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Have PreACT Scores Declined During the COVID-19 Pandemic?

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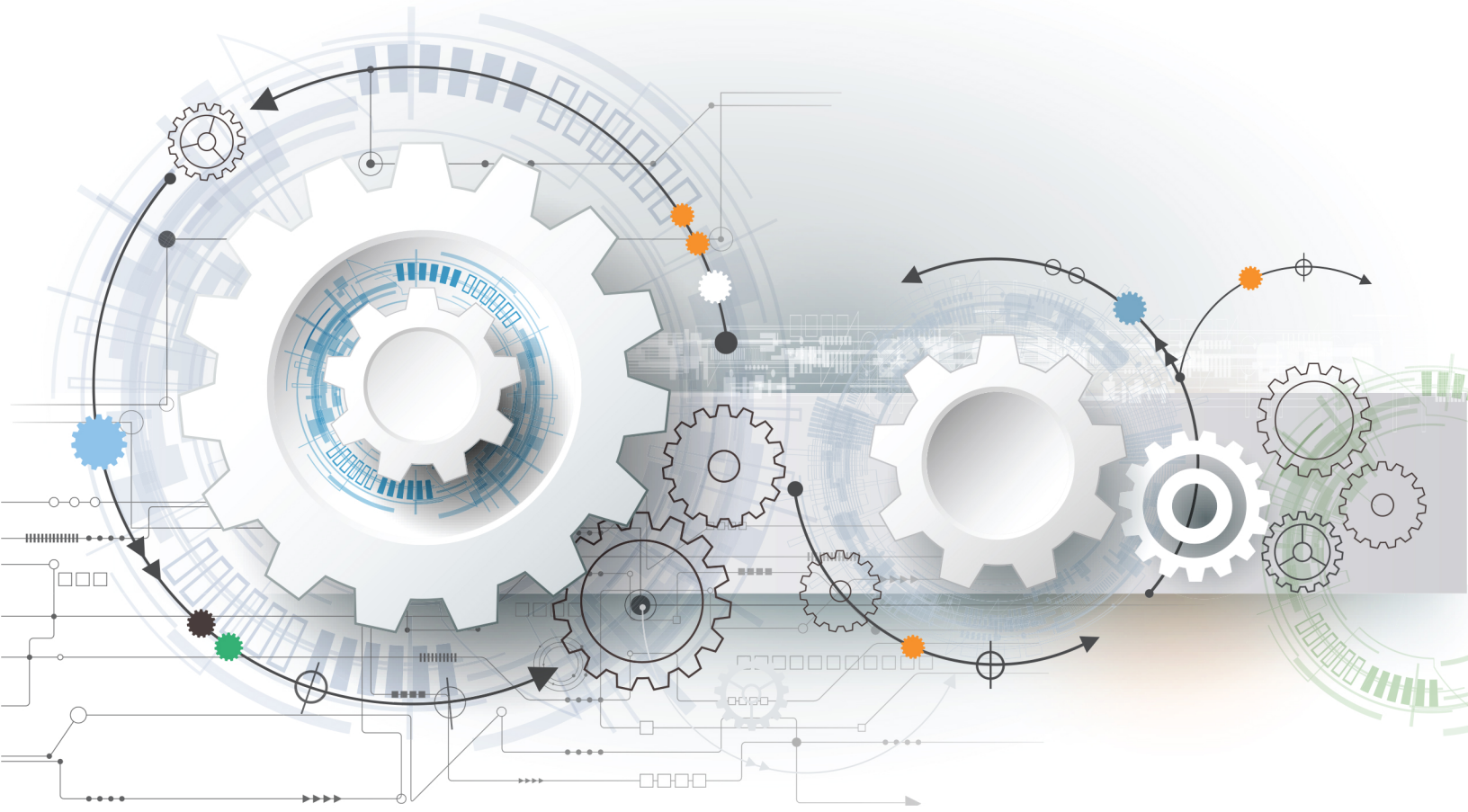

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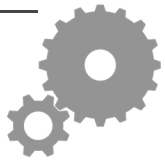
ACT WORKING PAPER SERIES



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Have PreACT Scores Declined During the COVID-19 Pandemic?

