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DOES SCHOOL INSTRUCTIONAL MODALITY PREDICT AVERAGE SCHOOL ACHIEVEMENT?

LEARNING DURING THE PANDEMIC IN ILLINOIS SERIES
PART 2

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This report was reviewed by scholars to ensure that its contents are rigorous, accurate, and useful to educators and policymakers with varying levels of background knowledge. The reviewers of this report included:

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EXECUTIVE SUMMARY

The onset of the COVID-19 pandemic in the spring of 2020 was marked by a transition to remote learning in Illinois schools and nationwide. The following school year, schools and families faced difficult decisions about how and when to return to in-person learning. School leaders, parents and caregivers, and students considered how to balance concerns for health and safety during the 2020-21 school year (SY21) with concerns about the impact of remote instruction on student learning, socioemotional development, and other needs (Darling-Aduana et al., 2022; Rapaport et al., 2020).

This report, the second in the *Learning During the Pandemic in Illinois* series, follows a study on patterns of remote and in-person instruction across Illinois public schools during SY21. In that report, we showed that schools statewide followed distinct patterns in learning modalities over the course of the year. While most schools started the year in remote learning, they varied widely in the amount of in-person instruction students experienced as the year progressed. To date, no studies have examined how the amount of in-person learning in SY21 related to student achievement in Illinois schools.

Here, we document the associations between instructional modality pathways and test scores for students in grades 3-5, 6-8 and 11 statewide. Using a difference-in-differences approach, we ask: *How do school modality pathways relate to average school achievement in the SY21?* Our findings show that schools' instructional modality pathway was an important predictor of their mean test score outcomes.

Key Findings

Average school test scores declined from SY19 to SY21 in all modality pathways and all grade levels.

For grades 3-5, schools with more in-person instruction had consistently smaller declines from SY19 to SY21 in math and English Language Arts (ELA) outcomes compared to schools where students experienced more remote instruction.

- These relationships were stronger for Illinois Assessment of Readiness (IAR) scores in math compared to ELA.
- Effect sizes ranged from moderate to large in math and from small to moderate in ELA.

For grades 6-8, relationships between instructional modality pathways and achievement outcomes were small and mixed.

- Schools that spent the most time in-person showed smaller declines in math, but not ELA.
- Schools that offered both remote and in-person instruction throughout the year declined more in ELA compared to schools that were remote all year.

For grade 11, we found no significant associations between instructional modality pathways and achievement.

These trends have implications for racial/ethnic and socioeconomic achievement disparities.

- Schools with more remote instruction disproportionately served Black, Latinx, English learner, and low-income students.
- Across schools serving grades 3-5, achievement disparities between these groups and Whiter, more affluent student groups appear to have widened.

Learning During the Pandemic in Illinois

Part 2: Does School Instructional Modality Predict Average School Achievement?

Background

Nationwide, student learning as measured by test scores declined during the COVID-19 pandemic. These declines occurred across grade levels and subject areas, with larger declines consistently observed in math compared to reading (Betebenner & Iwaarden, 2022; Dorn et al., 2021; EPIC, 2021; Goldhaber, Kane, Mceachin, & Morton, 2022; Halloran et al., 2021; Kogan & Lavertu, 2021; Lewis et al., 2021). Importantly, student learning losses were not equal across the board. Learning declines were larger for students of color, specifically Black and Latinx students (Betebenner & Iwaarden, 2022; Dorn et al., 2021; EPIC, 2021; Goldhaber, Kane, Mceachin, & Morton, 2022), students from disadvantaged and lower income backgrounds (Agostinelli et al., 2022; Betebenner & Iwaarden, 2022; Goldhaber, Kane, Mceachin, & Morton, 2022; Lewis et al., 2021), and students who were already behind in their learning (Goldhaber, Kane, Mceachin, & Morton, 2022; Kogan & Lavertu, 2021). Some evidence suggests that losses were also greater for students in lower grade levels (Lewis et al., 2021; The World Bank, UNESCO, & UNICEF, 2021), while others point to larger declines in achievement for higher grades (Betebenner & Iwaarden, 2022).

Instructional modality patterns also differed across demographic groups. Black and Latinx students and students from low-income backgrounds, in urban areas, with low prior achievement, and with limited English proficiency experienced higher rates of remote instruction (Darling-Aduana et al., 2022; Dorn et al., 2021; Goldhaber, Kane, Mceachin, Morton, et al., 2022; Kaufman & Diliberti, 2021). Students in elementary grades, on the other hand, experienced higher rates of in-person instruction (Haderlein et al., 2021; Hodgman et al., 2021).

Interviews with teachers across the country have revealed that they find remote instruction challenging (Bartlett, 2022; Trinidad, 2020). Teachers and principals have reported less instructional time and curriculum coverage in remote compared to in-person settings, as well as decreased student attendance and assignment completion (Kaufman & Diliberti, 2021). Surveys of parents whose children attended school remotely or in a hybrid model, which combines both remote and in-person instruction, found that they rated

educational quality lower than parents of children attending school in-person (Rapaport et al., 2020). Parents have also expressed concerns about their children's social and emotional well-being, which is foundational for academic success (Ashdown & Bernard, 2012; Bücker et al., 2018; Rüppel et al., 2015). Well-being declined among students of all ages in remote learning (Duckworth et al., 2021; Hanno et al., 2022), but perhaps especially among younger children, who rely heavily on in-person interaction and stable routines for the development of executive functioning skills like self-management and metacognition, emotional regulation, and social engagement (Tomasik et al., 2021; Wang, 2022). In turn, elementary-aged children have shown higher levels of anxiety and maladaptive behaviors in remote learning (Hanno et al., 2022).

Existing research has found a negative relationship between remote learning and student achievement. Studies have shown that U.S. districts offering remote instruction throughout the SY21 performed lower on state standardized tests than districts offering more in-person instruction, although estimates vary on which subject areas and grade levels declined the most (Darling-Aduana et al., 2022; Domina et al., 2022; EPIC, 2021; Goldhaber, Kane, Mceachin, Morton, et al., 2022; Halloran et al., 2021; Jack et al., 2022; Kogan & Lavertu, 2021). In a national analysis of which schools were affected most by instructional modality, Goldhaber and colleagues (2022) found that high-poverty schools declined more under remote instruction than low-poverty schools. All of these studies focused on elementary and middle school grades; to date, no studies that we know of have examined how learning modality relates to achievement at the high school level.

Our study builds on this nascent literature. We examine school-level data from all schools within all public districts in Illinois. These data allow us to control for a range of school-level potential confounders[a] that could vary substantially within districts, including measures of school quality, while also comparing schools across a wide range of district types. While we did not analyze the relationship between in-person instruction and test scores at the student level in this report, the use of schools as our unit of analysis allows us to analyze achievement across a wider range of grade levels than we are able to examine in

[a] Confounders refer to variables that influence the dependent and independent variables at the same time (Greenland et al., 1999). Statistically controlling for them allows us to better understand the relationship of interest – in this case, the relationship between in-person instruction and average student achievement.

our student-level analysis (the topic of report three in the series, *Does Student Instructional Modality Predict Student Achievement?*). To our knowledge, ours is the first study to examine how instructional modality predicts test scores for students in high school (specifically, grade 11).

Instructional Modality in Illinois

In part one of the series, *Trends in School Instructional Modality During the 2020-21 School Year*, we showed that the modality of instruction in schools across the state varied, and that schools' modalities changed throughout the school year. Using Latent Transition Analysis (LTA), we grouped schools into pathways based on their patterns of instructional modality at four key time points: September, 2020; December, 2020; February, 2021 and April, 2021. This resulted in four modality pathways representing 99% of schools statewide. Additional details about this analysis and resulting pathways are presented in *Report 1*. The four pathways were:

(1) Remote All Year. In this group of schools, students were instructed almost exclusively remotely at all four time points.

(2) Substantially Remote. The vast majority of students in schools in the *Substantially Remote* pathway started the school year in remote learning and spent a substantial part of the year learning remotely. However, over the course of the school year, schools transitioned into either dual (i.e., both in-person and remote) or in-person modalities.

(3) Mixed. This group of schools was characterized by dual instruction (instructing students both in-person and remotely) over the course of the year. Some schools in this pathway transitioned across entirely in-person and dual modalities through the year, while others were dual at all four time points.

(4) Substantially In-Person. In this group of schools, all students attended school in-person at multiple time points throughout the year.

Method

Data

Analyses were conducted for public schools in Illinois with test scores in both the 2018-19 (SY19) and 2020-21 (SY21) school years to compare test scores before and after the disruption of in-person schooling as a consequence of the COVID-19 pandemic.[b] To compare across age groups, we divided the sample into grade bands: schools serving (a) grades 3-5, (b) grades 6-8, and (c) grade 11. This means that a single school could be included in more than one analysis by grade band (e.g., a school serving grades K-8 would be included in both the 3-5 grade band and the 6-8 grade band). The analytical samples were restricted to those with no missingness on any variable used in our model (i.e., test scores, modality pathways, and controls), leaving the analytical sample sizes to be 92%, 90%, and 85% of the full school-sample for grades 3-5, 6-8, and 11, respectively.

The number and percentage of schools by modality pathway included in our analysis are shown in Table 1. As shown, the percentage of schools in each modality pathway is very similar across grade bands, with the exception that in grade 11 fewer schools were *Substantially Remote,* and more schools were *Mixed*.

