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Changes in academic achievement in Pittsburgh Public Schools during remote instruction in the COVID-19 pandemic

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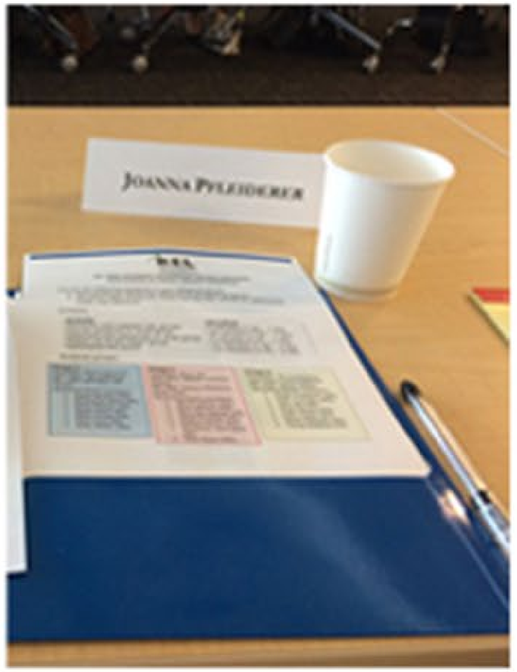
IES Institute of Education Sciences

Regional Educational Laboratories (RELs) address research and analysis needs of states and districts



Work directly with states and districts

1 of 10 RELs funded by the U.S. Department of Education's Institute of Education Sciences

Regional needs drive REL work

How was student achievement affected by the COVID-19 pandemic and disruptions to instruction?

- National evidence of declines relative to typical performance.[1]
- Reports suggest that students typically learned less in remote instruction than in-person.
- Reports from some districts suggest that proportion of students receiving failing grades has increased in 2020/21 relative to 2019/20.[2]

How did Pittsburgh students fare academically during remote instruction in the pandemic?

Preview of Findings

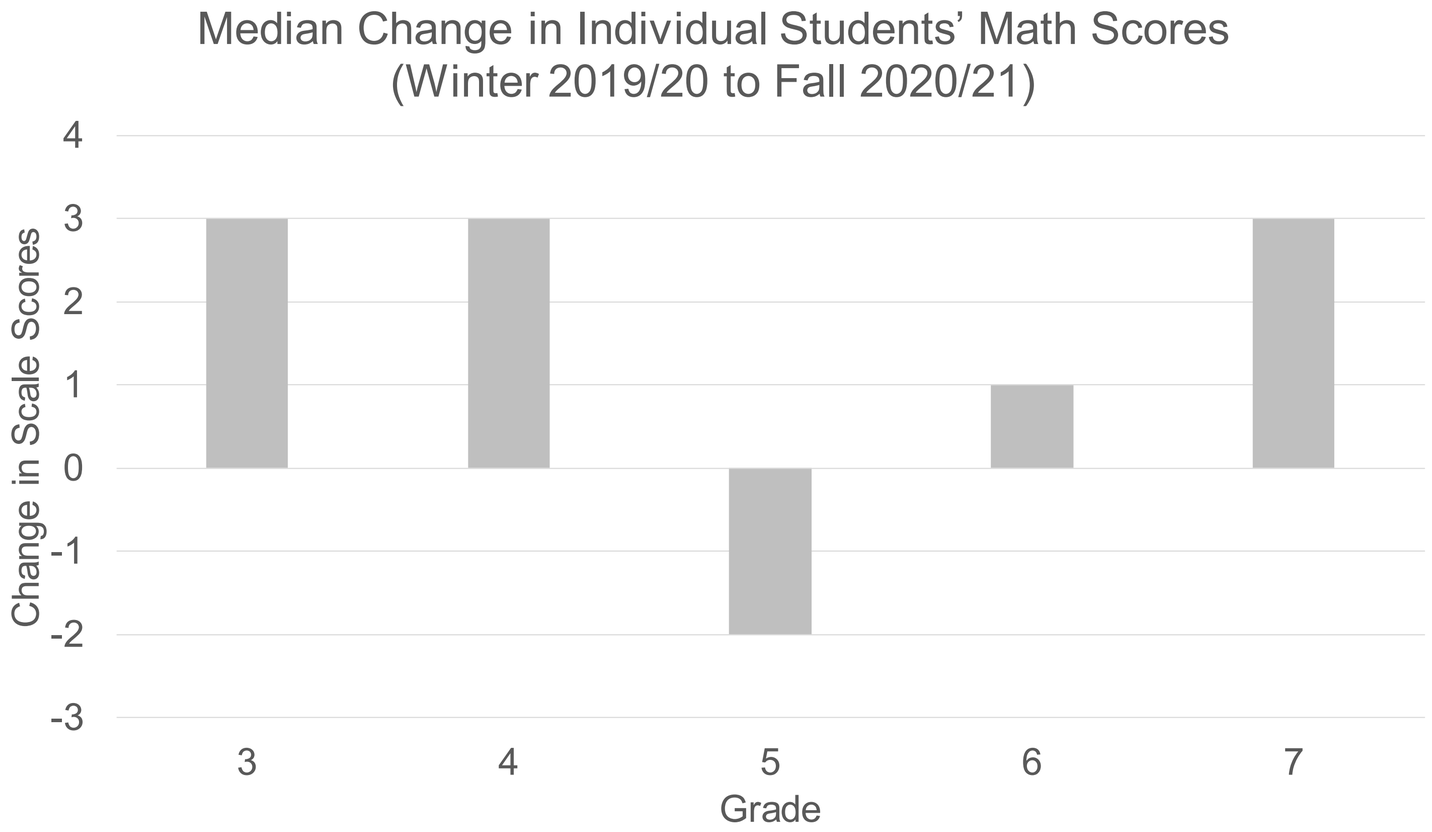
- PPS students in most grades experienced average test score growth.
- But the growth was less than typical pre-pandemic growth (nationally)
  - Growth lag largest for students in elementary grades.
  - Growth lag in Pittsburgh consistent with evidence of growth lags nationally
- PPS course failure rates increased substantially, especially in grades 6-12.
  - Course failure rates increased more among economically disadvantaged students.
  - Chronic absenteeism strongly predicted course failure—and chronically absent students missed a lot more days, on average, in fall 2020 vs fall 2019.
  - Course failure and absenteeism data suggests there is an identifiable group of students who were most negatively affected by the pandemic and remote instruction.

Did PPS students show learning growth while school buildings were closed during the pandemic?

PPS students' average test scores increased from winter 2019/20 to winter 2020/21.

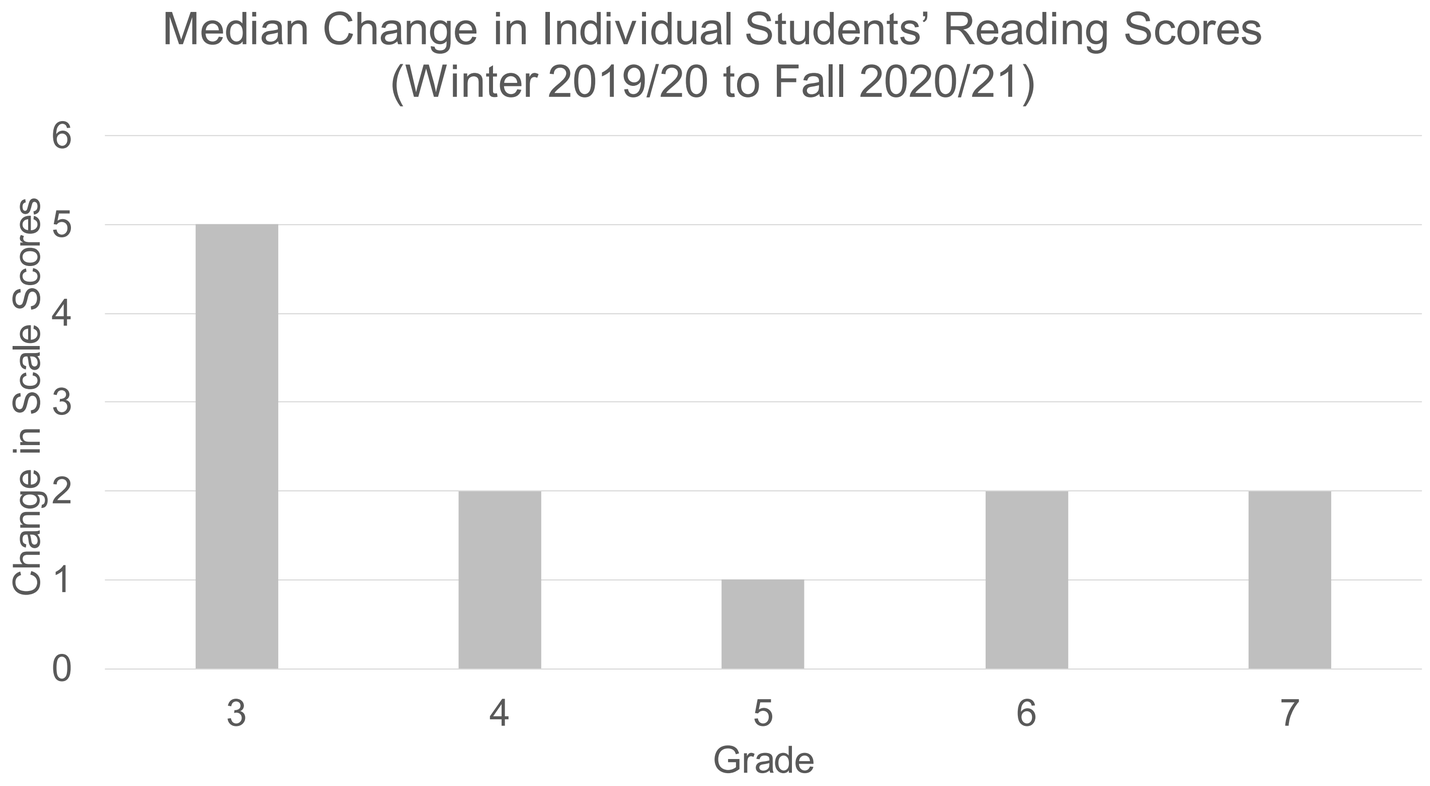
On average, PPS students showed math score growth

For students who took the math test in both Winter 2019/20 and Fall 2020/21, PPS students scored higher in fall 2020/21 than in winter 2019/20 in almost all grades, indicating learning occurred



On average, PPS students showed reading growth

For students who took the reading test in both Winter 2019/20 and Fall 2020/21, PPS students scored higher in fall 2020/21 than in winter 2019/20 in all grades, indicating learning occurred.

