The Impact of COVID-19 on Student Academic Growth in 2020–2021

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Executive Summary

Beginning spring 2020, the education system in the United States, like almost all facets of everyday life, was inexorably altered by COVID-19. While the long-lasting impacts are unknown, data from multiple sources indicates that the trajectory of cognitive (Curriculum Associates, 2021; Lewis et al., 2021), social-emotional (Chu & Lake, 2021; Hamilton & Gross, 2021), and behavioral (Office for Civil Rights, 2021) well-being of students were altered as a result of the response to the pandemic.

Unlike those previous reports, this paper examines differences in the **rate** of growth for a cohort of students during the 2020–2021 school year (the "COVID" cohort) compared to the rate of growth for a cohort of students prior to the 2020–2021 school year ("pre-COVID" cohort). Using longitudinal interim assessment data collected three times per academic year across two full school years from more than three million students using the *i-Ready Diagnostic*, we explore differences in student performance during pre-COVID academic years and during school years impacted by COVID. For brevity, we'll only report on the results for students in Grades 2, 4, and 6 in Reading and Mathematics, as the patterns discussed are consistent across all grades for which data were available. We show that while, on average, there were indeed differences between the student groups that were similar to what others have shown, a more nuanced picture emerges when looking at scale score changes in relation to initial grade-level placements, school-level demographic characteristics, neighborhood income levels, and school locale.

The main conclusions of these analyses, based on students who reported testing "in school" during the 2020–2021 school year, are:

- Students in the COVID cohort did not make up unfinished learning from the initial disruption to learning during spring 2020.
- On average, students in the COVID cohort had slower rates of growth compared students in the pre-COVID cohort, but the growth rate varied based on time period, grade, and subject.
- Students in the COVID cohort who were lower performing in the fall before COVID hit tended to have slower growth than similarly lower-performing students in the pre-COVID cohort, while students in the COVID cohort who were higher performing before COVID saw little, if any, significant change in their growth after the initial shock.
- Pre-existing differences between students across different race/ethnicity, neighborhood poverty, and school locales were maintained or exacerbated.
- The impact of student demographics, neighborhood poverty, and school locale were inconsistent, meaning that the direction and strength of impact differed by grade and time period.

Introduction

The initial shock of COVID-19 on all facets of life beginning in early 2020 in the US cannot be overemphasized, with ramifications being continually felt more than 18 months later. While the scope of this paper is limited to examining the impact on Grades K–8 public school students, what happened and continues to happen in schools in the US is inexorably linked to the economic, political, and societal upheaval caused by the pandemic.

For most students, face-to-face instruction during the last quarter of the school year in spring 2020 was impacted in some way by COVID. While there were pockets of schools that remained open for in-person learning, many schools decided to go to an online approach to learning or shut down completely (Office for Civil Rights, 2021). Researchers began publishing papers on the potential impact of this disruption, each with varying degrees of alarm (Allen et al., 2020; Dorn et al., 2020; Kuhfeld & Tarasawa, 2020) but with a consistent sense of apprehension for the future. Many of these reports, however, were based on assessment data that could not discern where a student took the assessment (e.g., at school or at home or other location away from school) or didn't make a distinction about testing location, and some researchers did not believe that where a student tested had any significant impact on the scores seen or believed that any impact on scores was minimal (Kuhfeld et al., 2020), an assumption to which we will return using our data. Regardless of where students tested, however, researchers were also able to identify differences in access to remote-learning tools and the continuing impacts of historical gaps for traditionally marginalized students of color and poorer students in both urban and rural locales (Curriculum Associates, 2020, 2021; Walton Family Foundation, 2020).

By the start of the 2020–2021 school year in fall 2020, school districts had, in theory, time to plan for reopening, but those plans were quickly impacted by numerous factors outside of educators' control, including an increase in COVID infections across the country (Harris & Oliver, 2021). This led to many different responses to reopening schools, from students being fully in school to students remaining fully remote and everything in between. Curriculum Associates, a company that currently serves roughly 25% of all public school students in the US, found that a greater number of students tested in school as the school year went on and that White students, as well as students who attended schools located outside of urban areas and students in the Midwest and South, were also more likely to have reported testing in school (Rome & Cançado, 2021). Curriculum Associates also reported that more than 60% of all students who took *i-Ready Diagnostic* self-reported taking the assessment outside of school in fall 2020, while by spring 2021, about 28% of students reported testing out of school (Curriculum Associates, 2021). While not a direct measure of where students were learning, it is safe to say that students who reported taking their Diagnostic assessment remotely were also mainly learning remotely.

Given these realities of learning during the 2020–2021 school year, research consistently showed students ended the school year with lower achievement than what was expected or compared to historical averages (Lewis et al., 2021; Renaissance Learning, 2021; West & Lake, 2021). The reported differences were usually based on looking at percentile norms, which, while informative, can mask performance differences for students at different percentiles. While saying that a student scored in the "50th percentile," meaning that student scored at the same level, or better than 50% of other students in the same grade, can be informative in many contexts, it can still be unclear whether being in the 50th percentile is "good" or "bad." Many testing programs focus on whether students are scoring in the 50th percentile without really addressing the actual content being assessed or understanding what the score means in relation to grade-level content knowledge expectations (Huff, 2020). Thus, a student can often meet percentile-norm expectations without ever mastering content that would help that student be deemed "proficient" in relation what students are expected to know and be able to do at their current grade level.

A criterion-referenced assessment of student performance helps to situate student performance in relation to grade-level expectations. Curriculum Associates (2021) took a different track than other researchers and reported on student outcomes during the 2020–2021 school year in relation to students' grade-level expectations. For example, instead of saying that Grade 4 students in spring 2021 scored, on average, 5 percentile points lower compared to Grade 4 students in spring 2019 (Lewis et al., 2021), results from a criterion-referenced test can report that the percentage of Grade 4 students performing **two or more grades below their chronological grade**, meaning testing at a Grade 2 level or lower, increased by 5 percent, from 12% historically to 17% in spring 2021, and the percentage of Grade 4 students finishing the school year **on grade level**, that is, testing at a Grade 4 level or above, decreased by 4% (Curriculum Associates, 2021).

Regardless, educators and researchers were trying to get answers to the same questions: How did student performance during the 2020–2021 school year compare to student performance in previous years? How far behind were they? The studies described earlier provided valuable insight into the academic performance of some students, but more detail was needed to understand which students really struggled and how to understand the implications of what the data were telling us. Simply looking at change in normed percentiles or even the differences in placement groups, while providing some general sense of performance or unfinished learning, does not sufficiently address whether students learned at a similar rate as in previous years, or what the consequences for slower growth might be, looking forward. In addition, simply averaging achievement across all students and/or grades can hide nuances in the data, even when disaggregating by different student or school-level characteristics such as race/ethnicity, income, or locale. Finally, looking at students over only one school year while COVID impacted performance over multiple school years can mask how the loss of schooling due to COVID-19 in spring 2020 manifested itself in those same students the following year as measured by assessments taken the following fall.

We also know that there were differences in the students who tested in fall 2020 compared to students in previous years. Researchers for one large testing company reported that the rate of attrition of students in fall 2020 was more than double that of fall 2019, and there were differences in important characteristics, including race/ethnicity, school locale, and socioeconomic status (Dorn et al., 2021; Johnson & Kuhfeld, 2020), although it is not clear if other testing companies had similar rates of attrition. Others estimated that more than three million students were not in school in fall 2020, mostly from the student groups most at risk and traditionally underserved (Korman et al., 2020).