Table 1

Sample Sizes by Modality Pathways

	Full Sample		
	Grades 3-5	Grades 6-8	Grade 11
N Schools	2157	1565	654
Remote All Year	339 (16%)	291 (19%)	108 (17%)
Substantially Remote	925 (43%)	604 (39%)	203 (31%)
Mixed	180 (8%)	151 (10%)	128 (20%)
Substantially In-Person	713 (33%)	519 (33%)	215 (33%)

Notes: Percentages within grade band in parenthesis

Table 2 shows how schools across instructional modality pathways differed in terms of demographic characteristics in SY19 (Table 2A) and SY21 (Table 2B). These characteristics were calculated using student-level data aggregated to the level of schools.[c]

[b] Note that this is a subset of the sample that is used in Report 1, which disaggregated descriptive statistics for all Illinois schools serving grades 3-8 and 11.

[c] ISBE shared student-level data with our team on April 1, 2022. We note this date due to ISBE's data revision process for recently collected data, which involves regular updates as new data becomes available.

The data displayed represent within-modality pathway averages of school demographic averages, rather than average demographics of students within each modality pathway.[d]

Across years, schools with higher proportions of White students experienced more in-person instruction, whereas schools with higher proportions of Black, Latinx, low-income, and English learner students had more remote instruction. Schools in the *Remote All Year* pathway were also less likely to be in districts categorized as Evidence-Based Funding Tier 4, a state designation for districts with sufficient local financial resources to meet students' educational needs. Small schools were more likely to be *Substantially In-Person*, whereas average enrollment was highest among schools that were *Substantially Remote*. We also explored whether there were systematic differences in pre-pandemic (SY19) *5Essentials* scores across schools that developed different modality pathways. The *5Essentials* correspond to five indicators of school quality, calculated annually based on responses to the *5Essentials* survey of students and teachers, which is administered at all Illinois schools annually (ISBE, 2022). These school quality indicators–effective leaders, collaborative teachers, involved families, supportive environments, and ambitious instruction–predict positive test score outcomes (Klugman et al., 2015). Scores for the 5Es range from 1-99 (UChicago Impact, 2020). We did not observe systematic differences in pre-pandemic 5Es by modality pathways.

Chicago Public Schools (CPS), a district that comprises approximately 18% of all schools in our sample, made up a predominant proportion of the *Remote All Year* pathway (59%) and a large proportion of the *Substantially Remote* pathway (22%). To understand how descriptive characteristics for these pathways may have been influenced by the characteristics of this single large district, we also examined the characteristics of modality pathways excluding CPS. A primary difference was that the proportion of schools that were *Remote All Year* dropped by around half, while the proportion of schools that were *Substantially In-Person* increased. Further details can be found in the first report of this series.

[d] See *Report 1* of the series for additional detail about our decision to display data in this way.

Table 2.

*A. **SY19** School Average Descriptive Statistics by Modality Pathways*

	Remote All Year	Substantially remote	Mixed	Substantially in-person
Race/ethnicity				
White	7.3%	40.7%	70.4%	82.4%
Black	43.2%	22.1%	7.8%	4.0%
Hispanic/Latinx	44.7%	26.6%	15.1%	7.6%
Two or more races	1.7%	4.1%	4.0%	3.7%
Free or Reduced-Price Lunch (FRPL)	82.6%	49.7%	45.8%	39.4%
Homeless	5.2%	2.2%	2.1%	2.1%
English learners (EL)	22.6%	13.2%	5.8%	3.0%
Individualized Education Program (IEP)	15.6%	14.5%	14.4%	14.5%
Enrollment	621.2	636.5	551.7	336.2
EBF Tier 4	1.8%	13.7%	15.6%	16.1%
*5Essentials**				
Effective leaders	47.2	46.9	42.6	43.9
Collaborative teachers	51.4	49.8	43.0	42.8
Involved families	50.1	52.2	41.9	42.6
Supportive environment	51.4	57.6	55.1	58.5
Ambitious instruction	64.0	58.9	52.5	52.5

* We considered 5Es only in SY19 because in SY21 these could potentially be affected by instructional modality.

*B. **SY21** School Average Descriptive Statistics by Modality Pathways*

	Remote All Year	Substantially remote	Mixed	Substantially in-person
Race/ethnicity				
White	7.0%	39.5%	69.0%	81.6%
Black	42.9%	22.2%	8.0%	4.0%
Hispanic/Latinx	45.3%	27.4%	15.5%	8.3%
Two or more races	1.8%	4.3%	4.5%	3.8%
Free or Reduced-Price Lunch (FRPL)	80.6%	49.0%	44.4%	38.6%
Homeless	1.4%	1.0%	2.3%	2.1%
English learners (EL)	23.8%	14.6%	6.6%	3.3%
Individualized Education Program (IEP)	16.1%	14.9%	14.7%	15.2%
Enrollment	582.8	610.1	536.1	318.7
EBF Tier 4	1.8%	13.7%	15.6%	16.1%

Table 3 shows additional characteristics that changed substantially from SY19 to SY21 across modality pathways. In grades 3-8, pre-pandemic (SY19) attendance and IAR test participation were similar across schools in different modality pathways. By SY21, schools in the *Remote All Year* pathway had the lowest attendance and test participation rates, and rates increased as the proportion of in-person instruction increased.

In grade 11, *Remote All Year* and *Substantially Remote* schools had the lowest pre-pandemic (SY19) average attendance rates, and by SY21 their rates declined more than schools in other pathways. Similarly, *Remote All Year* schools had the lowest pre-pandemic SAT participation, and their participation rates declined the most in SY21.Like attendance rates, test participation rates increased along with the proportion of in-person instruction, likely because standardized testing took place in-person.

Table 3 also shows average enrollment declines from SY19 to SY21 across schools in each modality pathway. Across grade bands, schools that were *Remote All Year* had a larger percent change in student enrollment than other modality pathways.

School Modality Pathways

Schools were categorized into four mutually exclusive modality pathways, including: *Remote All Year*, *Substantially Remote*, *Mixed*, and *Substantially In-Person*. More details for the construction of modality pathways can be found in *Report 1*. In our analyses, we compared how outcomes of schools in the *Substantially Remote*, *Mixed*, and *Substantially In-Person* pathways compared to outcomes of schools that were *Remote All Year*.

Table 3.

SY19 & SY21 Average Attendance Rates and Test Participation Rates, and SY19 to SY21 Average % Change in Enrollment, by Grade Bands

	Remote All Year	Substantially Remote	Mixed	Substantially In-Person
Grades 3-5				
Attendance rate				
SY19	94.7%	95.0%	94.8%	95.4%
SY21	91.9%	94.0%	94.4%	95.0%
IAR ELA test participation rate				
SY19	98.8%	98.6%	99.5%	99.4%
SY21	43.4%	71.5%	85.5%	91.7%
IAR Math test participation rate				
SY19	98.6%	98.4%	99.4%	99.4%
SY21	42.5%	70.6%	85.5%	91.5%
Enrollment % change from SY19 to SY21	-8.2%	-7.0%	-7.1%	-6.2%
Grades 6-8				
Attendance rate				
SY19	94.7%	94.7%	94.8%	95.1%
SY21	91.8%	92.9%	94.5%	94.6%
IAR ELA test participation rate				
SY19	98.5%	97.7%	99.2%	99.3%
SY21	41.5%	67.4%	84.4%	92.6%
IAR Math test participation rate				
SY19	98.2%	97.9%	99.0%	99.2%
SY21	40.7%	66.3%	83.6%	92.4%
Enrollment % change from 2019 to 2021	-7.6%	-4.7%	-2.9%	-5.3%
Grade 11				
Attendance rate				
SY19	85.5%	91.7%	93.2%	94.0%
SY21	78.5%	89.2%	92.5%	93.0%
SAT Reading test participation rate				
SY19	92.8%	97.6%	98.7%	98.7%
SY21	81.8%	91.6%	94.9%	96.1%
SAT Math test participation rate				
SY19	92.8%	97.6%	98.7%	98.7%
SY21	81.8%	91.6%	94.9%	96.1%
Enrollment % change from 2019 to 2021	-4.2%	-2.0%	-1.0%	-2.7%

