

Education Research Brief

Stephen Lipscomb, Duncan Chaplin, Alma Vigil, and Hena Matthias
Contributions from Candy Miller, Rhonda Johnson, and Rosemary Riccardo

How the COVID-19 Pandemic Affected Academic Proficiency Rates in Pennsylvania in 2021: Findings from a Predictive Model

Key findings for Pennsylvania students in grades 5 through 8

- / Students in vulnerable groups and in fully remote learning had lower assessment participation rates than other students in 2021.
- / The pandemic led to a substantial reduction in academic proficiency statewide in 2021, reducing academic achievement even more than the results for tested students indicated.
- / The pandemic had consistently large negative academic effects across student groups, including for vulnerable groups that had low rates of proficiency before the pandemic.
- / LEAs that were fully remote after winter break saw lower proficiency rates in 2021, compared with LEAs that offered fully in-person learning to similar students.

The disruptions to schooling created by the COVID-19 pandemic prompted nationwide concern about negative impacts on academic proficiency, particularly for vulnerable student populations. Pennsylvania's 2021 statewide assessments offered the first opportunity since the pandemic began to assess how students across the Commonwealth were faring, whether achievement gaps had widened, and how remote learning affected student performance. As in other states, the raw assessment data did not tell the full story of the pandemic's impacts on academic proficiency. Fewer Pennsylvania students participated in the 2021 assessments than in prior years, and test takers were not a representative sample of all students. In addition, test administration dates varied widely across the state in 2021, with some local education agencies (LEAs) postponing the usual spring assessments to the fall. Using a predictive model that accounts for the unique assessment issues in 2021 and the



instructional modes that Pennsylvania LEAs offered, this research brief provides a fuller picture of the pandemic's impacts on academic proficiency in grades 5 through 8. The brief is part of a partnership between the Pennsylvania Department of Education (PDE) and Mathematica to understand how the pandemic has shaped education outcomes in Pennsylvania.¹

Data for this brief come primarily from administrative records maintained by PDE. The brief also uses survey data from a large, representative set of LEAs on the instructional modes they offered during the 2020–2021 school year. Exhibit 1 explains the methods.²

.....

Exhibit 1. Methods

Prediction approach. We estimated the impacts of the pandemic on proficiency rates in grades 5 through 8 in 2021 by comparing rates *predicted with COVID-19* to those *predicted without COVID-19*.

- **Predicted proficiency with COVID-19** refers to what proficiency would have been if a more representative set of students took the 2021 assessments and all testing happened in the spring. We regressed student proficiency in English language arts (ELA) and math for each grade from 5 through 8 in 2021 on measures of 2019 assessment outcomes, other student and school characteristics, fall 2021 assessment timing, local COVID-19 case rates, and the instructional modes LEAs used during the 2020–2021 school year.^a We then used the resulting coefficient estimates to predict spring proficiency for almost all students in spring 2021, regardless of whether or when they took the assessments.
- **Predicted proficiency without COVID-19** refers to what proficiency would have been had COVID-19 not happened. We regressed student proficiency in 2019 on the same set of variables used to predict proficiency with COVID-19, but from 2017 and excluding pandemic-era variables on assessment timing, instructional modes, and COVID-19 case rates. We then used those coefficient estimates to predict proficiency in the absence of the pandemic for the same students in the 2021 cohort for which we predicted proficiency with COVID-19.

Sample and representation. Our target population included all Pennsylvania students in grades 5 through 8 in 2021 who had attended public schools in the state in 2019 and made the normal two grades of progress since then. We focused on grades 5 through 8 because students in these grades also took the statewide assessments in 2019 (in grades 3 through 6), before the pandemic began. The target population included 510,000 students in 2021, 8 percent less than the total enrollment in grades 5 through 8. The primary reason the target population was smaller than the total enrollment was because we excluded students who were not enrolled in the state in 2019. However, average characteristics of students in the target population were nearly the same as in the full grade 5 through 8 population (Exhibit A.1).

The regressions we estimated to help predict proficiency with COVID-19 involved test takers from the target population in each grade who had data for all the control variables. The main reason for missing data on control variables was because we only had information on instructional mode for a set of LEAs that served about half of all Pennsylvania students and were randomly selected for a survey. We predicted spring proficiency for students in the LEAs with instructional mode data, regardless of whether and when students took the assessments, and used weights designed to ensure that the results generalized to the target population. The weights worked well in representing the target population. Specifically, we obtained nearly identical prediction results from the weighted sample and the full target population in sensitivity analyses that omitted the instructional mode controls (Exhibit A.2).

- The Appendix provides more detail on the data and methods used in this study. ▲

.....

^a Most data were from PDE. COVID-19 case data were from the Pennsylvania Department of Health. Instructional mode data were from responses by more than 150 LEAs to a survey administered by PDE and Mathematica.

Context for student achievement and instruction during the pandemic

Research and data from other studies are beginning to shed light on education during the pandemic in Pennsylvania and other states. Notable results from previous research include the following:

- / **Previous studies found negative impacts of the pandemic on academic achievement, particularly during remote learning.** A study of 11 states, not including Pennsylvania, found that proficiency rates declined an average of 7 percentage points in ELA and 13 percentage points in math from 2019 to 2021 (Jack et al. 2022). Most students made some learning gains in both subjects, but their gains were less than those made in prior years by students in the same grades (Kozakowski et al. 2021; Kuhfeld et al. 2020; Cohodes et al. 2022).

Remote learning was associated with larger negative impacts on student achievement (Goldhaber et al. 2022; Jack et al. 2022; Cohodes et al. 2022). One study of 10,000 schools across nearly all states concluded that high poverty LEAs that used fully remote learning for most of the 2020–2021 school year will need to spend nearly all their federal aid on academic recovery to eliminate their students' losses (Goldhaber et al. 2022). Reduced academic engagement may help explain the findings about remote learning. In Pittsburgh Public Schools, course failures increased during fully remote learning and many students who were failing courses were not attending classes (Kozakowski et al. 2021).