Thus, this project examined longitudinal data for multiple cohorts of students—students who took assessments across two full school years before COVID-19 (e.g., starting in fall 2016 and ending in fall 2019), and students who started school before COVID-19 in fall 2019, and following them through the initial shock of the loss of schooling during spring 2020 and then throughout the entire 2020–2021 school year (Table 1). It should be noted that this data did not have the same issues with missingness as reported by others, meaning that the attrition rates for fall 2020 were similar, if not the same, as prior years.

Table 1: Testing Windows of the Project Sample

	Fall 1	Winter 1	Spring 1*	Fall 2	Winter 2	Spring 2
Pre-COVID	**Fall 2016**	**Winter 2017**	**Spring 2017**	**Fall 2017**	**Winter 2018**	**Spring 2018**
	Fall 2017	**Winter 2018**	**Spring 2018**	**Fall 2018**	**Winter 2019**	**Spring 2019**
COVID	**Fall 2019**	**Winter 2020**		**Fall 2020**	**Winter 2021**	**Spring 2021**

*Not included in this analysis

Research Question:

The following research question guided the present study:

> How did student growth during the two school years impacted by COVID-19 differ from growth during two school years not impacted by COVID-19?

Methodology

Sample

Data were collected from Grades K–8 public school students who took the *i-Ready Diagnostic* on six consecutive testing occasions (i.e., fall, winter, and spring) between fall 2016 and spring 2021, except for spring 2020, in which most schools were closed or did not test. Data from a total of 2,277,790 students who tested in Reading and 2,566,682 students who tested in Mathematics were used for this study. From this pool of students, two cohorts were constructed—one based on unique students who took assessments from fall 2016 through spring 2018 OR students who took assessments from fall 2017 through spring 2019, called the "pre-COVID" group, and one based on students who tested in fall 2019 through spring 2021, called the "COVID" group. Note that students cannot be in both groups. Using data from the Common Core of Data (2019), a summary of the school-level demographic characteristics of the sample is shown in Table 2.

The starting scale scores from the first fall Diagnostic for both cohorts were similar, and any differences were within the average standard error of measurement across all grades and subjects, except Grade 2 Reading. Tables 3 and 4 show the differences in starting scale scores (from the first fall Diagnostic) for Reading and Math. For the sake of brevity, only Grades 2, 4, and 6 are shown—full data is available in Appendix A. Note that the COVID cohort, especially in the earlier grades, scored slightly lower, on average, than the pre-COVID cohort. As this study is focused on growth rates and not differences in scale scores, no adjustment was made to try and match the groups. Future work that explores the impact of COVID-19 into the 2021–2022 school year on these same students will work for more formal baseline equivalence.

Table 2: Demographic Characteristics of Tested Students

	Reading				Mathematics			
	Pre-COVID		COVID		Pre-COVID		COVID	
	Count	N%	Count	N%	Count	N%	Count	N%
Less Than 25% White	421,094	39%	449,513	39%	428,084	37%	490,050	36%
25% to 49% White	225,744	21%	234,253	20%	226,712	20%	272,669	20%
50% to 74% White	237,963	22%	251,459	22%	256,083	22%	297,410	22%
More Than 75% White	206,693	19%	216,486	19%	246,025	21%	308,561	23%
Below 100% Income to Poverty Ratio	12,455	1%	15,995	1%	12,222	1%	18,516	1%
100% to 199% Income to Poverty Ratio	255,785	23%	282,493	25%	266,340	23%	326,463	24%
Greater than 200% Income to Poverty Ratio	823,966	75%	850,462	74%	878,975	76%	1,020,469	75%
Urban	284,331	26%	323,176	28%	319,330	28%	382,898	28%
Suburban	533,468	49%	520,427	45%	535,732	46%	583,497	43%
Town	103,361	9%	111,102	10%	111,472	10%	148,337	11%
Rural	168,155	15%	191,199	17%	186,553	16%	246,883	18%

Table 3: Initial Reading Scale Scores for Grades 2, 4, and 6

Reading									
		Pre-COVID				COVID				TOTAL
		Mean	SD	Median	Count	Mean	SD	Median	Count	Count
Grade 2	Fall 1 Score	464	48	467	211,138	455	51	457	186,298	**397,436**
Grade 4	Fall 1 Score	526	51	530	132,105	524	57	530	154,007	**286,112**
Grade 6	Fall 1 Score	561	57	567	53,167	566	60	574	75,548	**128,715**

Table 4: Initial Mathematics Scale Scores for Grades 2, 4, and 6

Mathematics										
		Pre-COVID				COVID				TOTAL
		Mean	SD	Median	Count	Mean	SD	Median	Count	Count
Grade 2	Fall 1 Score	404	23	404	225,524	400	26	401	225,902	451,426
Grade 4	Fall 1 Score	447	27	448	156,373	446	29	448	197,696	354,069
Grade 6	Fall 1 Score	473	32	477	61,093	474	34	478	95,244	156,337

Finally, Tables 5 and 6 show the starting relative grade-level placements of the two cohorts based on their first fall Diagnostic, for Reading and Mathematics, respectively (again, only Grades 2, 4, and 6 are shown here—full tables are in Appendix A). Note that, in general, there is a higher percentage of students with lower grade-level placements in the COVID cohort in the elementary grades and a lower percentage of students with lower grade-level placements in middle school grades.

Table 5: Initial Relative Grade-Level Placements for Reading for Grades 2, 4, and 6

		2+ Grades Below	One Grade Below	On Grade
Grade 2	Pre-COVID	19%	48%	33%
	COVID	24%	49%	27%
Grade 4	Pre-COVID	25%	46%	29%
	COVID	27%	43%	30%
Grade 6	Pre-COVID	49%	24%	28%
	COVID	43%	23%	33%

Table 6: Initial Relative Grade-Level Placements for Mathematics for Grades 2, 4, and 6

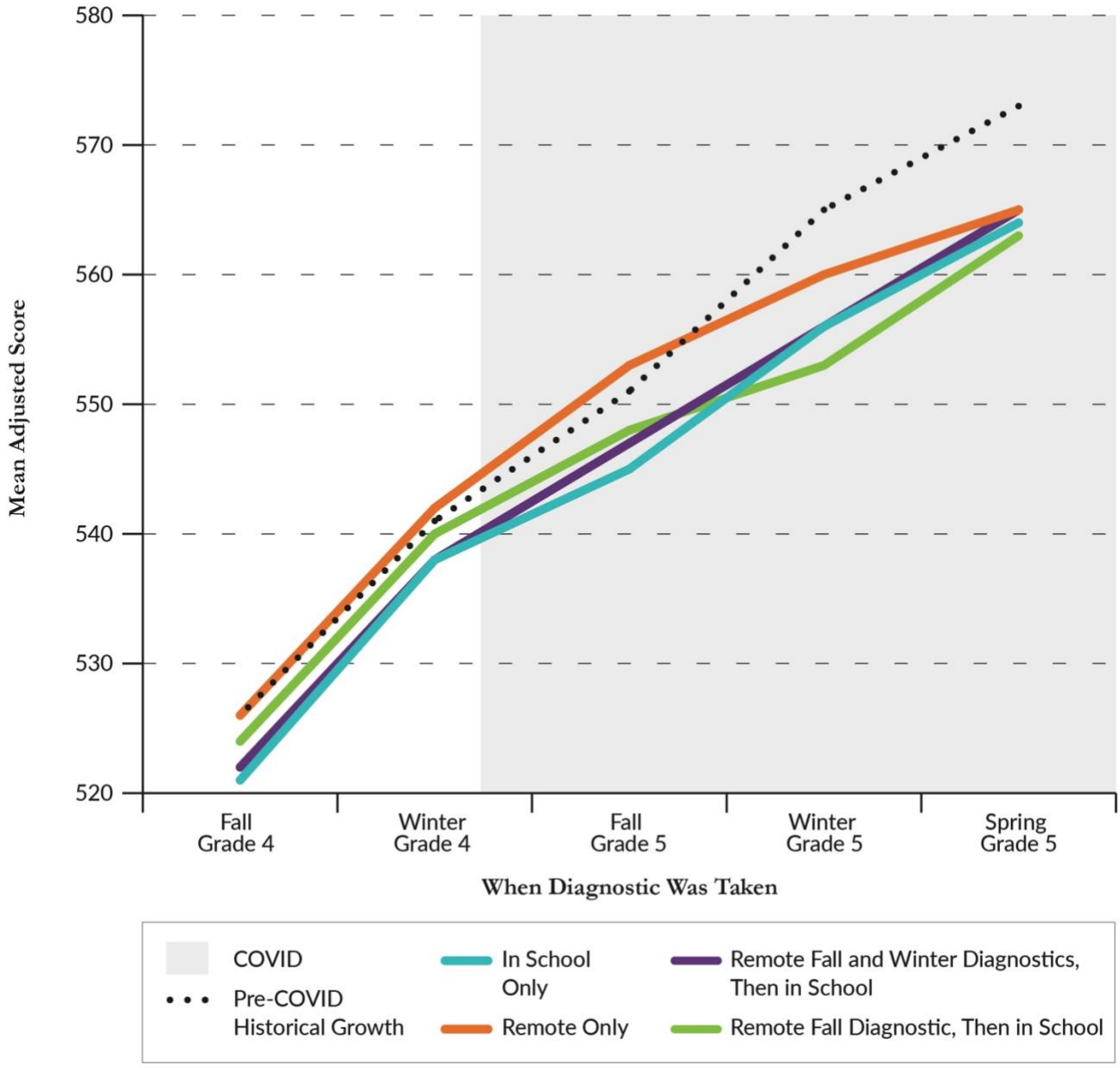
		2+ Grades Below	One Grade Below	On Grade
Grade 2	Pre-COVID	21%	63%	16%
	COVID	26%	59%	14%
Grade 4	Pre-COVID	28%	45%	27%
	COVID	28%	48%	25%
Grade 6	Pre-COVID	35%	38%	27%
	COVID	36%	34%	30%