Measures of School Achievement

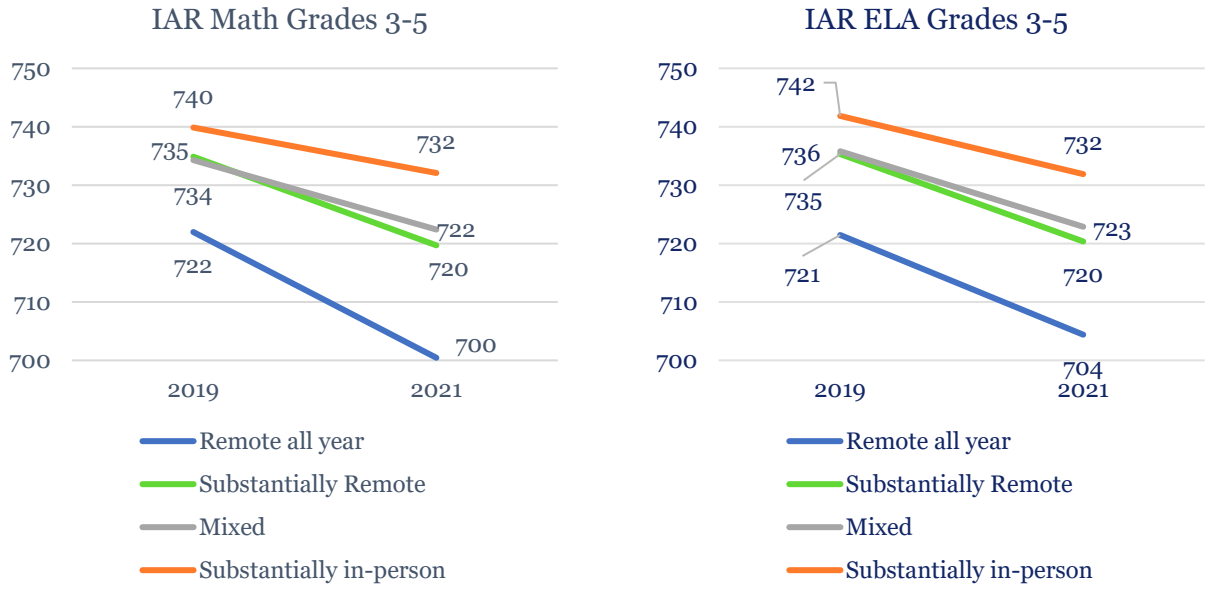
We measured average school achievement using scale scores of standardized tests in SY19 and SY21. For grades 3-8, achievement data is based on mean performance on the Illinois Assessment of Readiness (IAR) in ELA and math, and for grade 11, achievement data is based on mean performance on the reading and math strands of the SAT. Average school scores reflect the mean scores of schools that participated in both SY19 and SY21 testing.[e] IAR scores have a scale from 650-800 points (ISBE, 2019). In SY19, school IAR averages ranged from 650 to 798 in ELA and from 657 to 800 in Math. The SAT scale ranges from 200 to 800 for each subject (College Board, 2021). In SY19, school average scores ranged from 210 to 633 in Reading and from 200 to 637 in Math.

Figures 1a and 1b show the trends of IAR math and ELA scores, respectively, for grades 3-5 based on descriptive statistics. Although all schools had declines in math and ELA scores from SY19 to SY21, the *Remote All Year* pathway had the largest drops. Specifically, the *Remote All Year* pathway had a 22-point decline in math scores, whereas the *Substantially Remote*, *Mixed*, and the *Substantially In-Person* pathways had 15-, 12-, and 8-points decreases in math scores, respectively. Similar patterns of findings were also revealed in ELA scores. The drop in ELA scores for the *Remote All Year* pathway was 17 points—larger than the drops for most other modality pathways (15-, 13-, and 10-point declines for the *Substantially Remote*, *Mixed*, and *Substantially In-Person* pathways, respectively).

The trends in IAR math scores for grades 6-8 followed similar patterns as grades 3-5. The *Remote All Year* pathway had the largest decline in math (by 10 points) compared to any other modality pathways (9-, 8-, and 6-point declines for the *Substantially Remote*, *Mixed*, and *Substantially In-Person* pathways, respectively) (Figure 2a). However, trends in IAR ELA scores for grades 6-8 were different—the *Mixed* pathway had the largest drop (by 11 points), whereas other modality pathways had similar magnitudes of declines (by around 8 points) (Figure 2b).

[e] In SY21, districts were given the option to delay spring 2021 testing to the fall of 2021. For these districts, we measure SY21 test scores using data from the fall of 2021. However, as described in the section entitled *Complementary Analyses*, we reran our analysis excluding schools in districts that delayed testing to check whether our estimates change after including these schools.

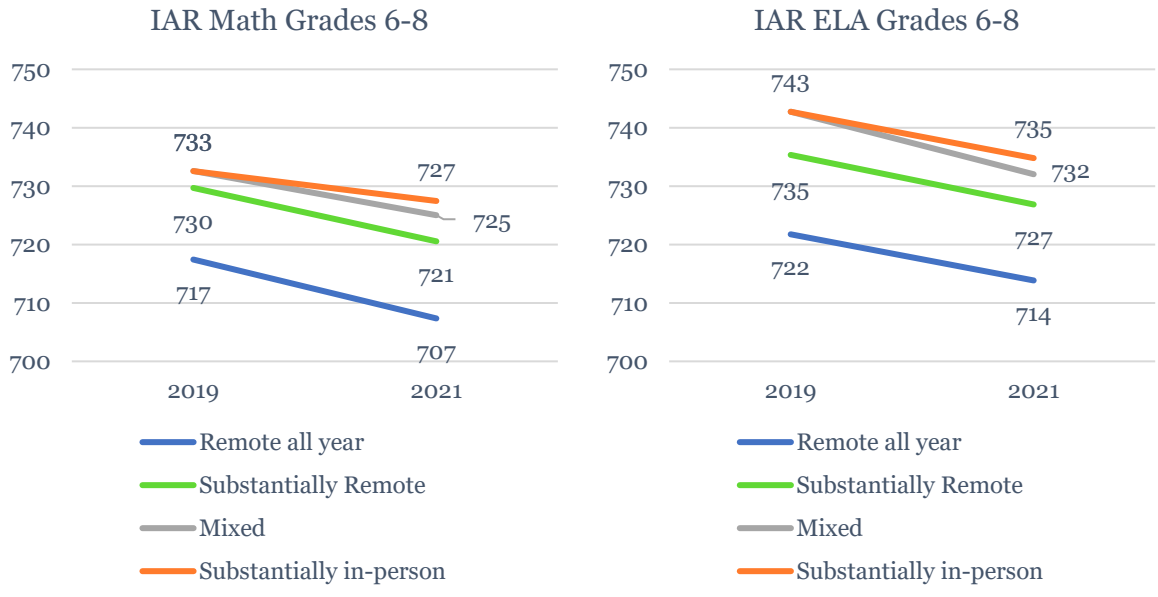
Figure 1.
Descriptive Trends of IAR Math and ELA Scores, Grades 3-5



a. Math

b. ELA

Figure 2.
Descriptive Trends of IAR Math and ELA Scores, Grades 6-8



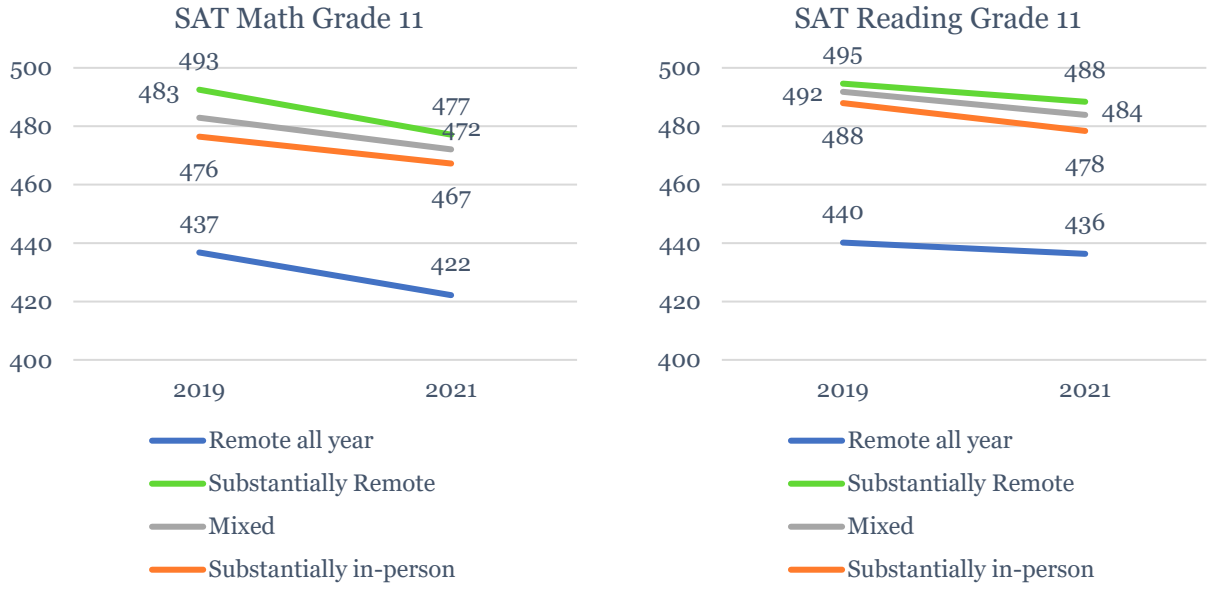
a. Math

b. ELA

Trends in SAT math and reading scores for grade 11 are shown in Figures 3a and 3b. All schools had decreases in SAT scores from 2019 to 2021, and the modality pathways that had the largest drops varied across reading and math tests. For instance, the *Substantially Remote* pathway had the largest drops in SAT math scores (by 16 points), followed by the *Remote All Year* pathway (15 points), the *Mixed* pathway (11 points) and, finally, the *Substantially In-Person* pathway (9 points). However, the *Substantially In-Person* pathway had a 10-point decrease in SAT reading (Figure 3b), which was larger than other modality pathways (8-, 7-, and 4-point declines for the *Mixed*, *Substantially Remote*, and *Remote All Year* pathways, respectively).

Figure 3.

Descriptive Trends of SAT Math and ELA Scores, Grade 11



a. Math

b. ELA

When examining descriptive trends, it is important to keep in mind that the relationships observed between schools in different modality pathways and test scores could be attributable to other factors that differed between schools in SY19 and SY21. In turn, we control for a range of these school characteristics. This means that when we compare schools, we use statistical models to hold constant the non-modality characteristics, such as

student demographics and school quality, that we think could influence differences in the outcomes we observe. This provides a clearer picture of the relationship between modality and outcomes, net of other factors.

