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# Examining Kentucky Students' Performance Trendlines Pre- and Post-COVID-19 Interruption Final Report

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# Examining Kentucky Students' Performance Trendlines Pre- and Post-COVID-19 Interruption

## Introduction

Kentucky students did not take the statewide assessment in 2020 due to the COVID-19 pandemic. Kentucky typically administers its summative assessment in the spring to grades 3-8 and high school for math and reading, and once in elementary, middle, and high school for writing, science, and social studies. Summative assessment scores are used in the accountability index computed for schools in the state. The Kentucky Summative Assessment (KSA) tests were administered in 2021, but no accountability indexes were computed based on them.<sup>1</sup> Kentucky, like most states, is interested in examining student performance trends as a means of estimating the impact of the interruptions in testing and in-person instruction during the pandemic. The purpose of this report is to summarize our examination of performance trendlines prior to, and immediately following, the COVID-19 related school closures.

Andrew Ho (Ho, 2021), in a presentation to the Technical Issues in Large Scale Assessment (TILSA) collaborative of the Council of Chief State School Officers (CCSSO) recommended reporting three metrics when characterizing student performance in the COVID-19 affected school year. The first is the *match rate*, or how many students can we match in the before and after samples. This ensures that when we compare trend pre- and post-COVID we can do so based on the same sample of students. The match rate and demographic descriptors of matched and unmatched students can also tell us about the groups of students who tested in 2021 versus those that did not. The second is the *fair trend* that examines scores for matched students only. The third is the *blind spot* that represents potentially large proportions of students who did not test in 2021. Most of Ho's (2021) paper is focused on generating school or district level scores, where sampling issues could generate substantive differences from one school or district to the next. For this study, we focused on state-level trends to better understand the overall impact of the COVID interruption.

At the time this report was written (2021-2022), the COVID pandemic continues to impact education in Kentucky. Our use of the term post-COVID refers to the time after the initial interruption in the 2019-20 academic year. This report represents an exploration of how the pandemic has impacted student achievement since it began. The use of the term post-COVID does not imply that the effects of the pandemic are over.

## Method

KDE provided HumRRO with student-level data files for each subject test from 2015-2019 and for 2021. Individual testing year files were combined into a master file for all students across all years using the SAS statistical package. Data cleaning was conducted in SAS, and analyses were conducted in SAS, Excel, or R depending on the type of analysis. Several factors limited the subjects and grade levels included in this study. Some assessments were not administered in some years (e.g., grades 4 and 7 science in 2017), some assessments were not administered consistently over the years (e.g., ACT, End-of-Course, grade 10 K-PREP), and some content

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<sup>1</sup> Kentucky administered the Kentucky Summative Assessment (KSA) in 2021. In prior years, Kentucky administered the Kentucky Performance Rating for Educational Progress (K-PREP). The KSA tests were built from the K-PREP item pool.

areas were not reported on a common scale across the years (e.g., writing reported on a raw score metric). Our analyses therefore include reading and math grades 3-8. Sample sizes for various analyses were further limited to those individuals who did not have a testing exemption, did not have an allegation flag for the specific content assessment, and did report a scale score for the specific content assessment. Table 1 presents the number of students, districts, and schools included in the final analysis files.

**Table 1. Student, District, and School Sample Size by Grade and Testing Year**

Testing Year	Grade	Reading			Mathematics		
		Student N	District N	School N	Student N	District N	School N
2015	3	46017	173	701	46016	173	701
	4	45957	173	701	45957	173	701
	5	46236	173	691	46236	173	691
	6	45200	173	395	45200	173	395
	7	43432	173	320	43432	173	320
	8	42118	173	319	42118	173	319
2016	3	52059	173	698	52059	173	698
	4	50578	173	698	50578	173	698
	5	49494	173	688	49494	173	688
	6	49337	173	396	49337	173	396
	7	49292	173	318	49292	173	318
	8	48712	173	319	48712	173	319
2017	3	51641	173	700	51641	173	700
	4	51826	173	700	51826	173	700
	5	50466	173	690	50466	173	690
	6	49353	173	391	49353	173	391
	7	49352	173	316	49352	173	316
	8	49174	173	317	49174	173	317
2018	3	50695	173	696	50695	173	696
	4	51666	173	696	51662	173	696
	5	51939	173	686	51932	173	686
	6	50164	173	388	50168	173	388
	7	49307	173	313	49305	173	313
	8	49194	173	313	49190	173	313
2019	3	48480	173	697	48490	173	697
	4	50608	173	697	50582	173	697
	5	51397	173	693	51429	173	693
	6	51536	173	392	51537	173	392
	7	49909	173	314	49893	173	314
	8	49245	173	314	49249	173	314
2021	3	39088	172	693	39105	172	693
	4	42080	172	693	42099	172	693
	5	42346	172	689	42330	172	689
	6	42894	172	389	42864	172	389
	7	43127	172	314	43064	172	314
	8	42964	172	314	42891	172	314



*Note.* Counts for districts and schools include all possible districts or schools, respectively, with a student sample size greater than 0. In district-based and school-based analyses, districts or schools with less than 40 students per grade were excluded from analyses, so final counts for specific regression-based analyses vary.

In 2021, KDE made the decision to report summative assessment scores on a modified scale (100-200) to highlight that 2021 scores reflected student performance following a school year marked by COVID-19 in-person school closures and extended periods of non-traditional instruction and to discourage inappropriate interpretations. For the present study, this required us to convert 2021 scores to the 100-300 reporting scale used in prior years. First, 2021 raw scores were converted to theta values using KDE-provided conversion tables. These theta values were then converted to scale scores using the 2019 KDE test specification conversion equation (see equation 1). New proficiency level assignments were then generated for converted 2021 scores using the 2019 KDE proficiency level cut points. Converted 2021 proficiency levels were then compared to original 2021 proficiency levels to verify that no student's overall proficiency level had changed between original and converted scores. This comparison yielded no differences in proficiency level counts across students for 2021.

$$SS = m(\theta - \theta_p) + b \quad (1)$$

In addition to these more general methodological issues, which were implemented across all analyses, specific methodological considerations were undertaken for each set of analyses. These analysis-specific methodologies are discussed in the remaining sections.

## State-Level Analyses

### Student scale score trends

State-level analyses were conducted to examine the mean scale score trend across all students for a specific subject and grade combination. For these analyses, the average scale score for all students in a specific subject and grade (e.g., Reading Grade 3) was calculated for each year the assessment was administered (2015 – 2019 and 2021). A trendline was calculated based on the average scores from 2015 – 2019, and the 2021 score was then plotted against this trendline to illustrate whether the 2021 average score was in line with, above, or below the expected score given the 2015 – 2019 trend. This analysis was conducted for Reading and Math Grades 3-8.

### Matched grade-band analyses

Once state-level trends had been established, student-level analyses were conducted to identify trends among the same students across grade bands. Students who completed assessments across a 2-year span for specific grade bands (e.g., matched students in 2015 and 2017 who completed Reading Grade 3 and Reading Grade 5 assessments) were identified for inclusion in the sample. Then, the average scale score for the specific subject and grade combination was calculated for both years. These averages were then used to compute an effect size of the change in score across the 2-year period, with positive effect sizes indicating higher mean score changes and negative effect sizes indicating lower mean score changes across the 2-year period. In addition, the percentage of students with scores categorized as “proficient-and-above” was calculated for each year. The change in percent proficient-and-above was then calculated by subtracting the time 2 score from the time 1 score, with a positive change indicating higher percentage proficient-and-above across the 2-year period and a negative change indicating lower percentage proficient-and-above. These analyses were done for Reading and Math grade bands 3-5, 4-6, 5-7, and 6-8 for the 2015-2017, 2016-2018, 2017-2019, and 2019-2021 time periods.

### Matched and unmatched student analyses

In addition to analyzing matched student samples, comparisons were made between matched and unmatched student samples for the 2017-2019 and 2019-2021 periods. Students were identified who had completed assessments for each specific subject within specified grade bands during these 2-year periods to generate the matched sample. Students who had completed an assessment in either the first or second year in the 2-year period (e.g., tested in 2019 or 2021), but not both, were identified for the unmatched sample. Average summative assessment scores were calculated for both matched and unmatched student samples in each 2-year period and compared within timeframe between groups, as well as across timeframes. These analyses were conducted for Reading and Math grade bands 3-5, 4-6, 5-7, and 6-8.

### ***Propensity matched sample analyses***

The final analysis of student-level data involved generating a propensity matched sample of students who tested in 2021 to reflect the demographic and performance characteristics of students who tested in 2019 but not in 2021. These propensity matched samples of students were then matched from 2019-2021 for specific subject grade bands (e.g., Math Grades 3-5). Average scale scores in each year were calculated and a regression analysis was performed to generate a trendline for the propensity matched sample from 2019 to 2021. This trendline was compared to the overall trendline for the specific subject grade band in 2017-2019 and 2019-2021 to identify if differences in trends for scores post-COVID-19 were due to changes in the sample of tested students or due to changes in overall student performance.

### ***District- and School-Level Analyses***

Upon completion of the state-level analyses, data analyses were also conducted at the district and school level. Districts and schools with sample sizes less than 40 students per grade were excluded from these analyses. Group estimates based on small sample sizes are less reliable than estimates based on larger samples. The requirement of 40 students per grade allows for better overall estimates of trend at the school and district levels but is a limitation of the design. These analyses were not designed to detect whether there are substantive differences between large and small schools.

### ***Mean score change analyses***

Mean score changes were calculated for each district and school for a specific subject and grade across a 2-year period. Average summative scores were calculated for each year, and score changes were calculated by subtracting the average of the first year from the average of the second year. These mean score changes were then plotted across districts and across schools in a histogram for the 2-year period. This analysis was done for Reading and Math Grades 3-8 for the 2015-2017, 2016-2018, 2017-2019, and 2019-2021 periods.

### ***Predicted versus actual 2021 mean comparison***

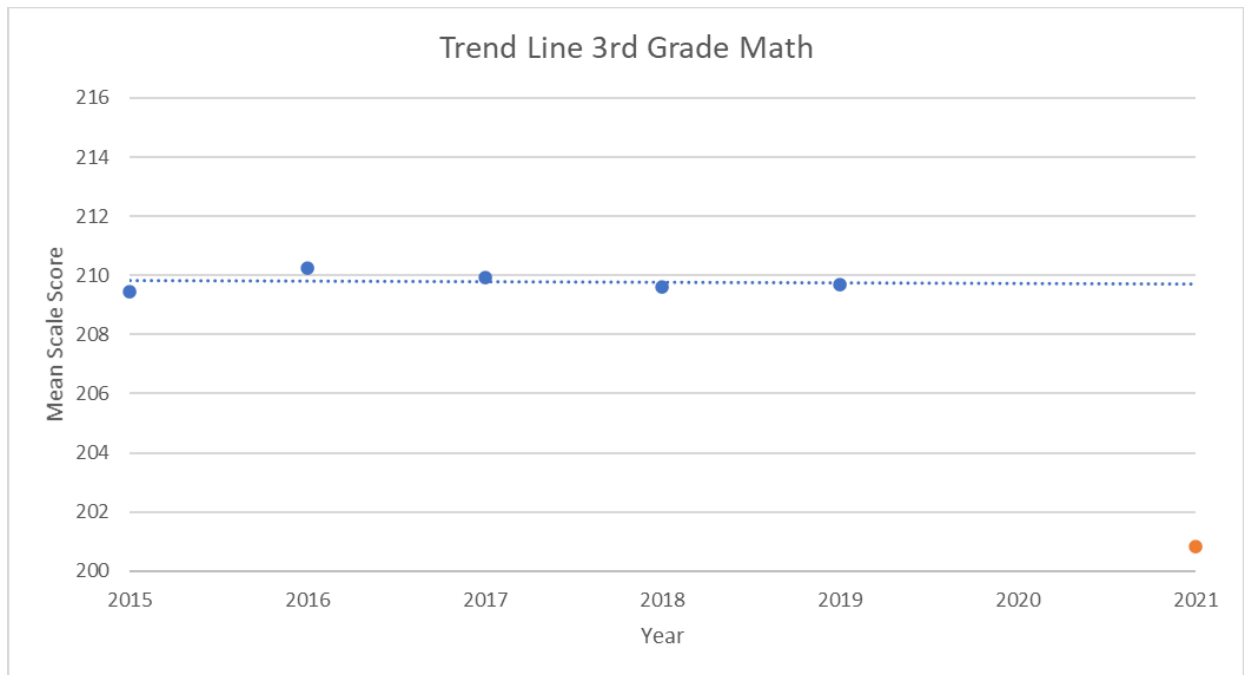
Regression analyses were conducted for each district and school using the 2015-2019 assessment years to predict the average scale score, with the 2015 assessment year centered at 0, resulting in unique regression equations for each eligible districts and schools. These equations were used to compute the predicted mean for 2021 scale scores for each district and each school. Actual and predicted means for 2021 were then plotted to identify potential outlier districts or schools that scored very differently than expected for 2021 in the specific subject/grade. The average predicted mean and actual mean were also calculated across all available districts and schools for each subject/grade.

## Results

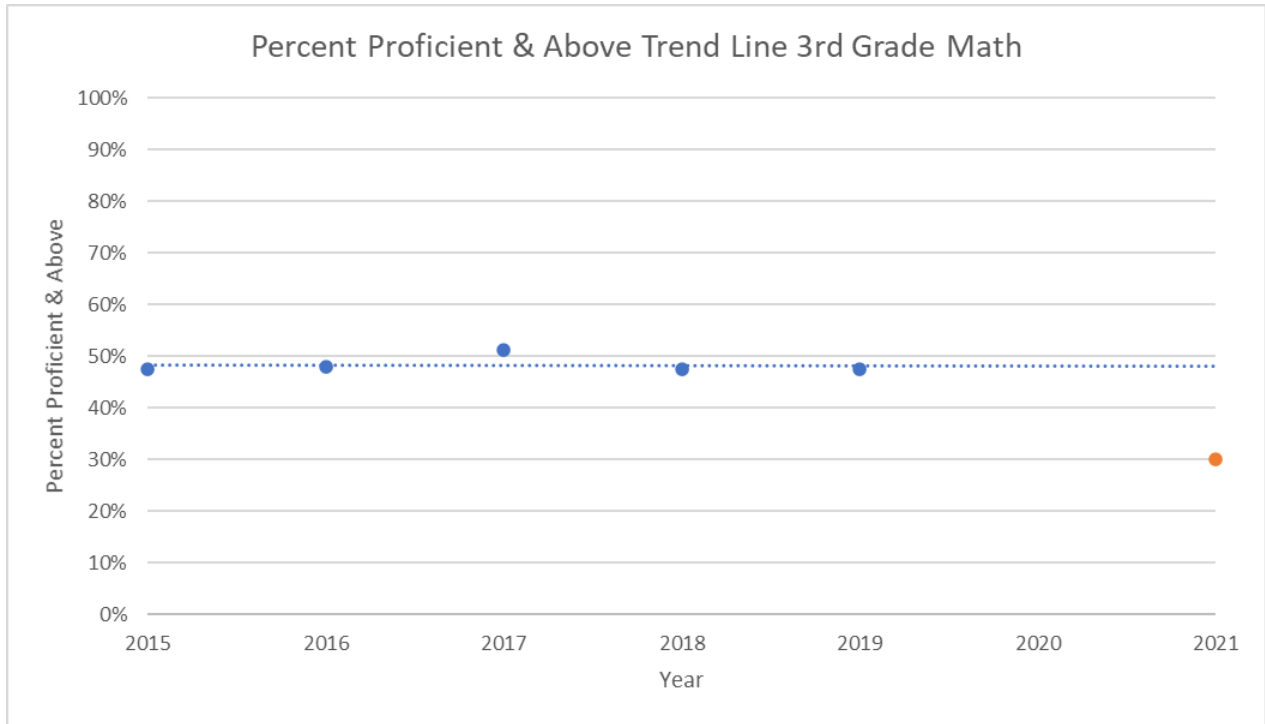
### State Level

#### Student scale score trends

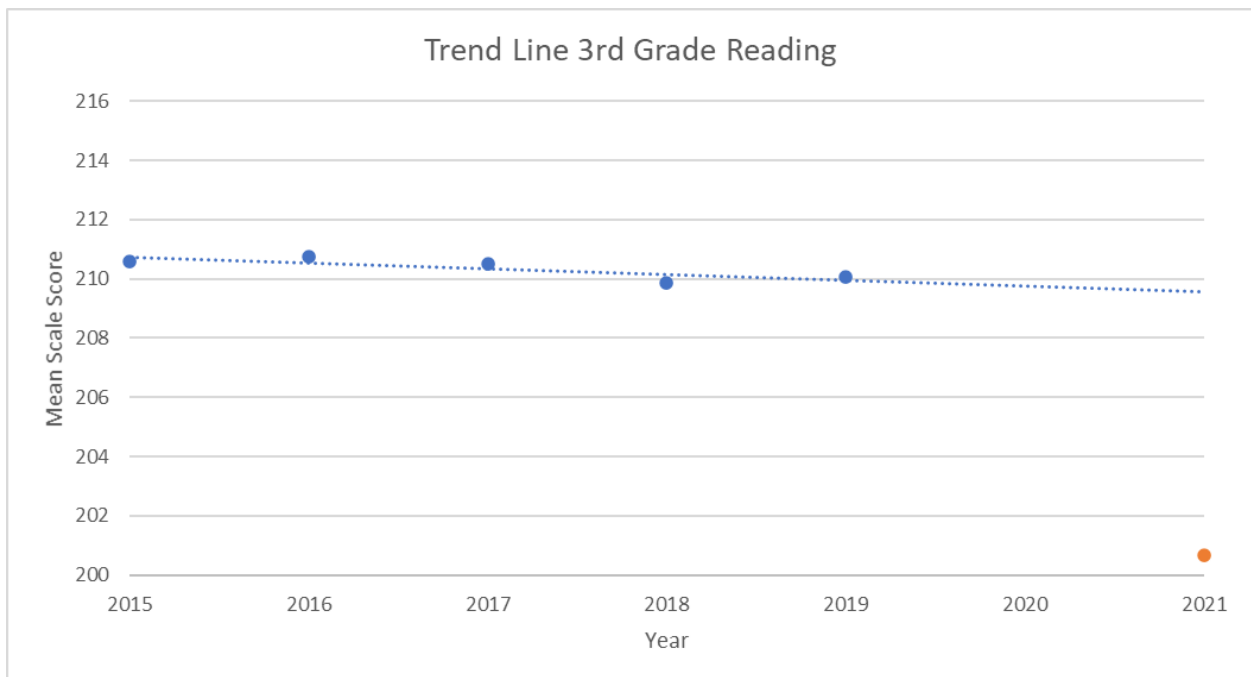
Figure 1a presents the performance trendline for Grade 3 mathematics. Figure 1a depicts stable state-level average scores from 2015-2019 (i.e., the blue dots in the figure), and a noticeable departure from that trend in 2021 (i.e., the orange dot in the figure). Specifically, the 2021 state-level average in Grade 3 mathematics was roughly 8 points lower than what was expected given the trend prior to the COVID-19 related school closures. To put this in context, Figure 1b depicts the percentage of students who scored at proficient and above for Grade 3 mathematics across the same time period. As shown, there was a roughly 20 percentage point drop (from approximately 50% of students at or above proficient to approximately 30%) in the number of students scoring at proficient and above in 2021 from what was expected given the trend from previous years. We observed similar trends across the grades in mathematics. Figures 2a and 2b provide the same information for Grade 3 reading, which had a similar decline in average scale score and percent proficient and above as Grade 3 mathematics. However, all other reading grade levels had somewhat smaller drops in scale score average and percent proficient than corresponding math grade levels, indicating that overall, reading was not as severely impacted as mathematics. Similar figures for all mathematics and reading grades are presented in Appendix A.



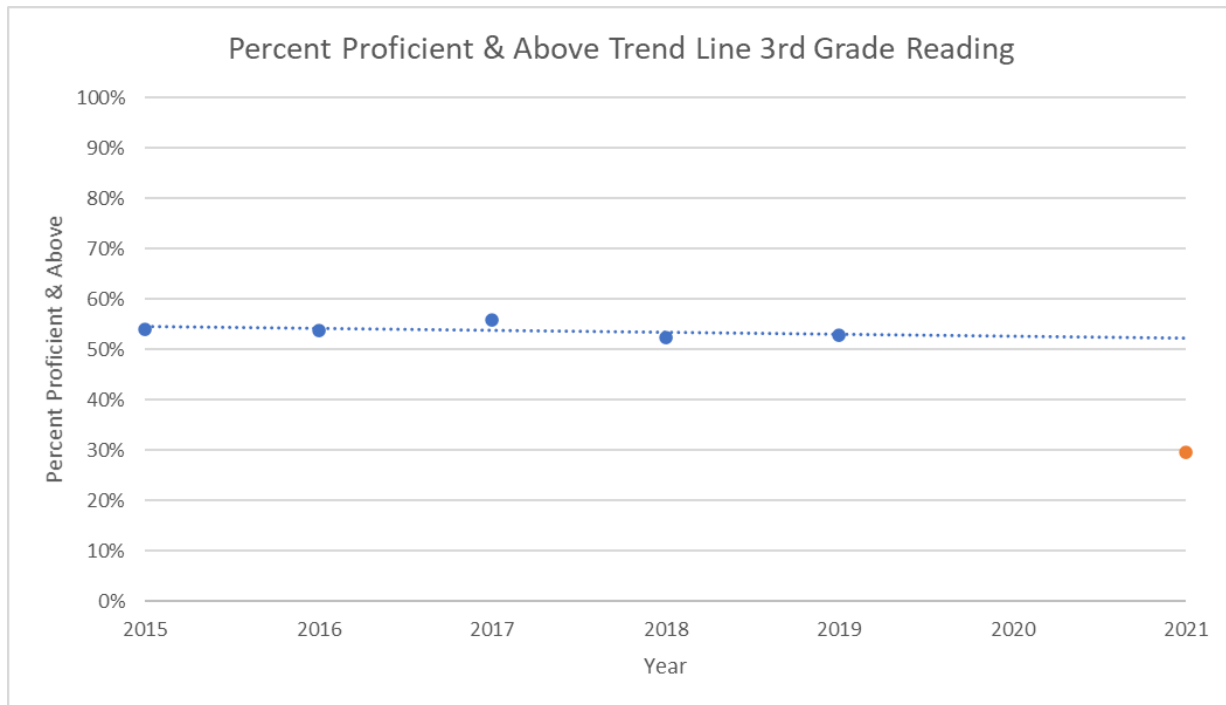
**Figure 1a. State level performance trend for Grade 3 mathematics**



**Figure 1b. State level proficient and above trend for Grade 3 mathematics**



**Figure 2a. State level performance trend for Grade 3 reading**



**Figure 2b. State level proficient and above trend for Grade 3 reading**

Tables 2 and 3 provide data on the average scale score and percent proficient, respectively, for all available subjects with scores for at least 2019 and 2021. Mathematics, reading, and science data are provided in both tables. As writing does not have a comparable scale score (only non-comparable raw scores are available), only percent proficient data is provided. Other KPREP subjects and ACT equivalents did not have the necessary data to be included (ACT data was provided for 2015-2019, but not for 2021). Based on the information in Tables 2 and 3, we can see a similar overall pattern to what was observed in Figures 1a – 2b above, as well as more information regarding differences in scale score means and percent proficient and above between 2019 and 2021. Specifically, while mathematics and reading average scale scores from 2021 to 2019 dropped substantially, both in mean scale scores and effect sizes, science does not. This is likely due to the fact that student performance in science prior to COVID-19 was lower than other subject areas, so the change in scale scores from 2019 to 2021 represents a smaller decline. For Grade 7, which has the highest decrease, the change still only represents a small effect size of roughly  $\frac{1}{4}$  standard deviation. This same pattern persists in Table 3 when examining percent proficient and above levels. Among mathematics and reading, there is a substantial decrease, but in science and writing (with the exception of Grade 8 writing, which actually improved) there is a much smaller decline.