- / **Pennsylvania LEAs offered different instructional modes to students during the 2020–2021 school year, with in-person learning expanding as the school year progressed.** About half of Pennsylvania elementary and middle school students were in LEAs that began the year with fully remote learning as the predominant instructional mode (Lipscomb, Crigler, and Chaplin 2021). The other half of students were split about evenly between LEAs that used hybrid learning (a mix of in-person and remote learning) or fully in-person learning. After winter break, LEAs serving about 10 percent of students had switched from fully remote learning

to hybrid learning. By the end of the school year, nearly all students in these grade bands who did not attend virtual charter schools were in LEAs that offered at least some in-person learning.

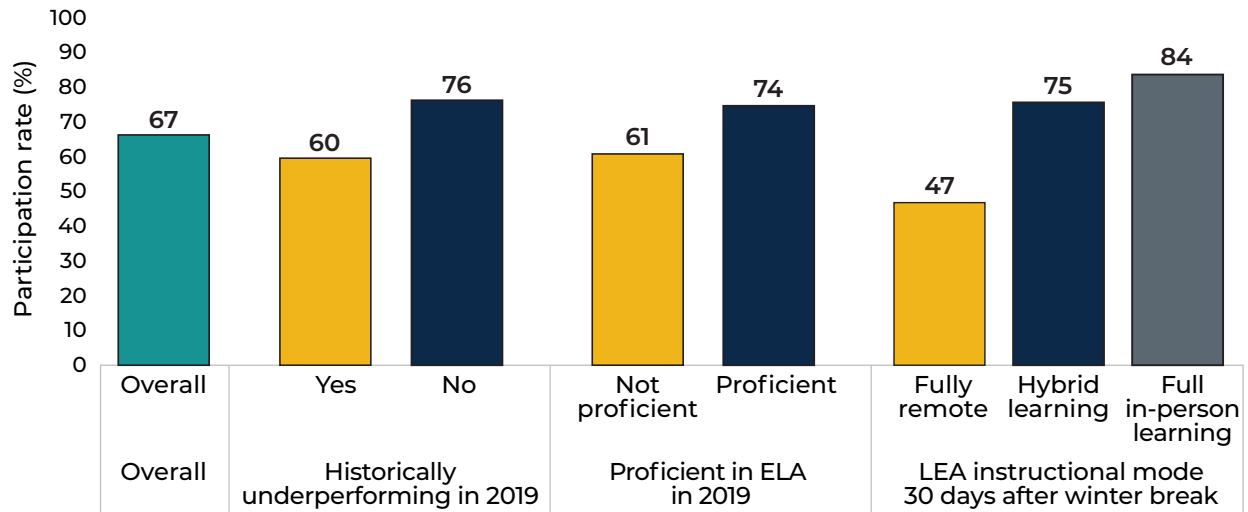
- / **Pennsylvania's raw proficiency rates in grades 5 through 8 were lower in 2021 than in 2019, according to the statewide assessment data.** The observed decline from 2019 to 2021 was 5 percentage points in ELA (from 60 percent to 55 percent) and 10 percentage points in math (from 38 percent to 28 percent), according to Pennsylvania System of School Assessment (PSSA) data.

Findings about assessment participation rates in Pennsylvania during 2021

In this section, we describe who took the 2021 statewide assessments and when. These results are based on raw data and not a predictive analysis.

- / **Assessment participation rates in 2021 were lower than usual, particularly among students in vulnerable populations and who had fully remote learning.** Federal accountability rules require that 95 percent of students take the statewide assessments. However, the requirements for testing participation were waived in 2021 and many states had testing rates well below 95 percent in 2021 (Gewertz 2021). For our target population, the participation rate in 2021 fell to 67 percent and it varied across groups of students (Exhibit 2; findings shown for ELA were nearly identical for math). For example, students who in 2019 were in PDE's historically underperforming group—comprising economically disadvantaged students, students with disabilities, and English learners—had lower participation rates in 2021 than students not in that group (60 percent versus 76 percent). By a similar margin, students who were not proficient in 2019 had lower 2021 participation rates than those who were proficient. The participation rate for students in LEAs that predominantly used fully remote learning in the month after winter break was nearly half as large as in LEAs where instruction was fully in-person (47 percent versus 84 percent).

Exhibit 2. Participation rates on the 2021 English language arts PSSAs for grades 5 through 8, overall and by student characteristics in 2019 and instructional mode in early 2021



Source: Study team analyses of data from PDE and a study-administered survey of LEAs.

Note: The sample for the first 5 bars was the target population, which included Pennsylvania students in grades 5 through 8 in 2021 who had attended public schools in the state in 2019 and made the normal two grades of progress in the next two school years. The sample for the last set of bars was further limited to students in LEAs that provided survey data on their predominant instructional mode; those data were weighted to represent the target population, including those not covered by the survey. Findings were similar for math.

Historically underperforming students = Students who are economically disadvantaged, English learners, and students with disabilities. This category is defined by PDE.

Spring remained the predominant test taking period in 2021, and assessment participation rates were higher on average in schools that tested in the spring than in the fall. More than three quarters of the students in our target population were in schools that offered the PSSA in spring 2021 (Exhibit 3). The remaining students

attended either schools that delayed testing until the fall or schools where the assessment timing was uncertain because data were missing or because schools appeared to have offered the assessments in both periods. Participation rates were higher, on average, in the spring than in the fall (70 percent versus 52 percent).

Exhibit 3. Students covered by the study and their PSSA participation rates in grades 5 through 8, by when schools offered the PSSA in 2021

	Overall	Spring 2021	Fall 2021	Uncertain
Total students in target population (1000s) [% of overall]	510	397 [78%]	67 [13%]	47 [9%]
PSSA participation rate (%)	67	70	52	64

Source: Study team analyses of data from PDE.