Controls

In all subsequent analyses, we controlled for SY19 and SY21 school-level demographics, which were aggregated from student-level data. These controls included race/ethnicity (% of students who were White, Black, Hispanic/Latinx, and had two or more races), eligibility for Free/Reduced-Price Lunch (FRPL), homelessness status, English learner (EL) status, participation in an Individualized Education Program (IEP), and school enrollment. We aggregated to the level of schools based on where students attended school in each year. We assigned students who switched schools during the school year to the school where they spent the majority of the year.

We also controlled for a number of school characteristics in SY19, including scores on the *5Essentials* measures of effective leaders and ambitious instruction in SY19, which were moderately correlated with instructional modality. We also controlled for SY19 attendance rates and test participation rates. We did not control for any of these school characteristics in SY21, because all could potentially be affected by instructional modality. For example, if remote instruction caused lower attendance rates, then controlling for SY21 attendance would reduce our ability to understand variation accounted for by modality.

Finally, we controlled for whether a school was in a district classified as Evidence-Based Funding (EBF) Tier 4. The state categorizes all districts into an EBF Tier, which reflects the extent to which local financial resources meet students' educational needs (ISBE, n.d.). Specifically, districts classified as Tier 4 are determined to have local funding exceeding that required to meet educational needs. In theory, schools in districts in EBF Tier 4 have funding to meet 100% of their expenses plus additional funding. This excess funding could hypothetically affect both test scores and modality choice. For example, schools with more funding nationally were reported to implement mitigation strategies more quickly, making in-person instruction viable sooner (Godoy, 2022). In turn, we controlled for EBF Tier 4 status, which was the same in SY19 and SY21 for all schools.

We also considered using publicly available data from the Illinois Department of Public Health (IDPH) to control for COVID-19 cases by county and overall hospitalizations by IDPH COVID-19 region (IDPH, 2022). In theory, COVID-19 rates could affect both schools' instructional modality choices and student test scores. However, none of these measures changed model estimates or improved goodness-of-fit of Likelihood Ratio Tests (LRT), so we ultimately did not include these as controls.

Missing Data

Overall, 3.8% of schools statewide were excluded from the sample because they did not have test score data for SY19 and/or SY21. Detailed characteristics of schools with missing test scores can be found in Appendix A1.

Additionally, testing participation rates within schools were lower for 2021 compared to 2019 (see Table 3). In turn, 2021 average school scores generally do not represent all students in each school. Participation rates were lower for grades 3-8 than for grade 11, and for schools with more remote instruction than for schools with more in-person instruction. In order to participate in testing, students had to come into school on the days of testing, even if they otherwise learned remotely. Coordinating in-person testing in otherwise remote schools may have presented unique organizational challenges for administrators and teachers. Testing in-person in these schools may also have been perceived negatively by students and/or parents with concerns about COVID-19 spread. Appendix Table A2 shows correlations between schools' test participation rates and demographic characteristics. Participation rates in SY21 were strongly and positively correlated with schools' proportion of white students and negatively correlated with schools' proportions of Black students, Latinx students, low-income students, and English learners, as shown in Appendix Tables A2 and A3. Because these groups historically have scored below-average on state standardized tests, it is likely that higher participation among these groups would have decreased average school scores in SY21. Because these groups were overrepresented in *Remote All Year* schools, which serve as our reference pathway, higher participation would have likely widened the differences observed between modality pathways. In other words, our estimates are likely *smaller* than the true relationships between modality and achievement due to missing data within schools.

Analytical Strategy

Using the school achievement scores in SY19 (i.e., before the pandemic) and SY21 (i.e., after the pandemic onset), this study adopts a difference-in-differences (DiD) approach to study the relation between modality pathways and average school test score outcomes. Our DiD model is illustrated as follows:

$$Y_s = \beta_1(SubRemote_s) + \beta_2(Mixed_s) + \beta_3(SubInPerson_s) + \beta_4 Year_t + \beta_5(SubsRemote_s * Year_t) + \beta_6(Mixed_s * Year_t) + \beta_7(SubInPerson_s * Year_t) + \Omega \boldsymbol{D_{st}} + \Omega \boldsymbol{X_s} + \varepsilon_s$$

Where,

Y_s is the ELA/reading or math score of school *s*;

β_1- β_3 represent coefficients on dummy variables for each modality pathway (*Substantially Remote, Mixed, Substantially In-Person*) of school *s* in SY21 (*Remote All Year* pathway is used as the reference group.);

β_4 represents the coefficient on a dummy variable for year (=0 for SY 19; =1 for SY 21);

β_5- β_7 represent coefficients on interactions between the modality pathways and year;

D is a vector of demographic controls for school *s* in year *t*, including proportions of students who were White, Black, Hispanic/Latinx, two or more races, FRPL-eligible, English learner, homeless; students with IEPs; and enrollment; and

X is a vector of other school characteristics in 2019, including mean attendance rate, test participation rate, scores on *5Essentials* measures of effective leaders and ambitious instruction, and an indicator for whether a school was categorized as EBF Tier 4.

What is a Difference-in-Differences Approach?

Evaluating the effects of policies is not straightforward because it is difficult to disentangle policy impacts from the effects of other contextual influences that change simultaneously. To address this, social scientists often use a technique called difference-in-differences (DiD). This technique allows them to compare nonequivalent groups before and after changes in time occur. In theory, if both groups are affected the same amount by other contextual influences, then we can assume that differences between groups are due to differences in policy impacts (Hong, 2015; p. 54).

In our case, the comparison groups differ in policies surrounding instructional modality. Unlike a traditional DiD, we cannot assume that all groups were affected equally by other contextual influences during the pandemic (see Bacher-Hicks & Goodman, 2022). For this reason, our estimates should not be interpreted causally. Instead, we control for other contextual influences using a wide range of school covariates. This approach in turn helps us estimate the relation between modality pathways of instruction and test scores.

β_5- β_7 in the above equation measure the changes in the associations between modality pathways and school achievement from SY19 to SY21, which are the parameters of interest as they show the relationship between modality type and school achievement.

Complementary Analyses

We reran our analyses to see how strongly our estimates were influenced by two groups of schools: schools that delayed spring 2021 testing to the fall of 2021, and schools that belong to Chicago Public Schools (CPS).

Students in schools that delayed testing experienced additional months of learning (and, potentially, summer learning loss) relative to students in schools that administered testing in the spring. While we do not have exact data on which schools tested in the spring and which schools tested in the fall, we do have a proxy measure of fall testing based on district reporting to ISBE. Schools in districts that reported that they tested in the spring were included in the December release of the SY21 report card. We found that schools in districts that did not report testing in the spring made up about 8% of our total sample and about 12% of schools that were *Remote All Year*. We reran the analysis excluding schools in districts that did not report spring testing (i.e., "fall testers") to see how our estimates changed.

CPS makes up 18% of schools in our total sample as well as 63%, 71%, and 67% of *Remote All Year* schools in grades 3-5, 6-8, and grade 11, respectively. As a result, schools in this single district may have had a large influence on the size of our estimates. Additionally, any unobserved district-level confounders from this single district have the potential to disproportionately impact the size of our estimates. We also conducted a complementary analysis excluding schools in CPS to examine if and how estimates changed.

Results

Modality Pathways Trends in Test Scores: Difference-in-Differences Model Results

The estimated associations between modality pathways and IAR test scores for grades 3-5 are shown in Table 4. The first and fourth columns show the associations between the IAR math and ELA scores with modality pathways, year, and interaction terms

between modality pathways and year, respectively. The second and fifth columns display the significance levels, whereas the third and sixth columns show the effect sizes (Cohen's *d*, calculated using student-level standard deviations).

Table 4

Estimated Associations between Modality Pathways and IAR Scores with Difference-in-Differences Models Grades 3-5 (as compared to Remote all Year schools)

	Math			ELA		
VARIABLES	Estimate (SE)	Significance level	Effect size *D*	Estimate (SE)	Significance level	Effect size *d*
Substantially Remote	-3.20	***	-0.09	-1.67	*	-0.04
	(0.66)		(0.02)	(0.68)		(0.02)
Mixed	-4.35	***	-0.12	-2.44	*	-0.06
	(0.97)		(0.03)	(1.00)		(0.02)
Substantially In-person	-5.22	***	-0.15	-2.88	***	-0.07
	(0.80)		(0.02)	(0.83)		(0.02)
Year (2021)	-22.02	***	-0.61	-17.71	***	-0.43
	(0.74)		(0.02)	(0.76)		(0.02)
Year*Substantially Remote	**7.02**	***	**0.20**	**3.01**	***	**0.07**
	(0.85)		**(0.02)**	**(0.88)**		**(0.02)**
Year*Mixed	**9.95**	***	**0.28**	**4.83**	***	**0.12**
	(1.24)		**(0.03)**	**(1.28)**		**(0.03)**
Year*Substantially In-person	**14.33**	***	**0.40**	**7.92**	***	**0.19**
	(0.89)		**(0.02)**	**(0.92)**		**(0.02)**
Constant	553.77	***	-5.03	545.81	***	-4.56
	(14.03)		(0.39)	(14.58)		(0.35)
R-square		0.77			0.75	
Number of observations		2,157			2,157	