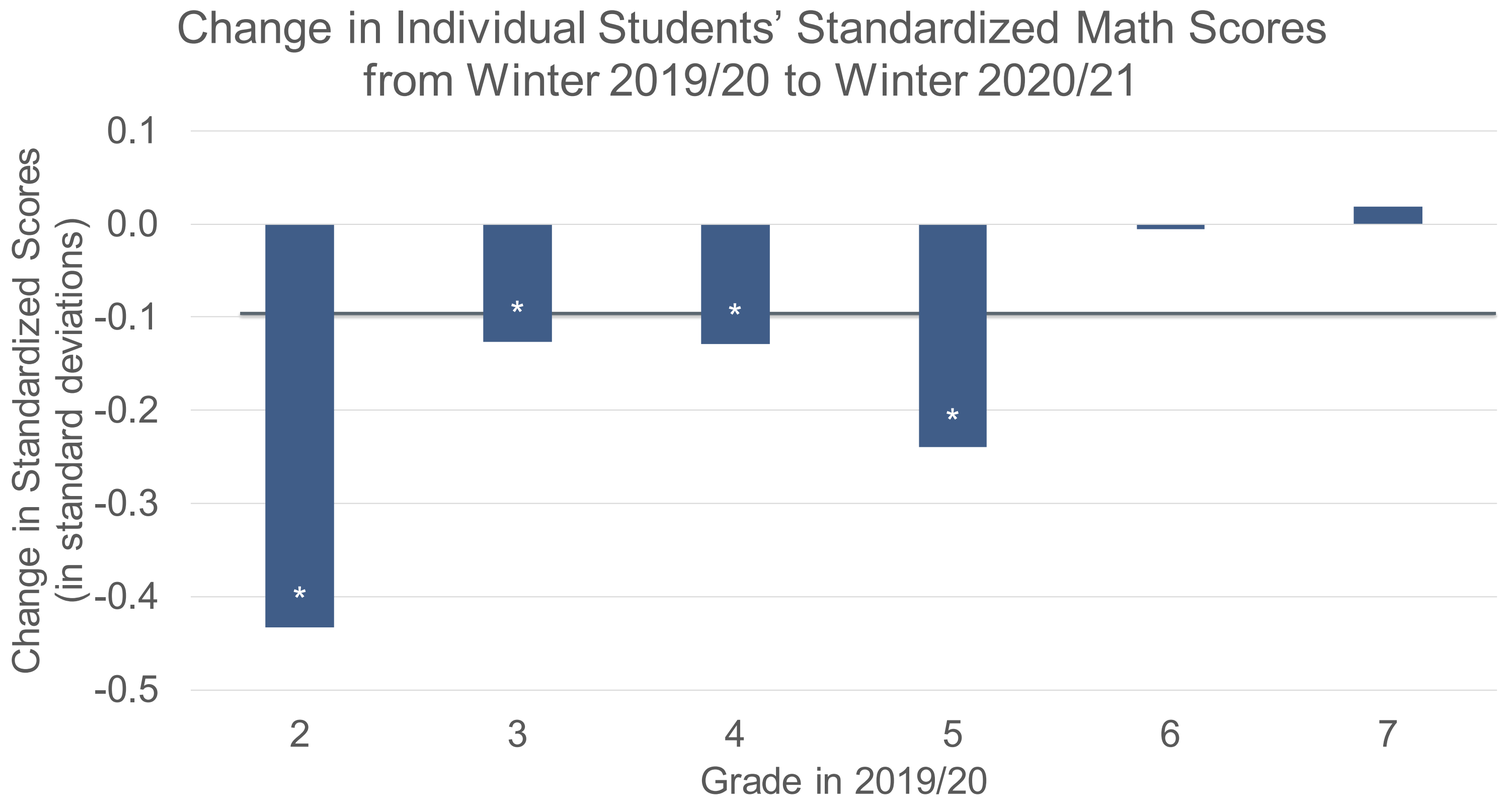


How did PPS students' scores change over time, relative to prior national norms?

Consistent with national findings, PPS students' test score growth in remote instruction was lower than average growth nationally in pre-pandemic years.

Examining individual students' change from 2019/20 to 2020/21, largest lags in math scores (relative to pre-pandemic national norms) in elementary grades.

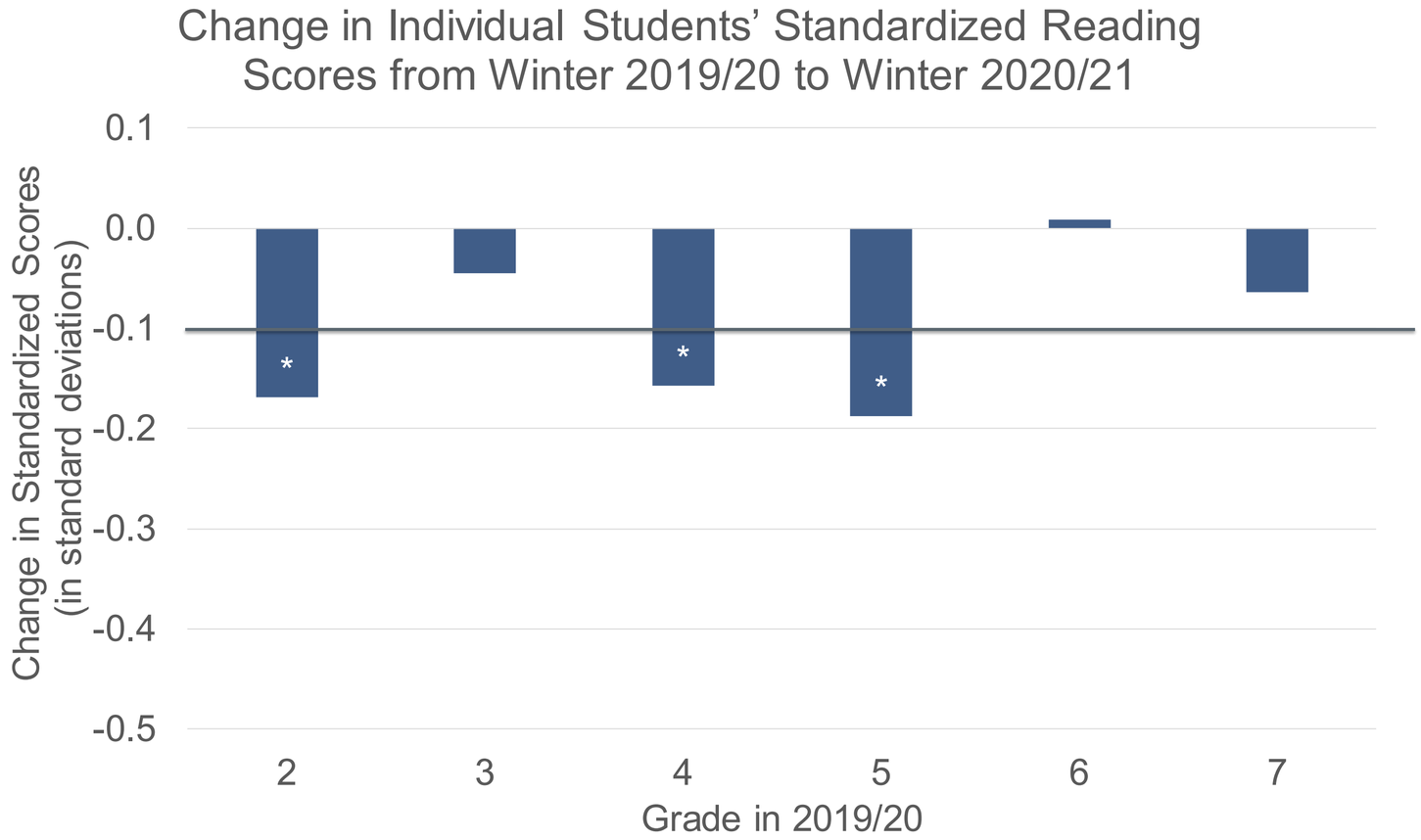
Students in grades 2-7 in 2019/20 had average declines from winter 2019/20 to winter 2020/21 of 0.15 standard deviations (SDs) in math.



Note: Stars indicate change was greater or equal to +/- 0.1 standard deviations.

Examining individual students' change from 2019/20 to 2020/21, lags in reading scores (relative to pre-pandemic national norms) are for grades 2, 4, and 5.

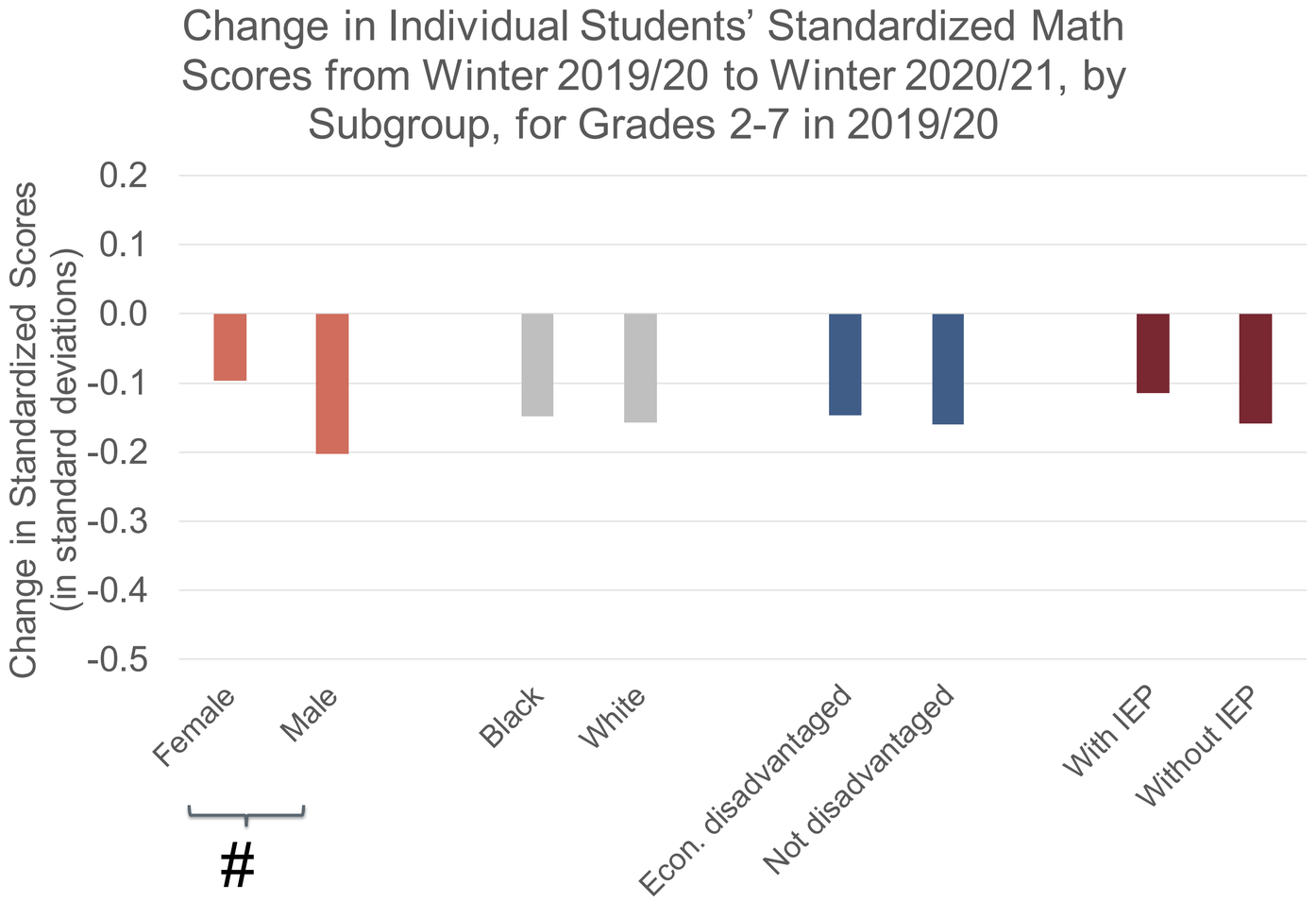
Students in grades 2-7 in 2019/20 had average declines from winter 2019/20 to winter 2020/21 of 0.10 standard deviations (SDs) in reading.



Note: Stars indicate change was greater or equal to +/- 0.1 standard deviations.