Data Analysis

Data were analyzed using a three-level, piecewise longitudinal growth model (Bryk & Raudenbush, 1992; Singer & Willett, 2003) to best represent the change in achievement across multiple time periods given findings of nonlinear growth across a school year (Kuhfeld & Soland, 2021). While there are multiple ways to model the data, we followed a convention similar to that described by Kuhfeld et al., (2021) to allow us to compare growth rates at different time periods. Details of the model are available in Appendix B.

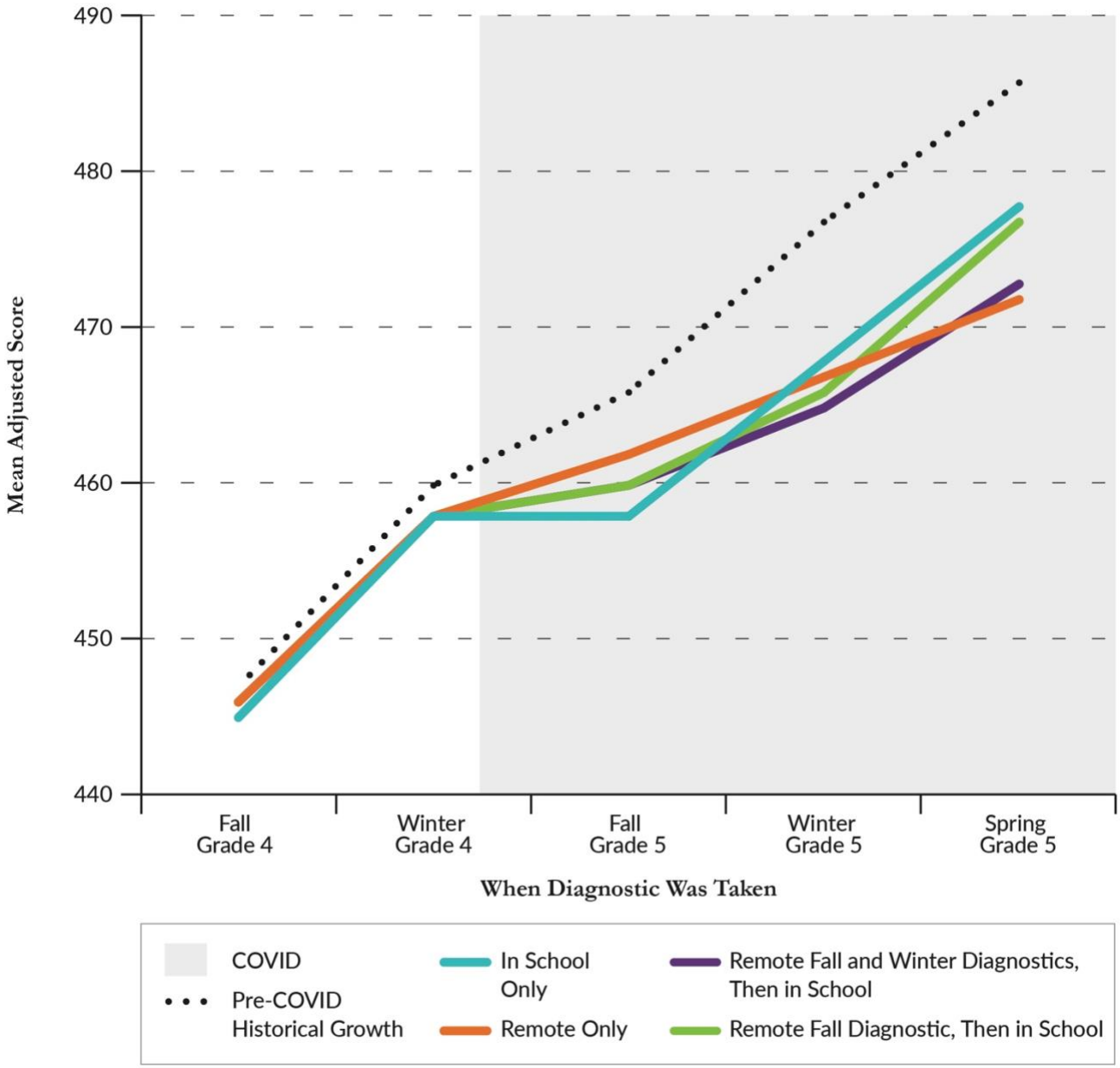
Before moving on to the results, it should be noted that we ran some models which included coding for where students reported taking their Diagnostic assessment. When we examine the reading performance of students in the pre-COVID cohort (i.e., the dotted line) compared to that of students in the COVID cohort and broke out the different patterns of reported testing location during the COVID school year (2020–2021), it is clear that students who reported testing remotely (i.e., the **orange** line) in fall 2020 had inflated scores in fall 2020 ("Fall Grade 5" on Figure 1 below) compared to students who reported testing in school only (i.e., the **blue** line). One should also note that growth in students who initially tested remotely in fall 2020 and then tested in school (i.e., the **green** line) tended to have similar growth from winter to spring when compared to students who reported only testing in school. Finally, it should be noted that all students in the COVID cohort wound up with similar scores in spring 2021, on average, regardless of where they reported testing throughout the year, and all were below the pre-COVID cohort.

Figure 1: Growth in Reading from Grade 4 to Grade 5 by Reported Testing Location



A similar pattern is seen in Grade 4 Mathematics (Figure 2), but it is a bit clearer than in Reading. While all students in both cohorts experienced very similar growth prior to the impact of COVID (which is represented by the blue shaded area in the figure), the scores for students who reported testing out of school in fall 2020 were consistently higher than those of students who reported testing in school. It is also of interest that, for Mathematics, unlike for Reading, the scores of students who reported testing out of school did not wind up in similar spots in spring 2021, with students who reported testing in school throughout the entire school year having the highest scores in the spring, even though, on average, they had the lowest scores in fall 2020.