**Table 2. KPREP Mean Scale Scores, Mean Differences, and Effect Sizes**

Subject	Grade	2015 M	2015 SD	2016 M	2016 SD	2017 M	2017 SD	2018 M	2018 SD	2019 M	2019 SD	2021 M	2021 SD	Mean Difference (19-21)	Effect Size (19-21)
Math	3	209.46	20.38	210.25	20.80	209.95	19.51	209.62	20.59	209.68	20.91	200.84	19.79	-8.85	-0.43
Math	4	209.96	18.83	211.56	18.59	210.66	18.61	209.73	18.86	209.70	19.05	202.41	18.68	-7.30	-0.39
Math	5	212.48	20.19	212.34	18.06	209.84	17.44	211.60	19.83	211.44	19.65	202.55	20.65	-8.89	-0.44
Math	6	208.40	17.48	210.74	19.59	208.85	17.27	210.30	18.56	209.79	18.52	201.34	18.53	-8.45	-0.46
Math	7	207.76	17.49	208.97	19.13	208.27	18.12	210.33	18.46	210.16	18.47	202.99	18.53	-7.17	-0.39
Math	8	208.78	17.72	209.16	18.53	210.09	19.74	209.13	18.60	208.75	18.76	200.30	19.92	-8.45	-0.44
Reading	3	210.59	17.58	210.74	19.63	210.50	17.59	209.85	18.55	210.06	18.69	200.69	20.58	-9.38	-0.48
Reading	4	210.34	15.82	211.64	17.47	209.50	17.60	210.67	15.67	210.33	15.92	206.18	16.61	-4.15	-0.25
Reading	5	211.22	15.25	212.76	15.76	211.57	16.32	212.20	16.13	212.14	16.10	207.33	18.79	-4.80	-0.27
Reading	6	211.16	14.84	211.62	17.17	211.71	14.43	212.84	15.75	212.50	15.99	208.67	17.49	-3.83	-0.23
Reading	7	211.72	15.25	211.84	16.44	210.91	15.05	211.76	15.90	211.86	16.34	206.07	17.39	-5.79	-0.34
Reading	8	210.76	15.91	210.57	15.02	211.50	16.87	213.86	16.67	213.71	16.87	210.77	18.86	-2.94	-0.16
Science	4	-	-	-	-	-	-	-	-	202.98	12.98	201.81	13.09	-1.17	-0.09
Science	7	-	-	-	-	-	-	-	-	200.99	13.67	197.73	15.23	-3.26	-0.23
Science	11	-	-	-	-	-	-	-	-	200.02	20.03	198.38	18.05	-1.65	-0.09

Note. A negative sign denotes that the Scale Score in the second year is lower than the Scale Score in the first year. Effect sizes represent Cohen's d.

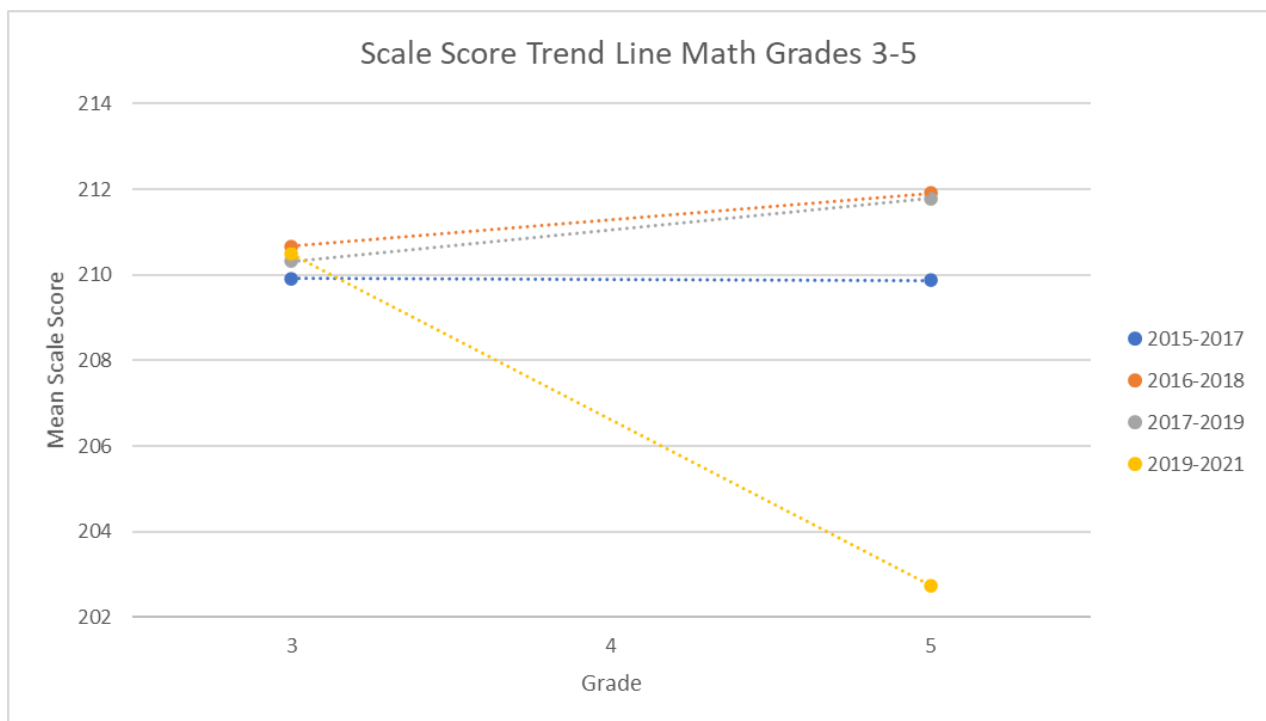
**Table 3. KPREP Percent Proficient and Above and Difference in Percentages from 2019 to 2021**

Subject	Grade	2015	2016	2017	2018	2019	2020	2021	Percent Difference (19 – 21)
Math	3	47%	48%	51%	48%	48%	-	30%	-17%
Math	4	49%	52%	48%	47%	47%	-	33%	-14%
Math	5	51%	56%	49%	52%	52%	-	31%	-21%
Math	6	44%	50%	49%	48%	47%	-	29%	-18%
Math	7	42%	46%	43%	48%	47%	-	28%	-20%
Math	8	44%	46%	49%	46%	45%	-	27%	-19%
Reading	3	54%	54%	56%	52%	53%	-	30%	-23%
Reading	4	52%	56%	50%	54%	53%	-	43%	-10%
Reading	5	56%	58%	57%	58%	58%	-	45%	-13%
Reading	6	53%	56%	59%	60%	59%	-	43%	-16%
Reading	7	55%	57%	55%	58%	58%	-	39%	-19%
Reading	8	54%	54%	57%	63%	63%	-	50%	-13%
Science	4	-	-	-	-	32%	-	25%	-7%
Science	7	-	-	-	-	26%	-	21%	-5%
Science	11	-	-	-	-	30%	-	27%	-3%
Writing	5	-	-	-	-	47%	-	40%	-7%
Writing	8	-	-	-	-	32%	-	51%	19%
Writing	11	-	-	-	-	50%	-	58%	7%

*Note.* A negative sign denotes that the Percent Proficient and Above in the second year is lower than the Percent Proficient and Above in the first year. Effect sizes represent Cohen's d.

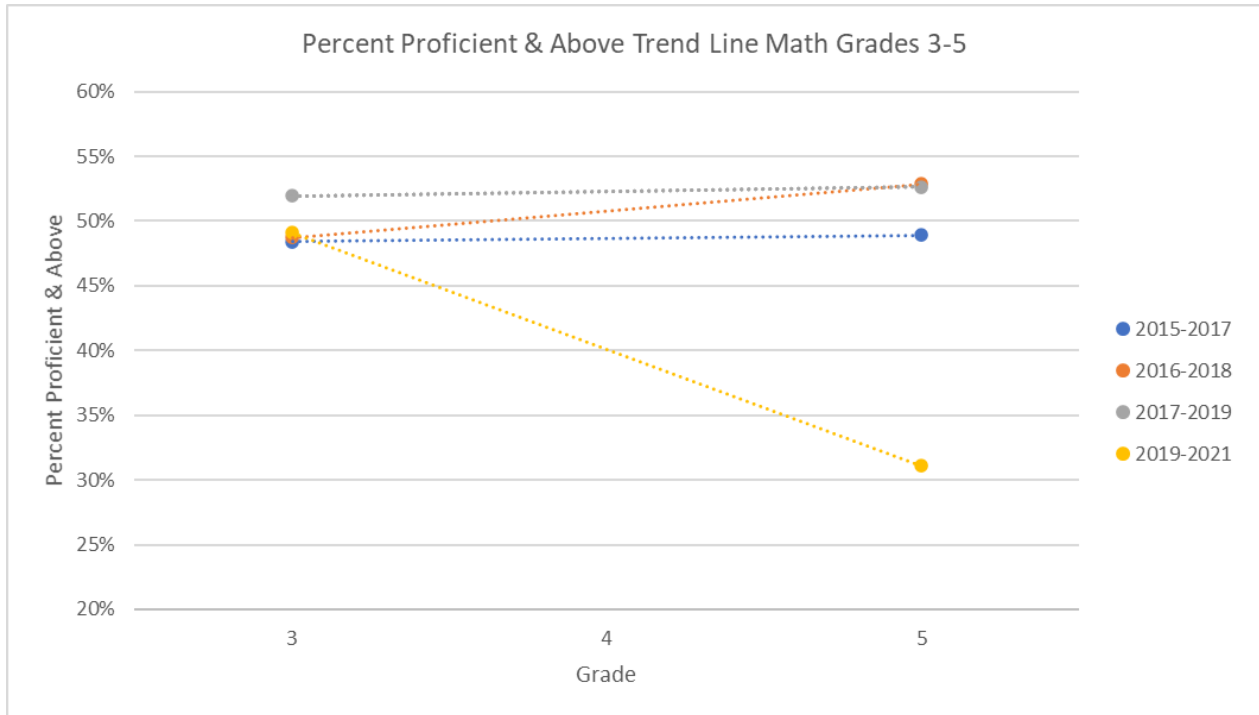
### Matched grade-band analyses

Figure 3a depicts the state-level proficiency trend for students who tested in mathematics in grades 3, 4, and 5<sup>2</sup>. The cohort trends are presented for 2015-2017, 2016-2018, 2017-2019, and 2019-2021. The trends for the three earlier cohorts tended to be somewhat flat or with a positive slope, whereas the slope of the trendline between 2019 and 2021 is noticeably negative. This suggests a COVID-related effect on student performance. Figure 3b illustrates a similar trend using the percentage of students scoring proficient and above for the same mathematics cohort. In contrast to previous years, the percent proficient and above drops by roughly 20 percentage points from 2019 to 2021. Figures 4a and 4b depict the same information, respectively, for reading, with a similar trendline pattern. However, from 2019 to 2021 the percentage drop for reading is smaller than mathematics at roughly 10%, indicating there may not be as pronounced a COVID-related effect on student performance for reading. Similar figures for all mathematics and reading cohorts are presented in Appendix B.

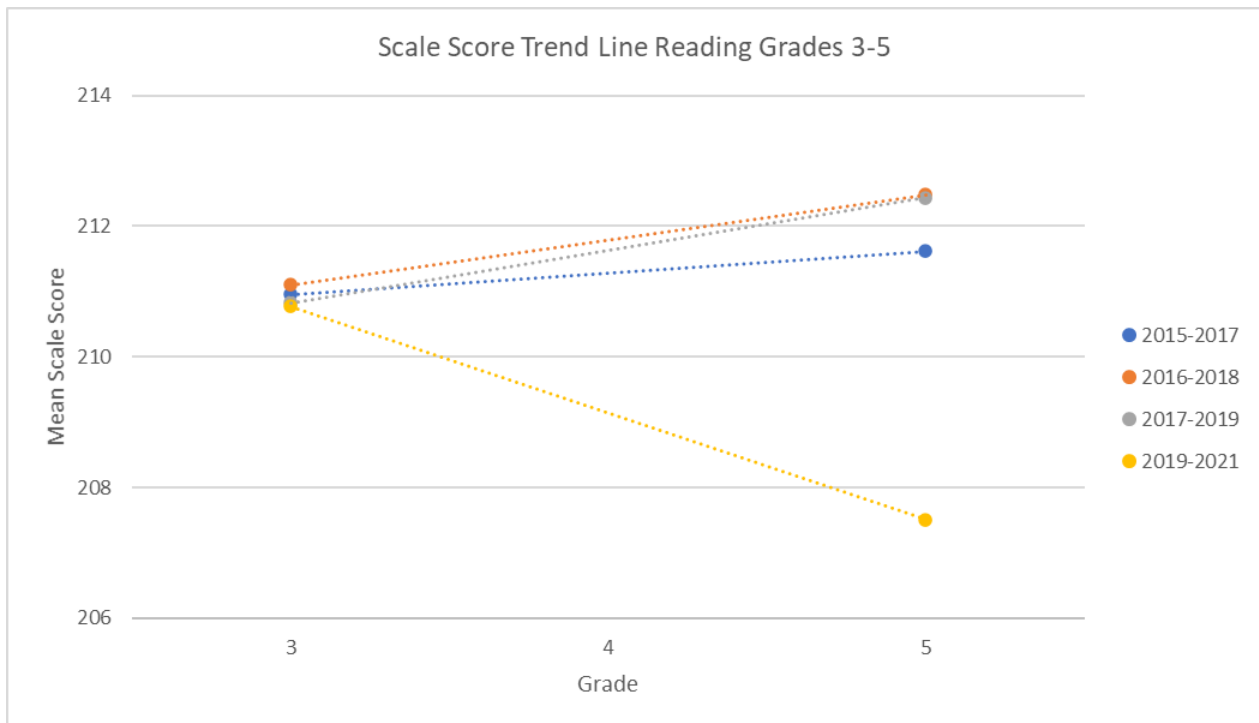


**Figure 3a. State level mathematics grade 3-5 cohort proficiency trendlines**

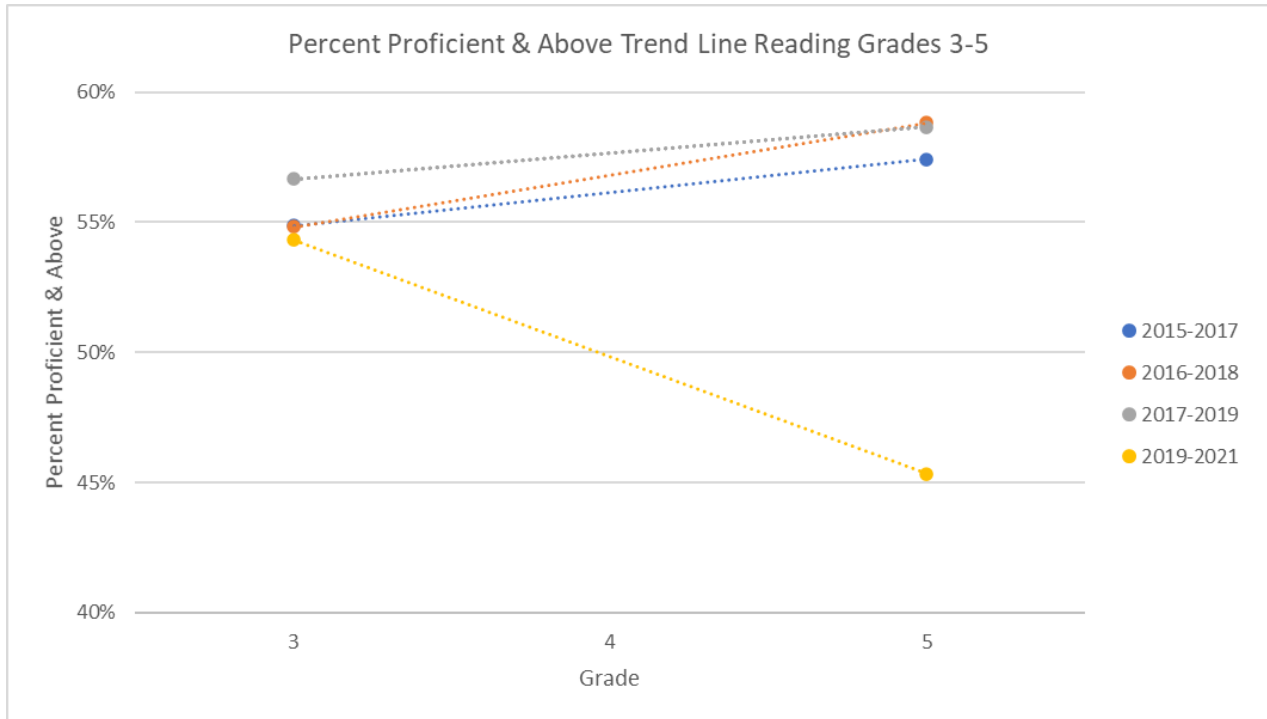
<sup>2</sup> For consistency, data for the middle grade is removed from all graphs, as there is no comparable data for the 2019-2021 trendline because the 2020 testing period was cancelled due to the Covid-19 pandemic.



**Figure 3b. State level mathematics grade 3-5 cohort proficient and above trendlines**



**Figure 4a. State level reading grade 3-5 cohort proficiency trendlines**



**Figure 4b. State level reading grade 3-5 cohort proficient and above trendlines**

Table 4 summarizes the trend results for all grade spans for both reading and mathematics. The table illustrates that there are “normal” fluctuations in scores from one grade to the next and that the percentage of students scoring Proficient or above can be expected to vary, even among the same students, as they progress from one grade to the next. However, we see a substantial negative shift in scores from 2019 to 2021. This pattern is similar across all of the 2-year cohorts we were able to analyze but is most severe for the grade span from 5 to 7, where students typically transition from elementary to middle school.



**Table 4. Grade Band Effect Sizes and Percent Proficient and Above Difference Scores Across Cohort Years**

	Reading Scale Score Effect Size	Reading Percent Proficient & Above Difference Score	Math Scale Score Effect Size	Math Percent Proficient & Above Difference Score
<b>Grades 3-5</b>				
2015-2017	0.04	3%	0.00	0%
2016-2018	0.08	4%	0.06	4%
2017-2019	0.10	2%	0.08	1%
2019-2021	-0.18	-9%	-0.37	-18%
<b>Grades 4-6</b>				
2015-2017	0.10	7%	-0.06	1%
2016-2018	0.08	4%	-0.06	-4%
2017-2019	0.19	9%	-0.04	-1%
2019-2021	-0.12	-11%	-0.48	-20%
<b>Grades 5-7</b>				
2015-2017	-0.01	-1%	-0.22	-7%
2016-2018	-0.05	0%	-0.10	-8%
2017-2019	0.03	1%	0.02	-1%
2019-2021	-0.38	-19%	-0.48	-26%
<b>Grades 6-8</b>				
2015-2017	0.04	5%	0.10	6%
2016-2018	0.15	8%	-0.08	-4%
2017-2019	0.14	4%	-0.00	-4%
2019-2021	-0.12	-10%	-0.53	-22%

*Note.* A negative sign denotes that the Scale Score or Percent Proficient & Above in the second year is lower than the Scale Score or Percent Proficient & Above in the first year. Effect sizes represent Cohen’s *d*, whereas difference scores represent differences in the percentage of students scoring at Proficient or higher.

### Matched and unmatched student analyses

Tables 5 and 6 present the mean summative assessment scores for students who were matched across testing years by grade band compared to those who were not matched across testing years. Across the grades, subjects, and testing years, the unmatched student groups tended to have lower mean summative assessment scores. Table 5 also shows that the mean 2019 summative assessment scores of matched students tended to be higher than or very similar to their corresponding mean 2017 summative assessment scores. Although the summative assessment is not vertically scaled to allow for direct comparisons of scores across grades, the pattern here is instructive. Table 6 shows that unlike the 2017-19 comparison, mean 2021 summative assessment scores of matched students tended to be considerably lower than their corresponding mean 2019 summative assessment scores. Table 6 also shows that a notably larger number of students who tested in 2019 did not have a corresponding record in the 2021 data. This is not surprising given that we know that many students continued NTI and therefore did not participate in the 2021 summative assessment. The percentage of students who were tested in 2019 and had a matched record in 2021 ranged from 78%-81% whereas the percentage of students who were tested in 2017 and had a matched record in 2019 ranged from 92%-93%.

**Table 5. Mean K-PREP Scores for Matched and Unmatched Samples: 2017 to 2019**

Subject	2017 Grade	2017 Matched			2017 Unmatched			2019 Grade	2019 Matched			2019 Unmatched		
		N	Mean	SD	N	Mean	SD		N	Mean	SD	N	Mean	SD
Math	3	47,643	210.3	19.3	3,998	206.3	21.1	5	47,643	211.7	19.5	3,786	208.0	21.3
Math	4	47,818	210.9	18.5	4,008	208.4	19.9	6	47,818	210.1	18.4	3,719	205.9	20.0
Math	5	46,296	210.1	17.3	4,170	206.7	18.4	7	46,296	210.5	18.2	3,597	205.3	21.1
Math	6	45,748	209.3	17.1	3,605	202.9	18.7	8	45,748	209.3	18.4	3,501	201.9	21.9
Reading	3	47,613	210.8	17.4	4,028	207.2	19.5	5	47,613	212.4	15.8	3,784	209.0	19.6
Reading	4	47,816	209.7	17.5	4,010	207.3	19.1	6	47,816	212.8	15.7	3,720	209.0	19.3
Reading	5	46,312	211.8	16.2	4,154	208.8	17.5	7	46,312	212.3	15.9	3,597	206.7	20.5
Reading	6	45,745	212.0	14.1	3,608	207.6	17.1	8	45,745	214.2	16.3	3,500	207.1	22.2

**Table 6. Mean K-PREP Scores for Matched and Unmatched Samples: 2019 to 2021**

Subject	2019 Grade	2019 Matched			2019 Unmatched			2021 Grade	2021 Matched			2021 Unmatched		
		N	Mean	SD	N	Mean	SD		N	Mean	SD	N	Mean	SD
Math	3	39,369	210.5	20.8	9,121	206.2	21.2	5	39,369	202.7	20.6	2,961	200.0	21.7
Math	4	39,965	210.5	18.9	10,617	206.8	19.2	6	39,965	201.5	18.5	2,899	199.4	18.9
Math	5	40,103	212.2	19.6	11,326	208.6	19.7	7	40,103	203.2	18.5	2,961	200.4	19.0
Math	6	40,088	210.7	18.3	11,449	206.5	18.9	8	40,088	200.6	19.9	2,803	196.2	19.8
Reading	3	39,408	210.8	18.4	9,072	207.0	19.4	5	39,408	207.5	18.7	2,938	205.0	19.7
Reading	4	40,031	210.8	15.7	10,577	208.4	16.7	6	40,031	208.8	17.5	2,863	206.8	17.6
Reading	5	40,149	212.6	15.9	11,248	210.5	16.8	7	40,149	206.3	17.3	2,978	203.3	18.1
Reading	6	40,168	213.1	15.5	11,368	210.2	17.4	8	40,168	211.1	18.7	2,796	205.8	19.9

Tables 7 and 8 present the effect size of the mean score difference between matched and unmatched students in each year, grade, and subject. This can help determine whether these differences between matched and unmatched students are meaningful. The negative values across both tables indicate that unmatched students score lower, on average, than matched students, though the strength of these effects varies based on year. In Table 7, the differences range from small (e.g., Grade 4 mathematics) to somewhat moderate (e.g., Grade 6 mathematics) in the 2017 comparisons, with a similar pattern in the 2019 comparisons. Table 8 indicates a similar pattern for the 2019 comparisons as those shown in Table 7, though the effect sizes tend to be small. Interestingly, the 2021 comparisons between matched and unmatched students also tended to be small, though the largest effects appeared in Grade 8 mathematics and reading. So, while those students tested in 2021 typically received lower scores than in previous years, the differences between matched and unmatched students overall were similar to differences pre-COVID.