Note: The sample included Pennsylvania students in grades 5 through 8 in 2021 who had attended public schools in the state in 2019 and made the normal two grades of progress in the next two school years. We labeled the assessment timing uncertain when we could not clearly distinguish it in PDE’s data, either because data were missing or because schools appeared to have offered the PSSA in both spring and fall.

Findings from the predictive analysis of proficiency rates in 2021

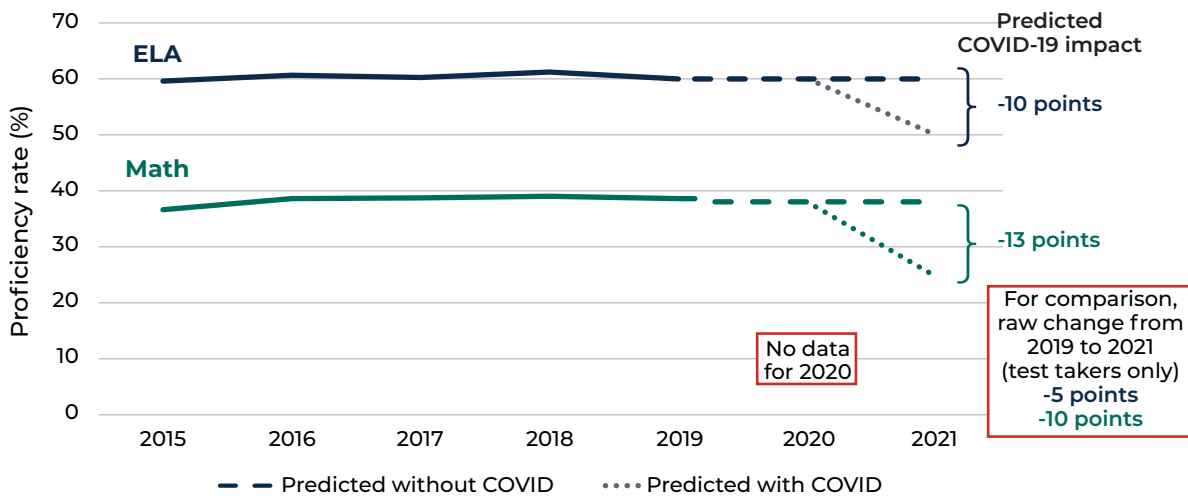
In this section, we present the key results about the predicted impacts of the pandemic on proficiency rates for students overall and for several groups of students.

The pandemic led to a substantial reduction in academic proficiency statewide in 2021, reducing academic achievement even more than the results for tested students indicated. Between 2015 and 2019, statewide proficiency rates for students in grades 5 to 8 were relatively flat in both ELA and math, at about 60 percent and 40 percent, respectively. In contrast, the predicted proficiency rates for 2021 from our analysis showed large declines relative to the previous trends (Exhibit 4). The predicted impacts of the

pandemic on proficiency rates were -10 percentage points in ELA and -13 percentage points in math for all students in grades 5 through 8. These impacts were the difference between students' predicted spring proficiency scores *with COVID-19* and *without COVID-19*. The predicted impacts were particularly large in math relative to their mean values, since pre-pandemic proficiency levels in Pennsylvania were lower in math than ELA.

The predicted pandemic impacts for the target population were more negative than the raw (observed) change in proficiency from 2019 to 2021 for test-takers. This was because we predicted proficiency for nearly all students, and non-test takers tended to be lower performing. We also accounted for differences in the amount of in-person learning the LEAs serving these students offered.

Exhibit 4. Actual and predicted proficiency rates in grades 5 through 8 in Pennsylvania, 2015–2021



Source: Data from 2015 to 2019 are from PDE. The 2021 data are predicted values from this study's analyses, averaged across grades 5–8 for each subject.

The findings about predicted proficiency rates and pandemic impacts were similar when we examined each grade separately (Exhibit 5). The predicted

pandemic impacts were consistently larger in math, ranging from -12 to -15 percentage points, than in ELA, ranging from -7 to -12 percentage points.

Exhibit 5. Raw and predicted proficiency rates in 2021 and 2019, by subject and grade

Subject and grade	Raw proficiency data (%)			Predicted proficiency for spring 2021 (%)		
	2021	2019	Difference	With COVID-19	Without COVID-19	Impact
ELA (5-8)	55	60	-5	49	59	-10
5	55	59	-4	49	56	-7
6	57	63	-6	51	63	-12
7	53	60	-7	49	59	-11
8	53	58	-5	49	58	-9
Math (5-8)	28	38	-10	25	38	-13
5	36	43	-7	31	42	-12
6	28	39	-11	24	39	-15
7	27	38	-11	24	38	-14
8	22	32	-10	20	33	-13

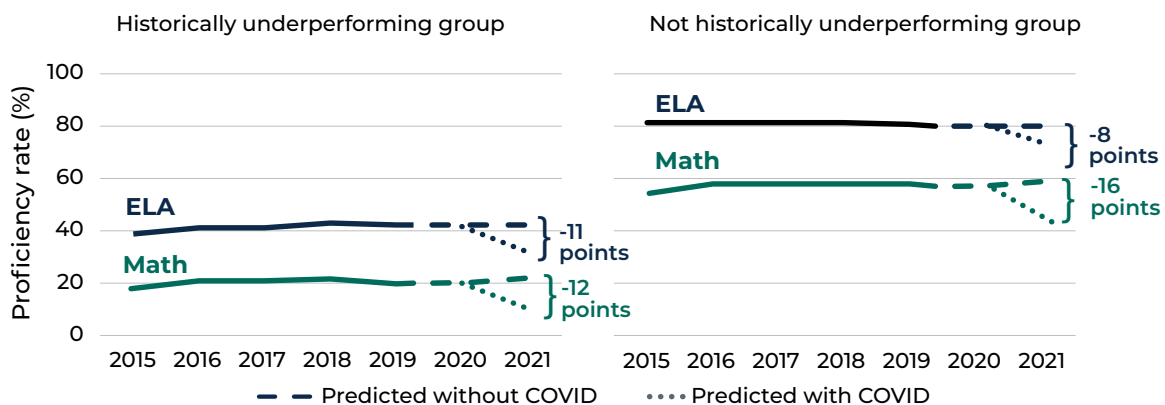
Source: Study analyses of data from PDE and a study administered survey of LEAs.