Examining individual students' change from 2019/20 to 2020/21, lags in math (relative to pre-pandemic national norms) larger for boys

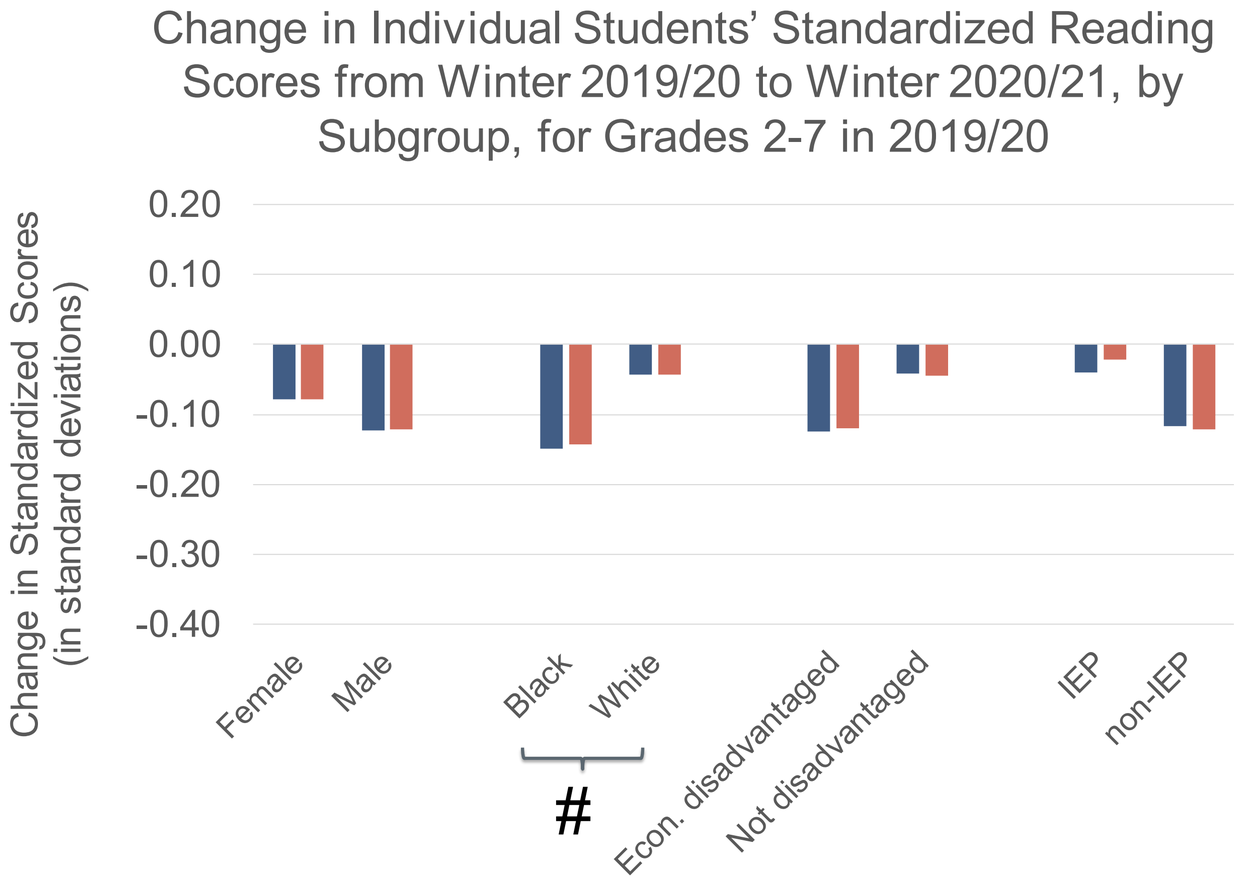
Differences in growth were minimal for Black and White students, economically disadvantaged and non-disadvantaged students, or IEP and non-IEP students.



Note: # indicates difference between the two groups listed was greater or equal to +/- 0.1 standard deviations.

Examining individual students' change from 2019/20 to 2020/21, lags in reading (relative to pre-pandemic national norms) larger for Black students than White students

Differences were smaller for boys vs girls, economically disadvantaged vs non-disadvantaged students, or IEP vs non-IEP students.

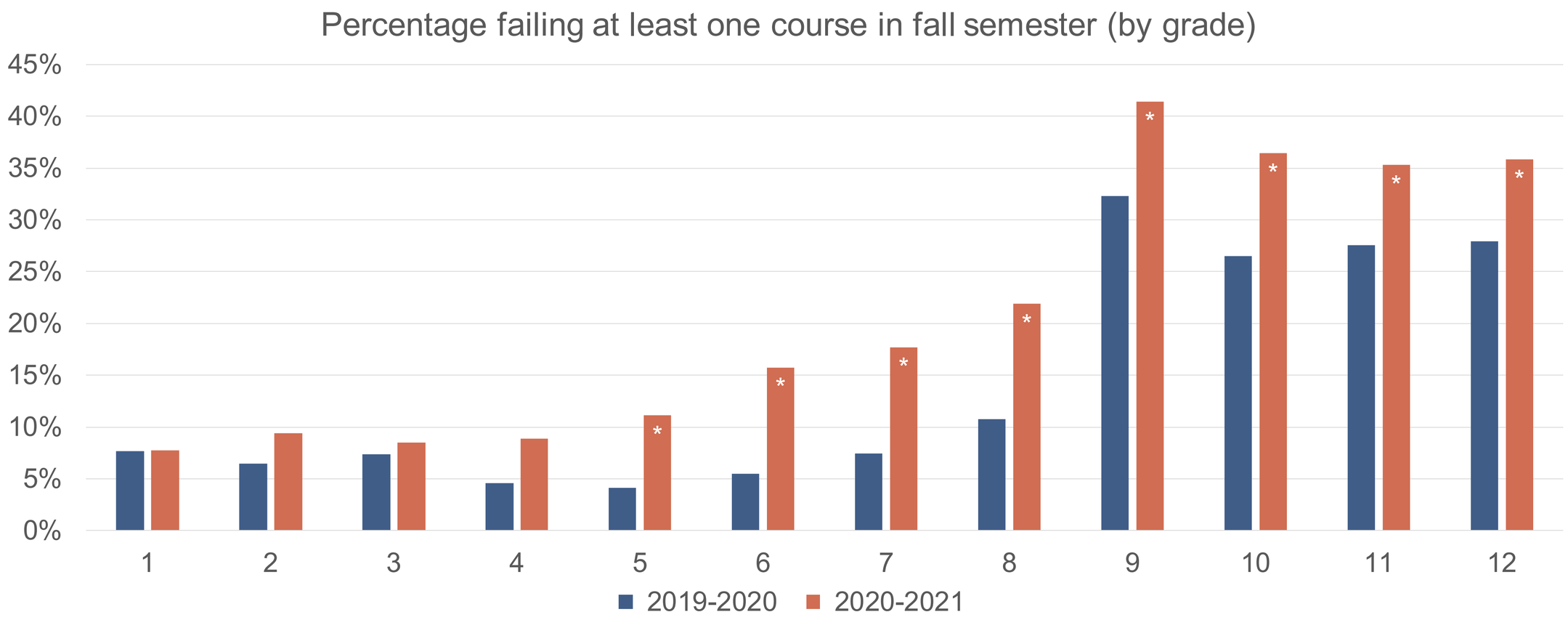


Note: # indicates difference between the two groups listed was greater or equal to +/- 0.1 standard deviations.

How did course failure rates change during remote instruction, overall and for particular student groups?

1. *Course failure rates increased substantially, especially in grades 6-12*
2. *Course failures increased more for economically disadvantaged students, and especially for chronically absent students*

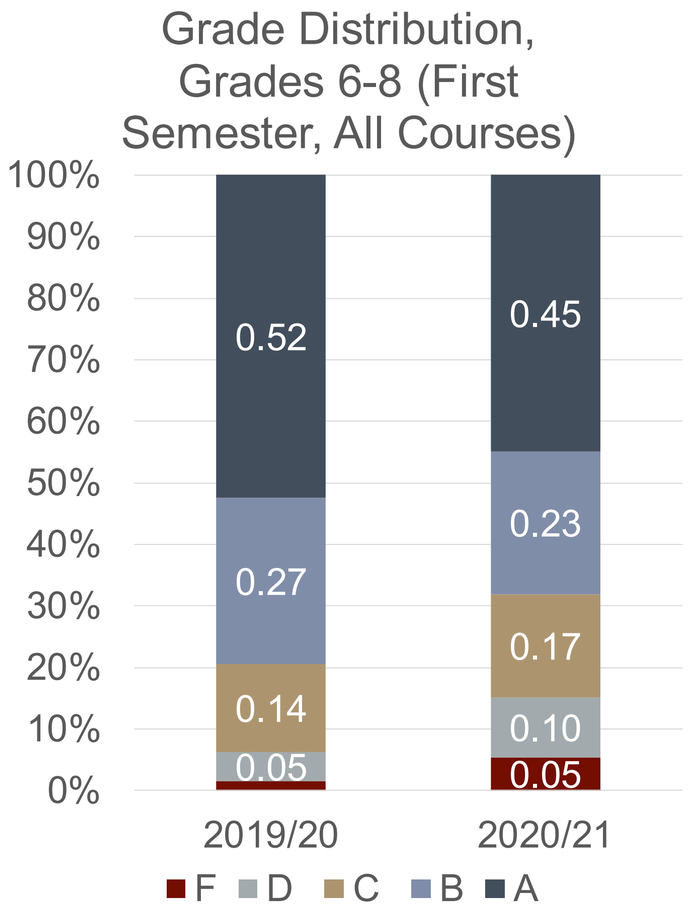
Percentage of students failing courses increased substantially in middle and high school grades

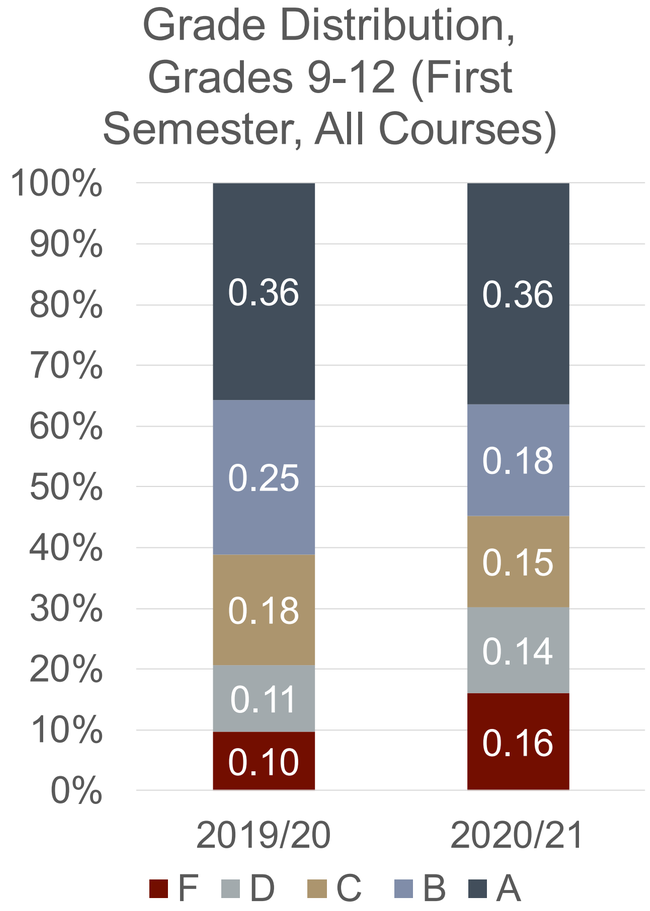


Note: Stars indicate difference between 2019/20 and 2020/21 was greater or equal to 5 percentage points.