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

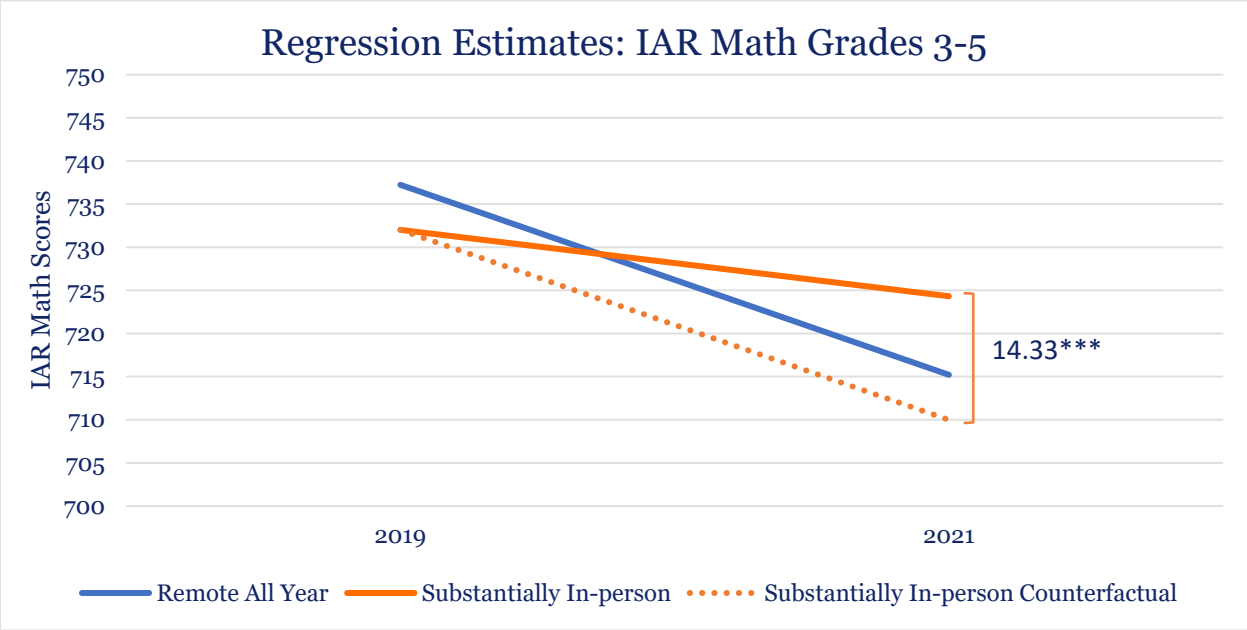
Note: Reference pathway was Remote All Year. Effect sizes are Cohen's *d*. Controls included the following school characteristics in SY19 and SY21: % White, % Black, % Hispanic/Latinx, % Two or more races, % Low-income, % Homeless, % English learners, % IEP, and enrollment. SY19 school characteristics that were controlled include: mean attendance rate, test participation rate, indicator for Evidence-Based Funding Tier 4, and scores on the *5Essentials* measures for Effective Leaders and Ambitious Instruction.

For grades 3-5 (in Table 4), coefficients in the three rows of interaction terms (*Year*Modality Pathway*) show how scores across modality pathways changed in 2021, relative to the change experienced by the *Remote All Year* pathway, after controlling for school characteristics. These are our primary estimates of interest. Results indicate that for grades 3-5, each modality pathway declined less in ELA and math from SY19 to SY21 than similar schools that were *Remote All Year*. Differences were larger for schools in pathways that spent more of the year in-person.

Figure 4 illustrates this finding graphically for schools in the *Substantially In-Person* pathway. Unlike Figure 1, which shows descriptively how subgroups performed from SY19 to SY21, here we show estimates of achievement *controlling for school characteristics*. In other words, we graph how schools with different modality pathways would be expected to perform if they served students with the same demographic characteristics and were the same on the other variables we controlled in our models (SY19 attendance rate, test participation rate, scores on *5Essentials* measures of effective leaders and ambitious instruction, whether a school was categorized as EBF Tier 4). The blue solid line shows the estimated associations between the *Remote All Year* pathway and IAR math scores. The orange dotted line, which is parallel with the solid blue line, displays the association that we would expect to see between the *Substantially In-Person* pathway and math scores if it had the same relationship with math scores as the *Remote All Year* pathway; that is, if the *Substantially In-Person* pathway had no significantly different association with math scores compared to that of the *Remote All Year* pathway. The solid orange line in Figure 4 shows the estimated association between the *Substantially In-Person* pathway and math scores. Notably, *Substantially In-Person* schools scored lower than *Remote All Year* schools, controlling for school characteristics, in SY19. However, the solid orange line representing their change from SY19 to SY21 has a flatter slope than the counterfactual (dotted). This indicates that *Substantially In-Person* schools had smaller declines (by 14.3 score points, or 0.40 SDs) in math scores than similar schools in the *Remote All Year* pathway from SY19 to SY21.

Figure 4.

Difference-in-Differences Estimates, IAR Math Grades 3-5, Substantially In-Person vs. Remote All Year



Findings in Table 4 show similar patterns across subject areas for grades 3-5. The *Substantially In-Person*, *Mixed*, and *Substantially Remote* pathways had significantly smaller declines in math (by 0.40, 0.28, and 0.20 SDs, respectively) than the *Remote All Year* pathway. Similar patterns of findings are revealed for ELA–the *Substantially In-Person*, *Mixed*, and *Substantially Remote* pathways had less loss in SY21 (by 0.19, 0.12, and 0.07 SDs, respectively), but these relationships were smaller than those observed in math.

Tables 5 and 6 display the results for grades 6-8 and grade 11, respectively. All estimates of the associations between modality pathways and school achievement display differences relative to the *Remote All Year* pathway, our reference group.

Table 5

Estimated Associations between Modality Pathways and IAR Scores with Difference-in-Differences Models Grades 6-8 (as compared to Remote all Year schools)

	Math			ELA		
VARIABLES	Estimate (SE)	Significance level	Effect size *d*	Estimate (SE)	Significance level	Effect size *d*
Substantially Remote	-0.43		-0.01	0.87		0.02
	(0.66)		(0.02)	(0.80)		(0.02)
Mixed	-0.99		-0.03	3.26	**	0.08
	(0.99)		(0.03)	(1.19)		(0.03)
Substantially In-person	-1.49	+	-0.04	2.06	*	0.05
	(0.87)		(0.02)	(1.04)		(0.03)
Year (2021)	-9.40	***	-0.26	-7.47	***	-0.18
	(0.74)		(0.02)	(0.89)		(0.02)
Year*Substantially Remote	**1.31**		**0.04**	**0.01**		**0.00**
	(0.87)		**(0.02)**	**(1.05)**		**(0.03)**
Year*Mixed	**1.75**		**0.05**	**-3.35**	*	**-0.08**
	(1.23)		**(0.03)**	**(1.48)**		**(0.04)**
Year*Substantially In-person	**4.45**	***	**0.12**	**-0.31**		**-0.01**
	(0.91)		**(0.03)**	**(1.10)**		**(0.03)**
Constant	615.00	***	-3.17	588.51	***	-3.55
	(12.77)		(0.36)	(15.51)		(0.37)
R-square		0.75			0.68	
Number of observations		1,565			1,565	

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Note: Reference pathway was Remote All Year. Effect sizes are Cohen's *d*. Controls included the following school characteristics in SY19 and SY 21: % White, % Black, % Hispanic/Latinx, % Two or more races, % Low-income, % Homeless, % English learners, % IEP, and enrollment. SY19 school characteristics that were controlled include: mean attendance rate, test participation rate, indicator for Evidence-based Funding Tier 4, and scores on the *5Essentials* measures for Effective Leaders and Ambitious Instruction.

Findings for grades 6-8 (Table 5) reveal a different pattern from grades 3-5. In SY19, controlling for school characteristics, each pathway group scored higher in ELA but lower in math than *Remote All Year* schools (although these differences were significant only for *Mixed* and *Substantially In-Person* schools in ELA). From SY19 to SY21, the declines in IAR math among schools in the *Substantially In-Person* pathway were significantly smaller than the *Remote All Year* pathway (by 0.12 SDs). A negative association was found between ELA

and the *Mixed* pathway for 6-8 graders, indicating that schools of the *Mixed* pathway declined more compared to their peers in the *Remote All Year* pathway from SY19 to SY21.

Table 6 shows the results for grade 11. Controlling for school characteristics, schools in each pathway scored lower in math pre-pandemic (SY19) than similar *Remote All Year* schools (although these differences were significant only for the *Mixed* and *Substantially In-Person* pathways). There were no significant SY19 differences in ELA. From SY19 to SY21, there were no statistically significant associations between modality pathways and SAT score declines.

Table 6

Estimated Associations between Modality Pathways and SAT Scores with Difference-in-Differences Models Grade 11 (as compared to Remote all Year schools)

	Math			Reading		
VARIABLES	Estimates	Significance level	Effect size	Estimates	Significance level	Effect size
Substantially Remote	-0.04		-0.00	4.56		0.05
	(3.26)		(0.03)	(2.83)		(0.03)
Mixed	-8.29	*	-0.08	-0.25		-0.00
	(4.00)		(0.04)	(3.46)		(0.03)
Substantially In-person	-15.17	***	-0.14	-4.58		-0.05
	(3.96)		(0.04)	(3.43)		(0.03)
Year (2021)	-17.48	***	-0.16	-4.29		-0.04
	(3.65)		(0.03)	(3.16)		(0.03)
Year*Substantially Remote	0.91		0.01	-2.57		-0.03
	(4.32)		(0.04)	(3.74)		(0.04)
Year*Mixed	5.78		0.05	-4.32		-0.04
	(4.79)		(0.05)	(4.15)		(0.04)
Year*Substantially In-person	7.51	+	0.07	-6.07		-0.06
	(4.37)		(0.04)	(3.79)		(0.04)
Constant	559.34	***	0.78	550.94	***	0.67
	(25.76)		(0.24)	(22.31)		(0.22)
R-square		0.77			0.78	
Number of observations		654			654	

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Note: Reference pathway was Remote All Year. Effect sizes are Cohen's *d*. Controls included the following school characteristics in SY19 and SY 21: % White, % Black, % Hispanic/Latinx, % Two or more races, % Low-income, % Homeless, % English learners, % IEP, and enrollment. SY19 school characteristics that

were controlled include: mean attendance rate, test participation rate, indicator for Evidence-based Funding Tier 4, and scores on the *5Essentials* measures for Effective Leaders and Ambitious Instruction.