**Table 7. Effect Sizes for Mean K-PREP Scores for Matched versus Unmatched Students: 2017 to 2019**

Subject	2017 Grade	2017 Matched- Unmatched	2019 Grade	2019 Matched- Unmatched
Math	3	-0.20	5	-0.18
Math	4	-0.13	6	-0.22
Math	5	-0.19	7	-0.26
Math	6	-0.36	8	-0.37
Reading	3	-0.20	5	-0.19
Reading	4	-0.13	6	-0.22
Reading	5	-0.18	7	-0.30
Reading	6	-0.28	8	-0.36

*Note.* A negative sign denotes that the average score for unmatched students is lower than the average score for matched students.

**Table 8. Effect Sizes for Mean K-PREP Scores for Matched versus Unmatched Students: 2019 to 2021**

Subject	2019 Grade	2019 Matched- Unmatched	2021 Grade	2021 Matched- Unmatched
Math	3	-0.20	5	-0.13
Math	4	-0.19	6	-0.11
Math	5	-0.19	7	-0.15
Math	6	-0.23	8	-0.22
Reading	3	-0.20	5	-0.13
Reading	4	-0.15	6	-0.11
Reading	5	-0.13	7	-0.17
Reading	6	-0.18	8	-0.28

*Note.* A negative sign denotes that the average score for unmatched students is lower than the average score for matched students.

Tables 9 and 10 present the percent proficient and above scores for matched versus unmatched students, as well as their difference score, in each year, grade, and subject. Across both tables, matched students have higher percentages of proficient and above scores than unmatched students. These results are parallel to previous scale score results but provided in terms of percent proficient and above to facilitate interpretation. Difference scores within year appear consistent, with the exception of 2017, which has higher difference scores among students in mathematics than in reading. In Table 9, looking across years, the difference scores between matched and unmatched students evidence a slight increase, which may be reflective of performance differences among students at higher grade levels in each subject. The percent proficient and above for matched students and unmatched students across the years is also fairly consistent. However, in Table 10, differences between matched and unmatched students from 2019 to 2021 tended to decrease (with the exception of Grade 7 and 8 Reading in 2021). This may be reflective of the overall lower average scores for matched and unmatched students in 2021 (reduced variance may limit how large the differences can be), as well as the considerable decrease in percent proficient and above for both student samples compared to their 2019 percentages.

**Table 9. Percent Proficient and Above for Matched and Unmatched Students: 2017 to 2019**

Subject	2017 Grade	Percent Proficient and Above			2019 Grade	Percent Proficient and Above		
		Matched	Unmatched	Difference		Matched	Unmatched	Difference
Math	3	52%	43%	-9%	5	53%	45%	-7%
Math	4	49%	43%	-5%	6	48%	39%	-8%
Math	5	49%	41%	-8%	7	48%	38%	-10%
Math	6	50%	36%	-14%	8	47%	32%	-15%
Reading	3	57%	49%	-8%	5	59%	53%	-6%
Reading	4	50%	46%	-4%	6	60%	52%	-8%
Reading	5	58%	51%	-7%	7	59%	47%	-11%
Reading	6	60%	48%	-12%	8	64%	50%	-14%

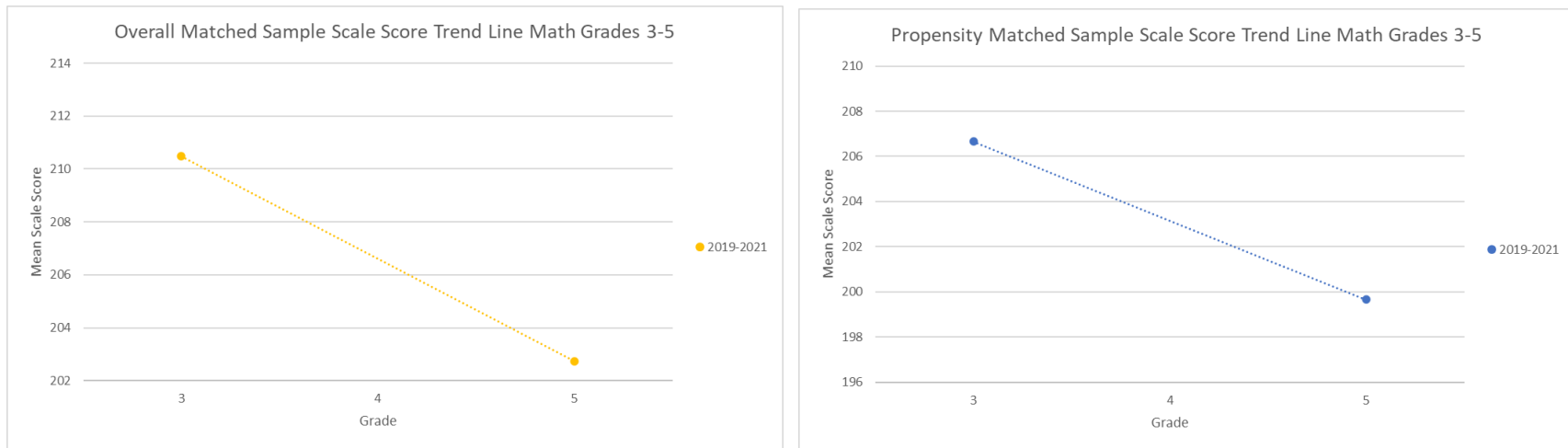
**Table 10. Percent Proficient and Above for Matched and Unmatched Students: 2019 to 2021**

Subject	Grade 2019	Percent Proficient and Above			Grade 2021	Percent Proficient and Above		
		Matched	Unmatched	Difference		Matched	Unmatched	Difference
Math	3	49%	41%	-8%	5	31%	28%	-3%
Math	4	49%	41%	-8%	6	29%	26%	-3%
Math	5	54%	46%	-7%	7	28%	23%	-5%
Math	6	49%	39%	-10%	8	27%	20%	-7%
Reading	3	54%	47%	-8%	5	45%	41%	-4%
Reading	4	54%	49%	-6%	6	44%	39%	-4%
Reading	5	59%	55%	-4%	7	40%	33%	-6%
Reading	6	61%	54%	-7%	8	51%	40%	-11%

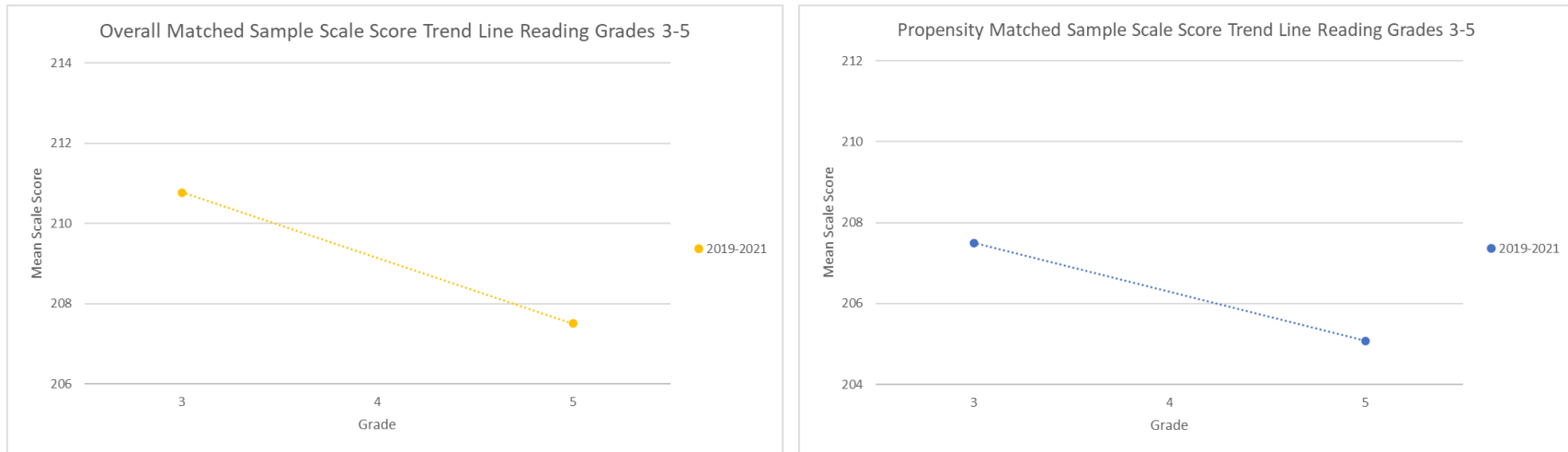


### *Propensity matched sample analyses*

The top left side of figure 5 presents the 2019-2021 mathematics score trend for the full grade 3-5 cohort, while the top right side of figure 5 presents the 2019-2021 mathematics score trend for a propensity matched sample of 2019 students who are demographically similar to the students who did not test in 2021. Not surprisingly, the propensity matched students designed to reflect students who did not test in 2021 were on average lower scoring than the full population. However, it is the slopes of the two lines that are of particular interest. The similarity of the two slopes indicates that the growth trajectory of the propensity matched group of students was not substantially different from the full group of students who tested in 2021. Figure 6 presents similar figures for the 2019 reading grade 3-5 cohort. While the average decline in student performance for the propensity matched sample is smaller than the decline for the mathematics grade 3-5 cohort, similar trends in score average and slopes between the full and propensity matched cohorts are present. Taken together, these results indicate that any changes in performance trends among the 2019-2021 cohorts reflect actual performance differences, rather than differences in the students tested versus those not tested. Similar figures for all propensity matched mathematics and reading cohorts are presented in Appendix C.

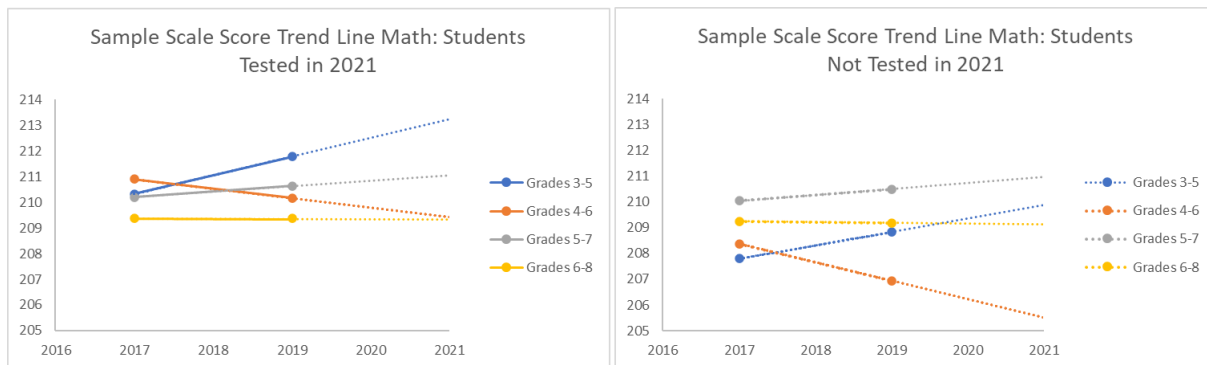


**Figure 5. Comparison of 2019-2021 performance of propensity matched mathematics grade 3-5 cohort with full mathematics grade 3-5 cohort**

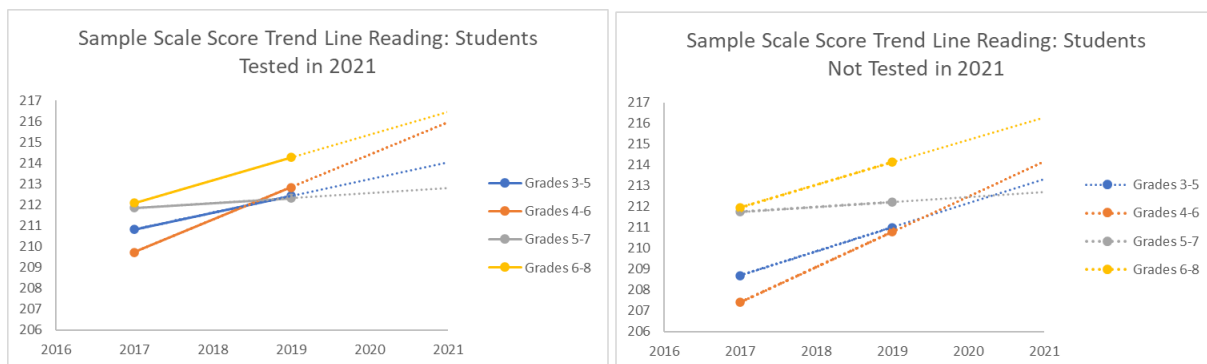


**Figure 6. Comparison of 2019-2021 performance of propensity matched reading grade 3-5 cohort with full reading grade 3-5 cohort**

We also examined 2017-2019 performance trends among the students who did not test in 2021 and forecasted their 2021 performance based on that trendline. Figures 7 and 8 again show that although scores tended to be lower among students not tested in 2021, the slopes among the tested and non-tested students are similar across the grade levels. This further supports the patterns observed in this study by confirming that they are likely not a by-product of sampling that occurred due to a large percentage of students not participating in testing in 2021.



**Figure 7. Comparison of 2017-2019 mathematics performance trends of students tested and not tested in 2021**



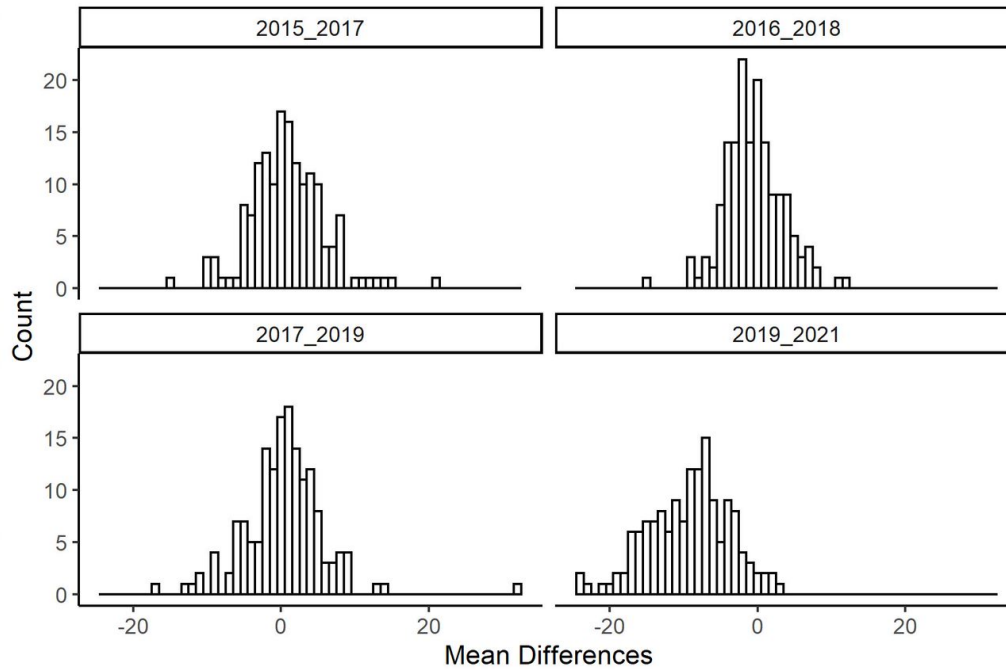
**Figure 8. Comparison of 2017-2019 reading performance trends of students tested and not tested in 2021**

### District and School Level

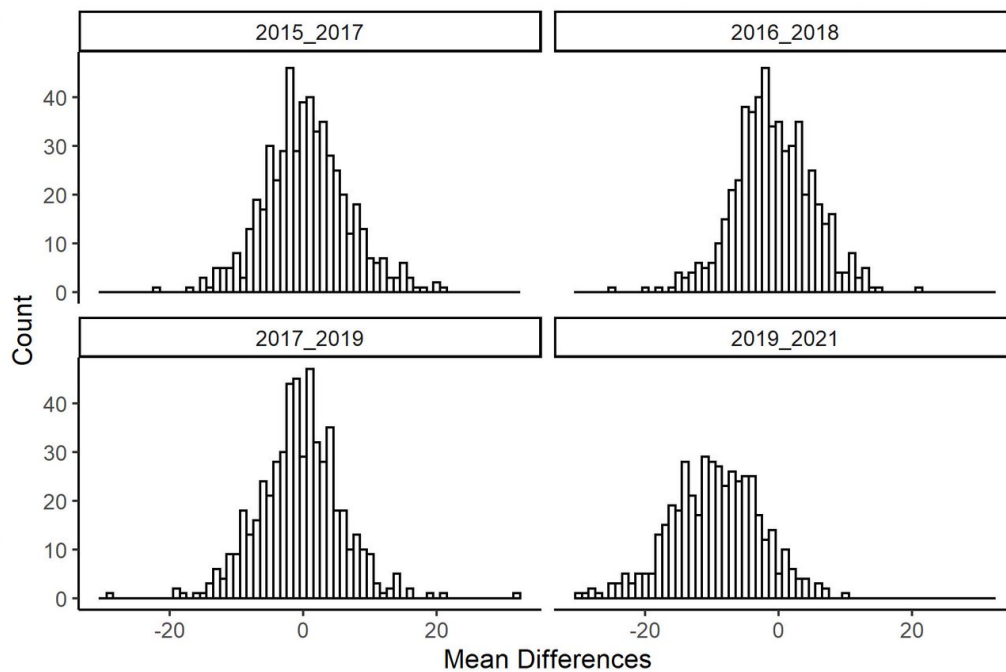
#### Mean Score Change Analyses

Figures 9 and 10 present the results from the mean score change analyses for districts and schools respectively, using grade 3 mathematics as an example. Figures 11 and 12 provide the same results for grade 3 reading. Each histogram represents the change in mean scores across a two-year period (positive changes will be greater than 0, negative changes lower than 0). The height of the bars represents the number of schools or districts with the same mean score change. Results for all grade/subject combinations are presented in Appendix D (districts) and Appendix E (schools). Comparing the shape and location of the four histograms in each figure shows that district and school mean score changes between 2019 and 2021 tended to be lower, or more negative, than in prior 2-year periods. The histograms also show that the change

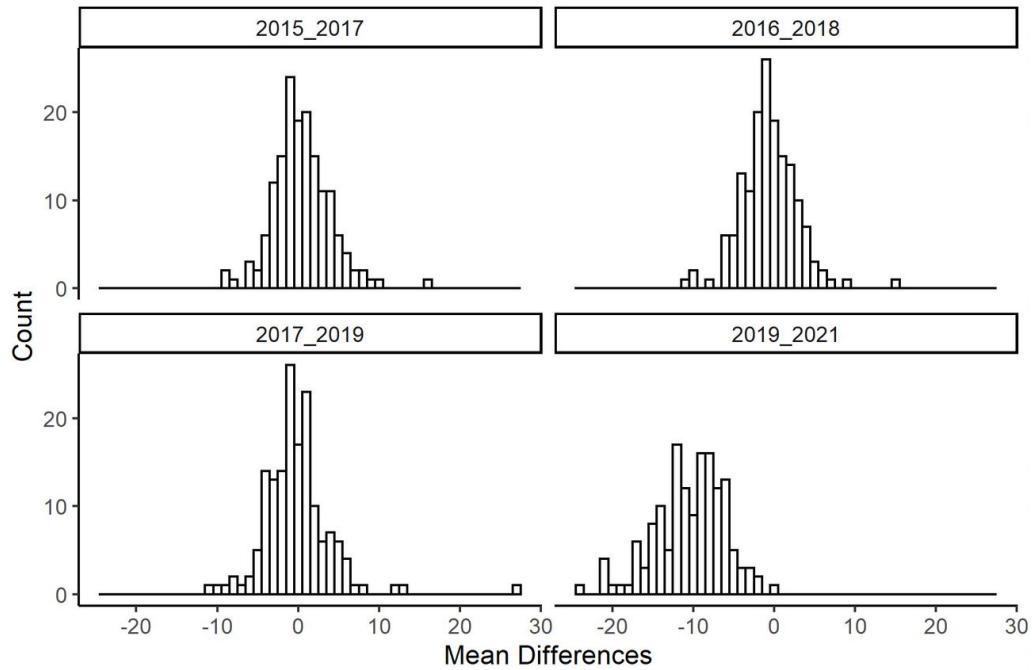
scores are more varied (the histogram is more spread out) for the 2019-2021 changes than for other two-year changes. This pattern is the same across the district and school histograms.



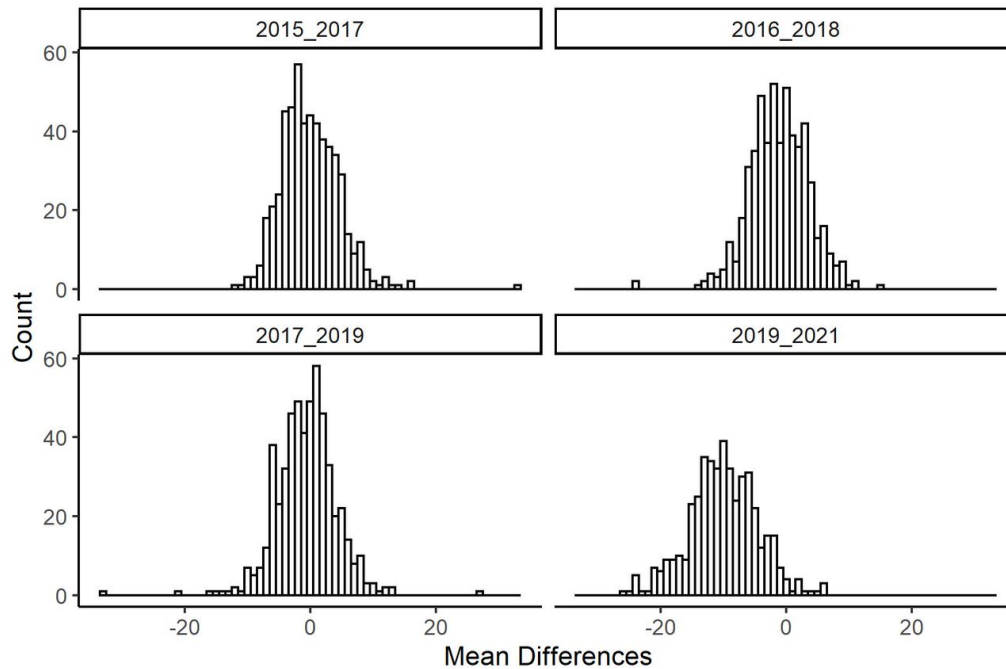
**Figure 9. Comparison of district-level score changes: Grade 3 mathematics**



**Figure 10. Comparison of school-level score changes: Grade 3 mathematics**



**Figure 11. Comparison of district-level score changes: Grade 3 reading**



**Figure 12. Comparison of school-level score changes: Grade 3 reading**

Tables 11 and 12 summarize the distributions presented in Figures 9 – 12 with the average district and school level score changes over the 2-year periods of 2015-2017, 2016-2018, 2017-2019, and 2019-2021. In contrast to the other 2-year periods, district and school level scores, on average, went down between 2019 and 2021, across all grades and subjects. Tables 13 and 14 provide further context by demonstrating similar average district and school changes, respectively, for the percentage of students who scored at proficient and above across the relevant 2-year periods. As shown, the change in percent proficient and above follows a similar pattern as the score changes, with the average change between 2019 and 2021 showing a substantial decrease compared to other 2-year periods.

**Table 11. Average 2-Year District-Level Score Changes**

Grade/Subject	2015-2017	2016-2018	2017-2019	2019-2021
Math 03	0.83	-0.42	0.39	-9.31
Math 04	1.43	-1.21	-0.94	-7.19
Math 05	-2.17	-0.50	2.19	-9.17
Math 06	0.68	-0.24	1.48	-9.09
Math 07	0.65	1.31	2.13	-7.53
Math 08	1.54	0.01	-1.12	-8.99
Reading 03	0.54	-0.58	-0.16	-10.37
Reading 04	-0.27	-0.50	0.78	-4.54
Reading 05	0.65	-0.20	0.78	-5.17
Reading 06	0.63	1.32	1.14	-4.85
Reading 07	-0.74	-0.23	1.04	-6.27
Reading 08	1.09	3.21	2.04	-3.62

*Note.* A negative sign denotes that the average score in the second year is lower than the average score in the first year.