Course-grade distribution shifted downward in middle and high school.

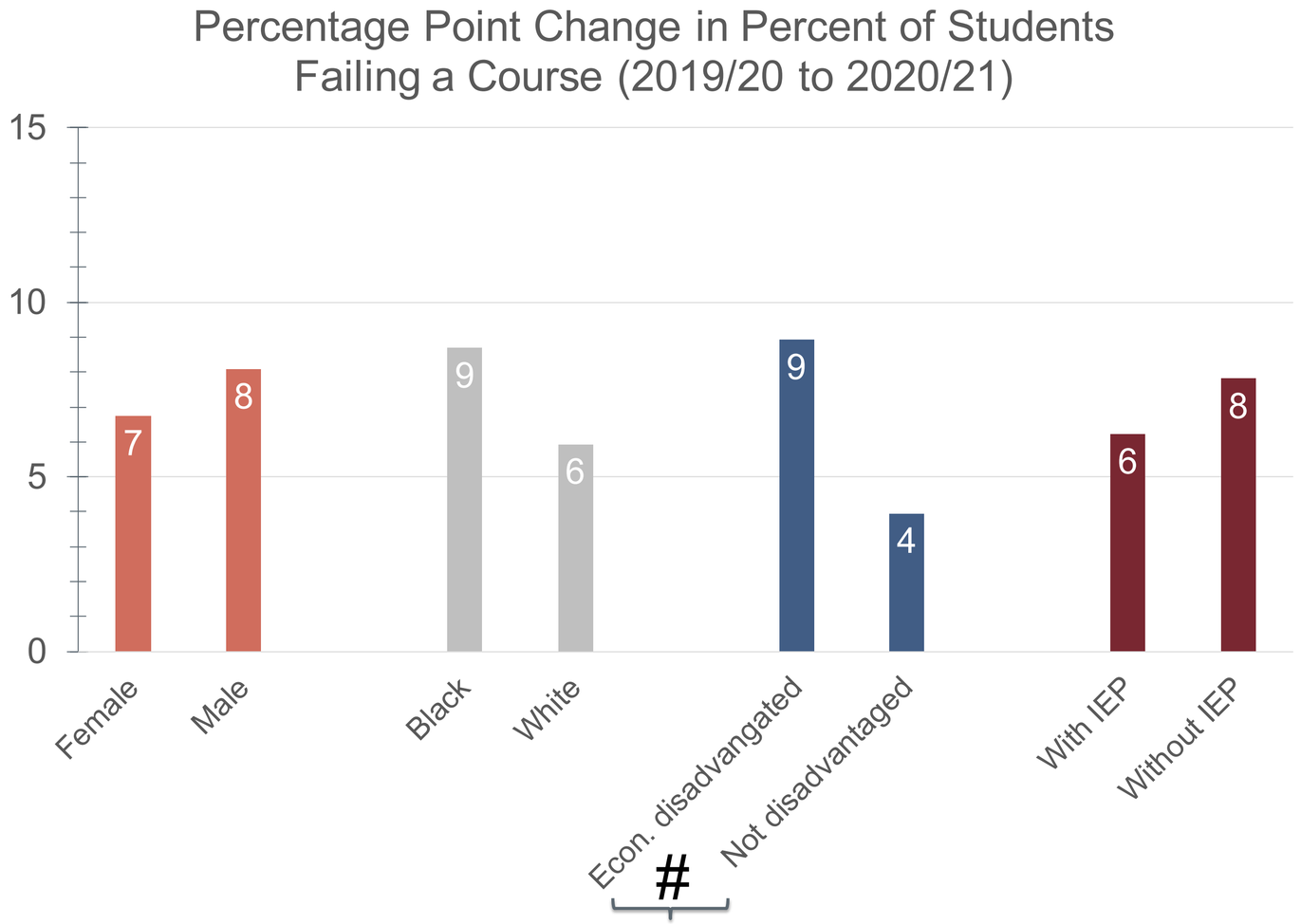
- Fewer grades at the top of the scale (A+B) and more at the bottom (D+F)





The percentage of students failing at least one course increased more for economically disadvantaged students

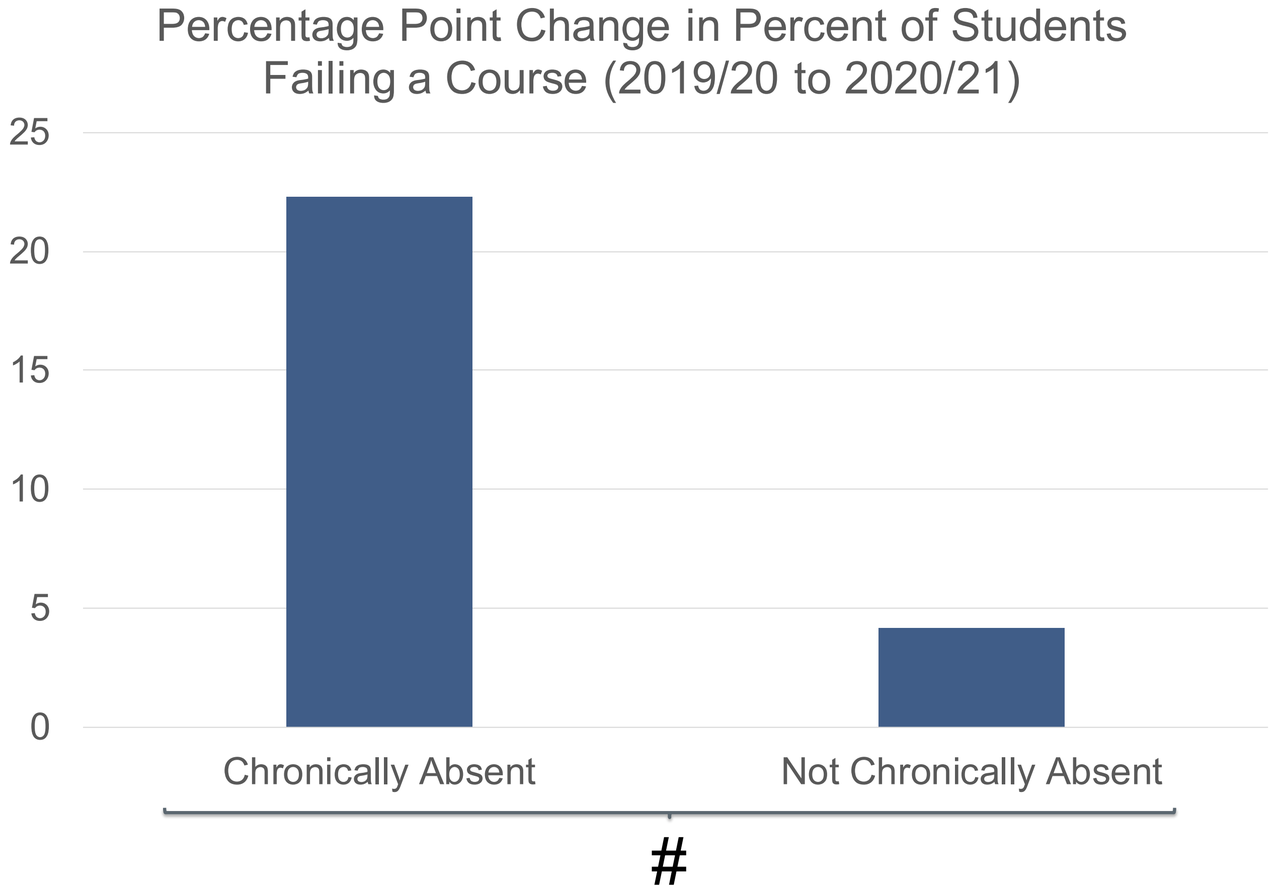
All notable subgroups had increases in failure rates



Note: Sample includes all students in grades 1-12. # indicates difference between groups exceeds 5 percentage points.

The percentage of students failing at least one course increased dramatically for students who were chronically absent

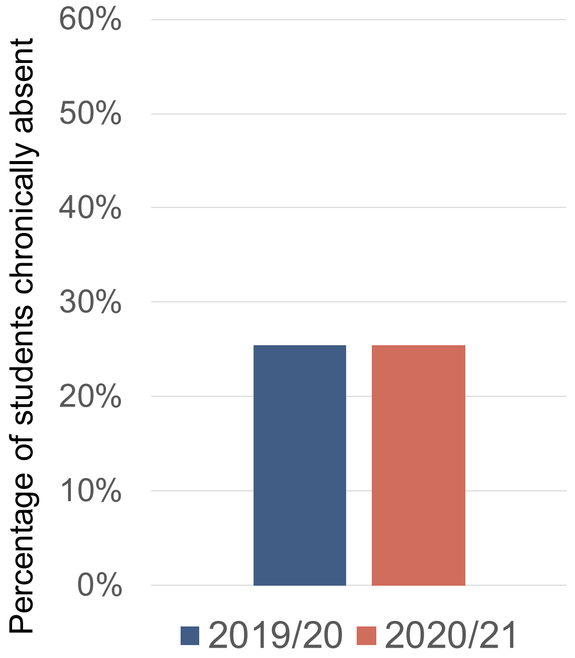
The percent of students who failed a course **increased by 22 percentage points** for those who were **chronically absent in first semester 2020/21, compared to those who were chronically absent in first semester 2019/20.**



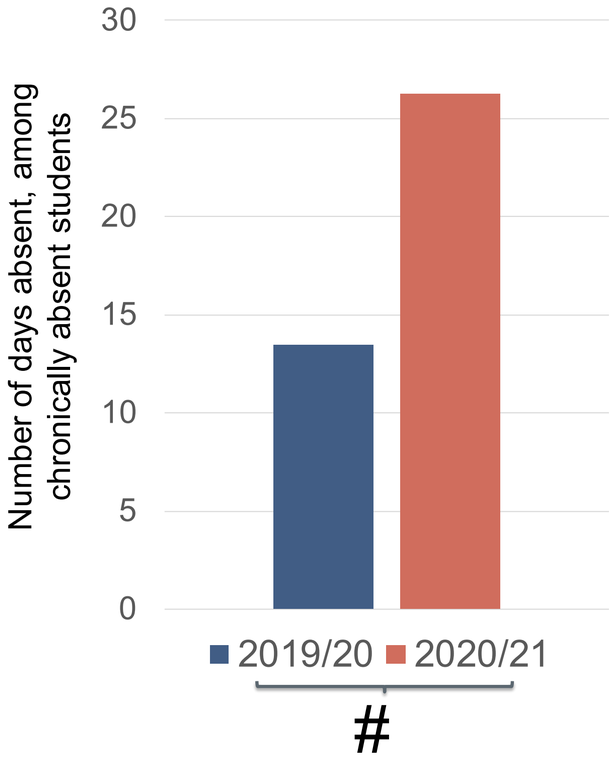
Note: Sample includes all students in grades 1-12. # indicates difference between groups exceeds 5 percentage points.

Chronically absent students missed over 10 more days on average than in prior year. Clear relationship between absences and course failure.