The same analysis was conducted on the sample excluding schools that were presumed to administer SY21 tests in the fall of 2021, as described above. Estimates were very similar for grades 3-5 and grades 6-8. In grade 11 math, estimates showed a more positive relationship between modality pathways with more in-person learning and test score outcomes. These relationships were statistically significant for schools in the *Mixed* and *Substantially In-Person* pathways. These estimates can be found in Appendix Tables B1-B3. These findings suggest that including all schools in our main analysis, regardless of whether they tested in spring or fall, decreases the precision of our estimates, thus obscuring some of the relationship between modality pathways and outcomes in grade 11.

We also conducted our analysis excluding schools in CPS to observe the influence of this single district (see Appendix Tables B4-B6). Patterns were about the same for math, but they changed for ELA. In grades 3-5 ELA, estimates were smaller, and the *Substantially Remote* and *Mixed* schools were no longer statistically significantly different from *Remote All Year* schools. *Substantially In-Person* remained significant. For grades 6-8, the associations between ELA and the *Mixed* pathway were no longer significant. These changes in significance for grades 3-8 may reflect the fact that the sample is smaller when excluding CPS schools, leaving less power in our models overall. The changes may also suggest that CPS schools serving grades 3-8 had a stronger ELA benefit than other schools from more in-person modality pathways. For grade 11, on the other hand, the *negative* association between the *Substantially In-Person* modality and SAT reading scores became significant after excluding CPS. In other words, schools in the *Substantially In-Person* pathway had larger drops in SAT reading scores than what we would expect if they had been *Remote All Year*. This finding suggests several possibilities. It could be the case that an unobserved confounder influenced estimates for CPS schools, biasing our overall results to obscure the true relationship. It could also be the case that CPS schools did not perform worse in grade 11 reading when they spent more of the year in-person, but other schools statewide did.

How Much Stock Should We Put in These Findings?

For policymakers and practitioners tasked with making decisions based on evidence from research, it is important to consider study quality when interpreting implications of

findings. The *Every Student Succeeds Act* (ESSA) of 2015 established a framework to help guide this evaluation process. As a correlational study with a number of statistical controls for selection bias, the present investigation would be considered a Tier 3 study, indicating "promising evidence," under this framework (U.S. Department of Education, 2016).

Estimates generated in this study, like in other studies of pandemic-related instructional modality, should not be interpreted causally. After the onset of the pandemic, a host of policy changes affected schools in conjunction with policies about learning modality. These policy changes may be correlated with instructional modality and may also have affected test scores, making it difficult to disentangle the relationship of modality with test scores from other school changes (Bacher-Hicks & Goodman, 2021). Other contextual factors such as COVID-19 case rates and community policies may be additional confounders. While we found no changes to our estimates when controlling for average county-level COVID-19 case rates or regional rates of hospital beds in use, we were not able to control for other post-pandemic changes in community characteristics that may have impacted outcomes.

The use of schools as our unit of analysis creates additional difficulty in our attempts to control for confounding factors. Schools in Illinois vary dramatically in student demographic makeup, and schools with very different demographic characteristics also tended to differ in terms of modality pathway. For example, among schools serving grades 3-5 that were *Remote All Year*, 99% served a student body that was over 50% non-White. This was the case for just 10% of *Substantially In-Person* schools. In turn, schools with different modality pathways often had little overlap in potentially confounding covariates, such that some estimates may be based on linear extrapolation beyond the data actually observed. If the relationship between school modality pathway and achievement differs among different demographic groups, our estimates could be biased (Cochran, 1957).

Another concern relates to low SY21 test participation rates, especially in schools serving grades 3-8, schools serving higher proportions of demographic subgroups that historically have scored lower on standardized tests, and schools that spent more time in remote learning. Based on these characteristics, it is likely that higher test participation overall would have decreased mean school scores in the *Remote All Year* pathway, with smaller decreases in modality pathways with more in-person instruction. In turn, it is likely that our findings *underestimate* the positive relationship between modalities with more in-

person learning and test score outcomes. This report also presents analyses of school-level averages; analyses of individual students can produce different results (e.g., Simpson's paradox: Blyth, 1972).

The third report in this series uses student-level data to address the limitations caused by dramatic demographic differences between schools and missing data. The use of students as the unit of analysis provides sufficient cases to ensure covariate overlap between students with different amounts of in-person instruction.

Discussion

The COVID-19 pandemic left education leaders with difficult decisions to make about whether, when, and how to resume in-person learning during the 2020-21 school year. Across Illinois, districts and schools weighed a number of factors as they constructed, and at times revised, plans for the instructional modalities they offered over the course of the year. Students and families within schools responded to these options, often choosing between in-person, dual, and/or remote modalities. As a result, the types of instruction students experienced varied tremendously across schools statewide. We analyzed this variation to understand how schools' instructional modality patterns were related to changes in school average test scores from 2019 to 2021 in grades 3-5, 6-8 and 11. By analyzing data at the school level, we are able to explore this relationship for a wider range of grade levels than the student-level data allows (as analyzed in Part 3 of this series).

We grouped schools into four modality pathways based on their patterns of instruction in the SY21. We showed that all modality pathways had declines in learning, suggesting that outside factors in addition to instructional modality likely contributed to lowering school average scores. However, schools in different modality pathways showed different patterns of learning declines, on average. When we controlled for school characteristics, we found that for grades 3-5, schools with remote learning all year had scored higher before the pandemic (in SY19) than schools with similar demographic characteristics. However, from SY19 to SY21, schools experiencing in-person instruction (i.e., *Substantially In-Person*, *Mixed*, and *Substantially Remote*) showed smaller declines in school average performance in both ELA and math in SY21 than schools with remote learning all year. These relationships were stronger for schools with higher proportions of in-person instruction and for math. For grades 6-8, the modality pathway with the highest

proportion of in-person instruction (i.e., *Substantially In-Person*) had smaller declines in math, but not ELA, from 2019 to 2021. There were no positive associations between instructional pathways with more in-person learning and ELA scores, and in fact schools that were in the *Mixed* pathway had larger declines than schools that were *Remote All Year*.

In our full sample, we found no significant associations between modality pathways and school average SAT reading and math scores among 11th graders statewide. However, including schools that administered SY21 testing in the fall instead of the spring of 2021 appears to have reduced precision in our estimates. When we exclude schools that did not report testing in the spring (presumed "fall testers"), we see lower declines in math in schools with more in-person instruction from SY19 to SY21. We also saw differences when excluding the influence of CPS. We found that in the remaining schools in the state, there was a negative relationship among schools that spent the most time learning in-person and school average SAT reading scores.

The findings for grades 3-5 are consistent with other research that has found greater declines in schools with more remote instruction during the pandemic (Darling-Aduana et al., 2022; EPIC, 2021; Halloran et al., 2021; Kogan & Lavertu, 2021). In terms of practical significance, the effect sizes estimated for each modality pathway compared to *Remote All Year* schools in grades 3-5 math can be considered moderate to large (Kraft, 2020). For a school at the 29th percentile of performance on the IAR Math assessment relative to other schools in SY21, an improvement by 0.40 standard deviations (as observed among *Substantially In-Person* schools in grades 3-5 math) would move them to into the 50th percentile. In grades 3-5 ELA and among *Substantially In-Person* schools in 6-8 math, effect sizes can be considered small to moderate (Kraft, 2020).

Overall, our findings suggest that spending a greater part of the year learning in-person was associated with higher average achievement for schools serving the youngest students. This finding is also consistent with existing literature on modality-related learning loss (Darling-Aduana et al., 2022; EPIC, 2021; Halloran et al., 2021; Kogan & Lavertu, 2021). However, for schools serving grades 6-8 and 11, the relationships were small and varied. The grade-level differences we observe may reflect the heightened importance of in-person interaction for younger children, which supports their developing executive functioning skills and may buffer their increased susceptibility to stressors such as those associated with the pandemic (Tomasik et al., 2021). Older students, on the other hand, do

not appear to be as adversely affected by remote instruction. There may be other alternative explanations of this finding. Future research should explore how and why instructional modality shapes outcomes for older students differently from elementary students.

Implications

In interpreting the implications of these findings, it is important to acknowledge that test scores were just one of many important outcomes of schooling during the pandemic. School leaders, students, and families weighed risks of different instructional modalities for health and safety, both physical and mental, of students and staff (Darling-Aduana et al., 2022; Rapaport et al., 2020). Many of these considerations took place during a time of great uncertainty about how schooling affected COVID-19's spread, and before vaccines were approved for use in younger children. Test scores were likely not the primary factor schools and families considered when making choices about instructional modality.