Note: The first row for each subject shows the average of the grade-specific results for grades 5 through 8.

The pandemic had consistently large negative academic effects across student groups, including for vulnerable groups that had low rates of proficiency before the pandemic. Exhibit 6 presents results disaggregated based on whether students were in PDE’s historically underperforming group in 2019. The findings show large declines in

predicted proficiency during 2021 for both students in the historically underperforming group and those not in the group. The declines for the historically underperforming group were particularly large relative to their mean values, considering this student group had lower proficiency rates than their counterparts prior to the pandemic.

Exhibit 6. Actual and predicted proficiency rates in grades 5 through 8 in Pennsylvania by historically underperforming status, 2015–2021



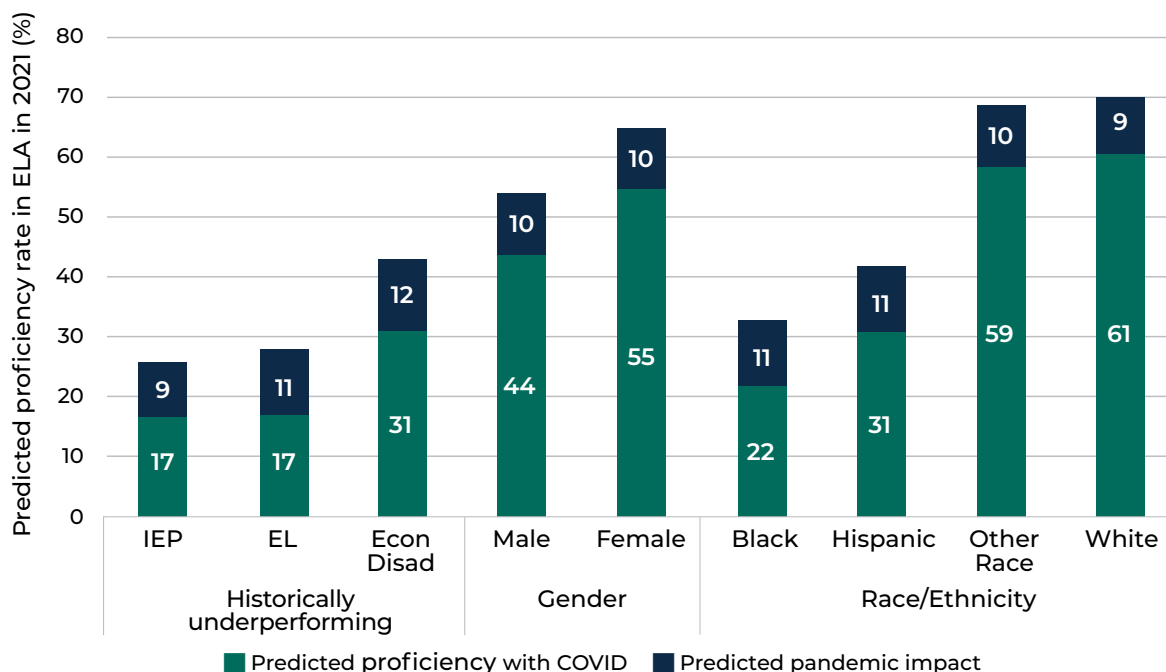
Source: Data from 2019 to 2021 are from PDE; No data for 2020. The 2021 data are predicted values averaged across grades 5-8 for given subject and subgroup.

Historically underperforming group = Students who are economically disadvantaged, English learners, and/or students with disabilities. This category is defined by PDE.

We found consistent patterns for the three groups that comprise PDE’s historically underperforming group, as well as for groups based on gender and race/ethnicity (Exhibit 7; results shown for ELA). The height of each bar in the exhibit represents a group’s predicted proficiency rate without COVID-19. The green portion represents the

predicted proficiency rate with COVID-19 and the blue portion is size of the predicted pandemic impact. We found consistent negative impacts across all groups, including vulnerable populations of students that had lower proficiency rates before the pandemic.³

Exhibit 7. Predicted proficiency rates in ELA with COVID-19 and size of predicted impact of the pandemic on proficiency rates, by student group



Source: Study analyses of data from PDE and a study administered survey of LEAs.

Note: All predicted pandemic impact values in the figure are negative. Results for ELL, Black, and Hispanic students should be interpreted with caution because the predictions are based on low assessment participation rates ranging from 46 to 51 percent. The other race group includes Asian, American Indian, Native Hawaiian/Pacific Islander, and multi-race students. None of these groups had 5 percent of the population so we did not analyze them separately.

Econ disad = Economically disadvantaged, EL = English learners, IEP = Receives special education and related services based on an individualized education program.

Findings about proficiency across instructional modes

In this section, we describe how proficiency rates differed across students with similar characteristics based on if their LEA mainly used fully remote learning, hybrid learning, or fully in-person learning.