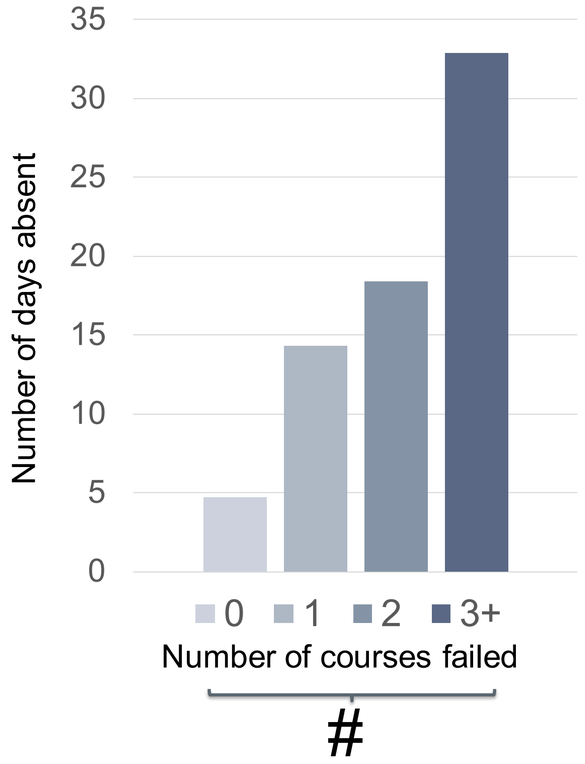
Percentage of Students Chronically Absent First Semester, 2019/20 vs 2020/21



Days Missed by Chronically Absent Students in First Semester, 2019/20 vs 2020/21



Average Days Absent by Number of Courses Failed, First Semester of 2020/21



Note: Sample includes all students in grades K-12. # indicates difference between groups exceeds 5 percentage points.

Limitations & Implications

Implications of test-score and grade results

- Test-score results suggest declines relative to pre-pandemic national norms larger for younger students, who might have more trouble learning remotely.
- Substantial increase in course failure, especially in grades 6-12, suggests that test scores alone might provide an overly optimistic picture for middle schoolers (Weren't able to examine high school test scores due to lower test taking rate).
- Fall 2021 assessments will be important for determining size of lags for students who missed assessments last year.
- Supports might be appropriate for students who had largest declines in grades (and also were more likely to miss tests)—notably chronically absent students and economically disadvantaged students.

Limitations of test score and grade analyses

- We do not calculate test score changes for the earliest (K and 1) and highest grades (8-12) because of the low test-taking rates in those grades, particularly in 2020/21. Results may differ for those students.
- Tests were administered remotely in fall 2020 and winter 2021. Test scores in remote environments were found by NWEA to be reliable in grades 3-8 but should be used with caution in earlier grades.[6]
- Criteria for failing a course may have shifted during the pandemic. If teachers applied less stringent grading standards, the change in course failure rates we calculate would understate what the change would have been had the failure criteria stayed constant.

Questions

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Disclaimer

This work was funded by the U.S. Department of Education's Institute of Education Sciences (IES) under contract ED-IES-17-C-0006, with REL Mid-Atlantic, administered by Mathematica. The content of the presentation does not necessarily reflect the views or policies of IES or the U.S. Department of Education, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. government.

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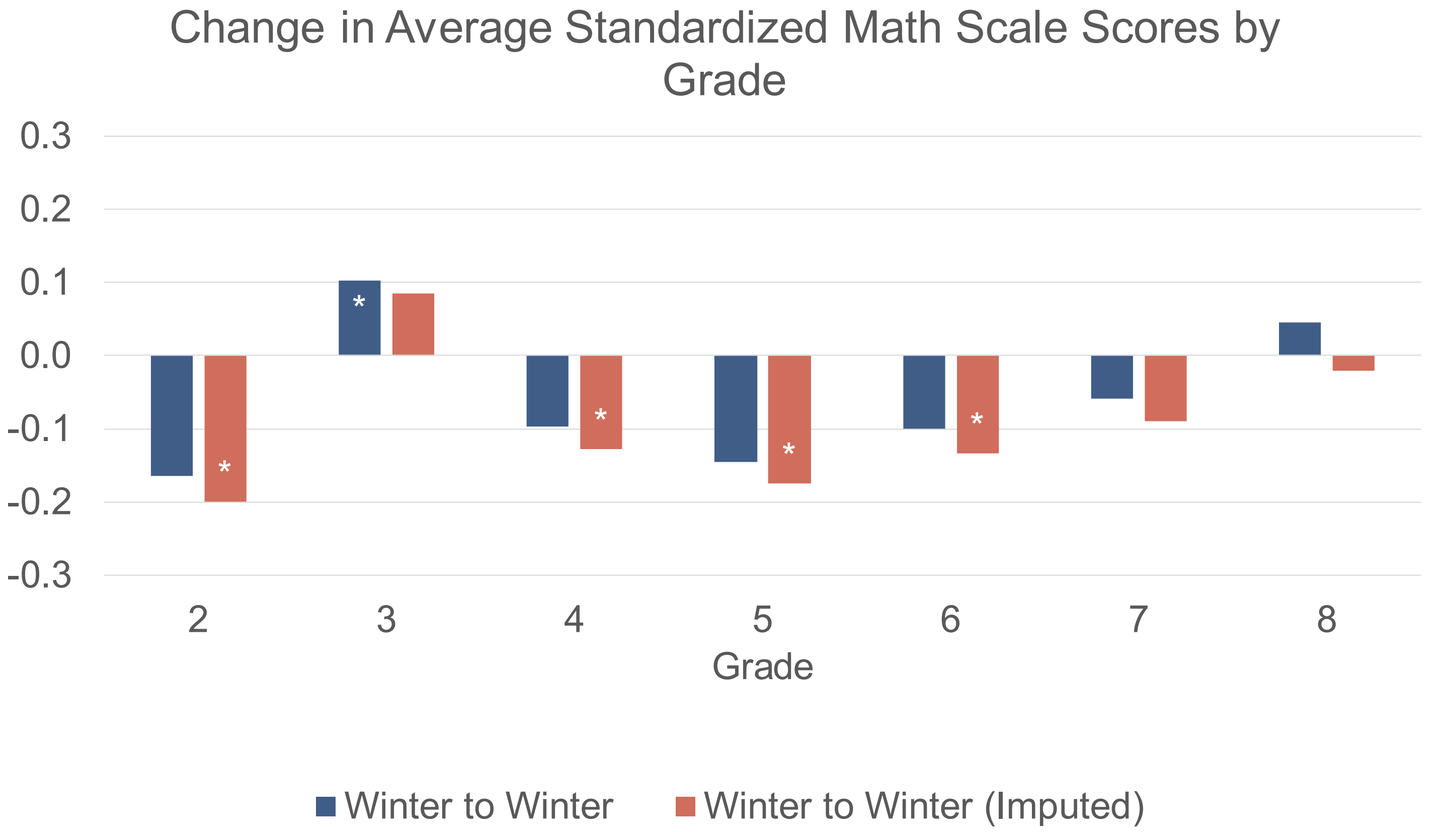
Appendix

Cross-sectional analysis with imputed scores: Comparing successive cohorts in the same grade, there are declines in 2nd and 4th–6th grades in math

Compares students who took the test in a specific grade in 2019/20 to those who took the test in that grade in 2020/21. (Note: Blue bar does not adjust for any differences between who took the test in different cohorts in 2019/20 vs 2020/21).

Imputed score comparisons help to account for those who did not take the test in 2020/21, but may not fully compensate for differences in the students who are taking the test in 2020/21.

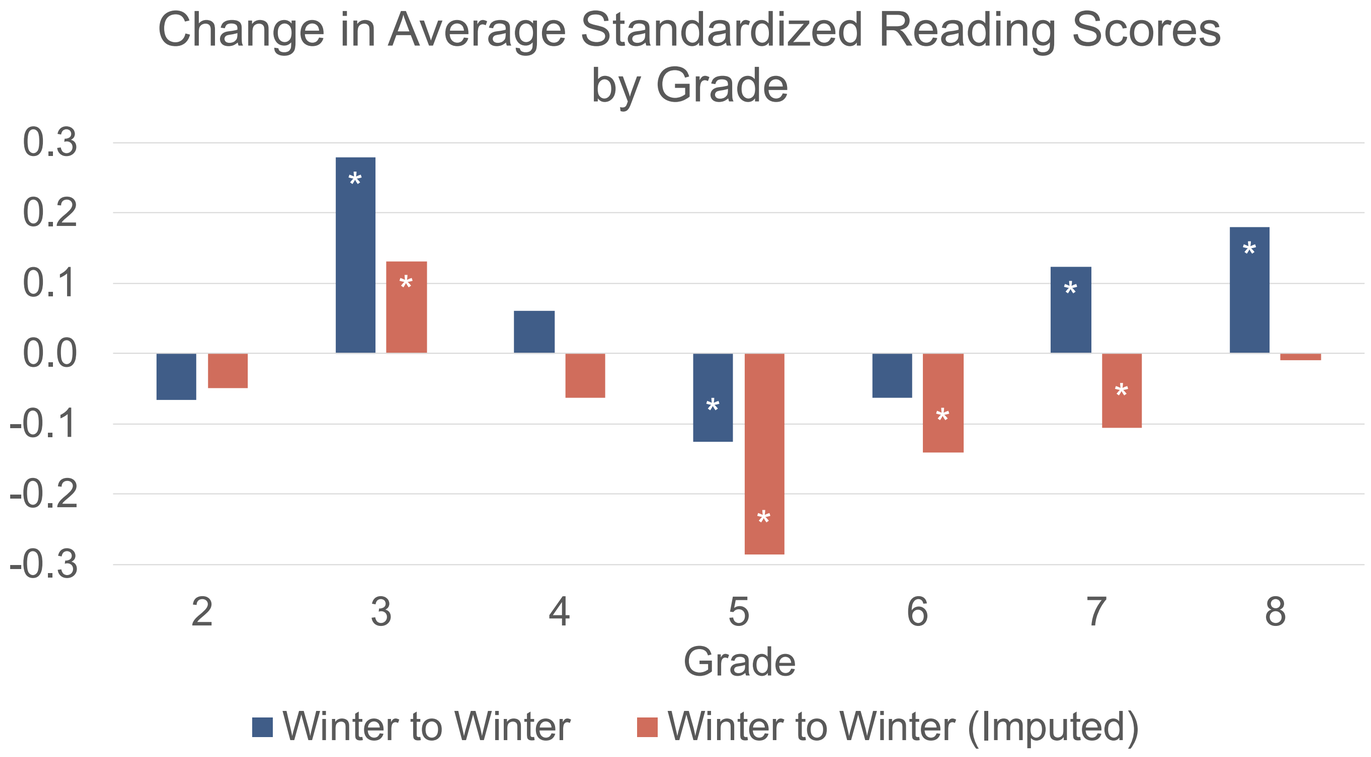


Note: Stars indicate the change in standardized student test scores from winter-to-winter exceeds the absolute value of 0.1 standard deviations.

Cross-sectional analysis with imputed scores: Comparing successive cohorts in the same grade, there are declines in 5th–7th grades in reading but increases in 3rd grade

Compares students who took the test in a specific grade in 2019/20 to those who took the test in that grade in 2020/21. (Note: Blue bar does not adjust for any differences between who took the test in different cohorts in 2019/20 vs 2020/21).