Figure 2: Growth in Mathematics from Grade 4 to Grade 5 by Reported Testing Location



Due to the score inflation shown above for remote testers, we choose to not include students who reported testing out of school during any testing period (or "hybrid" in some cases) for the rest of the analyses discussed in this paper. Thus, we only included students who tested in school across all three testing periods during the 2020–2021 school year. The focus of the current study was on overall growth rates and their similarity (or difference) compared to a pre-COVID baseline group. The amount of possible inflation for remote testers, regardless of the testing period, makes it hard to interpret the slopes for those students. We will be revisiting the impact of where students tested in future research.

Results/Discussion

Overall Findings

In general, students in the COVID group who reported testing in school showed slower weekly scale score gains during the early part of the 2020–2021 school year, but by the end of the school year, they were progressing at similar, if not faster, rates than pre-COVID students during a similar time period. In Reading, for example, when comparing students who were in Grade 2 progressing into Grade 3, students in the COVID group showed a decrease of .13 scale score points per week between the winter 1 and fall 2 Diagnostic assessment (i.e., winter 2020 to fall 2020). After factoring in the average number of weeks between those Diagnostic assessments, students in the COVID group started Grade 3 having gained 4 fewer points than expected when compared to students in the pre-COVID group (Table 7). These same students, however, then grew at a rate of .05 points per week faster from winter 2 to spring 2 (i.e., winter 2021 to spring 2021), on average. Similar results are seen in Mathematics (Table 8). These results, however, are based on the average performance of students and can hide some important trends that will be discussed in more depth later in this section.

Table 7: Differences in Growth Rate by Time Period—Reading

		Reading								
		Fall 1 to Winter 1		Winter 1 to Fall 2		Fall 2 to Winter 2		Winter 2 to Spring 2		
Grade	Group	Weekly Gain	Gain for Time Period	Weekly Gain	Gain for Time Period	Weekly Gain	Gain for Time Period	Weekly Gain	Gain for Time Period	TOTAL
2 -> 3	Pre-COVID	1.68	28	0.42	14	1.18	20	0.68	12	**75**
	COVID	1.66	28	0.29	11	1.02	17	0.73	13	**69**
	Difference	*-0.01*	*0*	***-0.13***	***-4***	***-0.16***	***-3***	***0.05***	*0*	***-6.1***
4 -> 5	Pre-COVID	0.91	15	0.29	10	0.81	14	0.45	8	**47**
	COVID	0.96	17	0.21	8	0.66	11	0.52	9	**44**
	Difference	*0.05*	***1***	***-0.08***	***-2***	***-0.15***	***-3***	***0.08***	*1*	***-2.8***
6 -> 7	Pre-COVID	0.53	9	0.29	10	0.51	8	0.28	5	**32**
	COVID	0.59	10	0.18	6	0.34	6	0.19	3	**26**
	Difference	*0.06*	*1*	***-0.11***	***-4***	***-0.16***	***-3***	*-0.09*	*-2*	***-6.7***

***Bolded** gain differences are statistically significant at the <0.001 level. Note that reported differences were rounded to the nearest 100th.

A reminder that the focus here is on the average weekly rate of growth and not the differences in average scores, so when we say that COVID students started Grade 3 (i.e., fall 2) having gained 4 fewer points compared to students in the pre-COVID group, it is not the same thing as saying students in the COVID group started the year, on average, 4 points behind the pre-COVID groups. Instead, we are saying that the COVID group grew more slowly between their winter Diagnostic in Grade 2 (i.e., winter 1) and their fall Diagnostic to start Grade 3 (i.e., fall 2), and were 4 points behind where, all things being equal, we would have otherwise expected them to be at the start of Grade 3 given their performance in Grade 2.

Table 8: Differences in Growth Rate by Time Period—Mathematics

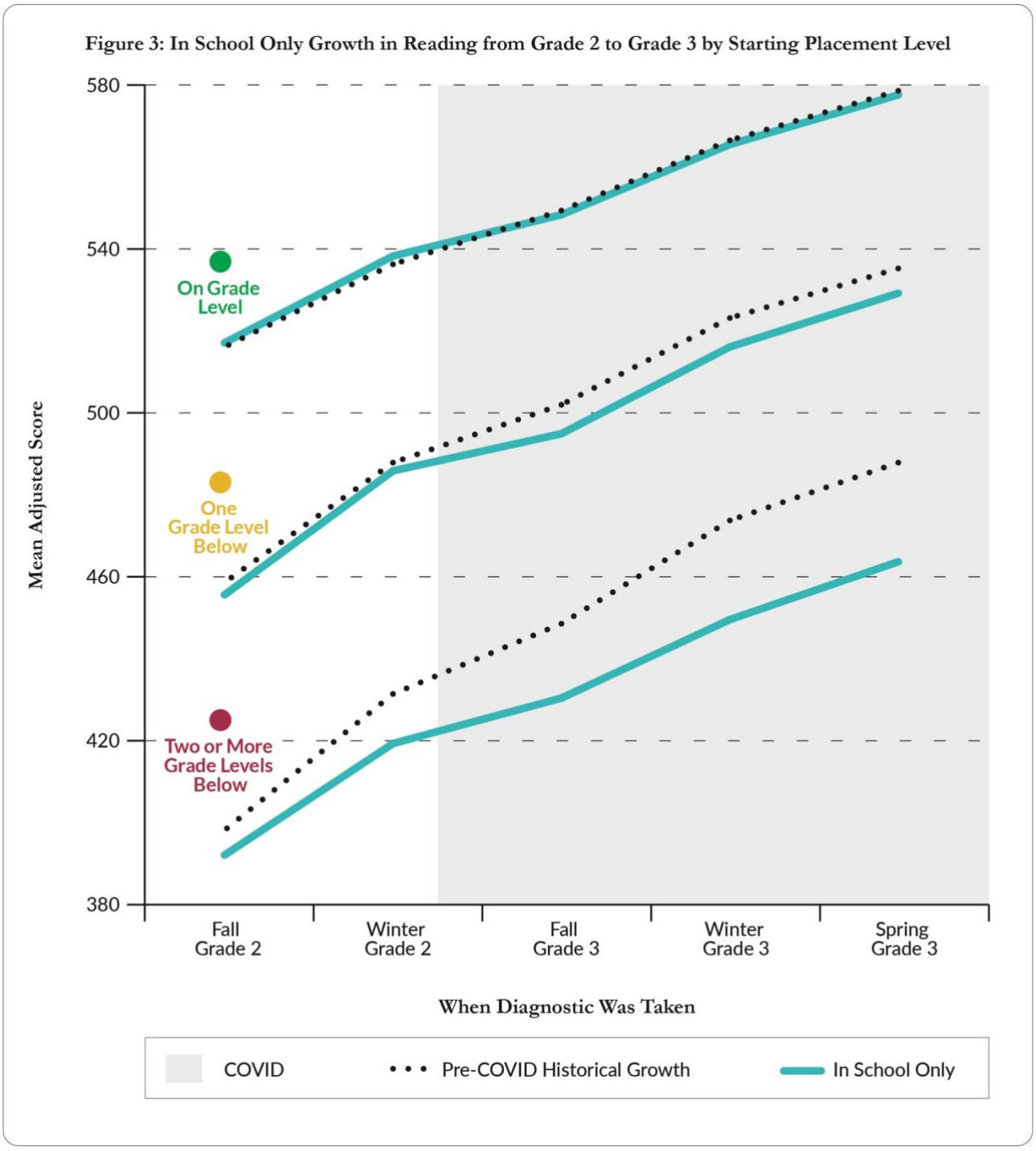
Grade	Group	Mathematics								
		Fall 1 to Winter 1		Winter 1 to Fall 2		Fall 2 to Winter 2		Winter 2 to Spring 2		
		Weekly Gain	Gain for Time Period	Weekly Gain	Gain for Time Period	Weekly Gain	Gain for Time Period	Weekly Gain	Gain for Time Period	TOTAL
2 -> 3	Pre-COVID	0.99	16	0.27	9	0.94	16	0.80	14	**56**
	COVID	0.94	16	0.14	5	0.81	13	0.73	13	**47**
	Difference	***-0.05***	***0***	***-0.14***	***-4***	***-0.14***	***-3***	***-0.08***	***-2***	***-9.2***
4 -> 5	Pre-COVID	0.81	14	0.18	6	0.62	11	0.50	9	**40**
	COVID	0.75	13	0.02	1	0.58	10	0.57	10	**33**
	Difference	***-0.06***	***-1***	***-0.17***	***-6***	*-0.04*	***-1***	***0.07***	***1***	***-6.3***
6 -> 7	Pre-COVID	0.46	8	0.11	4	0.34	6	0.27	5	**22**
	COVID	0.47	8	-0.03	-1	0.22	4	0.25	4	**15**
	Difference	*0.01*	*0*	***-0.15***	***-5***	***-0.12***	***-2***	*-0.01*	*0*	***-7.2***