Executive Summary

For schools that were able to administer the PreACT® during the pandemic, we observed notably lower scores in English, math, and reading compared to before the pandemic. Scores decreased by 1.02 points (0.17 standard deviations) in English, 0.59 points (0.13 standard deviations) in math, and 0.32 points (0.05 standard deviations) in reading. Score decreases of this magnitude are comparable to percentile rank decreases of about 7 points in English, 5 points in math, and 2 points in reading. Due to study limitations and natural year-to-year fluctuation in PreACT scores, the study does not provide a precise estimate of how much of the score decreases are due to the COVID-19 pandemic. Contrary to expectations and popular concern, score decreases in math and reading were not more pronounced for students from traditionally underserved backgrounds (e.g., African American, Hispanic, and students whose parents did not attend college). However, there is some evidence that female students have been impacted more by the pandemic, particularly in reading, and the observed score declines in math and reading were somewhat larger for students attending private or parochial schools relative to those attending public schools. In English, score decreases were more pronounced for Hispanic students (relative to White students), students whose parents did not attend college, and students attending public schools.

Introduction

With the disruptions to education caused by the COVID-19 pandemic, there are concerns that students are falling behind academically. Recent studies based on standardized test scores suggest this is indeed the case (Kuhfeld et al., 2020; Renaissance, 2020; Curriculum Associates, 2020). The initial studies suggest that the negative impacts of the pandemic are more pronounced for math relative to reading and for younger students relative to those in later grade levels.

In this report, PreACT® score trends are examined for possible impacts of the COVID-19 pandemic on high school students' academic achievement. Using schools that tested a comparable number of students before and during the pandemic, changes in average scores over time are examined. In addition to examining the overall trend, differences across student and school subgroups are examined, including by gender, race/ethnicity, parent education level, and school characteristics (school control and school locale).

Early studies on the pandemic's impact on academic achievement have focused on math and reading, have only included student samples up to grade 8, and have been based on diagnostic or interim assessments. This study contributes to the knowledge base by examining this issue for later grade levels (9–11) and additional subject areas (English and science, in addition to math and reading), and employing the PreACT test—a summative test aligned to college and career readiness standards.

The PreACT test

The PreACT includes four multiple-choice tests: English, math, reading, and science. Schools, districts, or states typically administer the PreACT to all students as an assessment of progress toward college and career readiness, to motivate college and career planning, and to help students prepare for the ACT® test. The PreACT test is usually administered to students in

10th grade but is also used in grades 9 and 11. More detailed information about the test is provided in the *PreACT Technical Manual* (ACT, 2020).

Methods

Sample

We considered high schools in the United States that administered the PreACT test during the 2019–2020 and 2020–2021 academic years to 9th, 10th, or 11th graders. High school by grade level combinations were eligible for the analysis if (a) at least 20 students were tested in 2020–2021, (b) the number of students tested in 2019–2020 was within 25% of the number tested in 2020–2021, (c) at least 75% of all enrolled students were tested across the two years, and (d) the tests were administered at most 30 days apart in their respective year (e.g., October 1, 2019 and October 31, 2020 would be acceptable). This yielded a sample of 490 high schools from 33 states that tested 62,385 students in 2019–2020 and 59,671 students in 2020–2021 (Table 1). During the 2019–2020 academic year, the schools administered the PreACT test between September 5 and January 13 (before schools were affected by the pandemic), with a median date of October 16. During the 2020–2021 academic year, the PreACT test was administered between September 9 and January 11, with a median date of October 14.