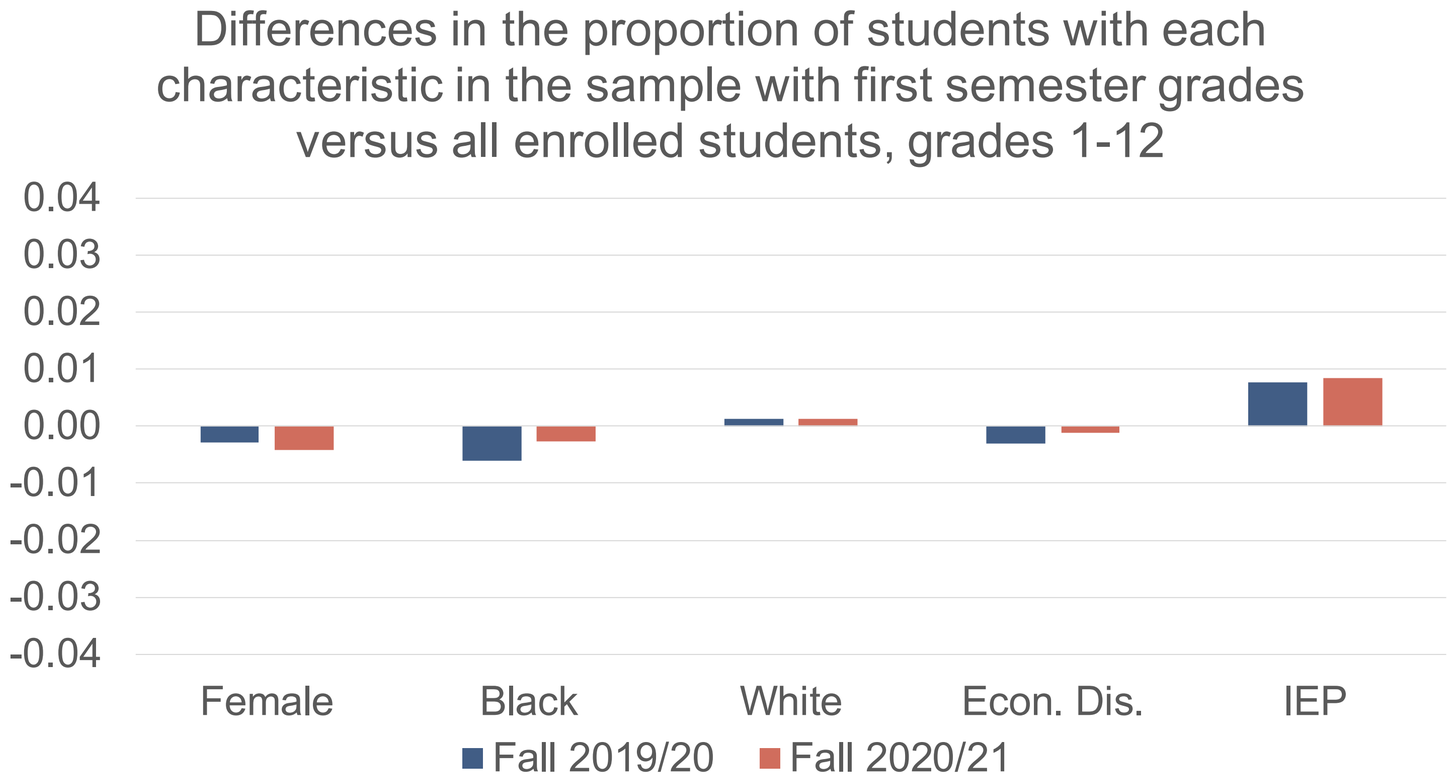
Imputed score comparisons help to account for those who did not take the test in 2020/21, but may not fully compensate for differences in the students who are taking the test in 2020/21.



Note: Stars indicate the change in standardized student test scores from winter-to-winter exceeds the absolute value of 0.1 standard deviations.

For grades 1-12, demographic composition of students with first semester grades is similar to the demographic composition of the total student body in 2019/20 and 2020/21.

- Standardized differences never exceed 0.01 standard deviations.



Note: Stars indicate the standardized difference between the proportion of students with a given characteristic in the sample with first semester grades and in the enrolled population exceeded 0.05 standard deviations.

Data

NWEA MAP scores	• Fall, Winter, and Spring from 2019-20 and Fall and Winter from 2020-21 • Offered in K-12 • Reading and math • Standardize scores relative to national norms (using pre-pandemic data)[4]
Student demographics and enrollment data	• 2019-20 and 2020-21 school years • Includes school attended, race and ethnicity, gender, economically disadvantaged status, English learner status, and Individualized Education Program (IEP) status
Student grades	• Focus on first semesters in 2019-20 and 2020-21 • Use grades to construct number of courses failed, percentage of courses failed, and GPA

Preliminary Research Question A:

During the 2019/20 to 2020/21 school years, how did the proportion and demographic composition of students (1) taking the NWEA math and reading tests and (2) receiving grades change?

Why start by examining changes in the demographic composition of students taking tests and earning grades?

Pandemic may have disrupted the number of students tested or grades submitted. Comparing averages from either period may not be appropriate if demographic composition of students with data in each period is different.

To assess the scope of this potential problem, we first:

1) Describe changes from 2019/20 to 2020/21 in the proportion of students taking NWEA math and reading tests and the proportion of students with reported grades.
2) Describe changes in demographic composition of students taking the test or receiving grades.

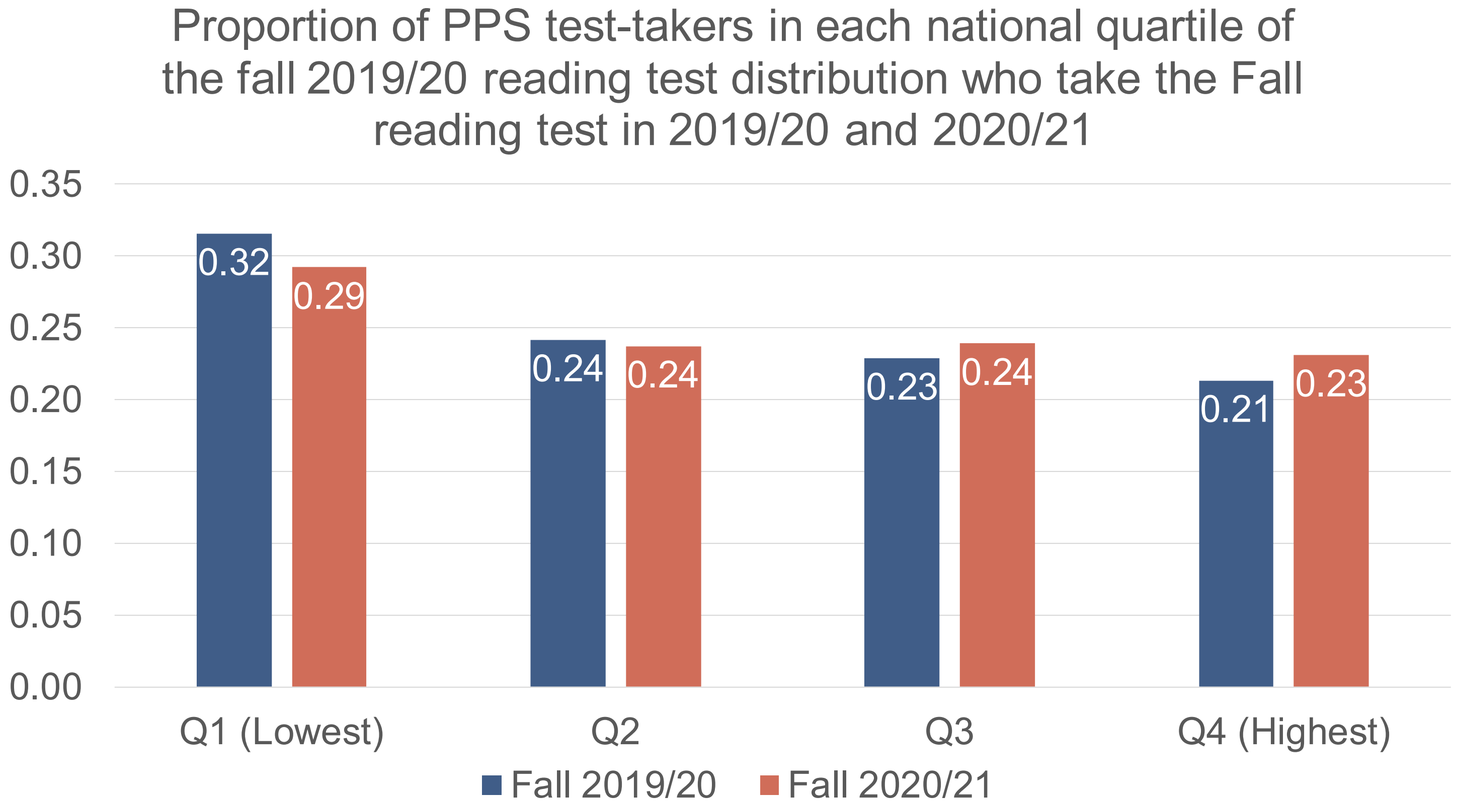
We focus on fall & winter tests for grades 2-8 due to lower test participation rates in spring and other grades.

Percentage of enrolled PPS students taking NWEA MAP tests

	Math					Reading				
	2019/20			2020/21		2019/20			2020/21	
	Fall	Winter	Spring	Fall	Winter	Fall	Winter	Spring	Fall	Winter
All	87%	87%	11%	66%	66%	85%	85%	11%	62%	64%
Grade K	78%	94%	6%	2%	1%	76%	94%	5%	3%	1%
Grade 1	93%	95%	5%	9%	2%	93%	94%	5%	12%	2%
Grade 2	94%	95%	4%	80%	86%	93%	94%	6%	77%	85%
Grade 3	94%	95%	9%	87%	87%	94%	95%	8%	86%	88%
Grade 4	93%	93%	9%	86%	87%	93%	92%	9%	84%	85%
Grade 5	93%	94%	7%	88%	87%	92%	94%	10%	85%	88%
Grade 6	93%	94%	24%	86%	86%	93%	93%	28%	83%	84%
Grade 7	92%	92%	25%	84%	82%	91%	89%	22%	82%	81%
Grade 8	91%	90%	25%	84%	82%	90%	91%	26%	83%	82%
Grade 9	82%	77%	9%	67%	73%	78%	68%	5%	58%	65%
Grade 10	80%	76%	7%	66%	73%	75%	64%	7%	62%	67%
Grade 11	76%	71%	6%	67%	66%	73%	69%	3%	56%	64%
Grade 12	66%	56%	4%	44%	42%	67%	64%	3%	37%	40%

Low achievers slightly less likely to take test in fall 2020/21—potentially inflating district-wide average scores

- Students scoring in the bottom quartile (relative to national norms) on the fall 2019/20 reading test were a smaller proportion of test-takers in fall 2020/21, while students scoring in the top quartiles were a larger proportion of test-takers in fall 2020/21.
- Students taking the test again in 2020/21 were slightly higher achieving at baseline.
- Results similar for math.



Note: Sample for blue bars includes all students in grades 2-7 in 2019/20 who took the Fall reading test. Sample for orange bars is the same but is further restricted to those who also took the Fall 2020/21 reading test. Blue bars show the proportion of students taking the reading test in fall 2019/20 who scored in each quartile, relative to national norms. Orange bars show the proportion of students in each quartile of the fall 2019/20 reading test who also took the fall 2020/21 reading test.

But remote instruction did *not* reduce the proportion of students with (first semester) course/subject grades

Vast majority of students enrolled in 2019/20 and 2020/21 have first semester grades, and there was little change in the proportion of students who have grades over time. One exception was kindergarten, which we do not include in the grade analyses.

Differences in the demographic characteristics of those with grades and the eligible student body were small and never exceeded 0.05 standard deviations.

Proportion of students with first-semester course/subject grades

	2019/20	2020/21
K	0.10	0.13
1	0.98	0.98
2	0.98	0.98
3	0.98	0.99
4	0.98	0.98
5	0.98	0.99
6	0.98	0.98
7	0.98	0.99
8	0.98	0.99
9	0.98	0.98
10	0.97	0.98
11	0.98	0.98
12	0.90	0.90

Implications

Test Score Analysis

Changes in students taking the test from 2019/20 to 2020/21 could make **cross-sectional comparisons** of successive cohorts of students in the same grade in 2019/20 and 2020/21 **potentially misleading**.