**Table 12. Average 2-Year School-Level Score Changes**

Grade/Subject	2015-2017	2016-2018	2017-2019	2019-2021
Math 03	0.52	-0.81	-0.57	-9.50
Math 04	0.69	-1.84	-1.18	-7.61
Math 05	-2.83	-0.76	1.55	-9.41
Math 06	0.91	-0.16	1.12	-9.14
Math 07	0.61	1.38	1.79	-7.53
Math 08	1.57	-0.03	-1.26	-9.07
Reading 03	-0.02	-1.09	-0.63	-10.01
Reading 04	-0.91	-1.05	0.75	-4.38
Reading 05	0.27	-0.65	0.59	-5.01
Reading 06	0.72	1.32	0.97	-4.37
Reading 07	-0.71	-0.15	1.07	-6.27
Reading 08	0.98	3.20	2.17	-3.42

*Note.* A negative sign denotes that the average score in the second year is lower than the average score in the first year.



**Table 13. Average 2-Year District-Level Percent Proficient Changes**

Grade/Subject	2015-2017	2016-2018	2017-2019	2019-2021
Math 03	4.24%	0.26%	-2.44%	-18.63%
Math 04	0.72%	-3.24%	-0.77%	-13.73%
Math 05	-1.34%	-3.87%	4.81%	-22.11%
Math 06	6.53%	-2.30%	-0.71%	-20.17%
Math 07	2.41%	2.52%	4.16%	-20.41%
Math 08	4.89%	1.09%	-3.12%	-19.65%
Reading 03	2.99%	-0.94%	-2.32%	-25.85%
Reading 04	-1.49%	-1.07%	3.65%	-11.33%
Reading 05	2.01%	0.30%	1.32%	-14.11%
Reading 06	6.10%	4.40%	0.77%	-18.31%
Reading 07	-0.70%	0.42%	2.65%	-19.27%
Reading 08	3.96%	9.43%	5.04%	-14.29%

*Note.* A negative sign denotes that the average percent proficient in the second year is lower than the average percent proficient in the first year.

**Table 14. Average 2-Year School-Level Percent Proficient Changes**

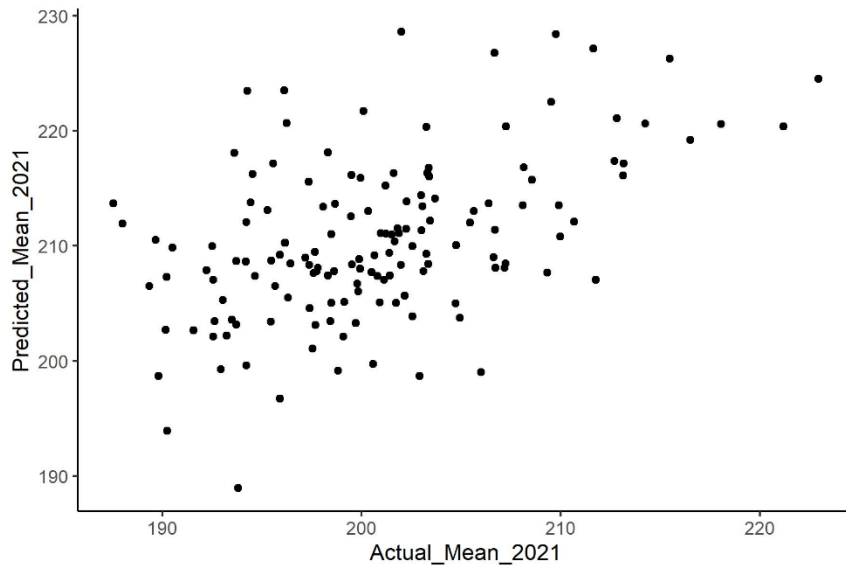
Grade/Subject	2015-2017	2016-2018	2017-2019	2019-2021
Math 03	3.64%	-0.75%	-4.45%	-18.67%
Math 04	-1.00%	-4.63%	-1.54%	-14.09%
Math 05	-2.02%	-4.27%	2.95%	-22.13%
Math 06	6.95%	-1.57%	-1.90%	-19.70%
Math 07	2.05%	2.32%	3.73%	-20.43%
Math 08	5.01%	0.73%	-3.48%	-19.53%
Reading 03	1.81%	-1.65%	-3.56%	-24.46%
Reading 04	-2.53%	-2.74%	2.82%	-10.56%
Reading 05	1.02%	-0.58%	0.66%	-13.58%
Reading 06	6.39%	4.91%	0.35%	-17.36%
Reading 07	-0.37%	0.52%	3.02%	-19.52%
Reading 08	3.64%	9.23%	5.31%	-13.82%

*Note.* A negative sign denotes that the average percent proficient in the second year is lower than the average percent proficient in the first year.

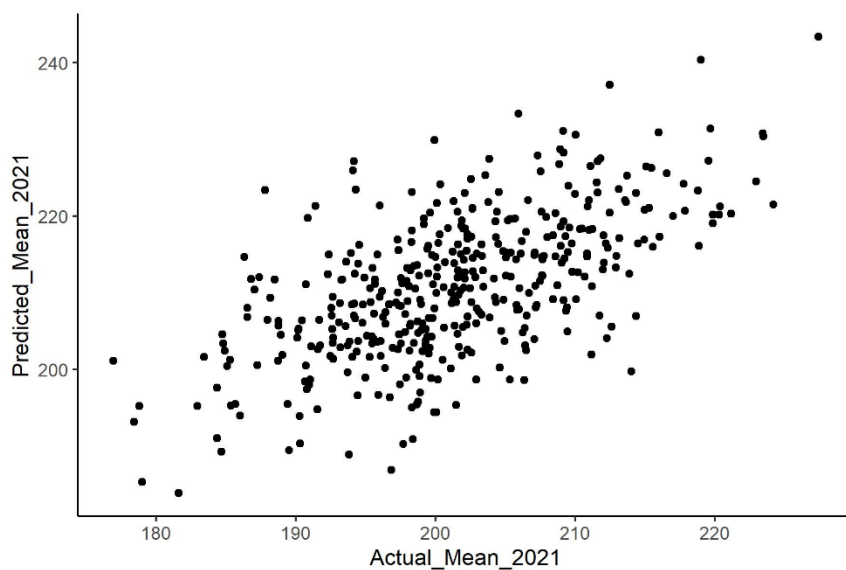
### **Predicted Versus Actual 2021 Mean Comparison**

Figures 13 and 14 present comparisons of actual 2021 district and school level scores with their predicted scores based on the regression model using 2015-2019 assessment years to predict the corresponding mean score, with grade 3 mathematics as an example. Figures 15 and 16 present results for grade 3 reading, as well. Results for all grade/subject combinations are presented in Appendix F (districts) and Appendix G (schools).

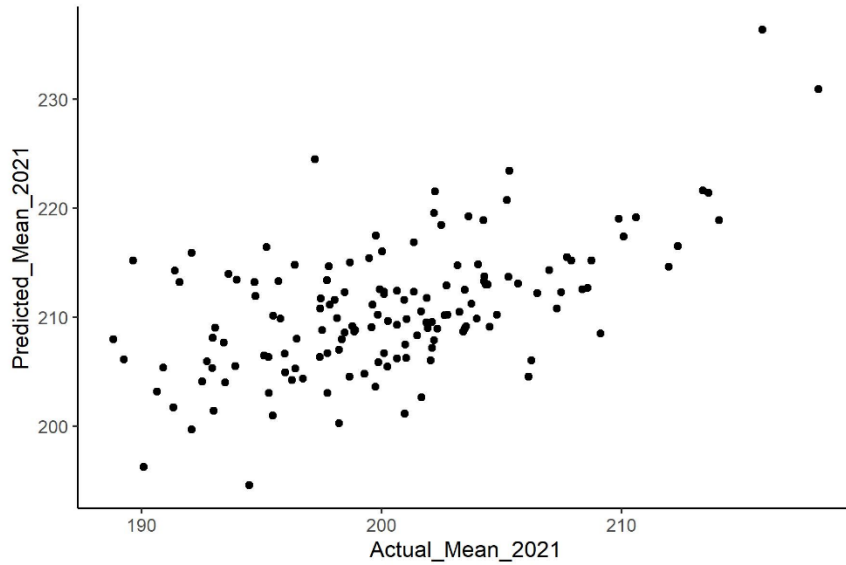
The amount of scatter among the points in Figures 13 and 15 indicate that several districts performed differently than expected based on their prior performance in mathematics and reading, respectively. The tighter clustering among the points in Figures 14 and 16 indicate that schools tended to perform as expected based on their prior performance, with some exceptions. HumRRO provided KDE with an electronic file identifying districts and schools that differed markedly from their expected performance.



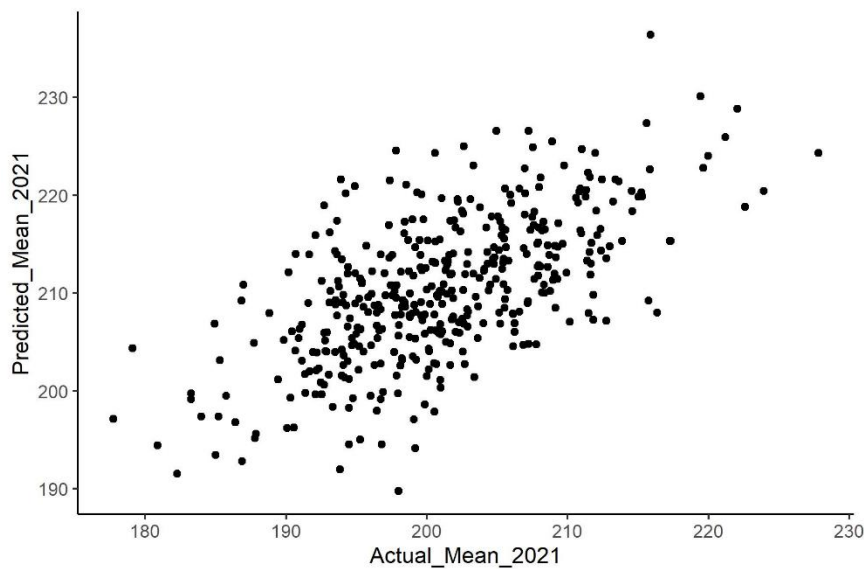
**Figure 13. Predicted 2021 district means compared to actual 2021 district means: Grade 3 mathematics**



**Figure 14. Predicted 2021 school means compared to actual 2021 school means: Grade 3 mathematics**



**Figure 15. Predicted 2021 district means compared to actual 2021 district means: Grade 3 reading**



**Figure 16. Predicted 2021 school means compared to actual 2021 school means: Grade 3 reading**

Tables 15 and 16 report the average predicted and actual 2021 means for each grade/subject at the district and school level, respectively. Both tables indicate that the average predicted 2021 mean score for each grade/subject was substantially higher than the average actual mean score. Across both levels, the average actual mean scores for mathematics were lower (typically around 8-10 points) in comparison to the average predicted mean score than reading (typically around 4-6 points). This further illustrates that, even at the district and school levels, the impact of COVID-19 on performance appears greater for mathematics than reading.

**Table 15. Average District-Level Predicted and Actual 2021 Mean Scale Scores**

Grade/Subject	2021 Predicted Mean	2021 Predicted SD	2021 Actual Mean	2021 Actual SD
Math 03	210.47	6.95	200.72	6.75
Math 04	209.9	7.20	202.44	6.04
Math 05	210.43	7.10	201.73	6.98
Math 06	211.03	7.06	201.10	6.02
Math 07	211.85	5.55	202.51	4.61
Math 08	209.55	6.41	200.18	5.69
Reading 03	210.70	5.95	200.38	5.74
Reading 04	210.77	4.59	206.06	3.88
Reading 05	212.94	4.38	206.96	4.90
Reading 06	214.04	4.10	208.04	3.77
Reading 07	211.97	3.38	205.72	3.41
Reading 08	216.25	3.90	210.42	3.65

*Note.* Means represent the average score across all districts for the specific grade/subject. District n-sizes for each grade/subject vary. Some districts did not have sufficient sample sizes (i.e., greater than or equal to 40 students per grade/subject) across each assessment year to compute the necessary regression equation.

**Table 16. Average School-Level Predicted and Actual 2021 Mean Scale Scores**

Grade/Subject	2021 Predicted Mean	2021 Predicted SD	2021 Actual Mean	2021 Actual SD
Math 03	210.87	9.34	201.34	8.68
Math 04	209.52	9.51	202.40	8.24
Math 05	211.14	9.81	202.81	9.57
Math 06	211.26	8.42	201.42	7.41
Math 07	211.98	6.99	202.81	5.71
Math 08	209.60	7.95	200.31	6.74
Reading 03	210.44	7.33	201.07	7.76
Reading 04	210.16	6.29	206.17	5.63
Reading 05	212.86	6.26	207.62	6.90
Reading 06	214.15	5.25	208.77	5.03
Reading 07	212.12	4.75	205.92	4.40
Reading 08	216.18	5.23	210.82	4.68

*Note.* Means represent the average score across all schools for the specific grade/subject. School n-sizes for each grade/subject vary. Some schools did not have sufficient sample sizes (i.e., greater than or equal to 40 students per grade/subject) across each assessment year to compute the necessary regression equation.

## Discussion

Kentucky students' mean performance declined substantially during the COVID-19 interruption. This report describes factors that had the potential to influence students' reported scores and the investigations conducted to determine their impact. None of those investigations revealed issues that would call the 2021 results into doubt. We therefore conclude that the differences in mean student performance from 2019 to 2021 represent real declines in overall student learning during that period.

This report describes both the magnitude of the mean performance decline and the changes in the population of students tested in Kentucky. The number of students tested in 2021 ranged from about 39,000 to about 43,000 per grade, compared to a range of about 48,000 to 51,000 per grade in 2019. Since 2015 the tested population in Kentucky has shifted somewhat as larger and smaller cohorts of students attended public school, but the number has typically been between 42,000 and 52,000 students per grade. The decline from 2019 to 2021 represents roughly a 20% decline in students tested.

### Cohort to Cohort Results

State-level assessment results are most often presented as cohort-to-cohort data. When we compare one cohort with another, we can get a sense of the effectiveness of the overall educational system. A cohort is one grade/subject, for instance 4<sup>th</sup> grade mathematics. Comparing results from the 4<sup>th</sup> graders from one year to the next means comparing different students but allows us to gauge the achievement of the group of fourth graders at a common point in their academic preparation—the spring of their 4th grade year. This kind of analysis allows Kentucky to track school- and district-level performance in terms of student achievement. It also allows us to estimate the impact of the COVID-19 interruption on student performance.

It is helpful to put the performance decline into perspective. We describe two main statistics that indicate the magnitude of the decline. First, we compute differences in mean scale scores. Because Kentucky uses its own reporting scale, those differences can be difficult to interpret. To make them more meaningful, we converted the scale score differences to effect sizes (Cohen's D). The second statistic is the percentage of students scoring at the Proficient level or above. This statistic is used for school accountability and is interpretable as the percentage of students scoring at the level expected of them for their particular grade and subject. Table 2 on page 9 summarizes these results.

Effect sizes represent the differences in terms of standard deviations. Cohen (reluctantly, as interpretation depends on the use of the mean differences) provided some guidance for interpreting effect sizes, suggesting that an effect size of 0-0.2 could be considered small, 0.2-0.5 medium, and 0.8 or higher as large. For context, HumRRO conducted analyses of annual mean changes for all US states in an evaluation of the impact of the federal No Child Left Behind (NCLB) (Center on Education Policy) in (2008) and concluded that most state mean scores for reading and mathematics across all grades changed less than 0.05 standard deviations. Those with greater than 0.05 shifts in one year were considered anomalies. State-level means tend to be very stable and changes, positive or negative, typically occur across several years. Kentucky's students' mean scores from 2015 to 2019 were also very stable (see Table 2 on page 9), but 2021 showed a substantial decline across grades and subjects.

The percentage of students who score Proficient and above has also been relatively stable in Kentucky across years (see Table 3 on page 10). For example, approximately 50% of third grade students scored Proficient or above from 2015 to 2019 in both reading and mathematics. The statewide percentage fluctuated from year to year, but there was never more than a 3-4 percentage point shift from one year to the next. In 2021, the percentage dropped precipitously from 50% to approximately 30%, or a shift of roughly 20 percentage points. The decline was greater for mathematics than for reading in other grades.

These results focus on reading and mathematics from grade 3 to 8. Other grades and subjects had substantial changes in testing during the same period or they are only tested once in elementary, middle and high school. We did examine the cohort-to-cohort differences for science and writing from 2019 to 2021 and found that science performance also declined sharply, though not quite as sharply as reading and mathematics. This may be partly explained by the recent adoption of three-dimensional science standards and the relatively lower scores on science compared to reading and mathematics prior to the COVID-19 interruption. Writing scores fluctuated, some grades increasing and others declining from 2019 to 2021, but the writing test was shortened substantially for 2021 and scored using raw scores only. These factors make writing estimates less reliable than other subjects. The remainder of this report focuses on reading and mathematics in grades 3-8.

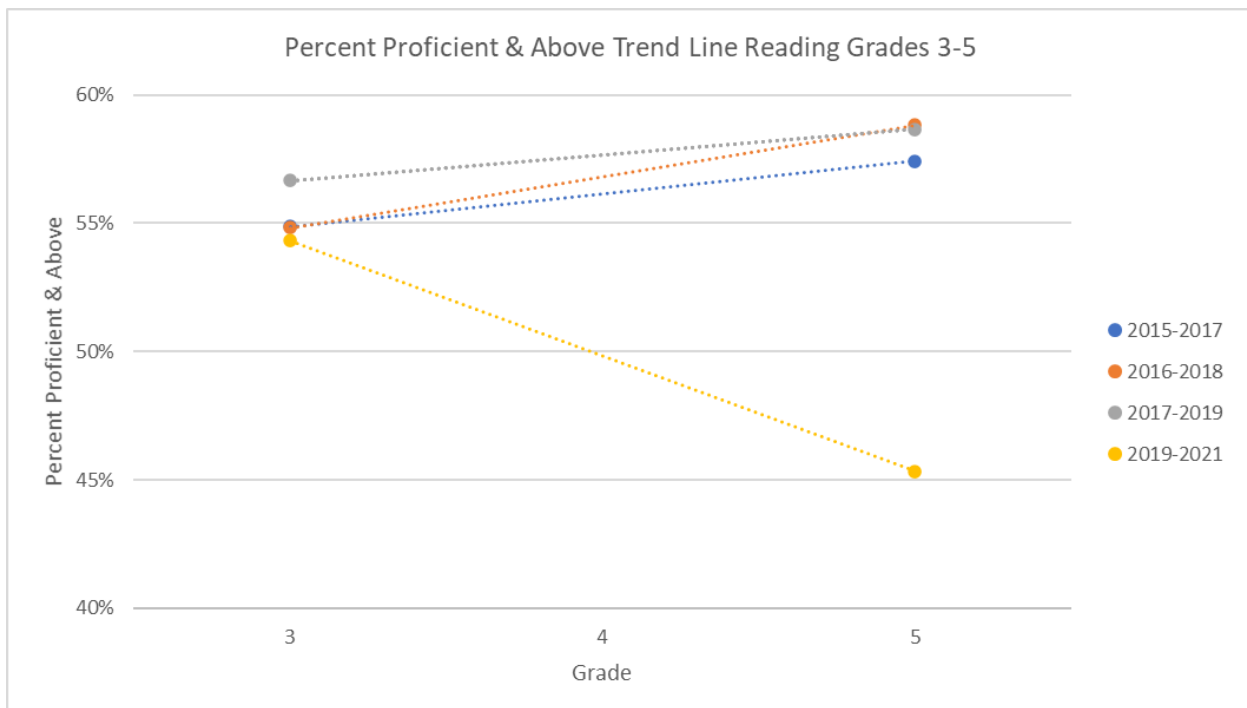
### ***Matched Student Results***

To investigate the sharp decline in scores from 2019 to 2021 it was important to be able to match students across grades and years. Matching students is important because we want to be sure that the declines in scores represent real changes in mean student performance. There was also a decline in the number of students participating in the state assessment in 2021. If the students who did not test were an abnormally high-performing group, we might see a similar pattern of declining scores. The only subjects where there was sufficient data to track students across grades were reading and mathematics in grades 3-8.

We can assume that our analyses of reading and mathematics data will generalize to other subjects. Students take the statewide assessments in a single testing window, so we can be reasonably confident that most fourth-grade students who took reading and mathematics assessments also took the science assessment. Similarly, students who did not take the reading and mathematics assessments very likely did not take the science assessments. So, even though we cannot track the same students' science scores from one year to the next, the reading and mathematics data should also tell us if the cohorts of students taking science were substantively different in 2019 versus 2021 and if we can trust the science score estimates to represent the full Kentucky student population.

It is important to note that not all the students who take the mathematics test as third graders will take the mathematics test as fifth graders two years later. This was not true prior to the COVID interruption and is not true for the two-year span from 2019 to 2021. Students may move out of the state, repeat or skip a grade, or miss testing for various other reasons. It is also true that the group of students with test scores in consecutive years tend to be higher performing than those who do not. It is not surprising that the matched student samples have higher scores than unmatched samples. Transience, poverty, and poor health are negative indicators of assessment performance and regular participation. For this study, we are more interested in whether the larger group of unmatched students might help us explain the decline in statewide performance.

We considered the matched (across a two-year span) students first. This allowed us to examine grade pairs from 3-5, 4-6, 5-7, and 6-8 for the years 2015-17, 2016-2018, 2017-2019, and 2019-2021 (see Tables 11 through 14 on pages 25-26). Matched students mean scores and overall percent Proficient tended to be fairly consistent across the two-year spans until the span from 2019-2021, where we see a sharp decline in performance. These results parallel the cohort-to-cohort declines seen within a grade/subject from 2019 to 2021. This data demonstrates that the declines we see in student performance are not an artifact of sampling (i.e., which students took the tests). Even if we limit our analyses to those students who took the test in 2019 and 2021, we still see the decline in performance. Figure 4b is replicated here to demonstrate this effect. Mean student performance, in terms of percent Proficient, tended to increase slightly from grade 3 to grade 5 in the years prior to 2019 (about 55% Proficient in grade 3 to about 58% in grade 5). The trend reversed in 2021, dropping to approximately 45% Proficient across the matched 5<sup>th</sup> graders.



**Figure 4b. State level reading grade 3-5 cohort proficient and above trendlines**

When we examined the differences between the matched and unmatched mean student scores across two-year spans (e.g., grade 3 to 5 from 2017 to 2019) prior to the COVID interruption, we found fewer unmatched students than in the unmatched group from 2019 to 2021. This is not surprising since we knew fewer students tested in 2021 than in previous years. When we looked at differences in performance between the matched and unmatched groups, the unmatched students scored lower than the matched for all two-year spans. The difference in mean scores between the matched and unmatched samples, however, was not radically different before the COVID interruption compared to afterward. This indicates that the students who did not test in 2021 tended to perform similarly (in 2019) to cohorts of students who did not have consecutive test scores across the two-year spans from the past. Students who did not test in 2021 had lower mean performance overall in 2019 than those who did, but they did not have lower mean scores than might be expected given prior trends in the data.



## *Students Untested in 2021*

To further explore how students who did not test in 2021 would have performed, we created a “propensity matched” sample of students who tested in 2019, but not in 2021. The propensity matched sample was created by finding students who were in the matched sample in 2019 with similar performance and demographic information as students who did not have scores in 2021. Each student from the unmatched sample was matched with the student that was most like them in the matched sample (all from 2019). Students could only be matched one time (i.e., no students are in the propensity matched sample more than once). This allowed us to track the propensity matched sample across grade spans in the same way we tracked matched students. Put simply, because we couldn’t examine 2021 test scores from students who did not test in 2021, we used those students’ data from 2019 to create a “comparable” group of students that we could track. From that data, we examined whether there were major differences in the performance trends of matched versus unmatched students (i.e., those who tested in 2021 versus those who did not).