Table 1. Demographics and Summary Statistics

Variable	School Year	
	2019–2020	2020–2021
Number of schools	490	490
Number of students	62,385	59,671
Gender (%)		
Female	48.6	42.2
Male	49.4	42.9
Missing	2.1	14.9
Race/Ethnicity (%)		
African American	12.2	12.0
Asian	2.7	2.6
Hispanic	10.9	10.8
Other	6.6	6.0
White	63.4	62.0
Missing	4.2	6.6
Grade Level (%)		
9	9.4	9.3
10	85.9	86.4
11	4.8	4.6
Parent Education (%)		
High School or less	10.7	9.5
< Bachelors	13.6	11.9
≥ Bachelors	32.3	29.7
Missing	43.4	48.9
School control (%)		
Public	81.4	81.0
Non-Public	18.6	19.0
School locale (%)		
Rural	26.9	27.5
Town	16.4	16.6
Suburb	31.6	30.8
City	18.5	18.4
Missing	6.7	6.7
Days since Sep. 1 (mean)	45.7	47.0
PreACT scores (mean)		
English	16.7	15.6
Math	18.0	17.4
Reading	20.1	19.8
Science	18.1	18.4
Composite	18.3	17.9
High school GPA		
Percent missing	52.3	56.3
Mean	3.26	3.30

Given the inclusion criteria described above, the 2019–2020 and 2020–2021 cohorts were quite similar in terms of the demographic characteristics and grade level tested. Across the two cohorts, most of the sample (86%) took the PreACT in 10th grade, with the remainder

testing in 9th or 11th grade. The sample included students from public (81%) and non-public (19%) schools and students from different racial/ethnic groups, including African American (12%), Asian (3%), Hispanic (11%), Other (6%), and White (63%). About 5% of the sample was missing race/ethnicity data.

Statistical Model

To estimate the difference in average PreACT scores from 2019–2020 (pre-pandemic) to 2020–2021, hierarchical linear regression models were used. More details on the statistical models are provided in the appendix.

Results

Table 2 provides the adjusted difference in average scores from 2019–2020 to 2020–2021. Estimates are provided for the total group and subgroups. As compared to the pre-pandemic 2019–2020 cohort, average PreACT scores were lower in English, math, and reading for the 2020–2021 cohort. The difference was largest in English (-1.02), followed by math (-0.59), and then reading (-0.32). For science, the average score increased (+0.34).

Table 2. Adjusted Difference in Average Scores from 2019–2020 to 2020–2021

Group	English		Math		Reading		Science		Composite	
	EST	SE	EST	SE	EST	SE	EST	SE	EST	SE
Total	-1.02	0.04	-0.59	0.03	-0.32	0.04	0.34	0.03	-0.40	0.03
Gender										
Female	**-1.12**	0.05	-0.61	0.03	**-0.68**	0.05	**0.17**	0.04	**-0.55**	0.04
Male	**-0.93**	0.05	-0.58	0.03	**0.03**	0.05	**0.51**	0.04	**-0.24**	0.04
Race/ethnicity										
African American	-1.09	0.09	**-0.35**	0.06	-0.17	0.10	0.27	0.08	-0.34	0.07
Asian	-0.83	0.18	-0.62	0.13	-0.36	0.20	0.21	0.15	-0.40	0.14
Hispanic	**-1.18**	0.09	**-0.50**	0.06	-0.20	0.10	0.37	0.08	-0.38	0.07
Other	-1.08	0.12	-0.53	0.08	-0.28	0.13	0.36	0.10	-0.39	0.09
White	**-0.99**	0.04	**-0.66**	0.03	-0.37	0.05	0.35	0.04	-0.41	0.03
Parent education										
High school or less	**-1.04**	0.10	**-0.45**	0.07	-0.30	0.11	0.26	0.08	-0.39	0.08
< Bachelors	-1.07	0.09	-0.54	0.06	-0.34	0.10	0.30	0.08	-0.42	0.07
≥ Bachelors	**-0.83**	0.07	**-0.66**	0.05	-0.37	0.07	0.38	0.06	-0.36	0.05
School control										
Public	**-1.07**	0.04	**-0.53**	0.03	**-0.27**	0.05	0.35	0.04	-0.38	0.03
Non-Public	**-0.87**	0.08	**-0.81**	0.06	**-0.53**	0.09	0.31	0.07	-0.48	0.07
School locale										
Rural	**-1.12**	0.07	-0.55	0.05	-0.36	0.07	**0.25**	0.06	-0.45	0.05
Town	**-1.14**	0.09	-0.55	0.07	-0.26	0.10	0.37	0.08	-0.40	0.07
Suburb	-0.90	0.07	-0.63	0.05	-0.25	0.08	0.36	0.07	-0.35	0.06
City	**-0.86**	0.09	-0.66	0.07	-0.33	0.10	**0.49**	0.09	-0.34	0.07