/ LEAs that were fully remote after winter break saw lower proficiency rates in 2021, compared with LEAs that offered fully in-person learning to similar students. For the test takers in

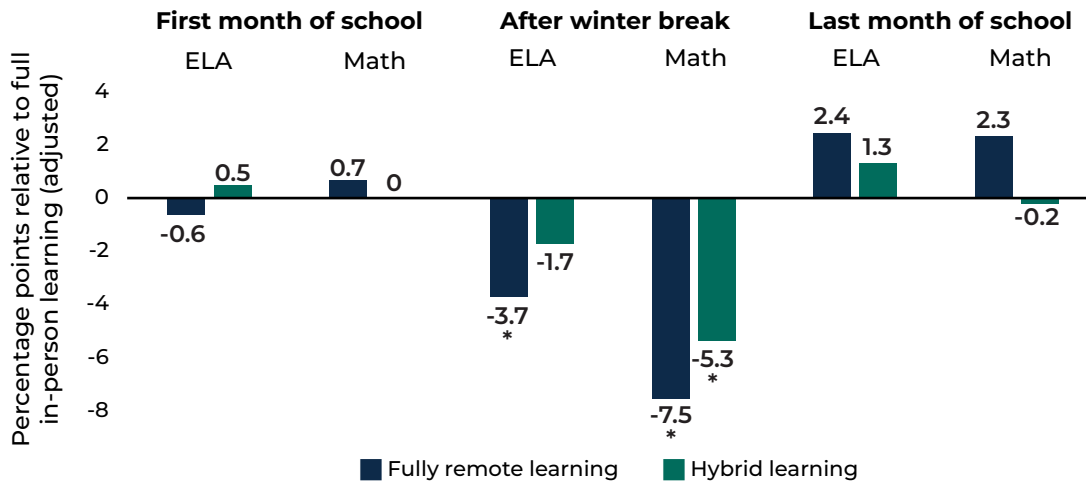
our sample, we estimated that math proficiency rates were 7.5 percentage points lower with fully remote learning and 5.3 percentage points lower with hybrid learning, relative to students who had fully in-person learning after winter break (Exhibit 8). These values hold constant the differences between students in their 2019 achievement outcomes and other student, school, and LEA characteristics (see Appendix). They are average estimates from across the grade-level regressions we used to predict proficiency with COVID-19.

For ELA, we estimated that proficiency rates were 3.7 percentage points lower in fully remote learning than in fully in-person learning after winter break. ELA proficiency rates did not differ by a statistically significant margin for students in hybrid and fully in-person learning after winter break.

There were no statistically significant differences in proficiency rates for either subject across instructional modes offered at the *start* or *end* of the 2020–2021 school year. Our findings do not indicate why instructional mode appeared to matter most after the winter break. One possibility for why instructional mode after the winter break mattered more than at the start of school is that the timing was closer to when most students took the assessments. Or perhaps student engagement lagged after months of remote learning. Another possibility is that the findings for winter also

captured duration in remote and hybrid learning, since LEAs tended toward offering more in-person learning as the school year progressed (Lipscomb, Crigler, and Chaplin 2021). There could be other possibilities as well. By the end of the school year, instructional mode may not have had a statistically significant relationship with proficiency rates because the mode change came after some schools had administered the PSSAs. In addition, hardly any LEAs other than virtual charter schools offered only fully remote learning to students in these grade bands by the end of the school year. This makes the findings for that instructional mode at the end of the school year harder to interpret because we controlled separately for whether the school students attend is a virtual charter school. Omitting the end-of-year variables does not change any of our results appreciably, including results for instructional mode at the start of the school year and after winter break.

Exhibit 8. Estimated difference in proficiency rates in 2021 for test takers in grade 5 through 8, based on LEA instructional mode relative to fully in-person learning



Source: Study team analyses of data from PDE and a study-administered survey of LEAs.

Note: This exhibit used the subject- and grade- specific regression coefficients we estimated for test takers as part of predicting proficiency with COVID-19 (see Appendix). We calculated the average coefficients and standard errors across grades 5 through 8. The regressions adjusted for students' 2019 achievement outcomes and other student, school, and LEA characteristics.

* Differs by a statistically significant margin from zero at the .05 level, two-tailed test.

In the appendix, we show related results from the regressions for local COVID-19 case rates and fall test taking (Table A.3). Higher case rates per capita in a LEA's area in March 2021, just prior to when schools administered the PSSAs, were associated with lower proficiency rates in both subjects. Fall test taking was associated with lower proficiency rates in math but not in ELA.

Looking forward

This brief helps document the extent of academic challenges during the 2020–2021 school year that many students, caregivers, and staff across Pennsylvania experienced firsthand. Statewide assessment data for spring 2022, when released, will provide the first data on the degree to which academic proficiency rates have bounced back in

Pennsylvania. National data for the spring of 2022 are already available from the National Assessment of Educational Progress (NAEP), also known as the Nation's Report Card. That assessment found that achievement between 2020 and 2022 for age 9 students nationally declined by the largest amount since 1990 in reading and for the first time ever in math (U.S. Department of Education, 2022). Moreover, in both subjects, the decreases were larger for lower-performing students. The NAEP results for 2022 indicate that substantial academic challenges related to pandemic recovery remain. Supporting students who experienced pandemic learning lags or other issues such as mental or behavioral health challenges is likely to remain an urgent need for years to come.

Appendix. Detailed data and methods description

This appendix describes the research questions, data, prediction approach, and samples used in the brief. We also discuss limitations of the approach.

Research questions

The brief answers the following two overarching research questions, and two related sub-questions, regarding students in grades 5 to 8 in Pennsylvania public schools in 2021 in our target population.

1. Who participated in the 2021 assessments and when?
2. What was the impact of the COVID-19 pandemic on proficiency rates for Pennsylvania students in 2021, including those not tested?
 - a. What would the proficiency rate have been if all these students had been tested in 2021 and all testing occurred in the spring?
 - b. What would the proficiency rate have been in the absence of COVID-19?

To address question 1, we summarized participation rates and sample sizes for various groups of students. The methods used for the remaining questions are described below.