Not surprisingly, the propensity matched sample did not perform as well as the matched sample. But, if we examine the trend lines (slopes) from 2019 to 2021, we find that the decline was relatively consistent across the matched and propensity matched groups (see Figure 5). Even though the propensity matched students did not perform as well in 2019, their decline in mean scores was very similar to the matched sample. This is another way of investigating whether the unmatched students who did not test in 2021 are sufficiently different from the tested students to substantially impact overall conclusions about performance trends during the COVID-19 interruption. These data support that the decline in statewide mean performance is accurately estimated.

## *School and District Level Analyses*

Kentucky uses student-level data to generate accountability indices for schools and districts. Student performance is used as an indicator of school and district effectiveness. Given the declines in student performance overall, it is not surprising that school and district level performance declined as well during the COVID-19 interruption. However, it is interesting to examine the patterns of school and district performance to see how statewide student mean declines were distributed among schools and districts. Schools and districts where the decline was most severe might need additional support during recovery efforts. Schools and districts where the decline was least severe (or did not occur at all) might offer lessons for how to implement non-traditional instruction more effectively.

We began by examining simple histograms of the changes in aggregated district-level scores from 2015 to 2017, 2016 to 2018, 2017 to 2019, and 2019 to 2021 (see Figure 9). The change scores for the first three two-year spans were relatively normally distributed with a mean near 0. The 2019 to 2021 change scores were much more negative and more varied than for previous years. There were several districts where the impact of the interruption was severe. There were also a few districts where the impact was negligible. This shows us that the pandemic interruption did not have a uniform impact across Kentucky and that students’ school districts may be one predictor of the severity of the pandemic on student performance.

When we examine school-level change scores across the same two-year spans, we see the same pattern we saw at the district level. These patterns hold across grades and subjects. Schools also had a more negative and varied distribution of change scores from 2019 to 2021 than in previous years. There were also schools with severely negative changes and schools with essentially no changes in mean student performance from 2019 to 2021.

Finally, we used each school's and districts' mean scores from 2015 to 2019 to generate a predicted score for 2021. These scores are our best estimate of what student performance would be in those schools and districts if the COVID-19 interruption had not occurred. We then compared the predicted to the actual scores in 2021. Not surprisingly, the overall predicted scores were much higher than the actual scores. However, when we plotted the predicted versus the actual scores, we noted that the scatter of the points representing schools and districts were not tightly clustered in a line. There were schools and districts that did not follow the expected patterns. Further investigation may help us understand the differential impact of the COVID-19 interruption in these schools and districts<sup>3</sup>.

### *Conclusions and Next Steps*

The COVID-19 interruption resulted in significant declines in overall student performance in Kentucky. Investigations of factors that might have influenced estimates of this decline indicate that the changes in mean student performance are genuine. School- and district-level scores also declined sharply during this period. There was, however, a great deal of variance in the school- and district-level scores, with some experiencing little or no decline from 2019 to 2021.

It will be important for Kentucky students to “make-up” for any learning loss they experienced during the pandemic interruption. This report characterizes the severity of the decline in student performance and verifies that it represents an overall decline in student learning. Recovery efforts may require more instruction and learning than students have experienced in the past. There may be lessons from schools and districts that were effective in implementing non-traditional instruction that can aide in the recovery. It will be important in the coming years to closely monitor student performance to gauge the effectiveness of recovery efforts. It will also be important to differentiate between effective and ineffective recovery practices. We recommend the following next steps:

1. Closely monitor student performance trends on the statewide assessments and link them back to actual and predicted scores for 2021.
2. Target recovery efforts in the lowest performing schools and districts, as well as the schools and districts that experienced the most severe performance declines from 2019 to 2021.
3. Make mathematics a priority for recovery efforts. Mathematics scores declined more than other subjects, which may reflect fewer students mastering foundational mathematics content and creating challenges for further mathematics learning.
4. Investigate schools and districts that were least impacted by the pandemic interruption to discover if they implemented non-traditional instruction differently than others.
5. Monitor recovery efforts in schools and districts and document methods and programs.
6. Promote efforts to extend traditional in-school instruction with effective non-traditional practices.

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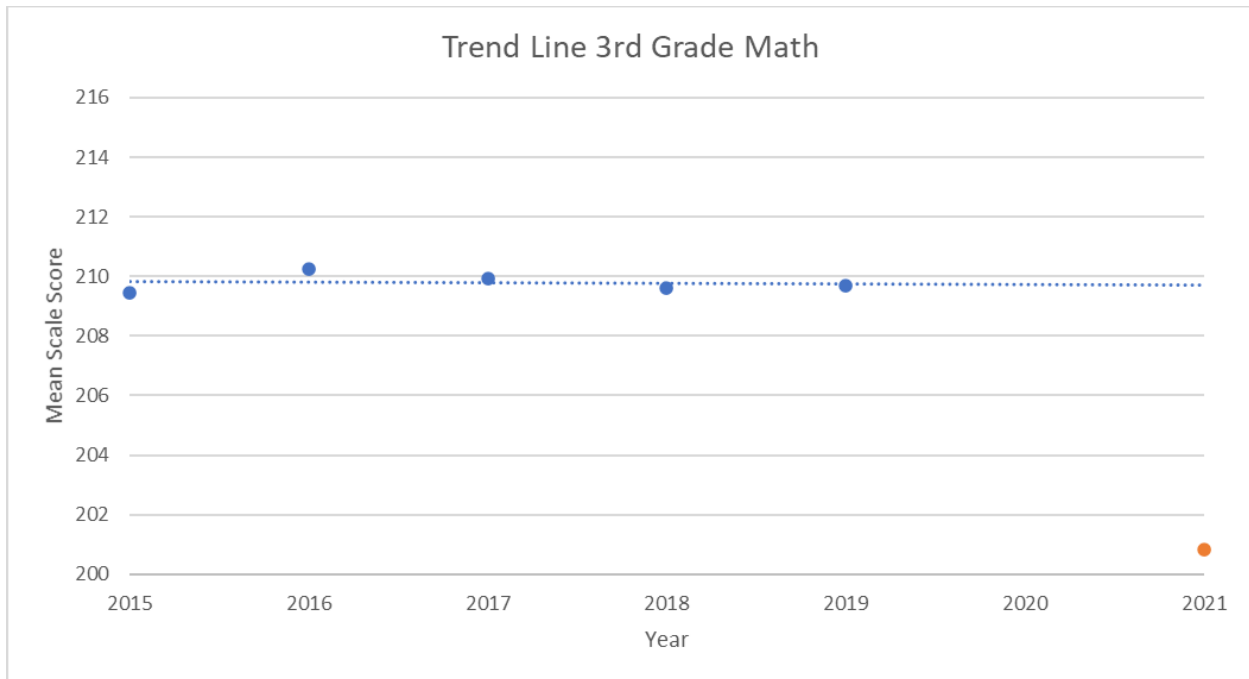
<sup>3</sup> No individual school or district results are presented in this report. An electronic file was provided to the Kentucky Department of Education for further investigation.

## References

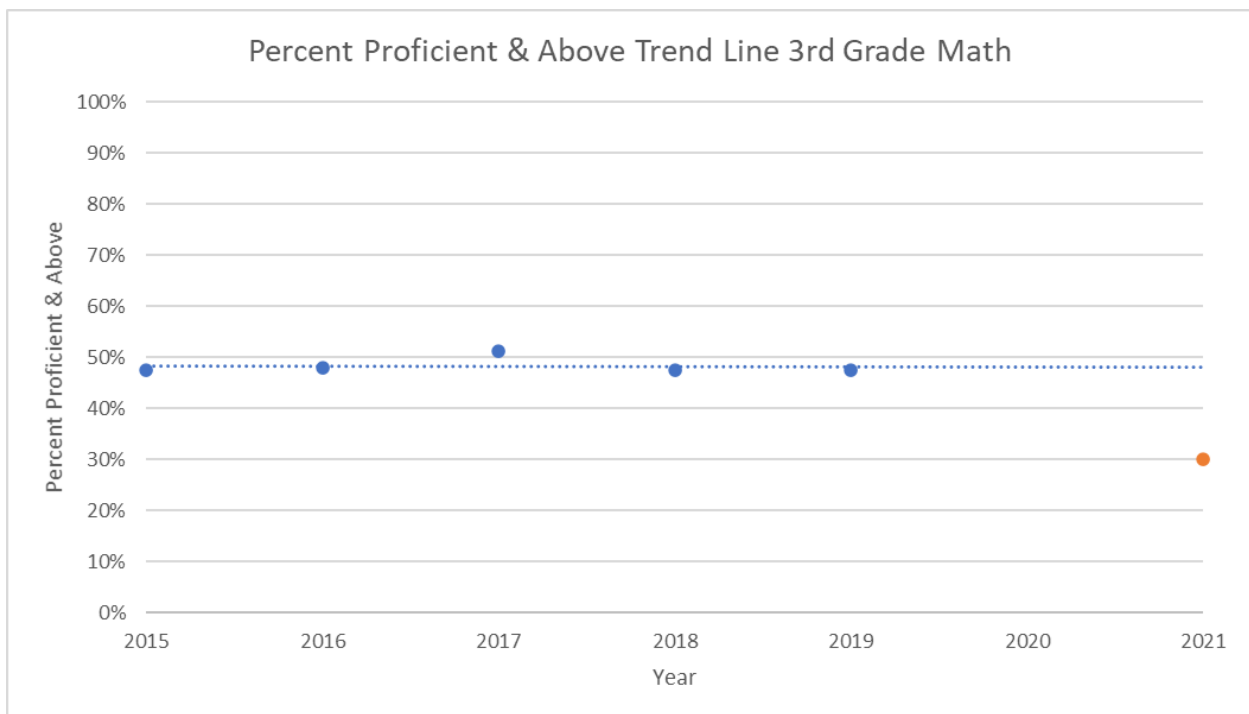
Center on Education Policy (2008). Has Student Achievement Increased Since 2002: State Test Score Trends Through 2006-07. Washington, DC, June 2008.

Ho, A. (2021). Three test-score metrics that all states should report in the COVID-19-affected spring of 2021. Draft Memo (February 26, 2021).

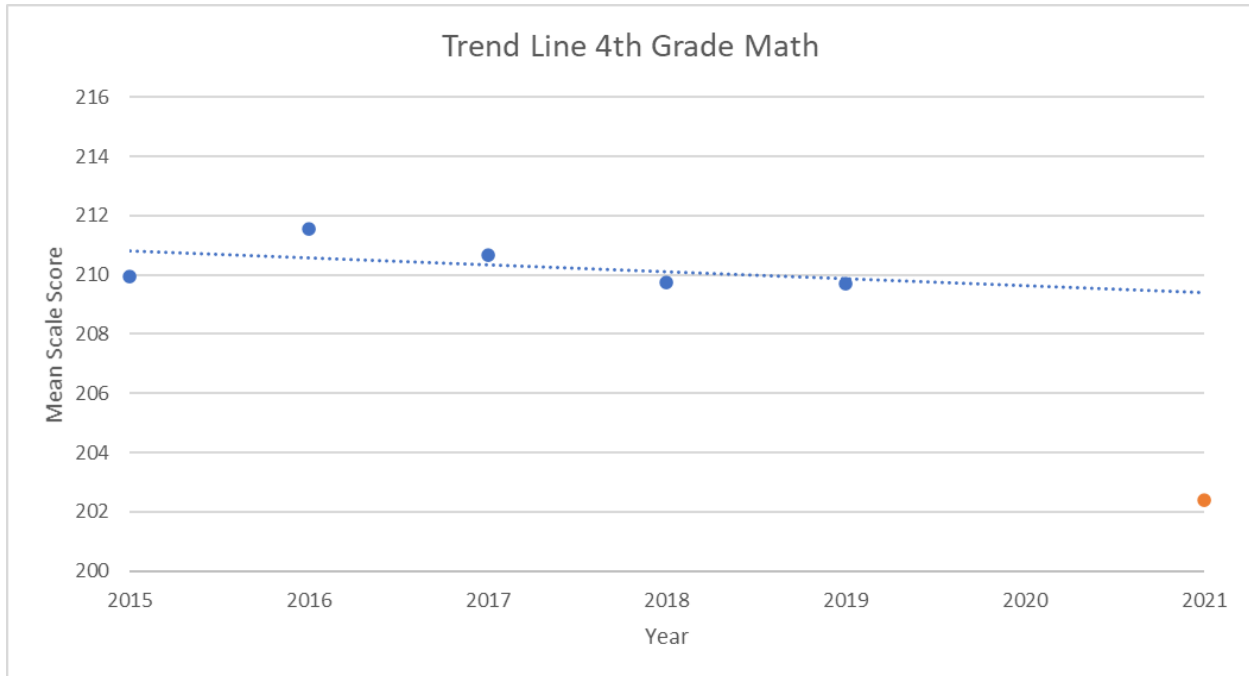
## Appendix A



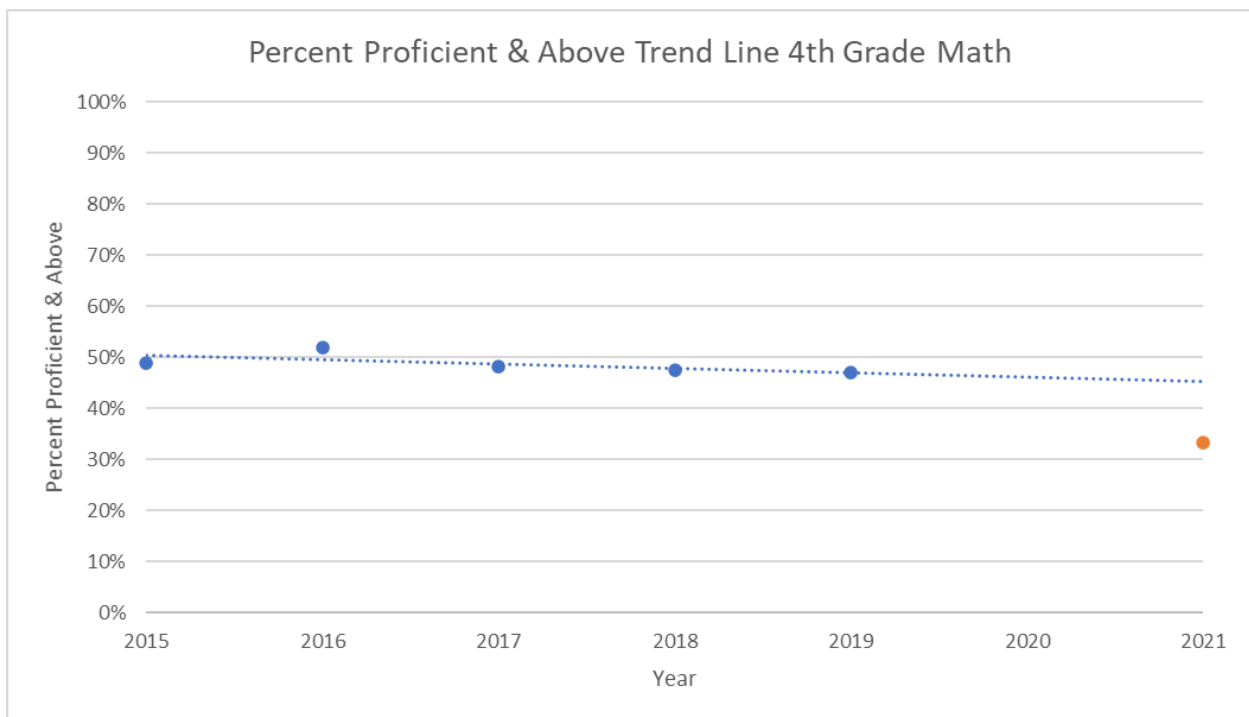
**Figure A-1. Performance trend for Grade 3 mathematics**



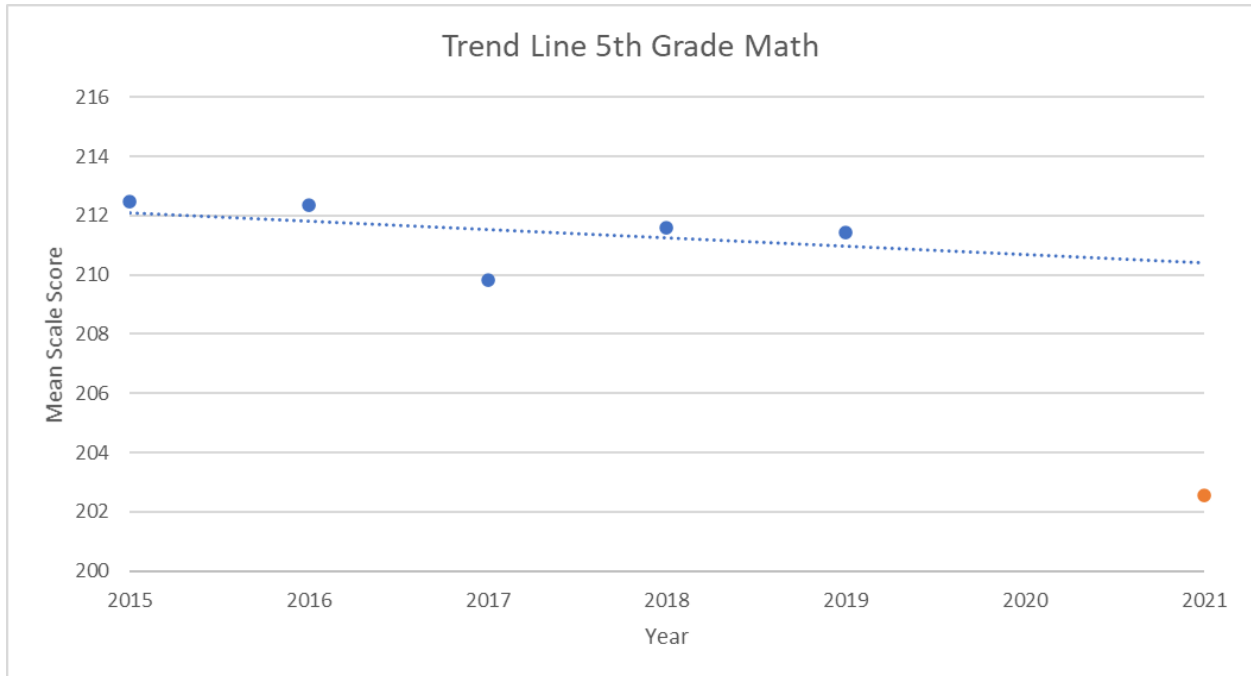
**Figure A-2. Percent proficient and above trend for Grade 3 mathematics**



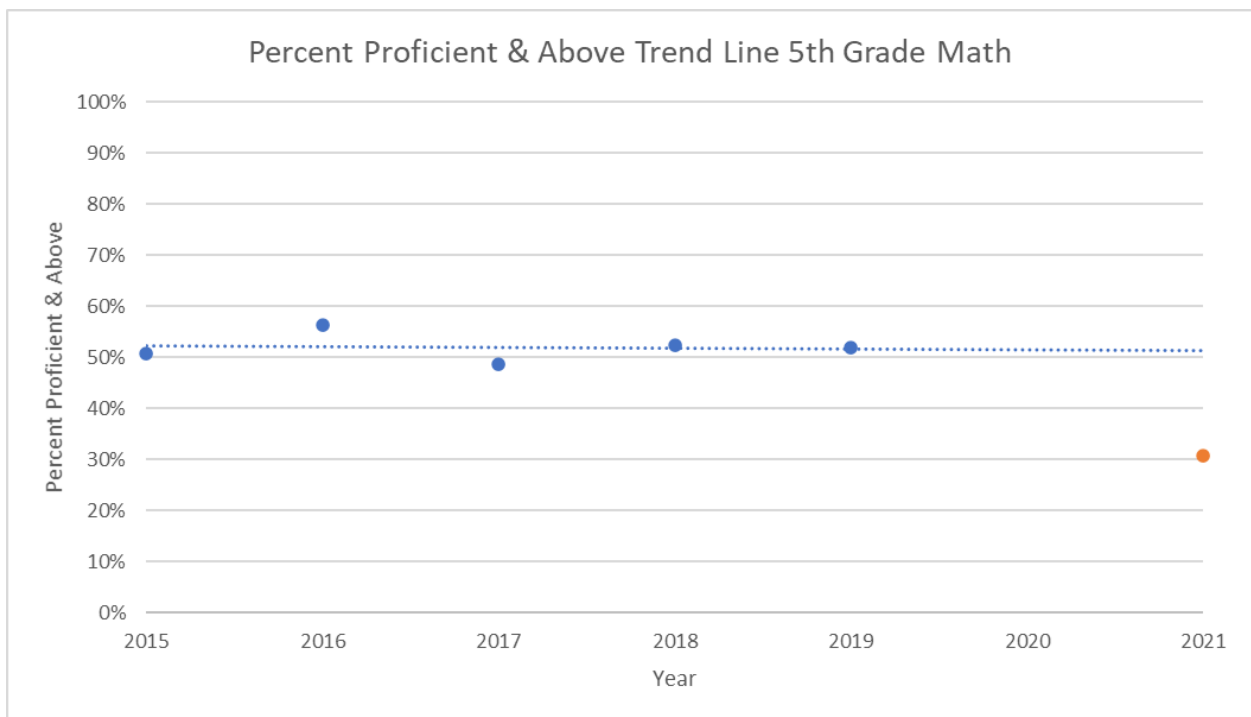
**Figure A-3. Performance trend for Grade 4 mathematics**



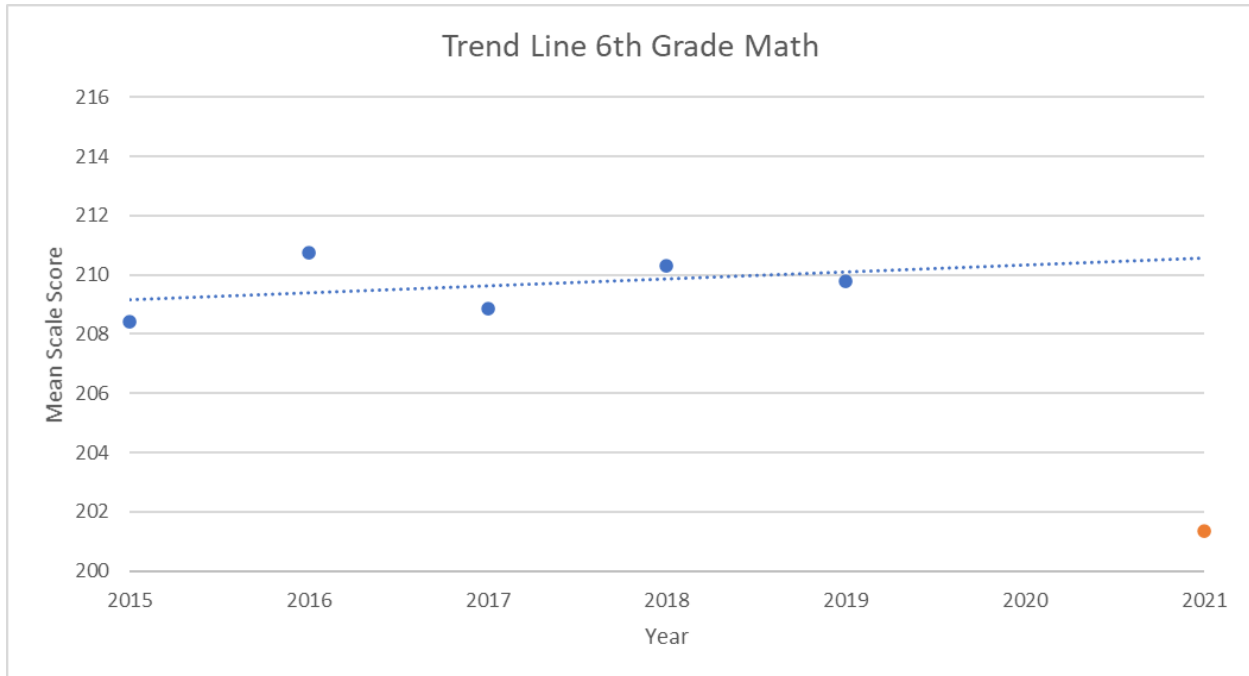
**Figure A-4. Percent proficient and above trend for Grade 4 mathematics**