Yet as measures of how instructional modality impacted student learning during the pandemic, school average test scores provide important information about whose learning was disrupted and by how much. This study shows that, for grades 3-5, schools with more remote instruction experienced worse outcomes than similar schools with more in-person learning, especially in math. For grades 6-8 and 11, the story is more nuanced, and the direction and significance of relationships depended on the specific subject area and school sample. Overall, more in-person learning was sometimes associated with smaller declines in school average math but larger declines in reading. However, these relationships for the higher grade levels were small.

Schools with disproportionately Black, Latinx, English learner, low-income, and homeless populations spent more time in remote learning, on average. Among schools serving grades 3-5, schools that were remote all year scored better than similar schools pre-pandemic but worse in SY21, after controlling for school characteristics. In turn, instructional modality patterns across schools could have exacerbated pre-existing racial/ethnic and socioeconomic disparities in student achievement, as has been found by other researchers (Goldhaber, Kane, Mceachin, Morton, et al., 2022).

These findings may not be generalizable outside of pandemic contexts. Under different conditions, well-designed and thoughtfully implemented models of remote instruction may or may not have the relationships with achievement observed in this study.

However, our findings are relevant as school leaders make decisions about how to allocate and target resources to schools as they address pandemic-related learning loss. Schools serving younger students who spent more time in remote learning may need additional support to address learning losses, especially in math. Findings also provide evidence to inform potential decisions about school instructional modality at different grade levels in response to future COVID-19 waves and other events, such as natural disasters, that interfere with schooling.

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Appendix A

Table A1

Characteristics of Schools with Missing Test Scores in SY19 or SY21

Grades 3-5			
Instructional Modality	Missing	Non-missing	Difference
Remote All Year	0.18	0.16	-0.02
Substantially Remote	0.32	0.43	0.11**
Mixed	0.18	0.08	-0.10***
Substantially In-person	0.33	0.33	0.00
Race/ethnicity			
White	0.49	0.48	-0.01
Black	0.26	0.20	-0.06**
Hispanic/Latinx	0.17	0.24	0.07**
Two or more races	0.04	0.04	0.00
Free/reduced-price lunch	0.55	0.52	-0.02
EBF Tier 4	0.18	0.13	-0.05*
EL	0.11	0.14	0.04**
IEP	0.27	0.16	-0.11***
Homeless	0.01	0.01	0.00
Attendance rate	0.94	0.94	0.00
Five essentials			
Effective leader	49.21	50.15	0.94
Collaborative teachers	45.12	46.42	1.31
Involved families	51.31	54.24	2.93
Supportive environment	67.08	69.43	2.35
Ambitious instruction	55.06	55.18	0.12
Grades 6-8			
Instructional Modality	Missing	Non-missing	Difference
Remote All Year	0.24	0.19	-0.06
Substantially Remote	0.33	0.39	0.06
Mixed	0.17	0.10	-0.07**
Substantially In-person	0.27	0.33	0.07
Race/ethnicity			
White	0.46	0.48	0.02
Black	0.28	0.21	-0.07*
Hispanic/Latinx	0.19	0.24	0.05*
Two or more races	0.04	0.03	-0.01
Free/reduced-price lunch	0.58	0.54	-0.04
EBF Tier 4	0.10	0.10	0.00
EL	0.06	0.10	0.03**
IEP	0.33	0.15	-0.18***
Homeless	0.02	0.01	0.00
Attendance rate	0.93	0.93	0.01
Five essentials			
Effective leader	48.00	51.66	3.66*
Collaborative teachers	46.60	49.50	2.90
Involved families	50.22	51.99	1.76
Supportive environment	64.11	64.83	0.71
Ambitious instruction	56.16	56.11	-0.05
Grade 11			
Instructional Modality	Missing	Non-missing	Difference
Remote All Year	0.33	0.17	-0.16***
Substantially Remote	0.31	0.31	0.00

Mixed	0.13	0.20	0.07
Substantially In-person	0.24	0.33	0.09
Race/ethnicity			
White	0.38	0.59	0.22***
Black	0.33	0.16	-0.17***
Hispanic/Latinx	0.23	0.19	-0.04
Two or more races	0.05	0.03	-0.02***
Free/reduced-price lunch	0.61	0.47	-0.13***
EBF Tier 4	0.11	0.11	0.00
EL	0.07	0.04	-0.03**
IEP	0.37	0.14	-0.23***
Homeless	0.03	0.02	-0.01**
Attendance rate	0.87	0.89	0.02
Five essentials			
Effective leader	50.11	48.04	-2.06
Collaborative teachers	56.21	49.97	-6.24
Involved families	57.39	55.53	-1.86
Supportive environment	61.18	62.26	1.08
Ambitious instruction	59.71	51.52	-8.18*

Note, difference is measured by the mean of missing group minus the mean of non-missing group. T-tests are used to examine if group differences are significant. Significance levels indicated as follows: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A2

Correlations between SY21 Test Participation Rates and School Characteristics

	Grades 3-5		Grades 6-8		Grade 11
	IAR ELA Participation	IAR Math Participation	IAR ELA Participation	IAR Math Participation	SAT Math and Reading Participation
Race/ethnicity					
White	0.72	0.73	0.72	0.73	0.48
Black	-0.42	-0.43	-0.38	-0.40	-0.46
Hispanic/Latinx	-0.46	-0.45	-0.48	-0.47	-0.24
Two or more races	0.14	0.14	0.22	0.22	-0.04
Free/reduced-price lunch	-0.49	-0.50	-0.46	-0.46	-0.44
EBF tier 4	0.16	0.16	0.12	0.11	0.14
EL	-0.45	-0.45	-0.47	-0.47	-0.37
IEP	-0.08	-0.08	-0.14	-0.14	-0.37
Homeless	0.11	0.11	0.22	0.21	-0.01
Attendance rate	0.31	0.33	0.24	0.25	0.57
Five essentials					
Effective leadership	-0.08	-0.07	-0.07	-0.07	0.06
Collaborative teachers	-0.12	-0.11	-0.15	-0.14	-0.02
Involved families	-0.05	-0.04	-0.14	-0.13	0.21
Supportive environment	0.28	0.29	0.17	0.17	0.14
Ambitious instruction	-0.01	-0.01	-0.04	-0.04	0.01

Table A3

Characteristics of Students Missing Test Scores in SY21

	Grades 3-5		Grade 6-8		Grade 11	
	Test-takers	Non-test takers	Test-takers	Non-test takers	Test-takers	Non-test takers
Race/Ethnicity						
White	55.6%	40.8%	56.1%	28.8%	50.7%	30.5%
Black	12.4%	19.6%	12.8%	23.4%	13.8%	29.2%
Hispanic/Latinx	22.1%	29.6%	21.8%	37.9%	26.2%	33.8%
Two or More	4.3%	3.8%	4.0%	3.7%	3.2%	4.1%
Homelessness	1.1%	1.4%	0.9%	1.2%	1.0%	3.4%
IEP	14.1%	15.4%	12.9%	16.0%	10.9%	28.2%
Free/reduced-price lunch	42.8%	51.0%	40.8%	58.1%	39.2%	66.3%

Appendix B

Table B1

Estimated Associations between Modality Pathways and IAR Scores with Difference-in-Difference Models Grades 3-5 (Excluding Presumed Fall Testers)

	Math			ELA		
VARIABLES	Estimates	Significance level	Effect size	Estimates	Significance level	Effect size
Substantially Remote	-3.37	***	-0.09	-1.54	*	-0.04
	(0.66)		(0.02)	(0.67)		(0.02)
Mixed	-4.50	***	-0.13	-2.33	*	-0.06
	(0.97)		(0.03)	(0.99)		(0.02)
Substantially In-person	-5.25	***	-0.15	-2.75	***	-0.06
	(0.80)		(0.02)	(0.81)		(0.02)
Year (2021)	-22.10	***	-0.62	-17.84	***	-0.43
	(0.74)		(0.02)	(0.75)		(0.02)
Year*Substantially Remote	**7.36**	***	**0.20**	**3.33**	***	**0.08**
	(0.85)		**(0.02)**	**(0.87)**		**(0.02)**
Year*Mixed	**10.88**	***	**0.30**	**5.83**	***	**0.14**
	(1.25)		**(0.03)**	**(1.26)**		**(0.03)**
Year*Substantially In-person	**14.65**	***	**0.41**	**8.33**	***	**0.20**
	(0.89)		**(0.02)**	**(0.90)**		**(0.02)**
Constant	557.92	***	-4.92	546.45	***	-4.55
	(14.14)		(0.39)	(14.45)		(0.35)
R-square		0.78			0.77	
Number of observations		2,057			2,057	

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Note: Reference pathway was Remote All Year. Effect sizes are Cohen's *d*. Controls included the following school characteristics in SY19 and SY21: % White, % Black, % Hispanic/Latinx, % Two or more races, % Low-income, % Homeless, % English learners, % IEP, and enrollment. SY19 school characteristics that were controlled include: mean attendance rate, test participation rate, indicator for Evidence-based Funding Tier 4, and scores on the *5Essentials* measures for Effective Leaders and Ambitious Instruction.