Data

We used several types of data in the analyses for this brief.

/ **Student-level assessment results.** PDE provided assessment data (PSSA scaled scores and proficiency) in ELA and math for grades 3 through 8 from 2021, 2019, and 2017. We used the student-level proficiency indicators from 2021 and 2019 as outcomes variables in our predictive models. We used the proficiency indicators and scaled scores in each subject from two grades/years earlier as control variables.

/ **Other student and school characteristics.** PDE provided additional characteristics that we used as control variables. At the student level, these included gender, race/ethnicity, and indicators for each of the following: economically disadvantaged

status, having an individualized education program (IEP) for special education services, and being an English learner (EL). At the school level, these controls included the average score in each subject for a student's grade and whether the school's 2021 testing occurred in the fall or was uncertain, either because data were missing or because schools appeared to have offered the assessments in both periods. We also included school urbanicity (urban, suburban, rural) and school type (charter, virtual charter, or traditional) categories from the U.S. Department of Education's Common Core of Data. All controls, except the fall 2021 test indicator, were from two years before the year of the outcome variable.

/ **COVID-19 cases.** The Pennsylvania Department of Health provided data on COVID-19 cases by month and zip code. We aggregated these data to each LEA using a crosswalk maintained by the U.S. Department of Education. We created two variables using these data—the number of cases per 100 people in the LEA in March 2021 (about one month before the spring assessments) and the total number of cases per 100 people in the LEA through February 2021 (a cumulative measure).

/ **Instructional modes.** PDE and Mathematica received responses from more than 150 LEAs to an online survey during summer and fall 2021. The survey included questions on the predominant modes of instruction during the 2020–2021 school year. LEAs chose between fully remote learning, hybrid learning, and fully in-person learning. They responded separately for elementary and middle school grades and for the first 30 days of the school year, the 30 days after winter break, and the last 30 days of the school year. The selected sample included the 50 largest LEAs and a random sample of 150 other LEAs (including brick-and-mortar and virtual charter schools) selected in proportion to size, meaning that larger LEAs had a higher probability of being selected. The response rate to the LEA survey was 80 percent weighted to the student population; responding LEAs served about half of Pennsylvania's public school students.

Prediction approach and samples

We estimated the impacts of the pandemic on proficiency rates by comparing rates *predicted with COVID-19* and *predicted without COVID-19*.

Predicted proficiency with COVID-19 refers to what proficiency would have been if a more representative set of students took the 2021 assessments and all testing happened in the spring. Using regressions, we estimated relationships between observed student proficiency in 2021 and the control variables for the test takers in each grade. We used the results to predict spring proficiency for our prediction sample which consists of all students from the target population that had the control variables used in our analysis, even if they actually took the assessment in the fall or did not take it at all.

Approach. We estimated Equation 1 separately for each subject and grade from 5 through 8.

$$(1) Y_{i,t} = \beta_0 + \beta_1 X_{i,t-2} + \beta_2 F_{i,t} + \beta_3 (X_{i,t-2} * F_{i,t}) + \beta_4 U_{i,t} + \beta_5 C_{i,t} + \epsilon_{i,t}$$

In this equation, $Y_{i,t}$ is a $\{0,1\}$ indicator for whether student i scored in the proficient or advanced range on the assessment at time t , which is 2021. $X_{i,t-2}$ includes a variety of student and school characteristics from 2019, before the pandemic began:

/ **Student characteristics** included gender, race/ethnicity categories, economically disadvantaged status, special education status, English learner status, and ELA and math scaled scores and proficiency.

/ **School characteristics** included school-grade averages of student scores in ELA and math; school urbanicity categories; and school type categories.

$F_{i,t}$ is a $\{0,1\}$ indicator for the school administering the 2021 assessments in the fall. Equation 1 also includes interactions between fall assessment timing and the characteristics in $X_{i,t-2}$. Finally, we include an indicator, $U_{i,t}$, for students whose school's assessment timing was uncertain.

$C_{i,t}$ includes indicators for whether the LEA's predominant instructional mode was fully remote learning or hybrid learning at three points—the first month of school in fall 2020, the month after winter break, and the last month of school in spring 2021 (resulting in six indicators, measured relative to fully in-person learning). We included the spring variables as controls even though the last month of school likely occurred after some LEAs administered the PSSAs. In addition, hardly any LEAs in Pennsylvania offered only remote learning to elementary and middle school students by spring 2021, beyond the state's virtual charter school LEAs for which we have a separate control in the model. All results in this brief are nearly identical if the spring instructional mode variables are excluded. Finally, $C_{i,t}$ includes the COVID-19 variables.

β are the estimated relationships between the covariates and the probability that students earn a score in the proficient or advanced range, and $\epsilon_{i,t}$ is a random error term.

After estimating Equation 1 for each subject and grade, we used the coefficient estimates to predict the probability that each student in the prediction sample scored in the proficient or advanced range on the assessment in spring (that is, setting the indicators for fall and uncertain assessment timing to zero regardless of whether and when they took the assessments). Weights were used to represent the target population.

Sample and representation. Our target population included all Pennsylvania students in grades 5 through 8 in 2021 who had attended public schools in the state in 2019 and made the normal two grades of progress over the next two school years. We focused on grades 5 through 8 because students in these grades had taken the statewide assessments in 2019, before the pandemic began, in grades 3 through 6. Sample restrictions excluded 8 percent of the total enrollment in grades 5 through 8 and resulted in a target population with about 510,000 students across the four grades. The average

characteristics of students in the target population were nearly the same as in entire grade 5 through 8 population (Exhibit A.1). The grade-level regressions we estimated to help predict proficiency with COVID-19 involved test takers from the target population who had data for all the control variables. The primary reason for missing data on control variables was the lack of information on instructional mode for a set of LEAs that served half of all Pennsylvania students and were randomly selected

for our survey sample. We predicted spring proficiency for students in our prediction sample (limited to these LEAs) regardless of whether and when students took the assessments. We used weights designed to adjust for the sampling methods and nonresponse to ensure that the results generalize to the full target population, including those not covered by the survey and those missing their 2019 test scores or other predictor variables.