Note: EST = estimate of adjusted difference in average score, SE = standard error of estimate

Adjusted differences in average scores are also provided for student subgroups and for groups defined by school characteristics (school control and school locale). Values that appear in bold in Table 2 indicate that the difference was statistically significant across different categories of the grouping variable. For example, for English, scores decreased by 1.12 score points for female students and by 0.93 score points for male students, and this gender difference (of 0.19 points) was statistically significant. For females, the decrease in reading scores (-0.68) was considerably larger than that observed for males (+0.03). The change in scores also differed by gender for science, with males increasing by 0.51 points and females increasing by 0.17 points. For math, the score decrease was similar for females and males.

The score changes were generally consistent across racial/ethnic groups, with some exceptions. In English, the average score decrease for Hispanic students (-1.18) was larger than the decrease for White students (-0.99). In math, the average score decrease for White students (-0.66) was larger than the decreases for African American (-0.35) and Hispanic (-0.50) students.

In English, students with lower parent education level had a larger score decrease (-1.04) than students with higher parent education level (-0.83). Conversely, in math, students with lower parent education level had a smaller decrease (-0.45) than students with higher parent education level (-0.66).

In both math and reading, students enrolled at public schools had lower score decreases than students enrolled at non-public schools. In math, scores for public school students dropped by 0.53 points, compared to 0.81 points for non-public school students. In reading, scores for public school students dropped by 0.27 points, compared to 0.53 points for non-public school students. In English, however, students enrolled at public schools had a larger score decrease (-1.07) than students enrolled at non-public schools (-0.87).

Differences in score changes across different school locales (rural, town, suburb, or city) were generally small. Relative to students enrolled at city schools, those in rural settings had larger decreases in English scores and smaller increases in science scores.

Discussion

The study revealed changes in PreACT English, math, and reading scores that may be at least partly attributed to the pandemic. The adjusted score differences in Table 2 are expressed on the PreACT score scale. To facilitate comparisons across studies using different assessments and scales, the differences can also be expressed in standard deviation units. Using standard deviation estimates obtained from the latest PreACT national norming study (ACT, 2020), the scores decreased by 1.02 points (0.17 standard deviations) in English, 0.59