Table B2

Estimated Associations between Modality Pathways and IAR Scores with Difference-in-Difference Models Grades 6-8 (Excluding Presumed Fall Testers)

	Math			ELA		
VARIABLES	Estimates	Significance level	Effect size	Estimates	Significance level	Effect size
Substantially Remote	-0.24		-0.01	1.18		0.03
	(0.67)		(0.02)	(0.79)		(0.02)
Mixed	-0.48		-0.01	4.02	***	0.10
	(0.99)		(0.03)	(1.18)		(0.03)
Substantially In-person	-1.16		-0.03	2.68	**	0.06
	(0.87)		(0.02)	(1.03)		(0.02)
Year (2021)	-9.37	***	-0.26	-7.48	***	-0.18
	(0.75)		(0.02)	(0.89)		(0.02)
Year*Substantially Remote	**1.44**	**+**	**0.04**	**0.23**		**0.01**
	(0.87)		**(0.02)**	**(1.03)**		**(0.02)**
Year*Mixed	**2.03**	**+**	**0.06**	**-3.01**	*	**-0.07**
	(1.23)		**(0.03)**	**(1.46)**		**(0.04)**
Year*Substantially In-person	**4.58**	***	**0.13**	**-0.01**		**-0.00**
	(0.92)		**(0.03)**	**(1.09)**		**(0.03)**
Constant	607.41	***	-3.38	588.36	***	-3.55
	(12.74)		(0.35)	(15.23)		(0.37)
R-square		0.77			0.70	
Number of observations		1,477			1,477	

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Note: Reference pathway was Remote All Year. Effect sizes are Cohen's *d*. Controls included the following school characteristics in SY19 and SY 21: % White, % Black, % Hispanic/Latinx, % Two or more races, % Low-income, % Homeless, % English learners, % IEP, and enrollment. SY19 school characteristics that were controlled include: mean attendance rate, test participation rate, indicator for Evidence-based Funding Tier 4, and scores on the *5Essentials* measures for Effective Leaders and Ambitious Instruction.

Table B3

Estimated Associations between Modality Pathways and SAT Scores with Difference-in-Difference Models Grade 11 (Excluding Presumed Fall Testers)

	Math			ELA		
VARIABLES	Estimates	Significance level	Effect size	Estimates	Significance level	Effect size
Substantially Remote	-1.04		-0.01	4.44		0.04
	(3.35)		(0.03)	(2.85)		(0.03)
Mixed	-9.65	*	-0.09	-0.74		-0.01
	(4.12)		(0.04)	(3.51)		(0.03)
Substantially In-person	-16.28	***	-0.15	-5.04		-0.05
	(4.06)		(0.04)	(3.46)		(0.03)
Year (2021)	-20.92	***	-0.20	-6.32	+	-0.06
	(3.83)		(0.04)	(3.26)		(0.03)
Year*Substantially Remote	**4.24**		**0.04**	**-0.67**		**-0.01**
	(4.48)		**(0.04)**	**(3.81)**		**(0.04)**
Year*Mixed	**10.06**	*	**0.09**	**-1.88**		**-0.02**
	(4.96)		**(0.05)**	**(4.22)**		**(0.04)**
Year*Substantially In-person	**11.19**	*	**0.11**	**-3.70**		**-0.04**
	(4.53)		**(0.04)**	**(3.86)**		**(0.04)**
Constant	515.06	***	0.37	470.66	***	-0.05
	(30.08)		(0.28)	(32.14)		(0.32)
R-square		0.76			0.78	
Number of observations		625			625	

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Note: Reference pathway was Remote All Year. Effect sizes are Cohen's *d*. Controls included the following school characteristics in SY19 and SY21: % White, % Black, % Hispanic/Latinx, % Two or more races, % Low-income, % Homeless, % English learners, % IEP, and enrollment. SY19 school characteristics that were controlled include: mean attendance rate, test participation rate, indicator for Evidence-based Funding Tier 4, and scores on the *5Essentials* measures for Effective Leaders and Ambitious Instruction.

Table B4

Estimated Associations between Modality Pathways and IAR Scores with Difference-in-Difference Models Grades 3-5 (Excluding Chicago Public Schools)

	Math			ELA		
VARIABLES	Estimates	Significance level	Effect sizes	Estimates	Significance level	Effect sizes
Substantially Remote	-3.48	***	-0.10	-2.13	*	-0.05
	(0.99)		(0.03)	(0.99)		(0.02)
Mixed	-3.57	**	-0.10	-1.98		-0.05
	(1.20)		(0.03)	(1.20)		(0.03)
Substantially In-person	-4.48	***	-0.12	-2.38	*	-0.06
	(1.07)		(0.03)	(1.08)		(0.03)
Year (2021)	-20.31	***	-0.57	-14.79	***	-0.36
	(1.21)		(0.03)	(1.22)		(0.03)
Year*Substantially Remote	**6.72**	***	**0.19**	**1.28**		**0.03**
	(1.32)		**(0.04)**	**(1.32)**		**(0.03)**
Year*Mixed	**8.28**	***	**0.23**	**2.03**		**0.05**
	(1.58)		**(0.04)**	**(1.59)**		**(0.04)**
Year*Substantially In-person	**12.62**	***	**0.35**	**5.06**	***	**0.12**
	(1.31)		**(0.04)**	**(1.32)**		**(0.03)**
Constant	554.21	***	-5.02	527.34	***	-5.01
	(20.34)		(0.57)	(21.39)		(0.51)
R-square		0.73			0.72	
Number of observations		1,712			1,712	

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Note: Reference pathway was Remote All Year. Effect sizes are Cohen's *d*. Controls included the following school characteristics in SY19 and SY 21: % White, % Black, % Hispanic/Latinx, % Two or more races, % Low-income, % Homeless, % English learners, % IEP, and enrollment. SY19 school characteristics that were controlled include: mean attendance rate, test participation rate, indicator for Evidence-based Funding Tier 4, and scores on the *5Essentials* measures for Effective Leaders and Ambitious Instruction.

Table B5

Estimated Associations between Modality Pathways and IAR Scores with Difference-in-Difference Models Grades 6-8 (Excluding Chicago Public Schools)

	Math			ELA		
VARIABLES	Estimates	Significance level	Effect sizes	Estimates	Significance level	Effect sizes
Substantially Remote	-2.23	*	-0.06	-1.92		-0.05
	(1.10)		(0.03)	(1.38)		(0.03)
Mixed	-1.52		-0.04	0.75		0.02
	(1.27)		(0.04)	(1.60)		(0.04)
Substantially In-person	-2.47	*	-0.07	-0.64		-0.02
	(1.20)		(0.03)	(1.50)		(0.04)
Year (2021)	-10.18	***	-0.28	-9.19	***	-0.22
	(1.35)		(0.04)	(1.69)		(0.04)
Year*Substantially Remote	**2.32**		**0.06**	**1.06**		**0.03**
	(1.47)		**(0.04)**	**(1.84)**		**(0.04)**
Year*Mixed	**2.41**		**0.07**	**-1.53**		**-0.04**
	(1.65)		**(0.05)**	**(2.06)**		**(0.05)**
Year*Substantially In-person	**5.17**	***	**0.14**	**1.42**		**0.03**
	(1.44)		**(0.04)**	**(1.80)**		**(0.04)**
Constant	640.41	***	-2.46	576.10	***	-3.83
	(18.30)		(0.51)	(25.80)		(0.62)
R-square		0.72			0.61	
Number of observations		1,118			1,118	

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Note: Reference pathway was Remote All Year. Effect sizes are Cohen's *d*. Controls included the following school characteristics in SY19 and SY21: % White, % Black, % Hispanic/Latinx, % Two or more races, % Low-income, % Homeless, % English learners, % IEP, and enrollment. SY19 school characteristics that were controlled include: mean attendance rate, test participation rate, indicator for Evidence-based Funding Tier 4, and scores on the *5Essentials* measures for Effective Leaders and Ambitious Instruction.

Table B6

Estimated Associations between Modality Pathways and SAT Scores with Difference-in-Difference Models Grade 11 (Excluding Chicago Public Schools)

	Math			Reading		
VARIABLES	Estimates	Significance level	Effect sizes	Estimates	Significance level	Effect sizes
Substantially Remote	11.31	**	0.11	9.75	**	0.10
	(4.30)		(0.04)	(3.65)		(0.04)
Mixed	5.02		0.05	7.63	*	0.08
	(4.55)		(0.04)	(3.87)		(0.04)
Substantially In-person	0.33		0.00	4.79		0.05
	(4.56)		(0.04)	(3.88)		(0.04)
Year (2021)	-4.76		-0.04	1.48		0.01
	(5.23)		(0.05)	(4.44)		(0.04)
Year*Substantially Remote	**-11.08**	+	**-0.10**	**-6.31**		**-0.06**
	(5.82)		**(0.05)**	**(4.95)**		**(0.05)**
Year*Mixed	**-6.61**		**-0.06**	**-9.71**	+	**-0.10**
	(5.87)		**(0.06)**	**(4.99)**		**(0.05)**
Year*Substantially In-person	**-4.91**		**-0.05**	**-11.44**	*	**-0.11**
	(5.62)		**(0.05)**	**(4.78)**		**(0.05)**
Constant	304.66	***	-1.61	384.38	***	-0.97
	(43.76)		(0.41)	(37.21)		(0.37)
R-square		0.75			0.74	
Number of observations		517			517	

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Note: Reference pathway was Remote All Year. Effect sizes are Cohen's *d*. Controls included the following school characteristics in SY19 and SY21: % White, % Black, % Hispanic/Latinx, % Two or more races, % Low-income, % Homeless, % English learners, % IEP, and enrollment. SY19 school characteristics that were controlled include: mean attendance rate, test participation rate, indicator for Evidence-based Funding Tier 4, and scores on the *5Essentials* measures for Effective Leaders and Ambitious Instruction.