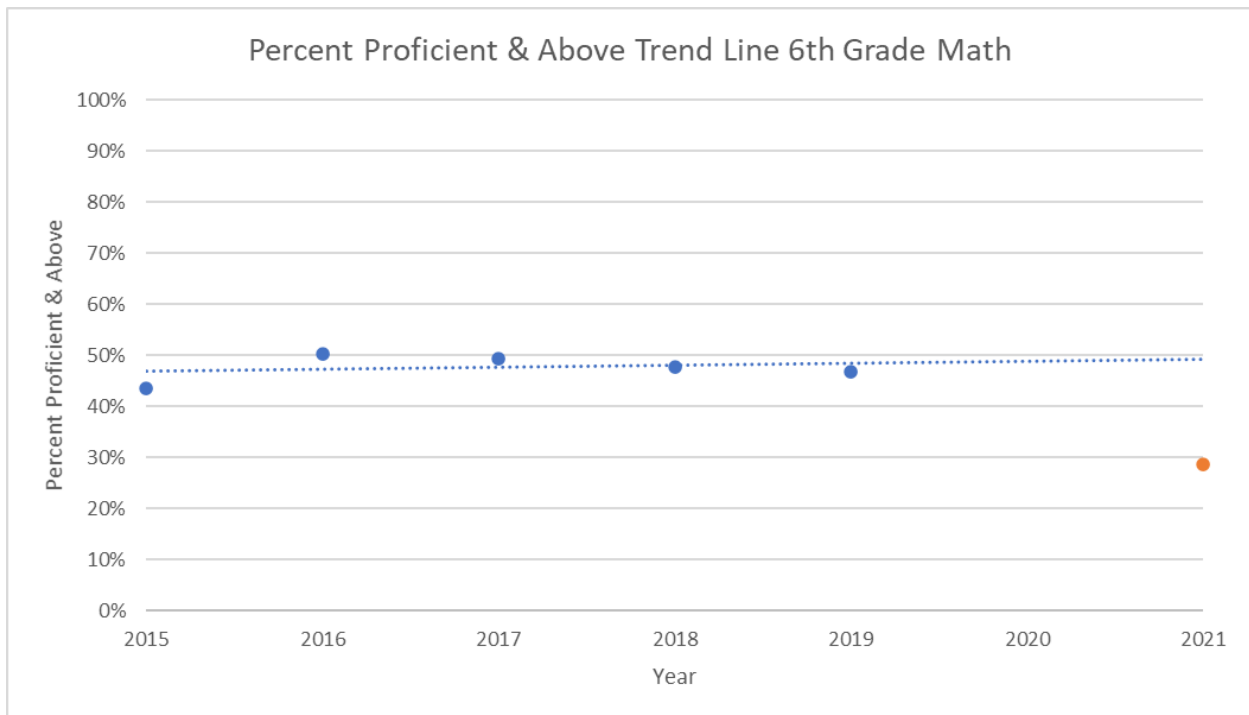
**Figure A-5. Performance trend for Grade 5 mathematics**



**Figure A-6. Percent proficient and above trend for Grade 5 mathematics**

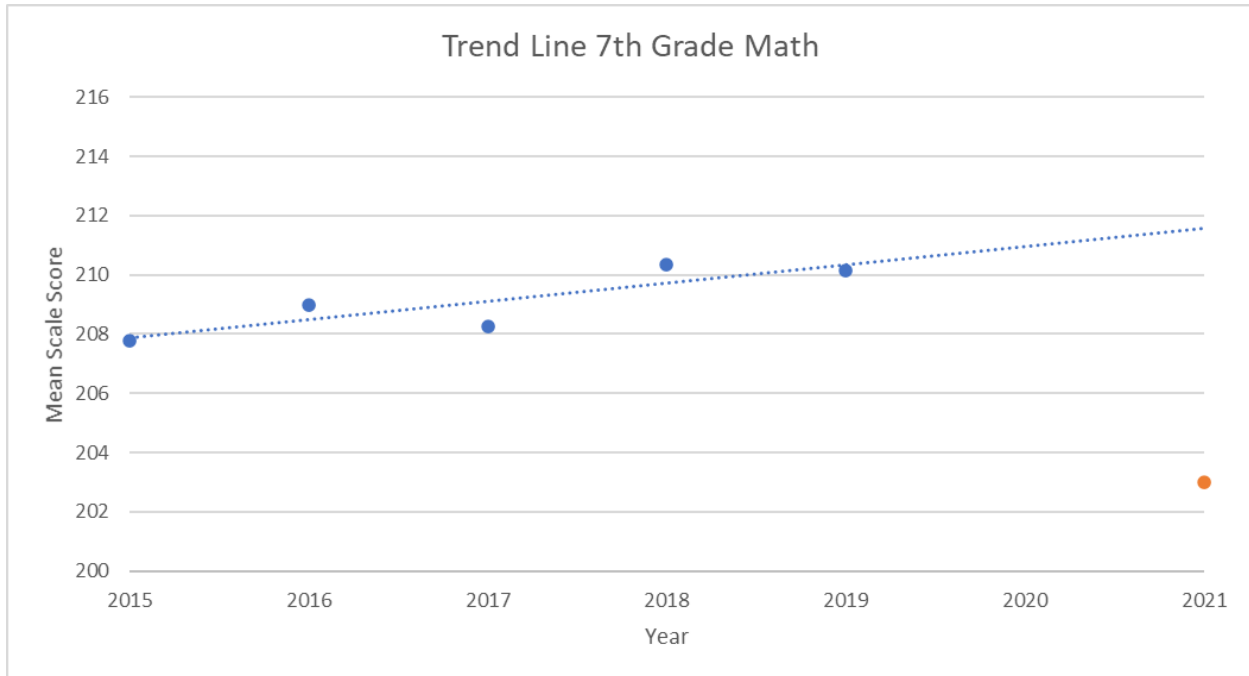


**Figure A-7. Performance trend for Grade 6 mathematics**

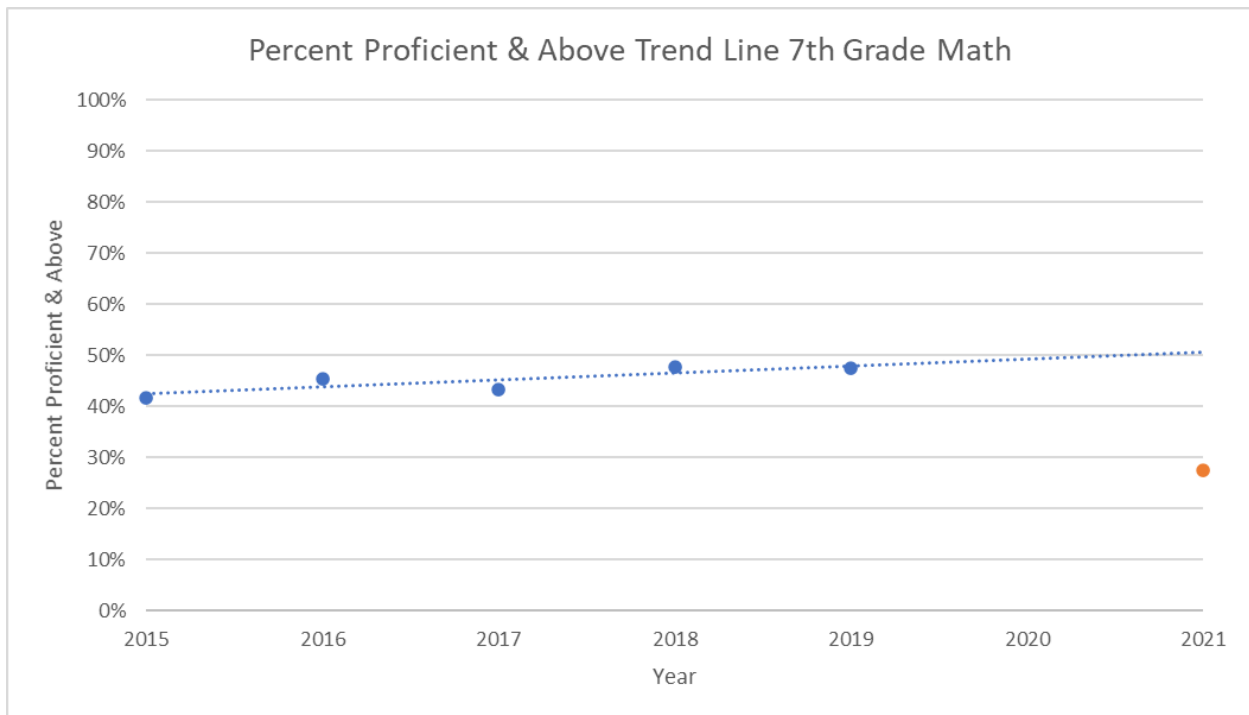


**Figure A-8. Percent proficient and above trend for Grade 6 mathematics**

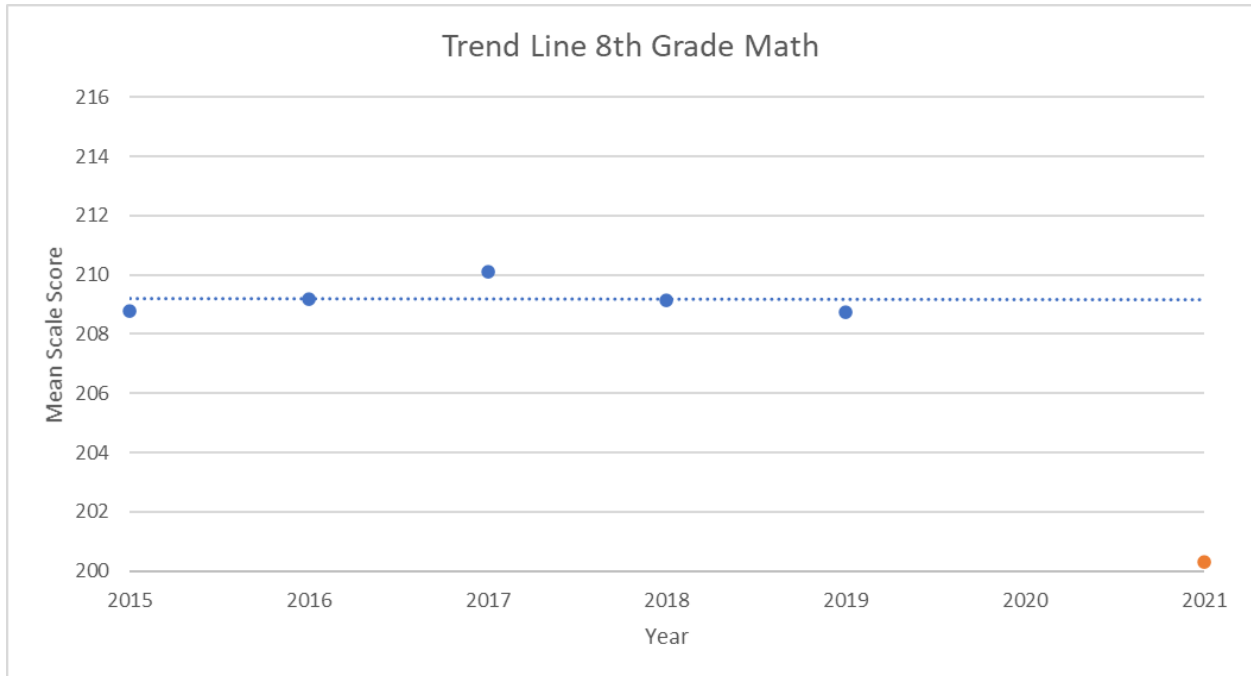




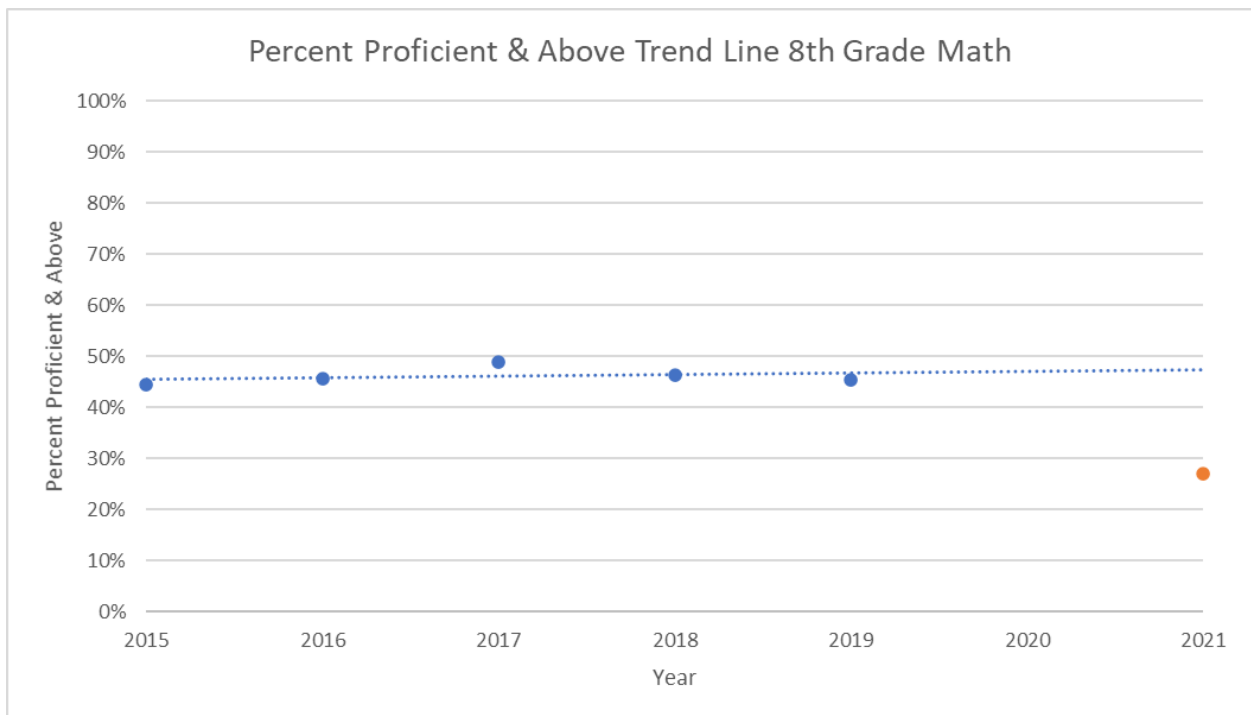
**Figure A-9. Performance trend for Grade 7 mathematics**



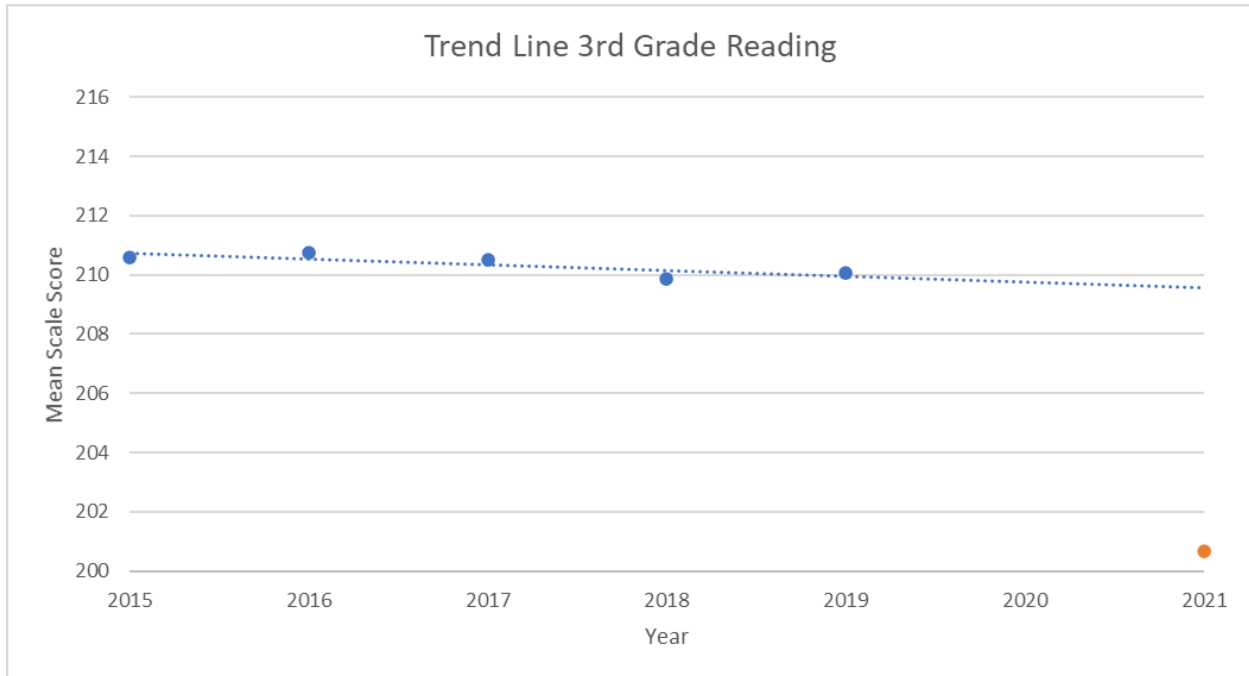
**Figure A-10. Percent proficient and above trend for Grade 7 mathematics**



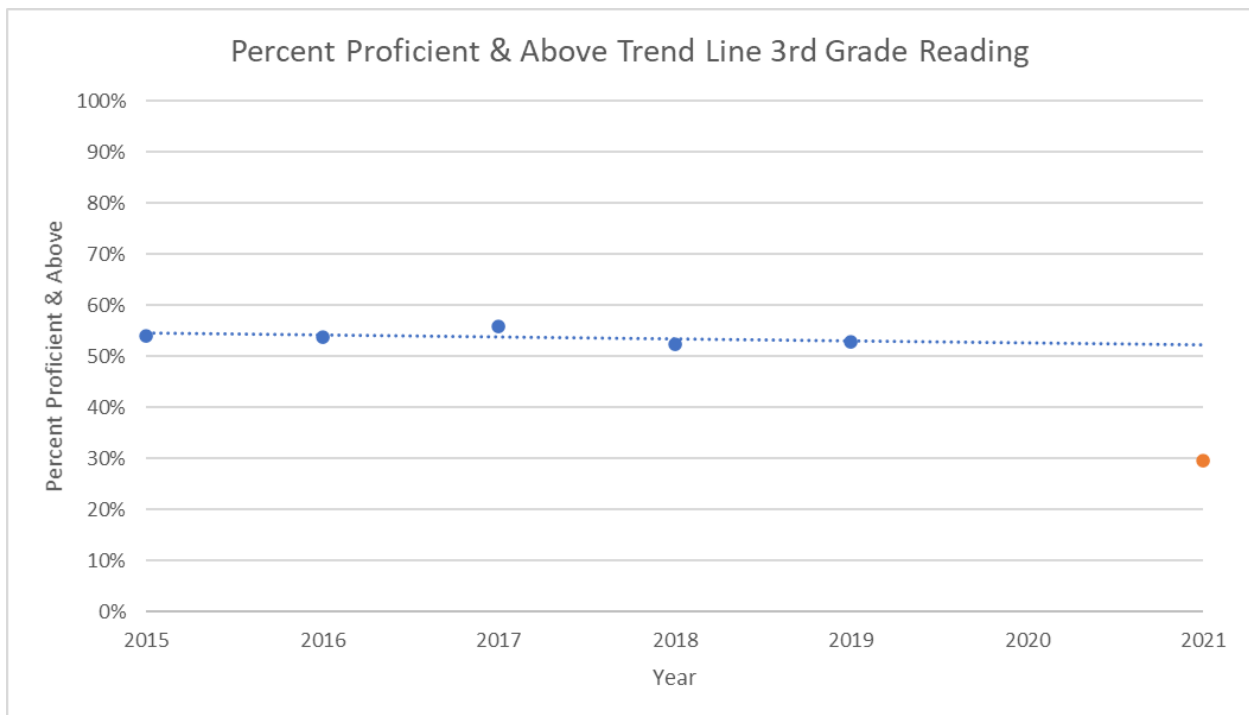
**Figure A-11. Performance trend for Grade 8 mathematics**



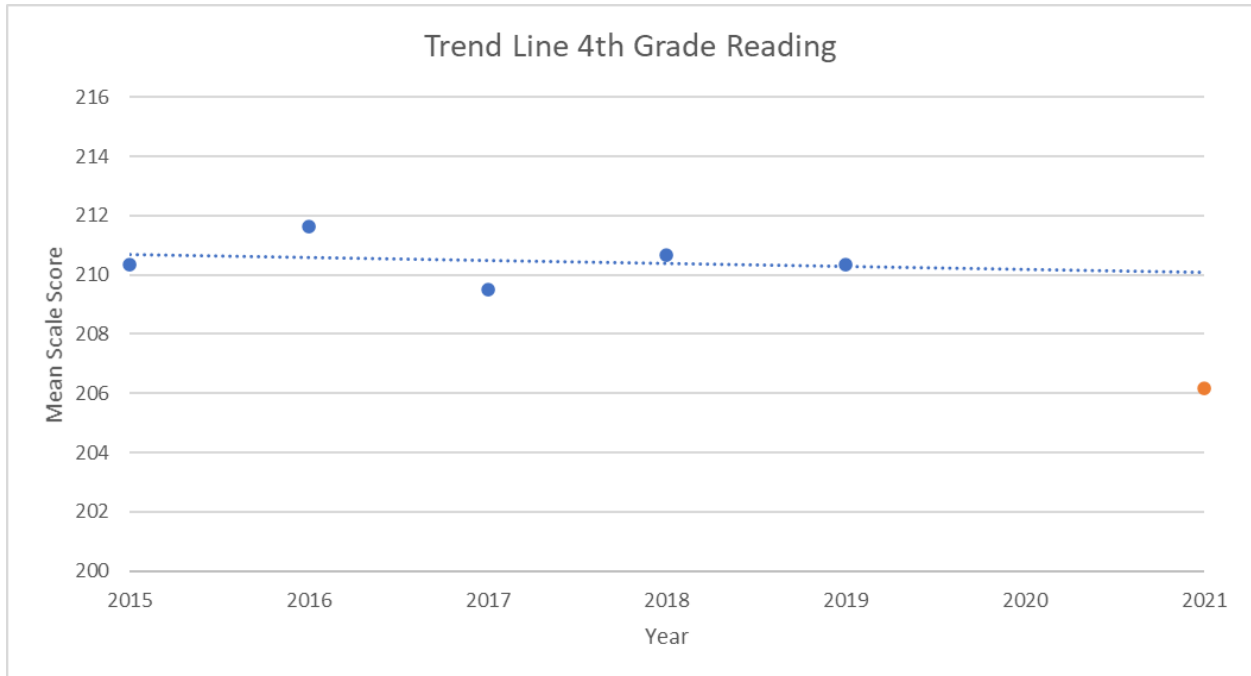
**Figure A-12. Percent proficient and above trend for Grade 8 mathematics**