***Bolded** gain differences are statistically significant at the <0.001 level. Note that reported differences were rounded to the nearest 100th.

A couple of interesting patterns are seen in Tables 7 and 8. First, there were large disruptions in student learning going from spring 2020 (when COVID shut down many schools) to the following fall (i.e., fall 2) that seemed to continue into the first part of the 2020–2021 school year (i.e., fall 2 to winter 2) in both Reading and Mathematics. Notice, too, that historically, students seem to learn at faster rates during the first half of the school year, especially in Reading and especially in the early grades. By the last part of the school year (i.e., winter 2 to spring 2), the differences were less stark, and in some cases, students performed better, on average, than pre-COVID students during the same time period. Whether these patterns hold into fall 2021 remains to be seen.

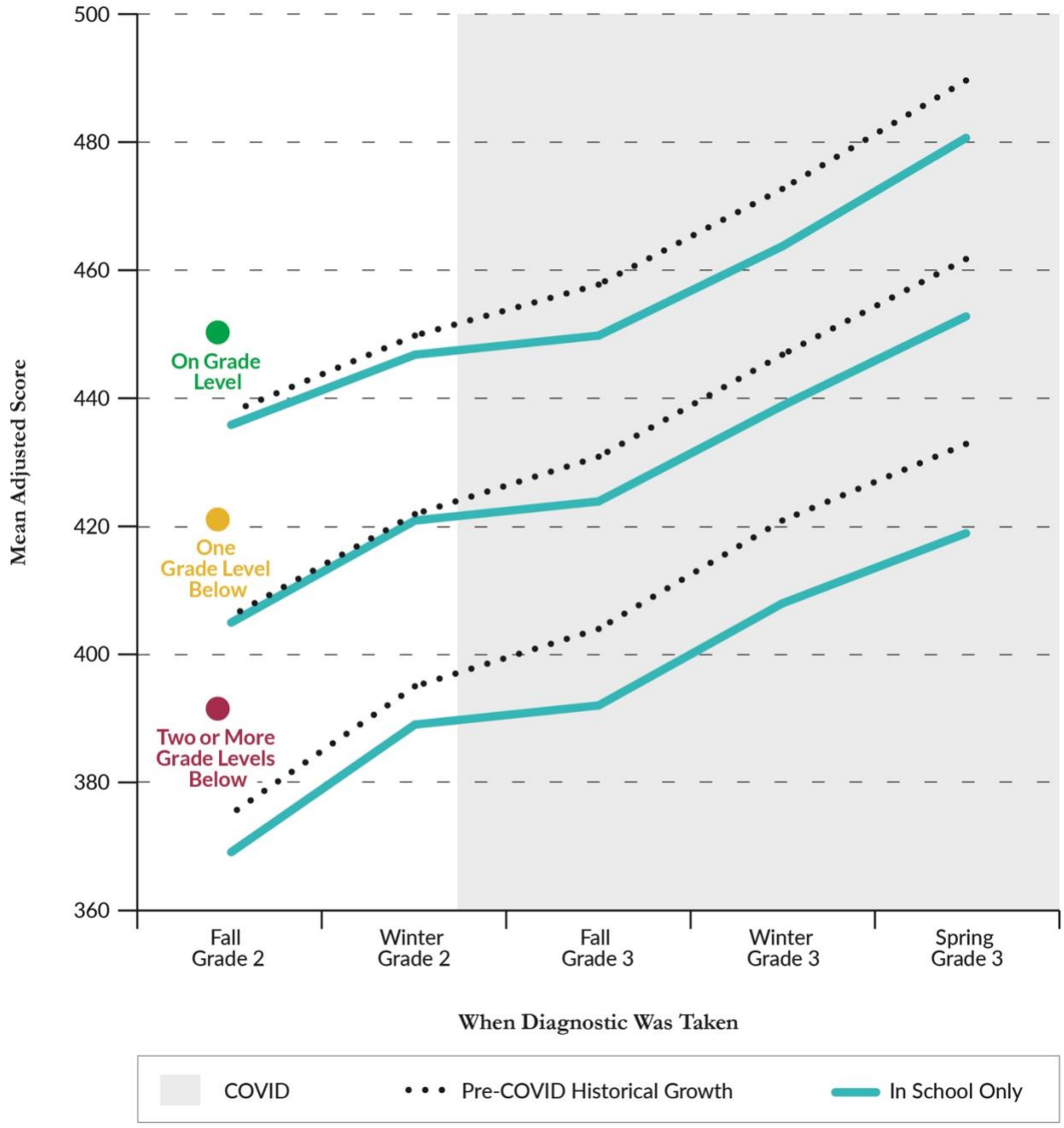
Differences by Starting Placement

The most obvious, and in many ways most distressing, pattern in the Reading data is that students who started their first year performing two or more grades below their chronological grade seemed to be driving most of the differences in Reading growth in early grades. As Figure 3 shows, students in the COVID group who tested two or more grades below their chronological grade in Reading at the start of Grade 2 (before COVID) showed slower overall gains by the end of Grade 3 (i.e., the gap between the lines is getting bigger), and especially in fall 2020, when compared to students who tested one grade level below their chronological grade, and students who were just below or at their chronological grade level to start Grade 2 didn't seem to see much impact at all from COVID. For students who started Grade 2 performing at a kindergarten level, their growth over the two-year period was about 17 points lower than students in the pre-COVID group, whereas the difference was 4 points for students who started Grade 2 performing at a first grade level, and 1 point for students who started Grade 2 performing at a second grade level (see Table 9 below for more details). This could have profound long-term consequences for students who were already behind during the years they are learning foundational reading skills.



A similar pattern can be seen in Mathematics, although all students in the COVID group seemed to have experienced some significant drop-off starting in fall 2020, regardless of their starting placement (Figure 4).

Figure 4: In School Only Growth in Mathematics from Grade 2 to Grade 3 by Starting Placement Level



The loss of schooling due to COVID in spring 2020 seemed to have a more pronounced impact on student scores to start the following fall (i.e., winter 1 to fall 2) in Mathematics compared to Reading, but growth in Mathematics throughout the year tended to be very similar to historical norms regardless of starting placement, while average gains in Reading were a little more mixed, especially in early grades (Table 9). Students who were two or more grades behind before COVID tended to consistently gain at slower rates compared to students at that level historically in both Reading and Mathematics during the first half of the school year (i.e., fall 2 to winter 2), while students who were one grade below or on grade level before COVID mostly gained at similar or slightly faster rates during the 2020–2021 school year, especially in Mathematics. Like other findings, there were some patterns, but not necessarily consistent ones, across all grades and subjects.