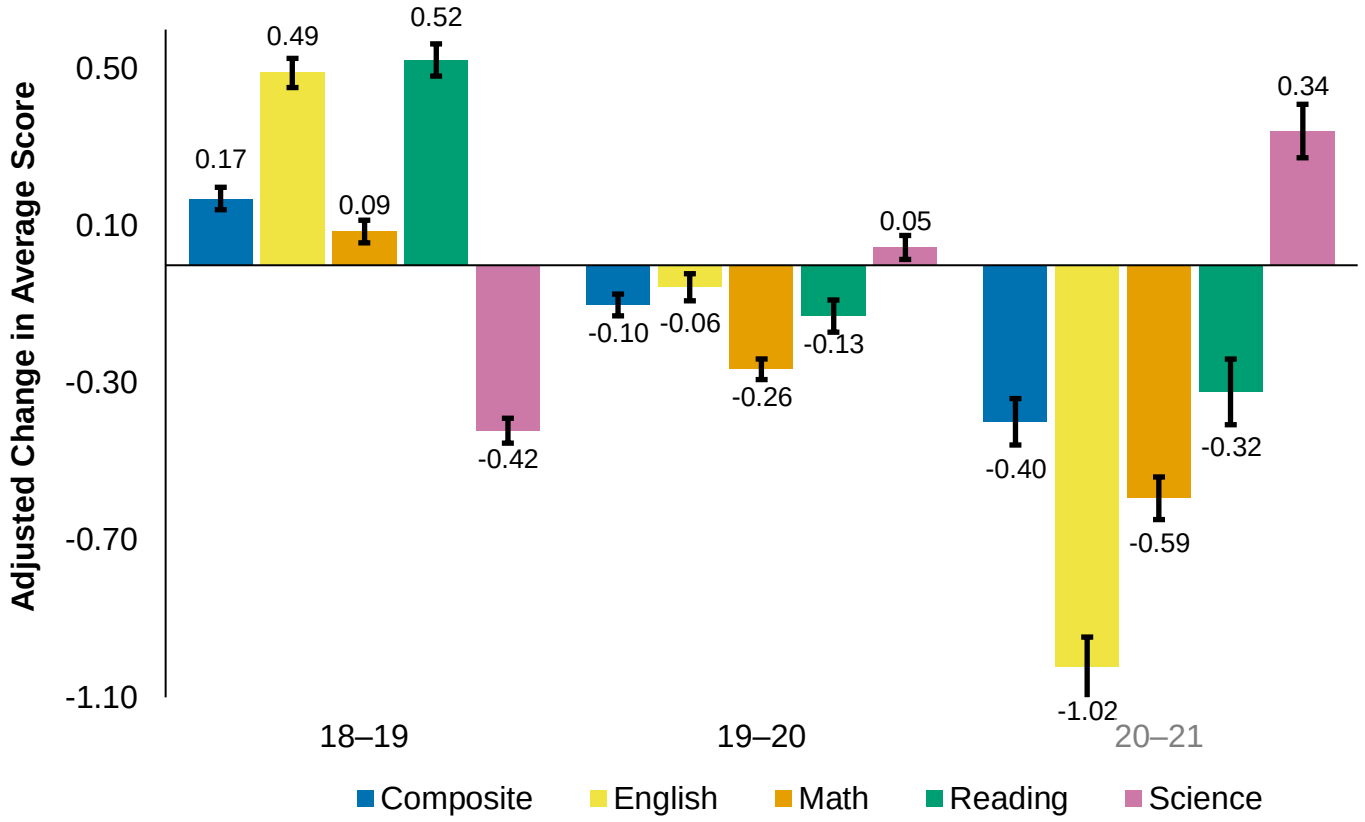
points (0.13 standard deviations) in math, and 0.32 points (0.05 standard deviations) in reading. The standard deviation differences can also be expressed as changes in percentile ranks:[1] The adjusted score differences are comparable to percentile rank decreases of about 7 points in English, 5 in math, and 2 in reading. The math and reading results generally agree with those from the initial studies for grades 1–8 (Kuhfeld et al., 2020; Renaissance, 2020; Curriculum Associates, 2020) which found that pandemic-related score decline seems to be larger for math than for reading.

The adjusted score differences can also be compared to averages for one-year gains in PreACT scores. For students who took the PreACT in grades 9 and 10 approximately one year apart, the average gain is 1.9 for English, 1.5 for math, and 2.2 for reading (ACT, 2020). If we use the average score gains as benchmarks for one year of academic growth, the English score decrease observed in this study is comparable to about 0.5 years of academic growth. Similarly, the math and reading score decreases are comparable to 0.4 and 0.15 years of academic growth, respectively.

While it is reasonable to attribute some of the score decreases to the pandemic, it is also possible for scores to change for other reasons, such as differences across cohorts in academic readiness and small differences across PreACT test forms in difficulty. To better understand year-to-year variation in average PreACT scores, we applied the same methods and statistical model to prior years of PreACT testing (2017–2018 vs. 2018–2019, 2018–2019 vs. 2019–2020). Figure 1 summarizes the results. The 2020–2021 comparison is the focus of this study, comparing the most recent pre-pandemic year (2019–2020) to the current year (2020–2021). The other comparisons show that there is some natural year-to-year variation in average PreACT scores, even when there are no major disrupting events like the pandemic, schools are kept constant, and scores are adjusted for gender and race/ethnicity. For the 2019–2020 comparison, the differences were no larger than 0.26 score points (for math), but for the 2018–2019 comparison, the differences were as large as 0.52 score points (for reading). If the score

decreases are expressed in standard deviation units, the pre-pandemic year-to-year score changes range from -0.08 to 0.08, with a standard deviation of 0.06.