Exhibit A.1. Average characteristics of the target population and all students in grades 5 through 8 in Pennsylvania public schools in 2021

Student characteristic	Target population (%)	All students (%)
Economically disadvantaged	48	47
English learner	5	4
Has individualized education program	20	21
Male	51	52
White	64	62
Black	15	15
Hispanic	13	13
Other race or ethnicity	9	9
Number of students (1,000s)	510	554

Source: Study team analyses of data from PDE for students in grades 5 through 8 in 2021. The target population included Pennsylvania students in grades 5 through 8 in 2021 who had attended public schools in the state in 2019 and made the normal two grades of progress over the next two school years.

Note: The other race group includes Asian, American Indian, Native Hawaiian/Pacific Islander, and multi-race students. None of these groups had 5 percent of the population so we did not analyze them separately.

Applying the approach. This section presents results to illustrate our method. We focus on issues connected to the weighted survey sample and the variables included in , , and —the controls for instructional modes, COVID-19 cases per capita in the LEA, and assessment timing.

Exhibit A.2 examines the sensitivity of our results to switching from the raw data (covering students tested in 2021), to the full target population (students who were there in 2019 and 2021 and made the normal grade progression, even if they were not tested), and then to the weighted survey sample without and with controls for instructional modes. The second column shows predicted spring proficiency rates for the target population of students for the 2020–2021 school year without restricting to those in LEAs covered by the survey. These results do not account for instructional mode

differences. The predicted proficiency rates were lower than the raw rates because we predicted proficiency for all students and non–test takers tended to be lower performing. We also excluded students retained in grade between 2019 and 2021 from the target population. This might have increased predicted proficiency rates slightly, but the number of these students was small.

The third column shows results based on the same model for just the survey sample and applies the weights. The results are nearly identical, which suggests the weights worked well.

The final column adds the controls for instructional mode from the survey. Proficiency rates fell further, which illustrates the importance of controlling for instructional modes.

Exhibit A.2. Raw and predicted proficiency with COVID under various specifications

Subject and grade in 2021	Raw data (%)	Predicted proficiency with COVID-19		
		Full target population (%)	Survey sample (weighted)	
			Same controls as full target population (%)	Adds controls for instructional mode (%)
ELA (grades 5–8)	55	51	51	49
5	55	51	52	49
6	57	54	54	51
7	53	50	50	49
8	53	50	50	49
Math (grades 5–8)	28	26	26	25
5	36	33	33	31
6	28	26	26	24
7	27	24	24	24
8	22	20	20	20

Source: Study team analyses of data from PDE and a study-administered survey of LEAs.

Note: The first row for each subject shows the average of the grade-specific results for grades 5 through 8.

Data in the first column in Exhibit A.2 are the raw proficiency rates from 2021, reported by PDE. These data are just for test takers and do not adjust for differences in assessment timing.

Exhibit A.3 shows the average coefficients combined across grades for the variables in our regression models that controlled for differences in local COVID-19 case rates and assessment timing. The results about COVID-19 cases came from the same

regressions where we extracted the results shown in Exhibit 8 about instructional modes. For assessment timing, the results in Exhibit A.3 came from similar regressions that omitted the interactions to make interpreting the coefficients on easier.

Exhibit A.3. Estimated difference in proficiency rates in 2021 for test takers in grade 5 through 8 based on local COVID-19 case rates and assessment timing

Student characteristic	ELA (% proficient)	Math (% proficient)
COVID-19 cases per 100 people in the area of the LEA		
March 2021	-4.2*	-2.7*
Cumulative through February 2021	0.3	-0.2
Assessment timing (relative to spring 2021)		
Fall 2021	-0.5	-4.5*
Uncertain	-0.3	0.2

Source: Study team analyses of data from PDE and the Pennsylvania Department of Health.

Note: The findings for COVID-19 case rates come from estimating Equation 1 by grade and calculating the average of the coefficient estimates and standard errors across grades. The findings for assessment timing are similar except they come from a variation of Equation 1 that omits the fall test timing interaction terms.

* Differs by a statistically significant margin from zero at the .05 level, two-tailed test.

The findings for COVID-19 cases indicated that local case rates in March 2021, just before most schools administered the PSSAs, were negatively and significantly associated with proficiency rates for test takers in both subjects. To put the results into perspective, the average case rate in March 2021 in our data was 0.7 cases per 100 people. The findings suggest that, controlling for the other model characteristics, an increase of 1 case per 100 people—a more than doubling of the case rate at the time—would lower proficiency rates among test takers by 4.2 percentage points in ELA and 2.7 percentage points in math. Historical case rates, in contrast, mattered little.

The findings for assessment timing showed a statistically significant average estimate of -4.5 in math. This means proficiency rates, on average, were 4.5 percentage points lower for fall test takers than for similar test takers in the spring.

Based on these results, our predictive model raised predicted math proficiency scores for students in schools that tested in fall 2021 to adjust for the difference in test timing. This adjustment is consistent with summer learning loss. However, we acknowledge that another possibility is that LEAs that were particularly hard hit by COVID-19, and thus disorganized in the spring, may have chosen to postpone testing to the fall, in which case the negative effect might be a pandemic effect rather than summer learning loss. For ELA, the average coefficient estimate on the fall indicator was close to zero and not statistically significant, meaning the adjustment for fall test timing mattered little in that subject. Similarly, for both subjects, the average coefficient for being in a school where the assessment timing was uncertain was approximately zero and not statistically significant, so the adjustment to predict spring scores for these students was negligible.