Table 9: Average Change in Diagnostic Score by Time Period and Subject

	Initial Fall Placement	Group	Average Diagnostic Score Change per Time Period									
			Reading					Mathematics				
			Fall 1 to Winter 1	Winter 1 to Fall 2	Fall 2 to Winter 2	Winter 2 to Spring 2	Overall	Fall 1 to Winter 1	Winter 1 to Fall 2	Fall 2 to Winter 2	Winter 2 to Spring 2	Overall
Grade 2->3	Two or More Grades Below	Pre-COVID	32	18	25	14	**88**	20	9	17	12	**58**
		In School Only	27	10	20	14	**71**	19	4	16	11	**49**
	One Grade Below	Pre-COVID	29	14	21	12	**76**	16	9	16	15	**56**
		In School Only	29	10	20	13	**72**	16	3	15	13	**47**
	On Grade	Pre-COVID	19	13	17	12	**61**	13	8	15	17	**52**
		In School Only	21	10	17	12	**60**	11	3	14	17	**45**
Grade 4->5	Two or More Grades Below	Pre-COVID	23	11	17	7	**58**	16	6	12	7	**41**
		In School Only	23	7	14	8	**52**	15	0	10	7	**32**
	One Grade Below	Pre-COVID	14	9	14	7	**45**	13	6	11	9	**39**
		In School Only	16	6	12	7	**42**	12	0	10	10	**32**
	On Grade	Pre-COVID	9	11	12	8	**40**	11	7	10	11	**39**
		In School Only	11	8	10	8	**36**	11	0	11	12	**34**
Grade 6->7	Two or More Grades Below	Pre-COVID	8	9	10	5	**32**	10	5	6	3	**24**
		In School Only	10	4	7	4	**25**	11	-2	6	4	**19**
	One Grade Below	Pre-COVID	8	10	7	5	**31**	8	4	6	5	**23**
		In School Only	10	5	6	3	**24**	9	-2	7	5	**19**
	On Grade	Pre-COVID	8	10	6	5	**29**	8	4	8	7	**28**
		In School Only	10	4	5	3	**22**	8	-1	8	8	**23**

Differences by School-Level Demographic Characteristics

There are also some differences based on school-level demographic characteristics, but they are not as pronounced nor as consistent. Tables 10 and 11 show a summary of the data. Where there are "+" signs, there was a positive relationship between the characteristic and student growth, while a "-" sign indicates a negative relationship. For example, a "+" sign in the "% White" column means that as the percentage of White students in a school grew larger, student growth was faster. Note that for "Locale," the comparison was to schools located in suburban areas and a "+/-" means that students in some locales (i.e., urban, town, or rural) grew at faster rates than students in suburban schools, while students in other locales grew at a slower rate compared to students in suburban schools.

Table 10: Differences in Growth Rate by Time Period and School Demographic Characteristics—Reading

	Reading											
	Fall 1 to Winter 1			Winter 1 to Fall 2			Fall 2 to Winter 2			Winter 2 to Spring 2		
Grades	**% White**	**Income**	**Locale**	**% White**	**Income**	**Locale**	**% White**	**Income**	**Locale**	**% White**	**Income**	**Locale**
Grade 2 -> 3	+**	+	-	+	+**	-	+**	-	-	+	+	+
Grade 4 -> 5	+*	+	+	+	+*	-	+	+	-	-	+	-
Grade 6 -> 7	+	-	-	-	+	+	+*	+	-	+	+	-

****Significant at <0.001; *Significant at <0.05**

Table 11: Differences in Growth Rate by Time Period and School Demographic Characteristics—Mathematics

	Mathematics											
	Fall 1 to Winter 1			Winter 1 to Fall 2			Fall 2 to Winter 2			Winter 2 to Spring 2		
Grades	% White	Income	Locale	% White	Income	Locale	% White	Income	Locale	% White	Income	Locale
Grade 2 -> 3	+*	+	-/+	-**	+**	-/+	+**	-*	+	+**	-	+/-*
Grade 4 -> 5	-	+	+	+*	+**	-*	+**	+	-	+**	-	-
Grade 6 -> 7	+	-	-	-	+*	+	+*	+	+	+	+	+

**Significant at <0.001; *Significant at <0.05

Looking more deeply into the data, we can examine differences based on a combination of the above factors. Looking at the performance of students in High White (i.e., >75% White)/Low Poverty (i.e., >200% of the poverty line) schools in a suburban locale, we see that there was little difference across the two-year time period for the pre-COVID and COVID groups in Reading, although more of a difference in Mathematics. At the same time, students in Low White (i.e., <25% White)/High Poverty (i.e., <100% of the poverty line) schools in an urban locale saw significant differences between the pre-COVID and COVID groups across all grades in Reading and Mathematics. Table 12 shows differences in the two-year gains for students in the pre-COVID and COVID groups. It is important to examine the 2020–2021 school year to understand the extent to which schools were or were not able to start reversing the unfinished learning students experienced due to the pandemic. Follow-up studies will demonstrate the rate of recovery in the 2021–2022 school year.

Table 12: Two-Year Gains for Students by Group and Demographic Characteristics

	Reading			Mathematics		
	Grade 2-> 3	Grade 4-> 5	Grade 6-> 7	Grade 2-> 3	Grade 4-> 6	Grade 6-> 8
Pre-COVID High White/Low Poverty, Suburban	74	45	30	56	40	26
COVID High White/Low Poverty, Suburban	73	44	25	49	34	21
Difference	***1***	***1***	***5***	***7***	***6***	***5***
Pre-COVID Low White/High Poverty, Urban	71	49	34	54	39	25
COVID Low White/High Poverty, Urban	63	44	22	47	31	16
Difference	***8***	***5***	***12***	***7***	***8***	***9***

As with other patterns described, the impact isn't consistent across all groups of students, grades, or subjects, but differences that existed prior to COVID were maintained, if not enlarged (Figures 5 and 6). In general, students in the pre-COVID groups were already scoring higher, on average, during their first fall, which indicates that there were more low-performing students, on average, in the COVID group prior to any impact. Regardless, students in Low White/High Poverty, Urban districts started, on average, with lower scores in the fall compared to their High White/Low Poverty, Suburban counterparts, and then lost even more ground in both Reading and Math (Grades 2–3 is shown, but the patterns are the same in Grades 4–5 and Grades 6–7).