Figure 1. Adjusted Annual Changes in Average PreACT Scores



Therefore, while the average score decreases observed for English, math, and reading are likely due—at least in part—to the pandemic, there is also an unexplained component to year-to-year changes in PreACT scores such that the actual effect of the pandemic could be more or less severe than suggested by the observed score changes. Based on the prior year comparisons, it seems plausible that the adjusted differences in Table 1 could be shifted by as much as 0.06 standard deviation units from natural year-to-year variation. If this were the case, the pandemic's true effect on English scores, for example, could be -0.17 +/- 0.06 (expressed in standard deviation units), or anywhere from -0.23 (-1.40 English score points) to -0.11 (-0.67 English score points).

Surprisingly, average PreACT science scores were higher during the pandemic. It is still possible that the pandemic is having a negative impact on science achievement, but that it isn't enough to negate an increase in science scores due to other factors (e.g., cohort differences and small differences in difficulty). In other words, perhaps the increase in science scores would have been larger had it not been for negative effects of the pandemic. Additional research using other assessments of college and career readiness (e.g., the ACT test and ACT® Aspire®) may help us better understand the results for science and may provide additional evidence of the pandemic's impact on achievement in English, math, and reading.

Subgroup Differences

If the pandemic is having a disproportionate effect on traditionally disadvantaged groups, achievement gaps will widen. If this happens, we would expect African American, Hispanic, and first-generation students to show larger score decreases than White students and those whose parents have a college degree. Some differences in score changes were observed across student subgroups, but they did not generally follow the expected pattern. For example, African American and Hispanic students showed **smaller** score decreases in math relative to White students, suggesting that they were not as adversely impacted. Similarly, students whose parents did not attend college showed smaller score decreases in math relative to students whose parents have a bachelor's degree or higher. A few exceptions were observed for English where Hispanic students had larger score decreases than White students, and first-generation students showed larger score decreases relative to students whose parents have a bachelor's degree or higher.

One surprising finding was that reading scores decreased for female students but not male students. This suggests that the pandemic had a harmful effect on the reading skills of female students but not male students. Another surprise was that math and reading scores decreased less for public school students relative to non-public school students, suggesting that the pandemic's effects have been more harmful on students attending non-public schools.

Study Limitations

While this study provides some evidence of the pandemic's effects on academic achievement, there are limitations to the study that should be considered. The study relied on schools that administered the PreACT to a comparable number of students in 2019–2020 and 2020–2021 and tested at least 75% of their enrolled students. Presumably, those schools were able to maintain their in-person PreACT testing program during the pandemic. Such schools may rely less on remote and hybrid forms of instruction, relative to schools that were not able to administer the PreACT to the same level during the pandemic. If that is the case, the results of the study do not generalize to all schools that normally administer the PreACT test, and the study results may provide a conservative estimate of the pandemic's negative impact on academic achievement.

Also, the study assumes that there is no major selection bias for students testing during the pandemic. By virtue of the inclusion criteria (only including schools who tested the vast majority of their enrolled students before and during the pandemic), this assumption may be reasonably well supported. However, it is still possible for the students who tested during the pandemic to be different than those who did not test on unmeasured variables, such as high school grades. The statistical model controlled for differences across years in race/ethnicity and gender, but no other variables. High school GPA data collected as part of the PreACT administration process was not available for most of the study sample: It was not available for 52% of students tested in 2019–2020 and 56% of students tested in 2020-2021 (Table 1). Among the students who reported high school grade data, the mean high school GPA was 3.26 for students in the 2019–2020 sample and 3.30 for students in the 2020–2021 sample. If we restrict the sample to those schools where at least 75% of students reported their grades, we find that average high school GPA is higher for students in the 2020–2021 cohort, showing that students who earn higher grades were slightly more likely to test during the pandemic.[2] This

suggests that the study may err on the side of underestimating the negative impact of the pandemic on PreACT scores.

While the study included 490 high schools from 33 states, we did not have equal representation across those states, and the schools are not representative of schools across the country. About half of the sample came from two states with high PreACT test volume.

A final limitation is that data were not available to examine how scores are impacted by mode of learning (e.g., remote, in-person, hybrid) and level of student engagement. As that data become available, additional studies should be done to examine those differences.