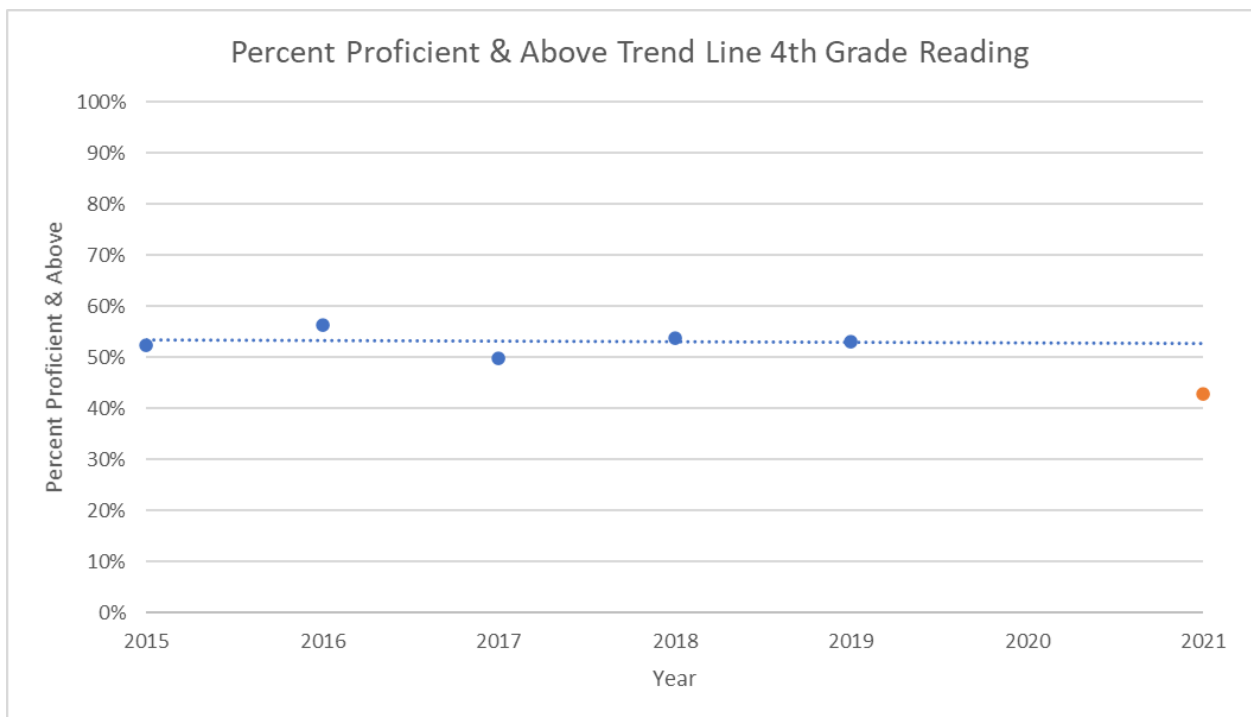
**Figure A-13. Performance trend for Grade 3 reading**



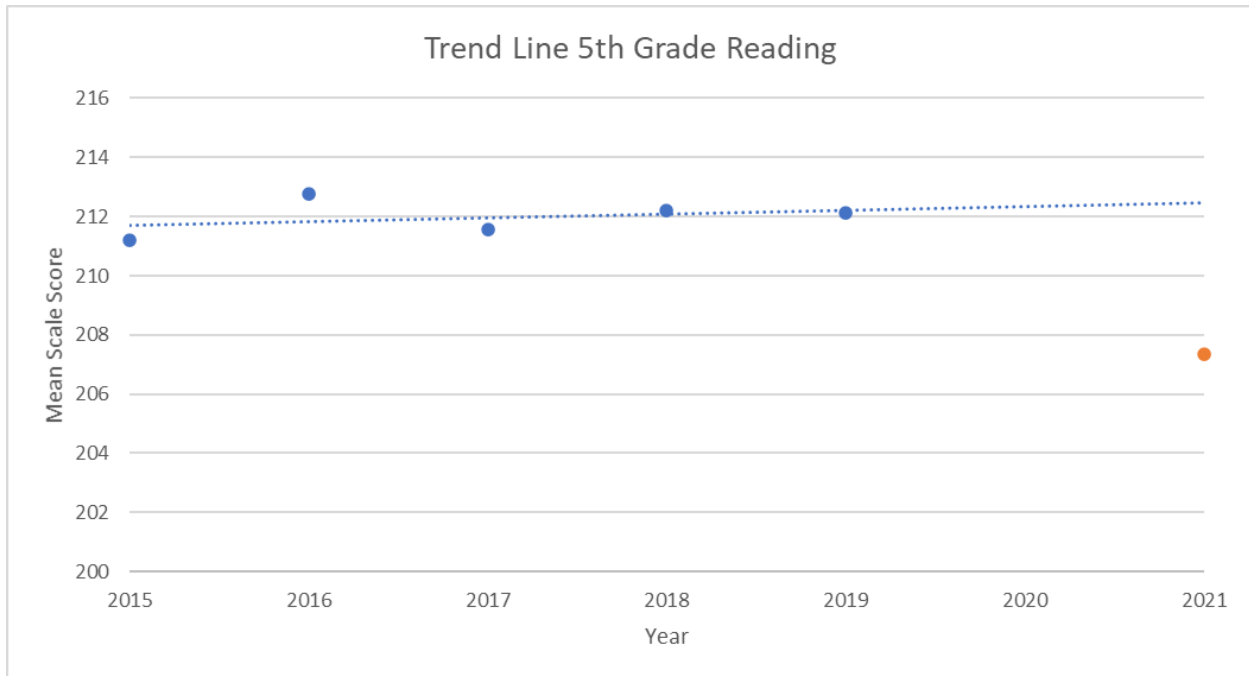
**Figure A-14. Percent proficient and above trend for Grade 3 reading**



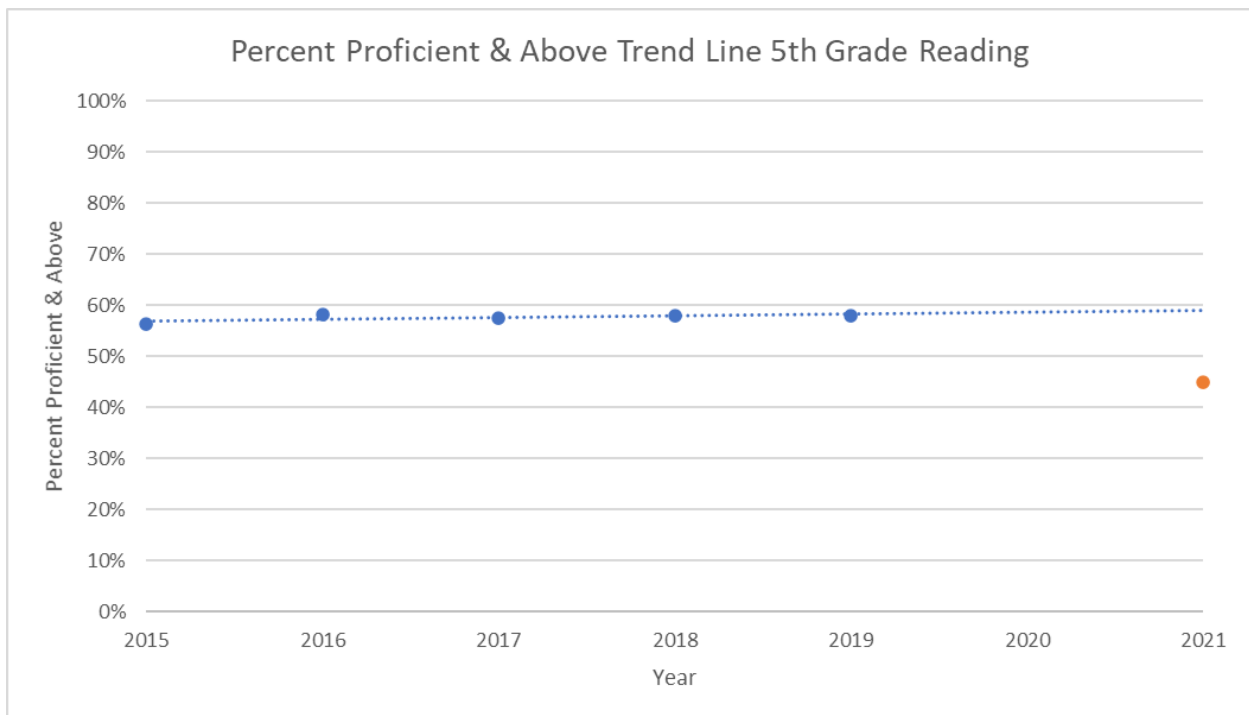
**Figure A-15. Performance trend for Grade 4 reading**



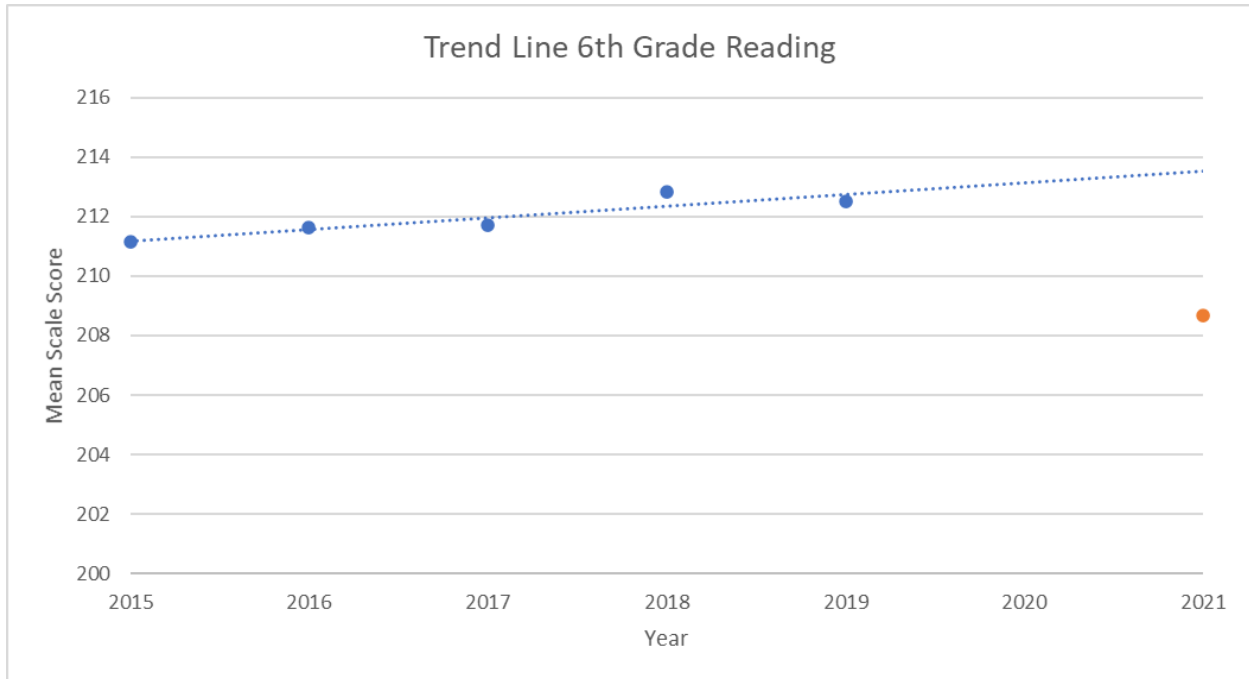
**Figure A-16. Percent proficient and above trend for Grade 4 reading**



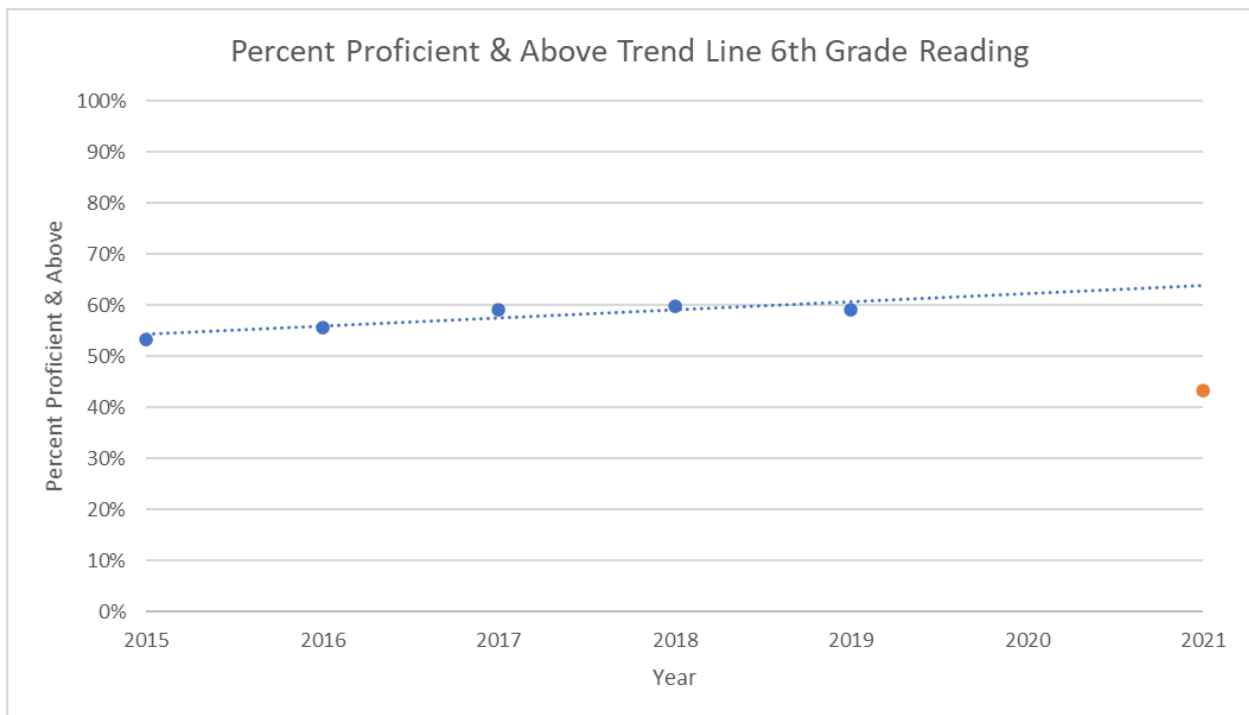
**Figure A-17. Performance trend for Grade 5 reading**



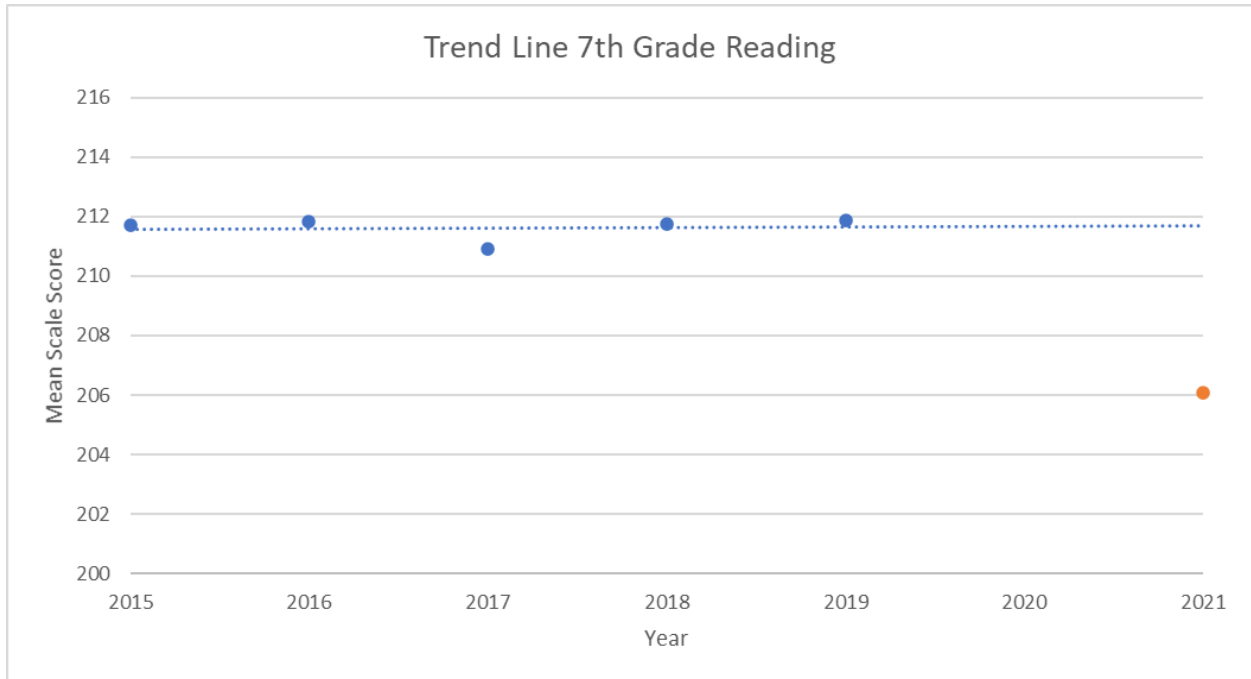
**Figure A-18. Percent proficient and above trend for Grade 5 reading**



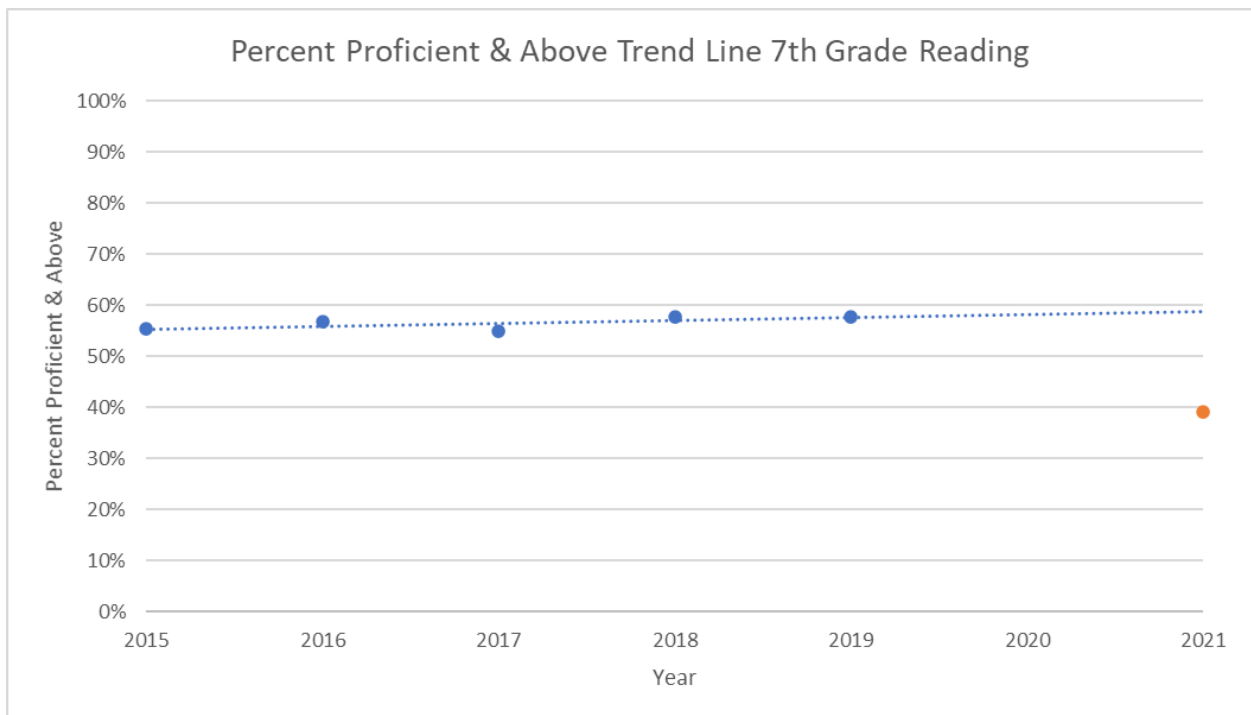
**Figure A-19. Performance trend for Grade 6 reading**