Figure 5: In School Only Growth in Reading from Grade 2 to Grade 3 by Demographic Characteristics

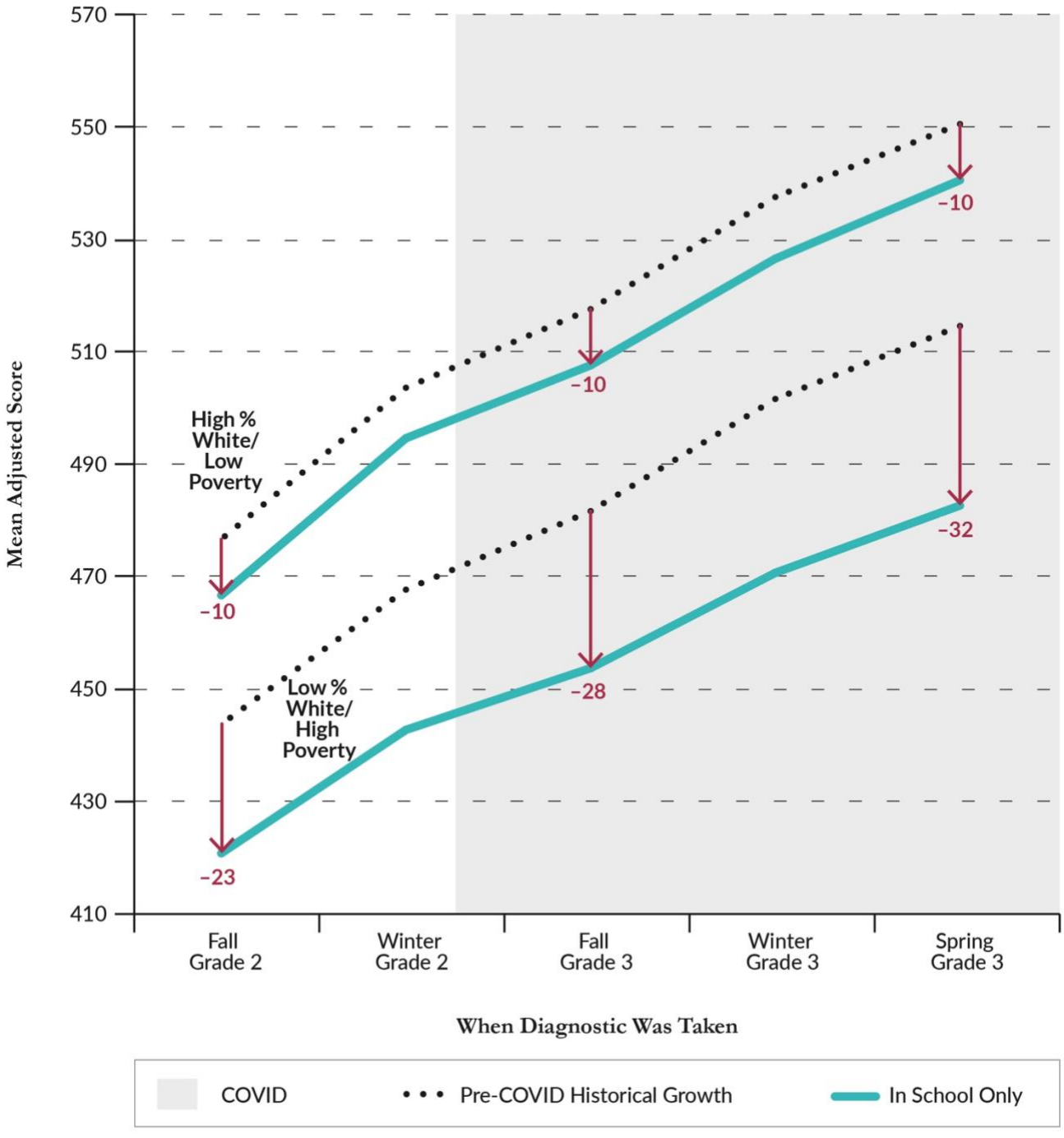
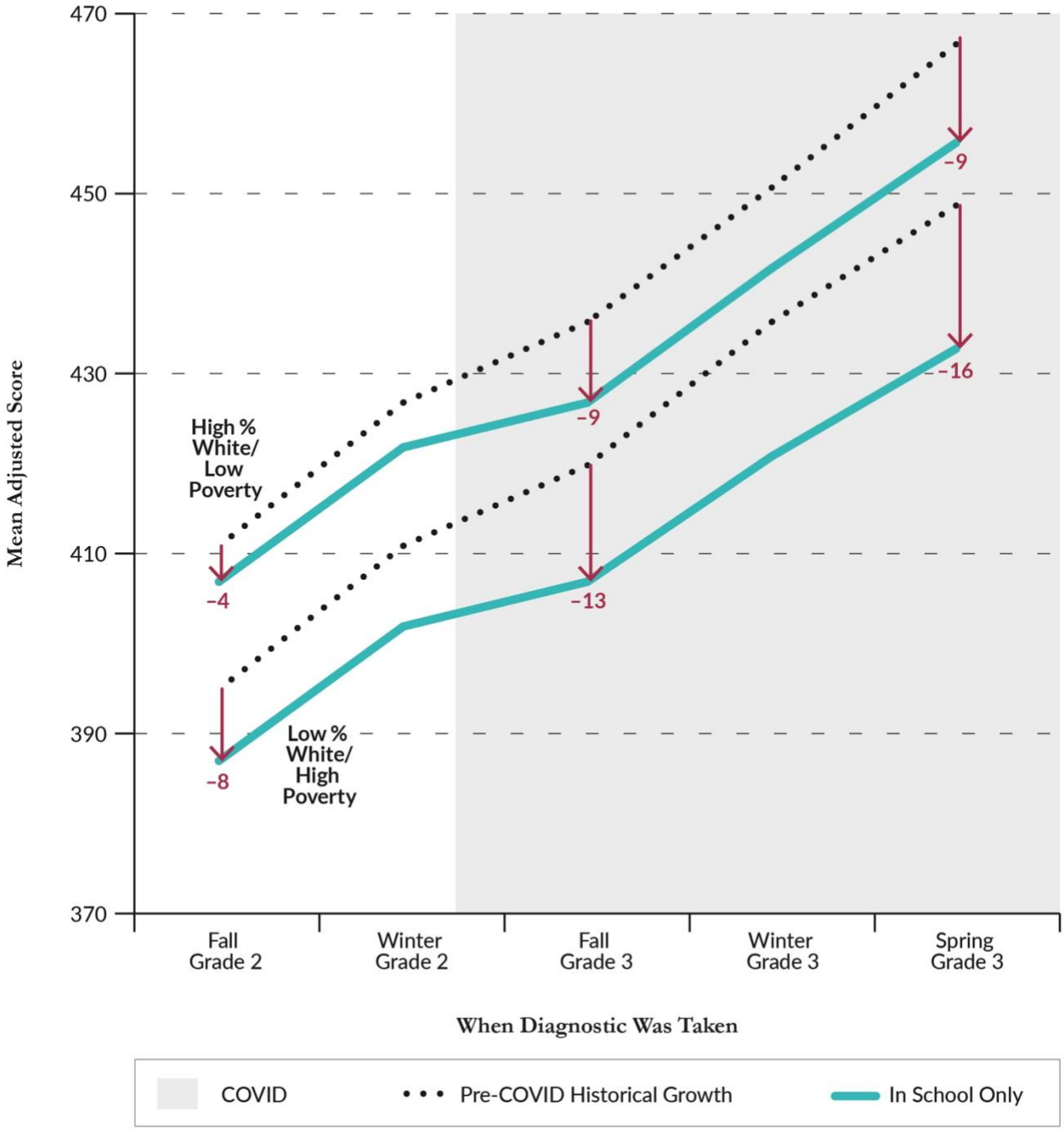


Figure 6: In School Only Growth in Mathematics from Grade 2 to Grade 3 by Demographic Characteristics



Summary

The loss of schooling during spring 2020 due to COVID clearly impacted all students in Reading and Mathematics across all grades. Numerous researchers have shown those initial impacts were evident at the beginning of the 2020–2021 school year, and the ongoing tremors were felt throughout the rest of the academic year. However, those analyses tended to be focused on the "average" impact, and while some disaggregation was done, many were based on scale scores or normed percentiles as opposed to criterion-based grade-level expectations, which can hide some nuances in the data.

The above analyses shows that while impacts were uneven and spread across all students, those who were already behind bore the brunt of the fallout. While not necessarily surprising, the depth and scope of the differences haven't been thoroughly explored. In addition, simply progressing at the same rate as in previous years isn't getting kids caught up to where they otherwise would have been. The reality is that the most vulnerable students are at risk of falling further behind. Relying on the average isn't exposing the full scope of what happened.