Conclusions

Concerns about the pandemic's negative effects should primarily center around the health and wellness of students, educators, and their families or caregivers. While secondary to those concerns, there is also broad interest in the pandemic's effects on student learning and progression towards college and career readiness. Valid and reliable data from national assessment programs, including the PreACT, are valuable for understanding the impact of the pandemic on academic achievement. This study found evidence of the pandemic's negative impact—particularly in English and math—and illustrated some of the technical challenges and limitations of using assessment trend data to measure the pandemic's impact.

References

ACT. (2020). *PreACT technical manual* (Version 2020.1). Iowa City, IA: ACT.

Curriculum Associates. (2020). *Understanding student needs: Early results from fall assessments.* North Billerica, MA: Curriculum Associates. Retrieved from https://www.curriculumassociates.com/-/media/mainsite/files/i-ready/iready-diagnostic-results-understanding-student-needs-paper-2020.pdf.

Kuhfeld, M., Tarasawa, B., Johnson, A., Ruzek, E., & Lewis, K. (2020*). Learning during COVID-19: Initial findings on students' reading and math achievement and growth*. Portland, OR: NWEA Research. Retrieved from https://www.nwea.org/content/uploads/2020/11/Collaborative-brief-Learning-during-COVID-19.NOV2020.pdf.

Renaissance. (2020). *How kids are performing: Tracking the impact of COVID-19 on reading and mathematics achievement.* Wisconsin Rapids, WI: Renaissance Learning.

Appendix: Statistical Model for Estimating Year-to-Year Score Changes

To account for clustering of students within high schools and grade levels, hierarchical linear regression models were used to model PreACT scores. Student gender, race/ethnicity, and number of days from September 1 to the PreACT test were used as covariates to reduce confounding in the comparison of scores across years.[3] Additional variables such as parent education level and high school GPA were considered but not used because too many students were missing data on these variables.

The model also included an indicator for year (e.g., I_{2021}=1 for students in the 2020–2021 sample, I_{2021}=0 otherwise). If the coefficient for year is negative, it provides evidence of a negative effect of the pandemic on PreACT scores. Model intercepts and year effects were allowed to vary across high schools/grade levels. The model was fit for each subject area of the test (English, math, reading, and science) and for the Composite score.

The hierarchical regression model can be written as:

$$Y_{ij} = b_{0j} + I_{2021ij} b_{1j} + \sum_{p=I}^{P} X_{ijp}\theta_p + e_{ij}$$

where Y_{ij} is the PreACT score for the *i*th student from the *j*th school/grade combination, b_{0j} is the intercept for the *j*th school/grade, I_{2021ij} indicates whether the *i*th student from the *j*th school/grade tested in the 2020-2021 academic year (during the pandemic), b_{1j} is the increase (or decrease) in average PreACT score associated with testing during the pandemic, X_{ijp} is the *p*th covariate for the *i*th student from the *j*th school with associated coefficient θ_p, and e_{ij} is the model's error term. Intercepts (b_{0j}) and year effects (b_{1j}) are assumed to vary across high school/grades, and the model also estimates the mean intercept (β_0) and mean year effect (β_1) across school/grades.

The model described above estimates the overall COVID-19 impact. Subgroup estimates can be obtained by estimating interactions between subgroup indicators and the year

indicator. For example, in the model below, the $\boldsymbol{\gamma}$ coefficient tests whether the COVID-19 impact is different for female students compared to male students.

$$Y_{ij} = b_{0j} + I_{2021ij} b_{1j} + \sum_{p=I}^{P} X_{ijp}\theta_p + \boldsymbol{female_{ij} I_{2021ij} \gamma} + e_{ij}$$

This approach was also used to obtain estimates by race/ethnicity, parent education level, school control, and school locale.

[1] Assumes an underlying normal distribution for test scores and measures change in percentile rank relative to the median score.
[2] Among high schools where at least 75% of students reported their course grades, we estimate that the mean high school GPA for all students (e.g., assuming no missing data) would be 3.23 for students tested during the 2019–2020 school year and 3.27 for students tested during the 2020–2021 school year.
[3] Gender and race/ethnicity were missing for some students (Table 1), so values were imputed prior to fitting the hierarchical regression models.