.3%	-18.9%
Grade 6						
Participation	-3.6%	-6.4%	-13.0%	-3.7%	-6.2%	-13.0%
Test score (SDs, adjusted)	-0.12	-0.19	-0.31	-0.32	-0.40	-0.37
Proficient (adjusted)	-6.6%	-9.2%	-10.9%	-14.3%	-17.6%	-17.2%
Grade 7						
Participation	-3.4%	-5.6%	-14.2%	-5.3%	-5.7%	-14.1%
Test score (SDs, adjusted)	-0.13	-0.17	-0.17	-0.30	-0.36	-0.25
Proficient (adjusted)	-7.6%	-8.6%	-10.5%	-13.4%	-16.6%	-16.2%
Grade 8						
Participation	-2.0%	-3.7%	-13.3%	-2.6%	-5.8%	-12.3%
Test score (SDs, adjusted)	-0.05	-0.08	-0.17	-0.28	-0.35	-0.21
Proficient (adjusted)	-2.0%	-3.4%	-7.0%	-12.7%	-17.1%	-15.5%

Note: We calculated participation rates using student enrollment in each grade (excluding those repeating a grade), including students with disabilities who are not required to take the standard Ohio State Tests. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject. Mode of instruction is determined based on weekly data submitted to the Ohio Department of Education for weeks between the fall and spring test administration windows. Due to changes in how mode of instruction was recorded over the course of the year, the "hybrid" category combines districts that offered fully hybrid instruction across all grades and districts that offered at least some in-person instruction for lower grades and remote instruction for older students.

Table A14. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in high school, by mode of instruction

	In-person	Hybrid/Mixed	Fully Remote
Algebra			
Participation	3.3%	-0.8%	+3.2%
Test score (SDs, adjusted)	-0.28	-0.34	-0.27
Proficient (adjusted)	-9.4%	-10.2%	-4.2%
Geometry			
Participation	-0.7%	-3.2%	-5.9%
Test score (SDs, adjusted)	-0.25	-0.33	-0.32
Proficient (adjusted)	-4.3%	-6.9%	+5.0%
English II			
Participation	-4.6%	-3.7%	-10.6%
Test score (SDs, adjusted)	-0.07	-0.08	-0.14
Proficient (adjusted)	-5.3%	-6.1%	-8.0%

Note: We calculated participation rates using student enrollment in grades 9 (for Algebra) and 10 (for Geometry and English II), excluding students repeating these grades. Some students may take these assessments in earlier or later grades, and we exclude these students from each year's testing sample. However, the participation rates above include students with disabilities who are not required to take the state assessments. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores (except in math) and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject. Mode of instruction is determined based on weekly data submitted to the Ohio Department of Education for weeks between the fall and spring test administration windows. Due to changes in how mode of instruction was recorded over the course of the year, the "hybrid" category combines districts that offered fully hybrid instruction across all grades and districts that offered at least some in-person instruction for lower grades and remote instruction for older students.

Table A15. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in grades 5-8, by baseline district achievement

	ELA				Math			
	1st (Bottom) Quartile	2nd Quartile	3rd Quartile	4th (Top) Quartile	1st (Bottom) Quartile	2nd Quartile	3rd Quartile	4th (Top) Quartile
Grade 5								
Participation	-8.6%	-4.5%	-4.1%	-5.9%	-8.9%	-4.6%	-4.1%	-5.4%
Test score (SDs, adjusted)	-0.22	-0.15	-0.12	-0.09	-0.33	-0.36	-0.32	-0.35
Proficient (adjusted)	-10.0%	-7.0%	-5.9%	-4.2%	-17.2%	-18.4%	-14.2%	-11.1%
Grade 6								
Participation	-9.1%	-5.1%	-4.0%	-5.6%	-8.8%	-4.9%	-5.1%	-5.1%
Test score (SDs, adjusted)	-0.26	-0.17	-0.14	-0.12	-0.33	-0.34	-0.38	-0.39
Proficient (adjusted)	-9.5%	-8.2%	-7.4%	-7.5%	-16.2%	-16.9%	-16.8%	-14.2%
Grade 7								
Participation	-9.0%	-4.6%	-4.7%	-4.2%	-8.7%	-5.6%	-7.3%	-5.2%
Test score (SDs, adjusted)	-0.16	-0.17	-0.15	-0.14	-0.24	-0.30	-0.35	-0.38
Proficient (adjusted)	-9.7%	-9.8%	-8.4%	-6.5%	-15.5%	-16.3%	-15.9%	-13.0%
Grade 8								
Participation	-6.8%	-2.4%	-3.8%	-3.8%	-3.2%	-1.1%	-2.2%	-3.6%
Test score (SDs, adjusted)	-0.12	-0.06	-0.07	-0.06	-0.24	-0.30	-0.37	-0.43
Proficient (adjusted)	-0.05	-0.02	-0.03	-0.03	-0.14	-0.14	-0.13	-0.12

Note: We calculated participation rates using student enrollment in each grade (excluding those repeating a grade), including students with disabilities who are not required to take the standard Ohio State Tests. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject.

Table A16. Differences in participation rates and test scores in 2020-21 compared to pre-pandemic years in high school, by baseline district achievement

	1st (Bottom) Quartile	2nd Quartile	3rd Quartile	4th (Top) Quartile
Algebra				
Participation	+2.4%	+1.9%	+2.6%	-0.3%
Test score (SDs, adjusted)	-0.23	-0.28	-0.31	-0.39
Proficient (adjusted)	-5.0%	-9.7%	-12.4%	-9.0%
Geometry				
Participation	-4.4%	+1.3%	-3.8%	-2.3%
Test score (SDs, adjusted)	-0.24	-0.25	-0.30	-0.37
Proficient (adjusted)	3.9%	-3.9%	-7.1%	-9.0%
English II				
Participation	-7.8%	-4.9%	-3.3%	-4.3%
Test score (SDs, adjusted)	-0.13	-0.09	-0.06	-0.04
Proficient (adjusted)	-8.3%	-6.2%	-5.0%	-4.2%

Note: We calculated participation rates using student enrollment in grades 9 (for Algebra) and 10 (for Geometry and English II), excluding students repeating these grades. Some students may take these assessments in earlier or later grades, and we exclude these students from each year's testing sample. However, the participation rates above include students with disabilities who are not required to take the state assessments. Pre-pandemic years include 2017-18 and 2018-19. "Adjusted" test scores and proficiency rates are estimated using statistical models that impute missing scores (except in math) and control for students' demographic characteristics and pre-pandemic test scores, as per the methodology we present in the appendix. The scaled scores were converted to Z-scores, so that effect sizes are comparable to those in other studies. The differences in normalized scaled scores can be interpreted as the change in student achievement in standard deviations. See Table A1 for the typical growth benchmark for each grade and subject.