It should also be noted that the analyses in this paper reflect only the subset of students who reported testing "in school" across all three testing windows, representing about 30% of students. While we do not know if those students also received instruction in school, it should be reasonable to assume that they did for most of the year, and their experiences reported here are the best-case scenario. We won't know the full impact of instruction for kids who were unable to be physically in classrooms until the results from fall 2021 assessments are in, which represents our next set of planned analyses.

Limitations

There are several limitations to this study. First, students were only included if they had taken a valid, non-rushed Diagnostic assessment during all assigned testing windows. Thus, if a student missed one assessment, they were excluded. This could have biased the sample in some unknown way. In addition, comparisons were made from student cohorts across different time periods, such that the pre-COVID cohort, which followed students from between a time period of fall 2016 to fall 2019, while the COVID cohort comprised students from starting from fall 2019 through fall 2021. Again, the conditions of schooling may have been different for the cohorts that could have impacted their performance, beyond the impact of COVID, and differences in performance could have been different even without the COVID.

Testing location data were captured via self-report. While the data is at the student level, there could be reasons why students answered this question incorrectly, and we did not take any steps to correct location information. Similarly, while location data for the Diagnostic was collected, one cannot assume that student learning happened at the same location where the student took the Diagnostic. We know that conditions were often rapidly changing, and "remote" learning in one school could be very different than "remote" learning in another school.

Appendix A—Sample Characteristics

Table A1: Initial Reading Scale Scores by Grade

Reading										
		Pre-COVID				COVID				TOTAL
		Mean	SD	Median	Count	Mean	SD	Median	Count	Count
Grade K	Fall 1 Score	351	30	349	194,058	347	31	343	179,038	**373,096**
Grade 1	Fall 1 Score	406	41	404	220,529	404	43	405	248,334	**468,863**
Grade 2	Fall 1 Score	464	48	467	211,138	455	51	457	186,298	**397,436**
Grade 3	Fall 1 Score	499	50	503	184,619	492	55	498	171,248	**355,867**
Grade 4	Fall 1 Score	526	51	530	132,105	524	57	530	154,007	**286,112**
Grade 5	Fall 1 Score	548	53	553	93,993	547	58	554	90,809	**184,802**
Grade 6	Fall 1 Score	561	57	567	53,167	566	60	574	75,548	**128,715**
Grade 7	Fall 1 Score	558	63	565	4,881	584	61	593	78,018	**82,899**

Table A2: Initial Mathematics Scale Scores by Grade

Mathematics										
		Pre-COVID				COVID				TOTAL
		Mean	SD	Median	Count	Mean	SD	Median	Count	Count
Grade K	Fall 1 Score	348	21	348	171,249	342	22	341	197,521	**368,770**
Grade 1	Fall 1 Score	379	22	379	228,014	375	25	376	274,312	**502,326**
Grade 2	Fall 1 Score	404	23	404	225,524	400	26	401	225,902	**451,426**
Grade 3	Fall 1 Score	426	25	428	207,366	424	27	427	211,656	**419,022**
Grade 4	Fall 1 Score	447	27	448	156,373	446	29	448	197,696	**354,069**
Grade 5	Fall 1 Score	462	29	464	105,691	462	31	464	117,183	**222,874**
Grade 6	Fall 1 Score	473	32	477	61,093	474	34	478	95,244	**156,337**
Grade 7	Fall 1 Score	470	36	473	4,982	484	36	489	86,876	**91,858**

Table A3: Relative Grade-Level Placements for Reading

		2+ Grades Below	One Grade Below	On Grade
Grade K	Pre-COVID	-	68%	32%
	COVID	-	72%	28%
Grade 1	Pre-COVID	6%	73%	21%
	COVID	8%	72%	20%
Grade 2	Pre-COVID	19%	48%	33%
	COVID	24%	49%	27%
Grade 3	Pre-COVID	28%	26%	46%
	COVID	34%	23%	43%
Grade 4	Pre-COVID	25%	46%	29%
	COVID	27%	43%	30%
Grade 5	Pre-COVID	40%	32%	28%
	COVID	41%	30%	29%
Grade 6	Pre-COVID	49%	24%	28%
	COVID	43%	23%	33%
Grade 7	Pre-COVID	61%	16%	23%
	COVID	42%	18%	40%

Table A4: Relative Grade-Level Placements for Mathematics

		2+ Grades Below	One Grade Below	On Grade
Grade K	Pre-COVID	-	74%	26%
	COVID	-	81%	19%
Grade 1	Pre-COVID	7%	80%	14%
	COVID	13%	75%	12%
Grade 2	Pre-COVID	21%	63%	16%
	COVID	26%	59%	14%
Grade 3	Pre-COVID	28%	54%	18%
	COVID	30%	55%	15%
Grade 4	Pre-COVID	28%	45%	27%
	COVID	28%	48%	25%
Grade 5	Pre-COVID	31%	41%	28%
	COVID	30%	42%	28%
Grade 6	Pre-COVID	35%	38%	27%
	COVID	36%	34%	30%
Grade 7	Pre-COVID	56%	31%	13%
	COVID	40%	35%	25%

Appendix B: Model

To examine the weekly growth rates for each student across different time periods, the Level 1 model was of the following form:

$$DIAGSCOR_{tij} = \pi 0ij + \pi 1ij*(TWK1tij) + \pi 2ij*(TWK2tij) + \pi 3ij*(TWK3tij) + \pi 4ij*(TWK4tij) + etij \quad [1]$$

where:

DIAGSCOR*tij* is the Diagnostic score at time I for child I in school *j*;
$\pi 0ij$ is the initial expected score of child *ij* on the first fall Diagnostic
$\pi 1ij$ is the learning rate for child ij during the first time period (i.e., fall 1 to winter 1)
$\pi 2ij$ is the learning rate for child ij during the second time period (i.e., winter 1 to fall 2)
$\pi 3ij$ is the learning rate for child ij during the third time period (i.e., fall 2 to winter 2)
$\pi 4ij$ is the learning rate for child ij during the fourth time period (i.e., winter 2 to spring 2)
TWKXtij is the number of weeks between Diagnostics across each of the four different time periods

To examine the differences in weekly growth rates between the different cohorts of students (TESTLOC) within schools while accounting for the student's placement level during fall of the academic year when the assessment was taken (F1RED,F2RED), the Level 2 model took the following form:

$$\begin{aligned}
\pi 0\ ij &= \beta 00j + \beta 01j*(TESTLOCij) + r0\ ij \\
\pi 1\ ij &= \beta 10j + \beta 11j*(TESTLOCij) + \beta 12j*(F1REDjk) + r1ij \\
\pi 2\ ij &= \beta 20j + \beta 21j*(TESTLOCij) + \beta 22j*(F1REDjk) + r2ij \\
\pi 3\ ij &= \beta 30j + \beta 31j*(TESTLOCij) + \beta 32j*(F2REDjk) + r3ij \\
\pi 4\ ij &= \beta 40j + \beta 41j*(TESTLOCij) + \beta 42j*(F2REDjk) + r4ij
\end{aligned} \quad [2]$$

Finally, variation between schools accounting for school-level demographic characteristics such as the percentage of White students (PCT_WHIT), the neighborhood poverty estimate of the school (IPR_EST), and the National Center for Education Statistics (NCES) locale code was modeled at Level 3. Note that both the percentage of White students and child poverty estimates were grand mean centered, and the NCES locale categories were dummy coded, with suburban being the reference category.

$$\beta pqj = \gamma pq0 + \gamma 001(PCT\_WHITj) + \gamma 002(IPR\_ESTj) + \gamma 003(L\_TOWNj) + \gamma 004(L\_RURALj) +$$

$$\gamma 005(L\_URBANj) + upqj \quad [3]$$

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