Grade Analysis

Because almost all students have grades and there is little change in the demographic composition of students with grades in first semester 2019/20 versus first semester 2020/21, **cross-sectional comparisons** of successive cohorts in same grade **should not be misleading** due to sample changes.

Changes in academic achievement: test score analysis

Main approach: Compare individual students' performance to their own performance in a prior period (in a longitudinal analysis):

- Compare a student's score in winter of 2020/21 to winter 2019/20.
- Standardize scores relative to NWEAs national norms (set before the pandemic) for each grade and subject (not year). Ensures common standard of comparison for 2019/20 and 2020/21.

Benefit: Hold the set of students in the sample in 2019/20 and 2020/21 constant.

Drawback: Can't examine students that were not present in both testing windows.

Sensitivity Analysis: Impute scores for those with scores in Winter 2019/20 who do not have them in 2020/21.

- Predict scores based on the Winter 2019/20 score; GPA, number of course failures, and absences in first semester 2020/21; and demographic characteristics.

Changes in academic achievement: course grade analysis

Compare successive cohorts of students in the same grades or subgroups in a cross-sectional analysis:

- Calculate difference between average outcomes (GPA or whether a student fails a course) for students in the same group (e.g. 3rd grade) in the first semester of 2019/20 to 2020/21.
- Comparing individual students' performance in 2020/21 to 2019/20 less ideal here because of natural increases in course failure with some grade transitions (e.g., 8th to 9th grade) that would be conflated with effects of COVID-19.

NWEA national study provides useful comparison, though their study sample has more attrition in test-taking than PPS experienced

- Useful to benchmark findings to what has occurred in other districts this year.
- NWEA conducted a study using districts that administer the MAP test in the U.S. (about 10% of the U.S. 3rd -8th graders in 2019/20).[5,6]
- Among students who took the math MAP test in fall 2019/20, PPS had a higher proportion of students take the test again in winter 2019/20 and fall 2020/21 than in the NWEA sample.*
- Demographically, the NWEA sample has a larger proportion of White (about 50% vs. 30% in PPS) and Hispanic students (about 20% vs 4% in PPS), while PPS has a much larger proportion of Black students (53% vs. about 15% in NWEA).

NWEA Study Sample (Math)			
Grade in 2019/20	Took Test Fall 19/20	Took Test Fall 19/20, Winter 19/20, & Fall 20/21	Proportion
3	441,301	329,752	0.75
4	447,049	325,346	0.73
5	462,520	257,667	0.56
6	433,165	260,857	0.60
7	420,810	258,290	0.61

PPS (Math)			
Grade in 2019/20	Took Test Fall 19/20	Took Test Fall 19/20, Winter 19/20, & Fall 20/21	Proportion
3	1,667	1,348	0.81
4	1,519	1,223	0.81
5	1,518	1,210	0.80
6	1,590	1,271	0.80
7	1,615	1,283	0.79

*NWEA study sample used students who took the test in Fall 2019/20, Winter 2019/20, and Fall 2019/20.

References

1. Lewis, K., Kuhfeld, M., Ruzek, E., & McEachin, A. (2021). *Learning during COVID-19: Reading and math achievement in the 2020-21 school year*. NWEA. https://www.nwea.org/research/publication/learning-during-covid-19-reading-and-math-achievement-in-the-2020-2021-school-year/
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3. Thum, Y. M., & Kuhfeld, M. (2020). NWEA 2020 MAP Growth Achievement Status and Growth Norms Tables for Students and Schools. NWEA Research Report. Portland, OR: NWEA.
4. Kuhfeld, M., Ruzek, E., Johnson, A., Tarasawa, B., & Lewis, K. (2020). *Technical appendix for: Learning during COVID-19: Initial findings on students' reading and math achievement and growth*. NWEA. https://www.nwea.org/research/publication/technical-appendix-for-learning-during-covid-19-initial-findings-on-students-reading-and-math-achievement-and-growth/
5. U.S. Department of Education, National Center for Education Statistics, Statistics of Public Elementary and Secondary School Systems, 1980-81; Common Core of Data (CCD), "State Nonfiscal Survey of Public Elementary/Secondary Education," 1985-86 through 2018-19; and National Elementary and Secondary Enrollment Projection Model, 1972 through 2029. (Table 203.10. Enrollment in public elementary and secondary schools, by level and grade: Selected years, fall 1980 through fall 2029).
6. Kuhfeld, M., Lewis, K., Meyer, P., & Tarasawa, B. (2020). Comparability analysis of remote and in-person MAP Growth testing in fall 2020. NWEA. https://www.nwea.org/research/publication/comparability-analysis-of-remoteand-in-person-map-growth-testing-in-fall-2020/

Understanding changes in academic achievement in Pittsburgh Public Schools during the COVID-19 pandemic: Methodology memo

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NWEA MAP test scores. The NWEA MAP test score files include test scores for math and reading in grade levels K-12. NWEA MAP tests are offered in fall, winter, and spring in PPS. At the time the data were collected in early spring 2021, we received fall, winter, and spring test scores for 2019/20 and fall and winter scores for 2020/21.

Because the NWEA MAP tests are vertically aligned, students across grades receive scores on the same scale. We use these scale scores for some analyses to identify how much students have grown in terms of scale score points over the last year. We also calculate standardized scale scores, standardizing within subject, grade level, and year relative to the national means and standard deviations reported by NWEA from a norming study conducted before the pandemic (Thum & Kuhfeld, 2020). Standardizing scores in each year relative to the same pre-pandemic benchmark allows us to examine changes in student achievement relative to pre-pandemic national norms.

We also use the standardized scores to create indicator variables to assign students to quartiles of the national distribution using the fall 2019/20 math and reading scores. These indicators identify student subgroups based on baseline test scores.

Table 1. Student characteristics and outcomes used in the study

Characteristic	Description
Demographic and behavior variables	
School year	Academic year (either 2019/20 or 2020/21)
Grade level (fall)	Which grade level (K-12) the student was at the time of NWEA fall MAP testing
Grade level (winter)	Which grade level (K-12) the student was at the time of NWEA winter MAP testing
Grade level (spring)	Which grade level (K-12) the student was at the time of NWEA spring MAP testing
Female	Whether a student was female
Race/ethnicity	Whether a student was • Black • White
Economically disadvantaged	Whether student directly certified for the national school lunch program
IEP (Individualized Education Program)	Whether student received special education services
Chronic Absentee	Whether a student was absent for more than 10 percent of the first semester (quarter 1 and quarter 2)
Grades	
Indicator for failing any courses/subjects	Indicator for failing any graded course/subject (received an E or F) in the first semester
Grade point average (GPA)	Average grade in graded courses/subjects that students took in the first semester. Courses that were pass/fail or ungraded were not included in GPA.
NWEA MAP tests	
Math scale score fall	NWEA MAP scale score for math in the fall
Math standardized (std.) scale score fall	NWEA MAP scale score for math in the fall, standardized within grade level relative to national norms
Reading scale score fall	NWEA MAP scale score for reading in the fall
Reading std. scale score fall	NWEA MAP scale score for reading in the fall, standardized within grade level relative to national norms
Math scale score winter	NWEA MAP scale score for math in the winter
Math standardized (std.) scale score winter	NWEA MAP scale score for math in the winter, standardized within grade level relative to national norms
Reading scale score winter	NWEA MAP scale score for reading in the winter
Reading std. scale score winter	NWEA MAP scale score for reading in the winter, standardized within grade level relative to national norms
Math scale score spring	NWEA MAP scale score for math in the spring
Math standardized (std.) scale score spring	NWEA MAP scale score for math in the spring, standardized within grade level relative to national norms
Reading scale score spring	NWEA MAP scale score for reading in the spring

Characteristic	Description
Reading std. scale score spring	NWEA MAP scale score for reading in the spring, standardized within grade level relative to national norms
Quartile 1 of std. math scale score fall	Indicator that standardized math scale score in fall is below the 25th percentile
Quartile 2 of std. math scale score fall	Indicator that standardized math scale score in fall is in the 25th percentile and below the median
Quartile 3 of std. math scale score fall	Indicator that standardized math scale score in fall is in the 50th percentile and below the 75th percentile
Quartile 4 of std. math scale score fall	Indicator that standardized math scale score in fall is in the 75th percentile and above
Quartile 1 of std. reading scale score fall	Indicator that standardized reading scale score in fall is below the 25th percentile
Quartile 2 of std. reading scale score fall	Indicator that standardized reading scale score in fall is in the 25th percentile and below the median
Quartile 3 of std. reading scale score fall	Indicator that standardized reading scale score in fall is in the 50th percentile and below the 75th percentile
Quartile 4 of std. reading scale score fall	Indicator that standardized reading scale score in fall is in the 75th percentile and above

Table 2. Descriptive statistics

Characteristic	2019/20	2020/21
Demographic and behavior variables (Grades K-12)		
Female	0.49	0.49
Black	0.52	0.52
White	0.32	0.31
Economically disadvantaged	0.70	0.70
IEP (Individualized Education Program)	0.22	0.22
Chronic Absentee	0.25	0.25
Grades (Grades 1-12)		
Indicator for failing any courses/subjects	0.11	0.18
Grade point average (GPA)	2.96	2.75
Number of courses failed (First semester)	0.29	0.57
NWEA MAP tests (Grades 2-8)		
Math scale score fall	200.2	201.6
Math standardized (std.) scale score fall	-0.25	-0.19
Reading scale score fall	196.1	197.8
Reading std. scale score fall	-0.24	-0.17
Math scale score winter	204.6	203.9
Math standardized (std.) scale score winter	-0.34	-0.40
Reading scale score winter	198.3	199.0
Reading std. scale score winter	-0.42	-0.39
Math scale score spring	218.4	—
Math standardized (std.) scale score spring	-0.18	—
Reading scale score spring	208.2	—
Reading std. scale score spring	-0.31	—
Quartile 1 of std. math scale score fall	0.33	0.32
Quartile 2 of std. math scale score fall	0.26	0.26
Quartile 3 of std. math scale score fall	0.21	0.21
Quartile 4 of std. math scale score fall	0.20	0.21
Quartile 1 of std. reading scale score fall	0.32	0.33
Quartile 2 of std. reading scale score fall	0.25	0.21

Characteristic	2019/20	2020/21
Quartile 3 of std. reading scale score fall	0.22	0.21
Quartile 4 of std. reading scale score fall	0.21	0.25

Notes: In the first section, the sample includes all students enrolled in PPS in 2019/20 (n= 21,819) or or 2020/21 (n=20,630). In the second section, the sample includes all students enrolled in PPS in 2019/20 in grades 1-12 who have grades in the first semester (n=19,390) or the equivalent for 2020/21 (n=18,716). In the third section, the sample includes all students enrolled in PPS in 2019/20 in grades 2-8 who took the fall, winter, or spring tests, respectively, or the equivalent for 2020/21.

Sample

The sample sizes differed by analysis (table 3).