Predicted proficiency without COVID-19 refers to what proficiency would have been had the COVID-19 pandemic not happened. We estimated relationships between student proficiency in 2019 and the same set of control variables, but from 2017 and excluding pandemic-era variables on assessment timing, instructional modes, and COVID-19 case rates. We then applied those estimated relationships to students in 2020–2021 to predict student proficiency in the absence of the pandemic.

Specifically, we estimated Equation 1 with pre-pandemic data (outcomes in 2019; controls in 2017) and setting and for all observations. This is appropriate for 2019 since all testing occurred in the spring, COVID-19 rates were zero, and instruction was fully in-person except in virtual charter schools, for which we have a separate control. We then predicted proficiency without COVID-19 for students in the 2020–2021 school year based on their 2019 characteristics, using the estimated relationships between 2019 outcomes and 2017 characteristics for students in the 2018–2019 cohort who were in the same grades.

Estimated impacts of the pandemic. We estimated COVID-19 impacts by taking the difference between predicted proficiency with and without COVID-19 for students in grades 5 to 8 in 2020–2021.

Limitations

Our method of estimating impacts of COVID-19 has several limitations. First, the instructional mode data are at the LEA level; we could not account for differences in access to in-person learning within LEAs and schools. This could bias the results if that variation was correlated with test-taking rates, even after controlling for all the other variables in our model. Second, other unobserved student characteristics might bias the results. Third, while the analyses included nearly all students, they did exclude students who were not enrolled in Pennsylvania public schools in 2019 at two earlier grades. Thus, the results may not generalize to those students. Fourth, the timing of assessments might have been affected by the COVID-19 pandemic, in which case our adjustment for test timing may be introducing some bias instead of removing it.

References

Cohodes, Sarah, Dan Goldhaber, Paul Hill, Andrew Ho, Vladimir Kogan, Morgan Polikoff, Carrie Sampson, and Martin West. "Student Achievement Gaps and the Pandemic: A New Review of Evidence from 2021-2022." Center on Reinventing Public Education, August 2022. https://crpe.org/wp-content/uploads/final_Academic-consensus-panel-2022.pdf.

Gewertz, Catherine. "State Test Results are In. Are they Useless?" Education Week, October 21, 2021. <https://www.edweek.org/teaching-learning/state-test-results-are-in-are-they-useless/2021/10>.

Goldhaber, Dan, Thomas J. Kane, Andrew McEachin, Emily Morton, Tyler Patterson, and Douglas O. Staiger. "The Consequences of Remote and Hybrid Instruction During the Pandemic." Research Report. Cambridge, MA: Center for Education Policy Research, Harvard University, 2022. <https://cepr.harvard.edu/files/cepr/files/5-4.pdf?m=1651690491>.

Jack, Rebecca, Clare Halloran, James Okun, and Emily Oster. "Pandemic Schooling Mode and Student Test Scores: Evidence from U.S. School Districts." Working Paper, 2022. https://emilyoster.net/wp-content/uploads/MS_Updated_Revised.pdf.

Kozakowski, Whitney, Brian Gill, Patrick Lavelle, Alyson Burnett, and Jonathan Ladinsky. "Understanding Changes in Academic Achievement and Online Learning Application Use in Pittsburgh Public Schools During the COVID-19 Pandemic: Methodology Memo." Regional Educational Laboratory Mid-Atlantic, National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education, 2021. https://ies.ed.gov/ncee/edlabs/regions/midatlantic/app/Docs/TechnicalAssistance/Understanding_changes_in_academic_achievement_in_PPS_during_the_COVID-19_pandemic_memo.pdf.

Kuhfeld, Megan, Beth Tarasawa, Angela Johnson, Erik Ruzek, and Karyn Lewis. "Learning During COVID-19: Initial Findings on Students' Reading and Math Achievement and Growth." Washington, DC: NWEA, 2020. <https://www.nwea.org/research/publication/learning-during-covid-19-initial-findings-on-students-reading-and-math-achievement-and-growth/>.

Lipscomb, Stephen, Forest Crigler, and Duncan Chaplin. "School Instruction in Pennsylvania During the COVID-19 Pandemic." Cambridge, MA: Mathematica, 2021. <https://www.mathematica.org/publications/school-instruction-in-pennsylvania-during-the-covid-19-pandemic>.

U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2020 and 2022 Long-Term Trend (LTT) Reading and Mathematics Assessments. <https://www.nationsreportcard.gov/highlights/ltt/2022/> Accessed September 1, 2022.

Endnotes

¹ Future analyses will use the survey data and administrative records to describe staff turnover and student outcomes in Pennsylvania during the COVID-19 pandemic, and the factors that may have shaped educational inequities.

² PDE and Mathematica administered the survey. Findings are reported in Lipscomb, Crigler, and Chaplin (2021).

³ Readers should use caution when interpreting Exhibit 7 because the predictions for English learners, Black students, and Hispanic students were based on lower assessment participation rates than for other groups of students (rates for these groups were 46 to 51 percent compared with 59 percent for the group with the next lowest rate).

Suggested citation: Lipscomb, Stephen, Duncan Chaplin, Alma Vigil, and Hena Matthias. "How the COVID-19 Pandemic Affected Academic Proficiency Rates in Pennsylvania in 2021: Findings from a Predictive Model." Cambridge, MA: Mathematica, 2022.

Acknowledgment: We are grateful to several individuals for their contributions that made this brief possible. We thank our partners at PDE, Candy Miller, Rhonda Johnson, and Rosemary Riccardo, for their thoughtful insights and close collaboration throughout. Brian Gill provided excellent quality assurance feedback. Finally, we are grateful to Allen Ruby and the U.S. Department of Education's Institute of Education Sciences for supporting the research.

Disclaimer: The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through grant R305S210026 to the Pennsylvania Department of Education. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.