Table 3. Sample sizes by research question and analysis sample for the analyses presented in the slides

Research question (RQ)	Analysis sample	Sample size
RQ A		
RQ A. Proportion of students taking the NWEA MAP tests	Students enrolled in grade levels K–12 during the testing window for each assessment window (fall, winter, spring)	Fall 2019/20: 21,819 Winter 2019/20: 21,394 Spring 2019/20: 22,445 Fall 2020/21: 20,630 Winter 2020/21: 20,529
RQ A. Changes in the composition of students taking the test (grades 2–8)	All students enrolled in grade levels 2–8 during the testing window for each assessment window (fall, winter, spring)	Fall 2019/20: 11,727 Winter 2019/20: 11,522 Spring 2019/20: 12,073 Fall 2020/21: 11,229 Winter 2020/21: 11,163
RQ A. Proportion of PPS test-takers in each national quartile of the fall 2019/20 reading test distribution who take the fall reading test in 2019/20 and 2020/21	All students enrolled in grade levels 2–7 who took the fall 2019/20 reading test	Took test in fall 2019/20: 8,486 Took test also in fall 2020/21: 7,328
RQ A. Proportion of students with grades	All students enrolled in grade levels K–12 during the fall testing window for 2019/20 and 2020/21	2019/20: 21,819 2020/21: 20,630
RQ B		
RQ B. Change in individual student math scores (winter-to-winter)	Students who were enrolled in grade levels 2–7 in 2019/20 who took the winter math test in 2019/20 and 2020/21	7,517
RQ B. Change in individual student math scores (winter-to-winter, imputed)	Students who were enrolled in grade levels 2–7 in 2019/20 who took the winter math test in 2019/20 and who had grade and absence data in 2020/21.	8,420
RQ B. Change in individual student reading scores (winter-to-winter)	Students who were enrolled in grade levels 2–7 in 2019/20 who took the winter reading test in 2019/20 and 2020/21.	7,366
RQ B. Change in individual student reading scores (winter-to-winter, imputed)	Students who were enrolled in grade levels 2–7 in 2019/20 who took the winter reading test in 2019/20 and who had grade and absence data in 2020/21.	8,338
RQ B. Change in individual student math scores compared to NWEA study during the same period	Students who were enrolled in grade levels 3–7 in 2019/20 who took the winter math test in 2019/20 and fall math test in 2020/21	6,423
RQ B. Change in individual student reading scores compared to NWEA study during the same period of time	Students who were enrolled in grade levels 3–7 in 2019/20 who took the winter reading test in 2019/20 and fall reading test in 2020/21	6,194
RQ B. Change in grade outcomes (GPA, whether a student failed a course)	Students who were enrolled in grade levels 1–12 in 2019/20 and 2020/21 with first semester grades.	2019/20: 19,390 2020/21: 18,716
RQ B. Distribution of first-semester grades	All grades received in instructional courses	High school:

Research question (RQ)	Analysis sample	Sample size
in 2019/20 vs. 2020/21	in grade levels 6–12	47,741 grades in 2019/20 46,786 grades in 2020/21 Middle school: 34,641 grades in 2019/20 33,622 grades in 2020/21
RQ B. Change in proportion of students chronically absent	Students who were enrolled in grade levels K–12 in 2019/20 and 2020/21 with absence data	2019/20: 21,806 2020/21: 20,628
RQ B. Average Days Absent by Number of Courses Failed	Students who were enrolled in grade levels 1–12 in 2019/20 and 2020/21 with grades and absence records	19,390 students in 2019/20 18,715 students in 2020/21

Source: Authors' samples based on administrative data and online learning application data provided by Pittsburgh Public Schools, 2019/20 and 2020/21.

Analysis methods

This study is focused on understanding how academic achievement, as measured by test scores and grades, changed during the pandemic. One challenge in this analysis is that the pandemic may have disrupted the number of students tested in the 2020/21 school year or the number of grades submitted. As a result, taking the average student performance during the baseline period (before school closures in 2019/20) and comparing it to 2020/21 may be misleading.

To understand the scope of this problem, we first address research question A.

First, we describe changes in the proportion of students enrolled in each grade level in PPS during the testing window for each test (fall, winter, and spring of 2019/20 and fall and winter of 2020/21) who take NWEA math and reading tests.

Second, to understand whether the sample of students taking the tests are representative of the enrolled students, we calculate the proportion of students who have a characteristic (e.g., who are female) in the enrolled student population and the tested student population. We then calculate the difference between these two and determine if the standardized difference exceeds 0.05 standard deviations. For this analysis, we focus on students in grade levels 2–8, as these are the tested grade levels that we use for the analysis of the change in test scores. We examine differences in the proportion of students who are female, Black, White, economically disadvantaged, or have an individualized education program (IEP). (We do not include English learners as a group because they represent less than 5 percent of students in PPS in 2020/21. Similarly, we do not include other non-Black minority groups because 83 percent of students enrolled in 2020/21 are either Black or White and no other race/ethnicity groups exceed 10 percent of the enrolled population).

Third, we examine changes in the demographics of students who took the NWEA MAP tests in 2020/21 compared to 2019/20 to understand if students who took the test in both periods had higher or lower test scores in 2019/20. To do so, we use a sample of students in grade levels 2–7 who took the test in fall 2019/20 and assign them to quartiles based on national norms. We then report the proportion of students who took the test for each quartile in fall 2019/20 and those who also took the test in fall 2020/21.

Next, we address research question B. From research question A, even for grade levels 2–8 which have the highest rates of test participation, we still observe a small decline in the proportion of students taking the test and some shifts in the characteristics of students taking the test, although these changes did not exceed 0.05 standard deviations. To address these challenges, we conduct a longitudinal analysis comparing individual students' performance to their own performance in a prior period. For example, we compare a student's score in winter 2020/21 to a period in 2019/20, specifically fall 2020/21 or winter 2020/21. (We focus on winter 2019/20 to winter 2020/21, except for an analysis comparing the changes in PPS against another study (Kuhfeld et al., 2020a) which

reported differences from winter 2019/20 to fall 2020/21). This has the benefit of holding constant the sample with test scores in 2019/20 and 2020/21. However, one drawback of this approach is that we cannot examine the changes in test scores for students who do not take the test in 2020/21.

To address this drawback, we also conduct a sensitivity check in which we impute scores for those with scores winter 2019/20 who do not have them in winter 2020/21. To do so, for students within grade levels 2–7 in 2019/20, we regress the Winter 2020/21 score for a given subject on the winter 2019/20 score for that subject, first semester 2020/21 GPA, the number of course failures in the first semester of 2020/21, and the number of absences in the first semester 2020/21. We also include indicator variables for the following demographic characteristics: gender, race/ethnicity, economically disadvantaged, IEP status, and English learner status. To improve model fit, we include second and third order polynomials for the winter 2019/20 score, GPA, number of courses failed, and absences. We run regressions separately for students in each grade level. We then impute the predicted winter 2020/21 score for those who are missing winter 2020/21 scores. In total, 90.5 percent of students with winter 2019/20 reading scores and 90.4 percent of students with winter 2019/20 math scores were enrolled in winter 2020/21. Among these students, 12 percent (915 students in math, 985 in reading) who took the winter 2019/20 math test did not take the winter 2020/21 test. We impute scores for all but 14 of these students who were missing course grades. We did not attempt to impute scores for students no longer enrolled in PPS. In total, we have real or imputed scores for 90.4 percent of those with winter math scores in 2019/20 and 90.4 percent of those with winter reading scores in 2019/20 (Students with actual scores in Winter 2020/21 constitute 80.1 percent of those with scores in the preceding winter, and 89.2 percent of those who had scores in the preceding winter *and* were enrolled in PPS in winter 2020/21).

Imputing scores allows us to include almost all students still enrolled in the district during the winter 2020/21 testing window. Additionally, one advantage of using variables based on grades and absences in 2020/21 for the imputation, as opposed to just prior test score, is that we are able to use information about students from the 2020/21 school year to inform the imputation. However, all imputation has error and may over- or under-estimate the test scores for those who did not take the test. In this case, imputed scores may over-estimate true scores, given that many students who were failing courses in the first semester of 2020/21 did not take the MAP test in 2020/21 (table 4).

Table 4. Proportion of students in grade levels 2–7 in 2019/20 who have a winter 2020 math score, by the number of courses failed during the first semester of 2020/21

Number of courses failed in first semester of fall 2020	Proportion with a winter 2020 math score	Frequency
0	0.89	7,802
1	0.72	522
2	0.64	213
3	0.49	155
4	0.39	110
5	0.30	63
6	0.38	39
7	0.40	5
8 or more	0.29	9
Total		8,918

Source: Sample includes all students in grade levels 2–7 in 2019/20. Authors' samples based on administrative data provided by Pittsburgh Public Schools, 2020/21.

To interpret test score findings, we use a threshold of 0.1 standard deviations to identify meaningful changes in standardized test scores. For scale score changes, we use a threshold in scale score points that is equivalent to 0.1 standard deviations in the pre-pandemic national distribution (For example, for grade 2 in math, this would be 1.3

scale score points). We use these thresholds when discussing how individual students' scores changed from 2019/20 to 2020/21 and when discussing average differences in the changes students experienced in different groups (e.g., male versus female students). Because the analyses are not intended to generalize to a larger population, we do not conduct tests of the statistical significance of differences.

In contrast to test scores, the proportion of students with outcomes based on grades (specifically, whether they fail a course and GPA) is high in all grades but kindergarten and does not change from 2019/20 to 2020/21 (see slide 13 in the attached deck). We therefore conduct a cross-sectional analysis for grade-based outcomes because we are not concerned about the composition of the sample changing in ways that might bias the results from 2019/20 to 2020/21. Specifically, we compare successive cohorts in the same grade levels or subgroups, calculating the difference in outcomes based on first-semester grades from 2019/20 and 2020/21. The cross-sectional analysis is preferable to a longitudinal analysis because there are increases or declines in course failures that typically occur at some grade level transitions (for example, students moving from grade 8 to grade 9 often experience an increase in course failures). A longitudinal analysis would conflate the effects of the pandemic with these natural changes that occur across some grade-level transitions, while the cross-sectional analysis avoids this problem by holding grade level constant.

To interpret findings when discussing changes in the proportion of students failing at least one course, we use a threshold of 5 percentage points to identify meaningful changes. When interpreting changes in GPAs, we use a threshold of 0.1 GPA points.

Limitations

The test score analysis has a few limitations. First, the analysis sample was limited to students in grade levels 2–7 in 2019/20 who took the test in both testing periods. Students who took the test in 2019/20 but not in 2020/21 would not be included in the main analysis. It is possible students who did not take the test in 2020/21 would have different learning gains than those who did take the test. Also, the analysis sample was restricted to grade levels 2–7 because a lower proportion of students took the NWEA MAP tests in earlier grade levels (kindergarten and grade 1) or late grade levels (grades 8–12) in both 2019/20 and 2020/21. It is possible the findings could differ in these grades. Second, the tests were administered remotely in the 2020/21 school year for both fall and winter. Test scores in remote environments were found by NWEA to be reliable in grade levels 3–8, but should be used with caution in earlier grades (Kuhfeld et al., 2020b). Third, MAP tests were first offered in 2019/20 in Pittsburgh. As a result, part of the change in scores from 2019/20 to 2020/21 may be due to students and teachers becoming more familiar with the test. This may have helped mitigate some of the declines relative to pre-pandemic national norms that PPS students experienced. Fourth, for the sensitivity check that uses imputation, imputation is not perfect and may under- or over-estimate the scores for students who had scores in 2019/20 but did not take the test in 2020/21. In particular, it is possible imputed scores were overly optimistic given that many students who were failing courses in the first semester of 2020/21 did not take the MAP test in 2020/21.

The analysis of grades also faces a limitation. Criteria for failing a course may have shifted during the pandemic. To the extent that teachers lowered grading standards, the change in course failure rates we calculate would understate what the change would have been had the failure criteria stayed constant.

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