**Figure A-20. Percent proficient and above trend for Grade 6 reading**

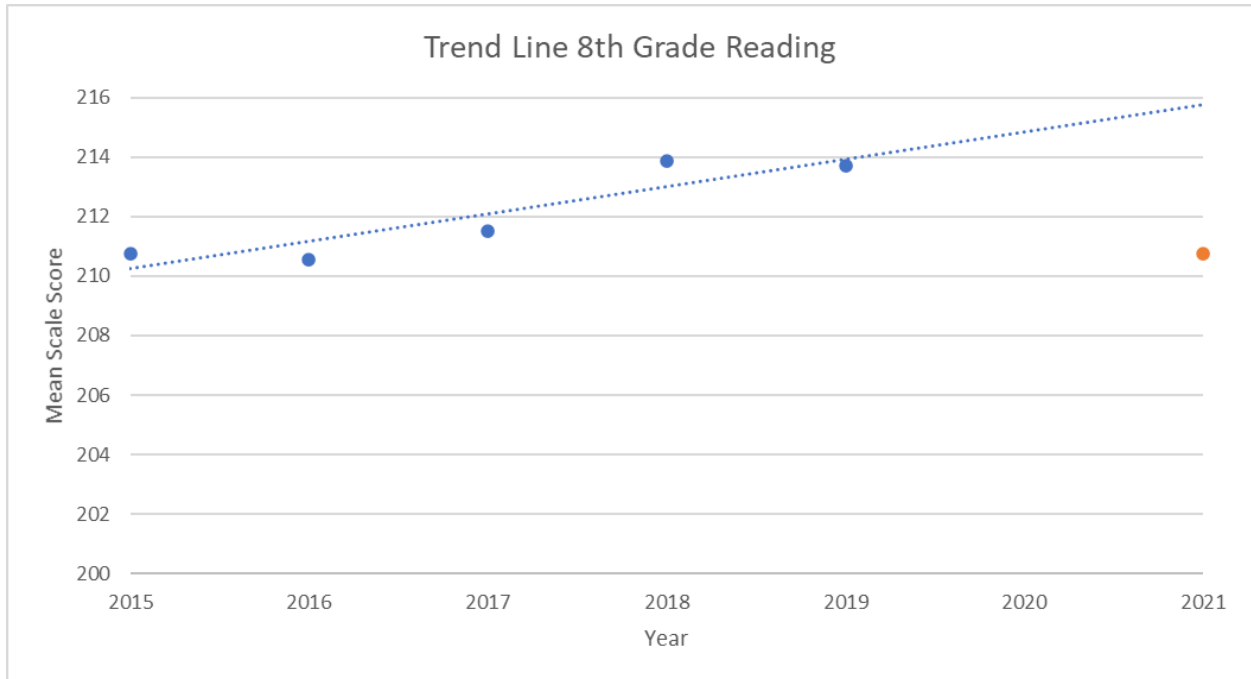


**Figure A-21. Performance trend for Grade 7 reading**

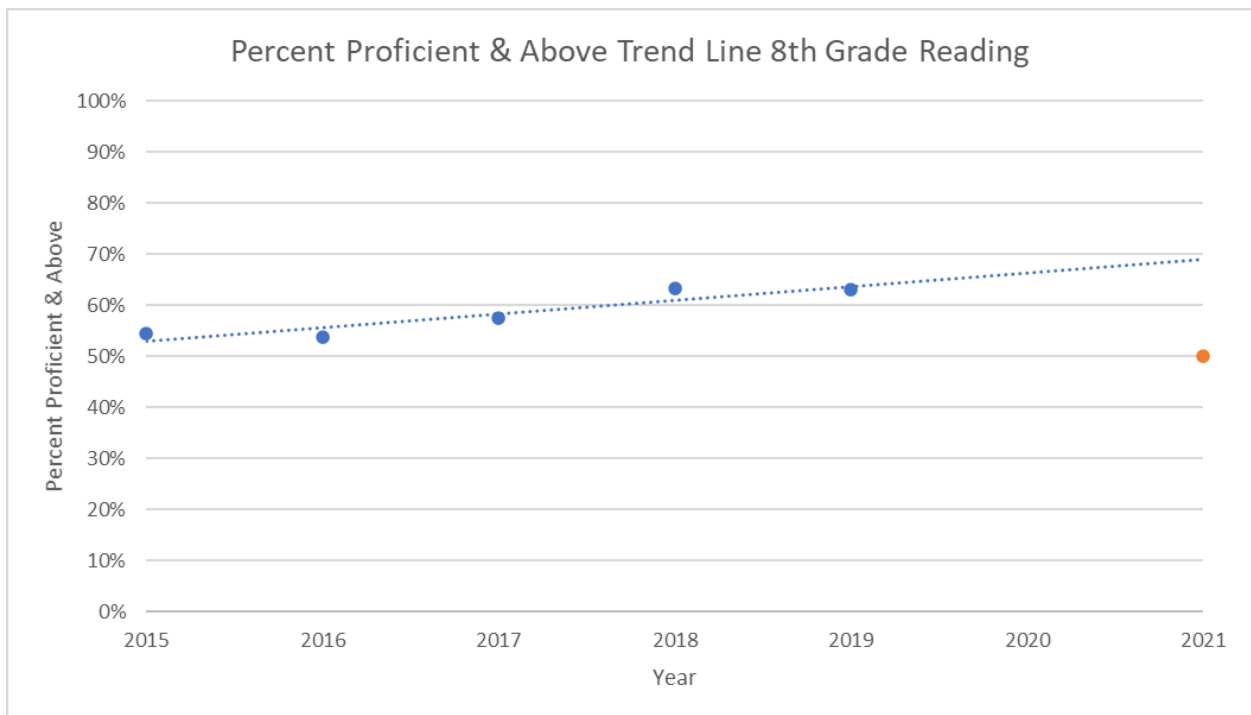


**Figure A-22. Percent proficient and above trend for Grade 7 reading**



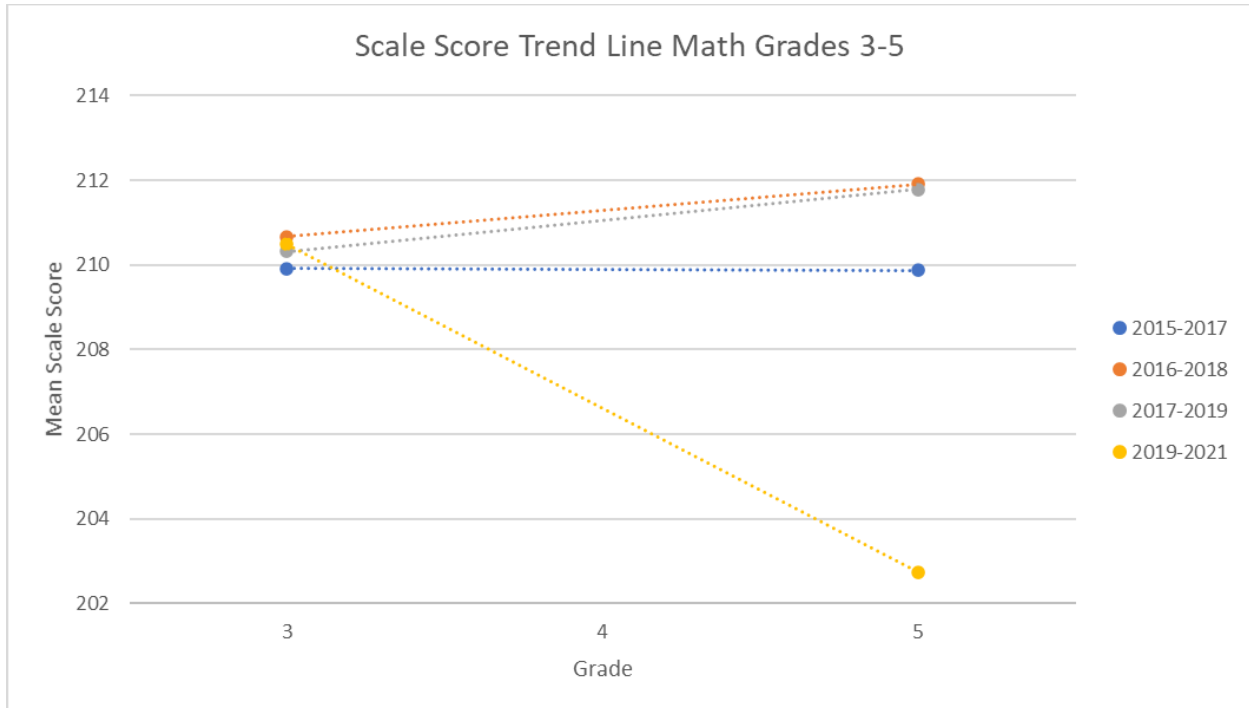


**Figure A-23. Performance trend for Grade 8 reading**

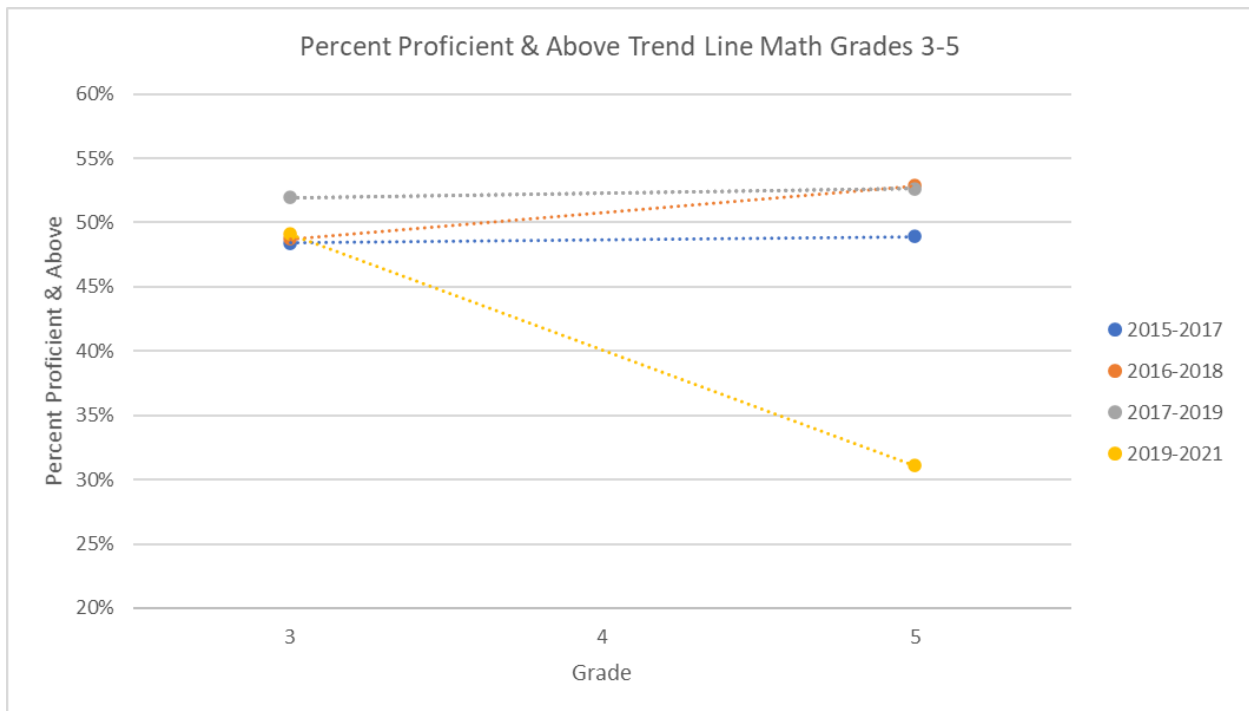


**Figure A-24. Percent proficient and above trend for Grade 8 reading**

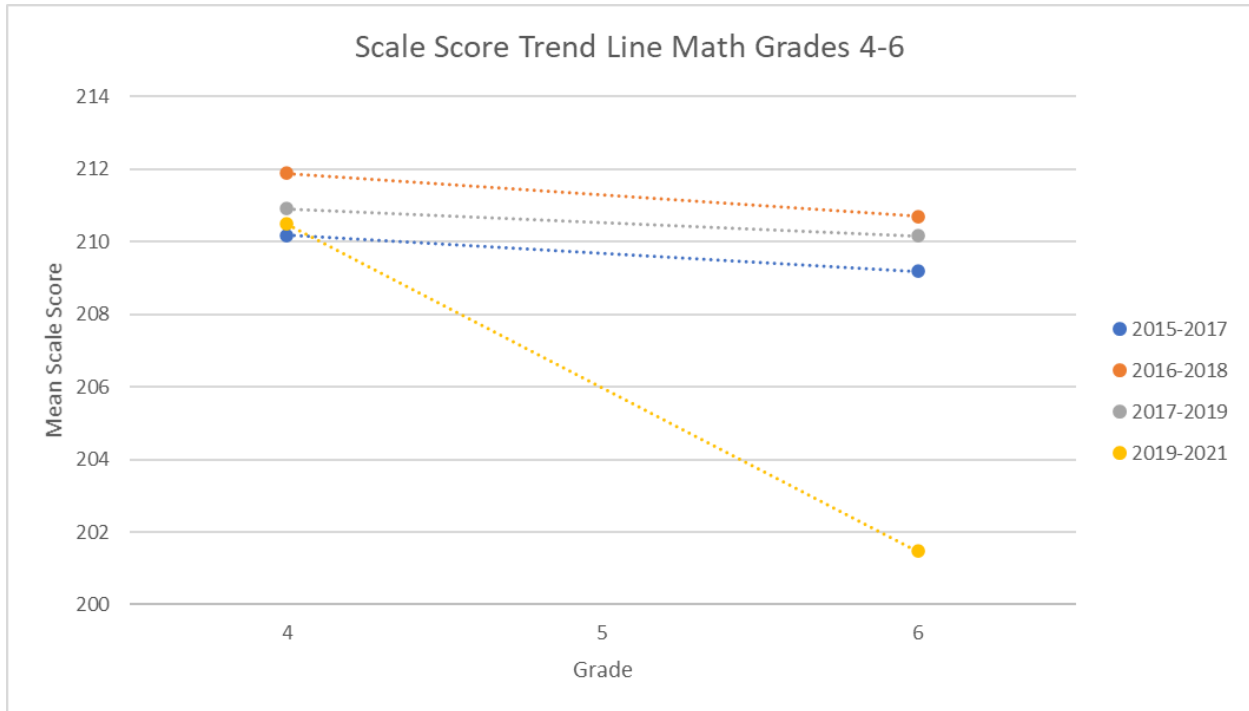
## Appendix B



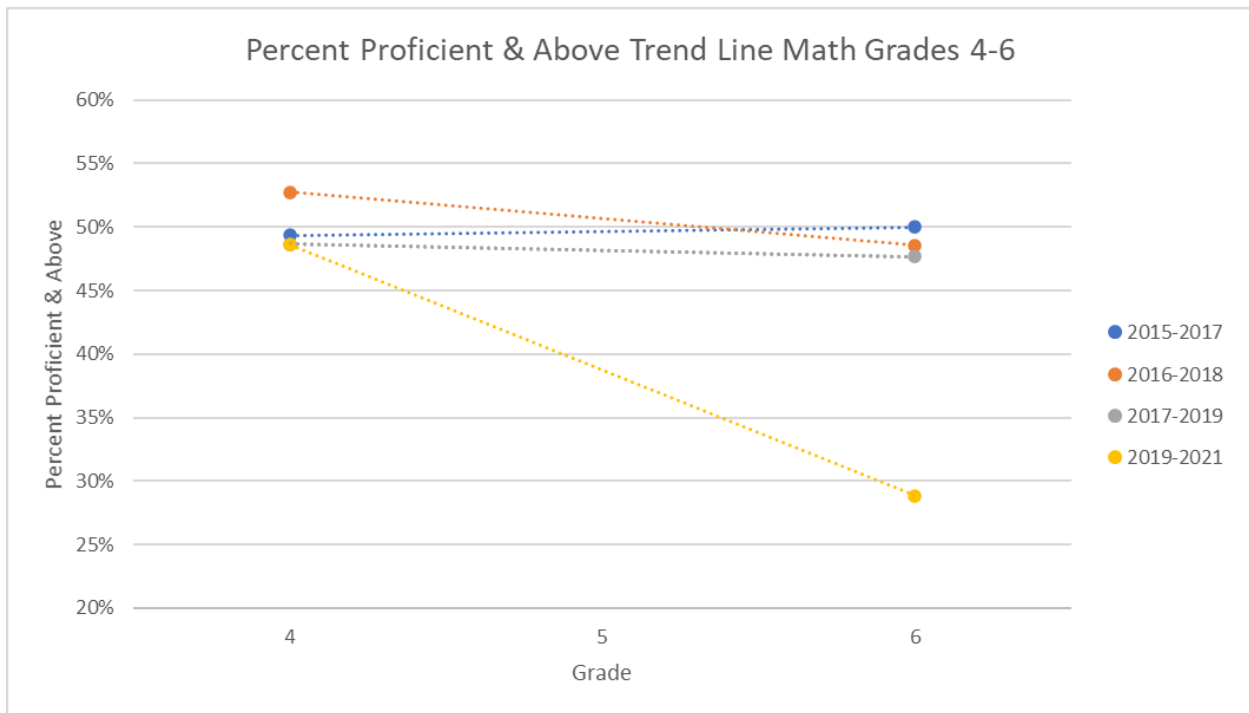
**Figure B-1. State level mathematics grade 3-5 cohort proficiency trendlines**



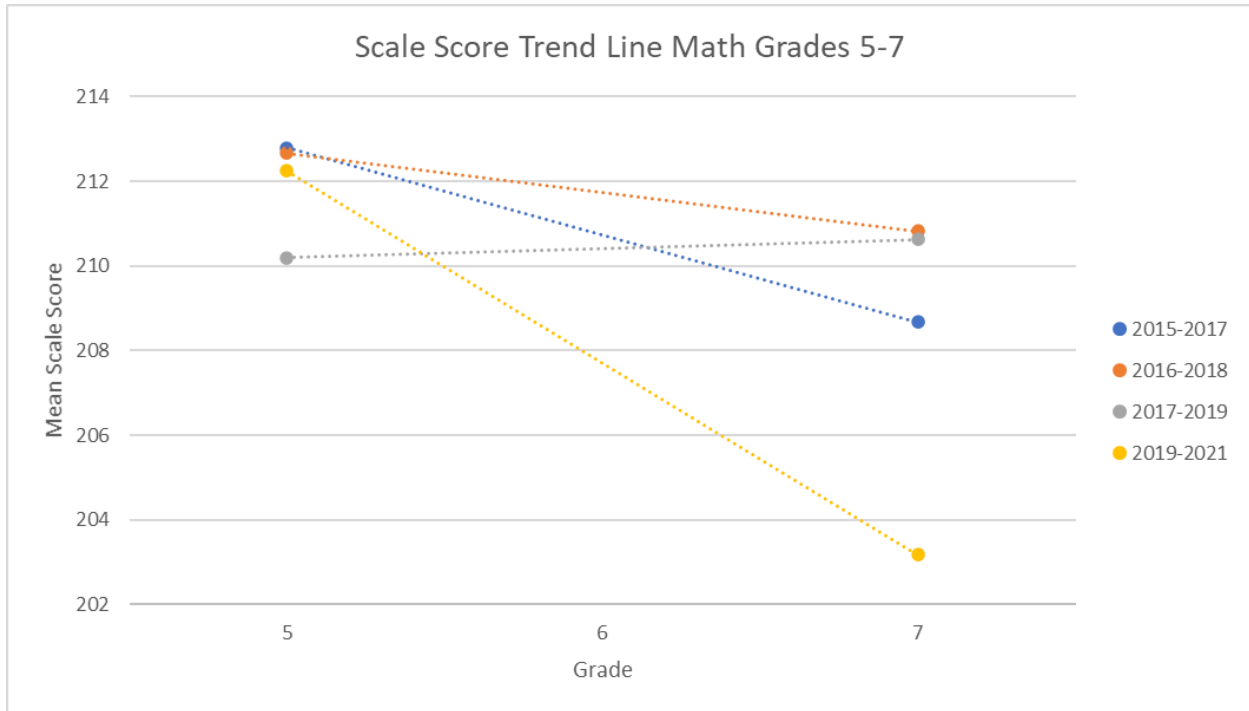
**Figure B-2. State level mathematics grade 3-5 cohort proficient and above trendlines**



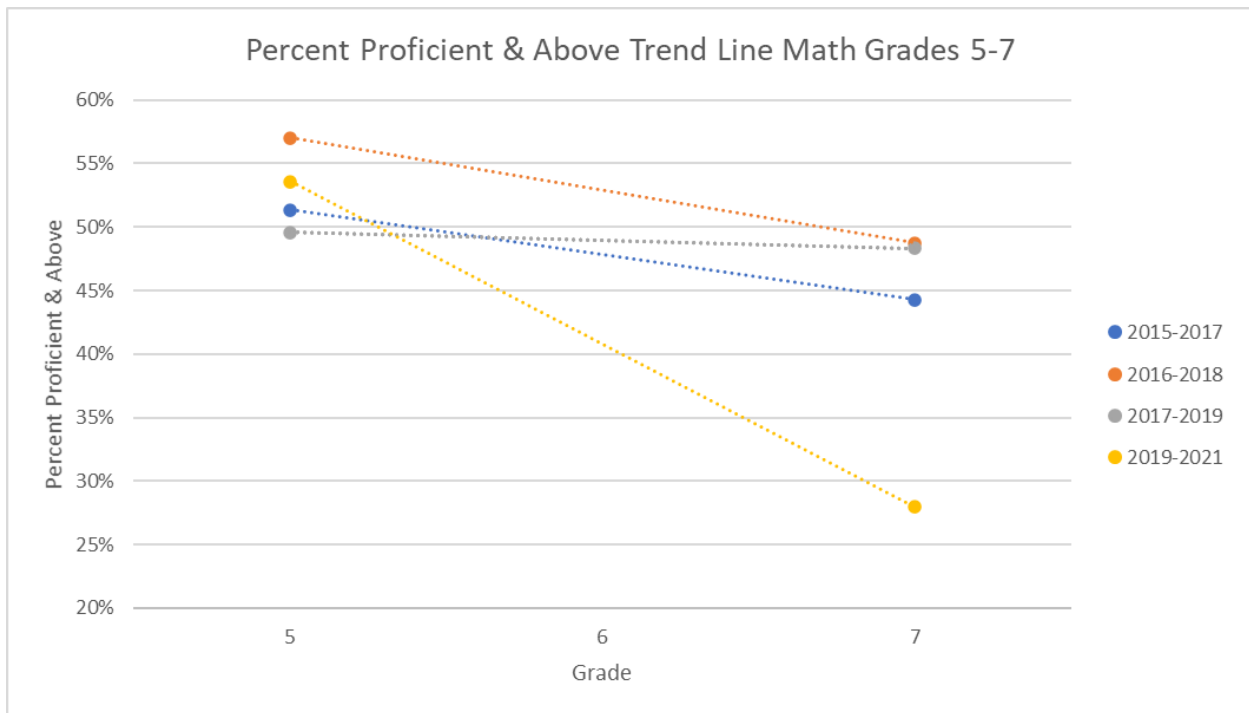
**Figure B-3. State level mathematics grade 4-6 cohort proficiency trendlines**



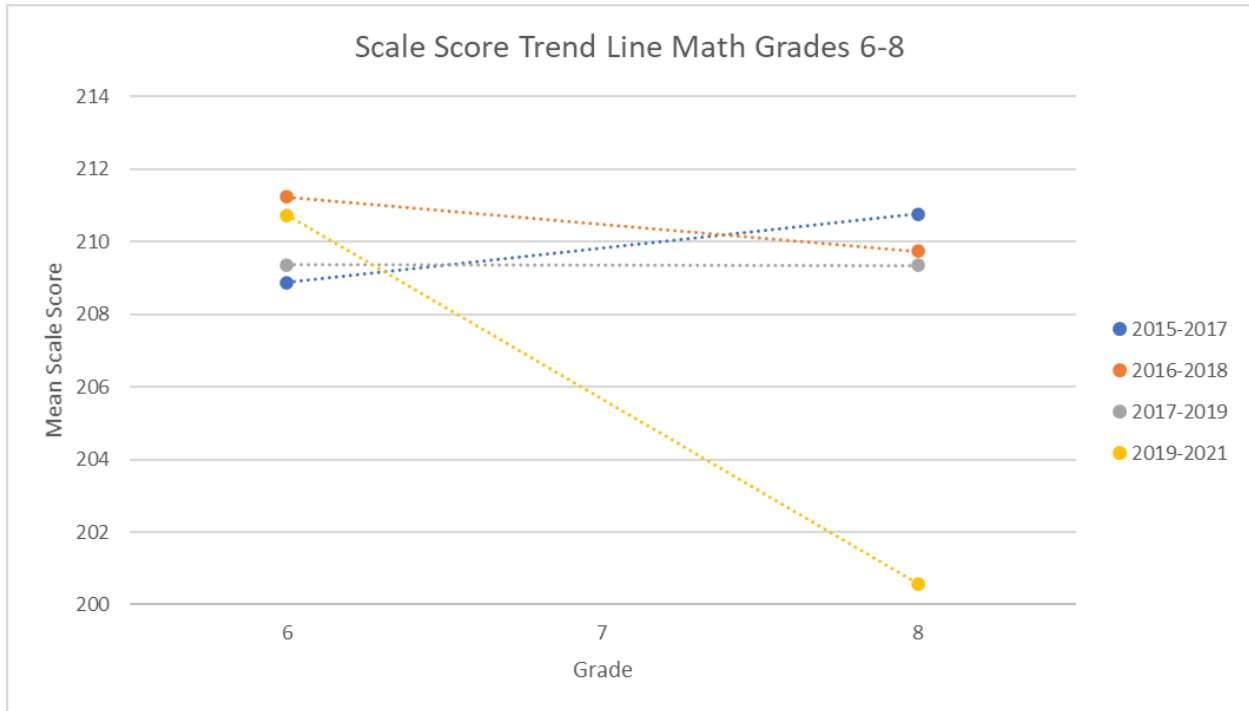
**Figure B-4. State level mathematics grade 4-6 cohort proficient and above trendlines**



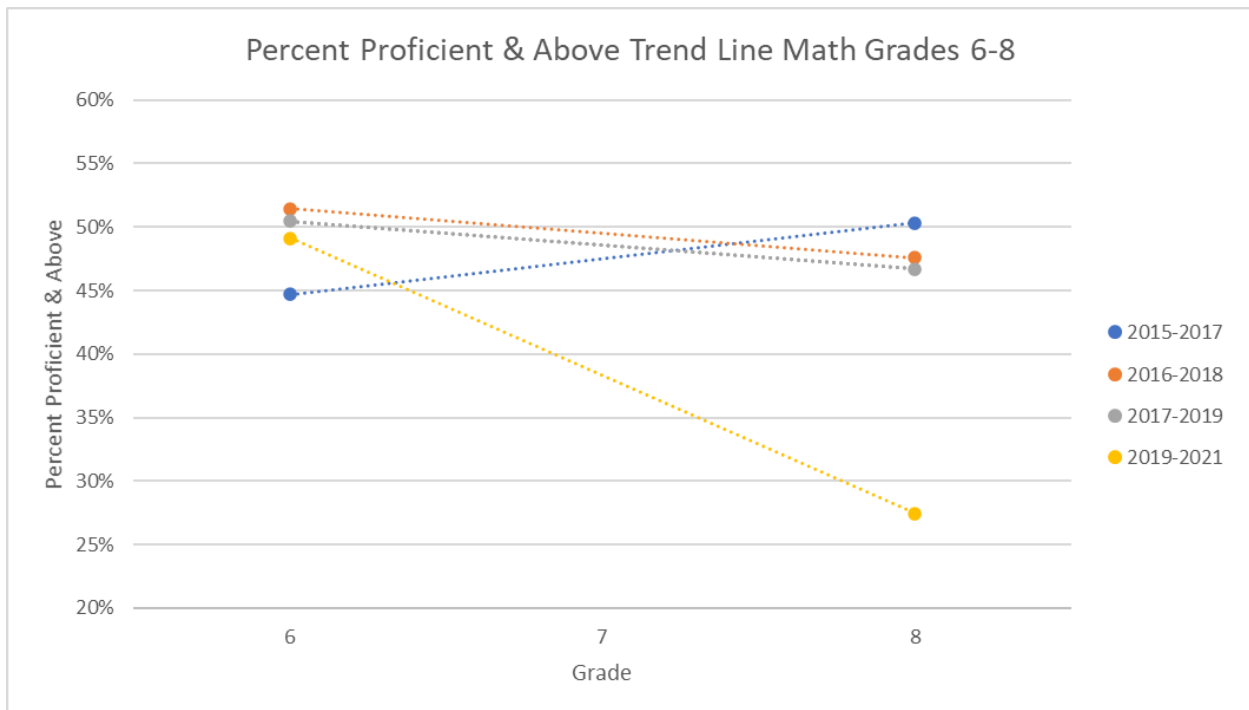
**Figure B-5. State level mathematics grade 5-7 cohort proficiency trendlines**



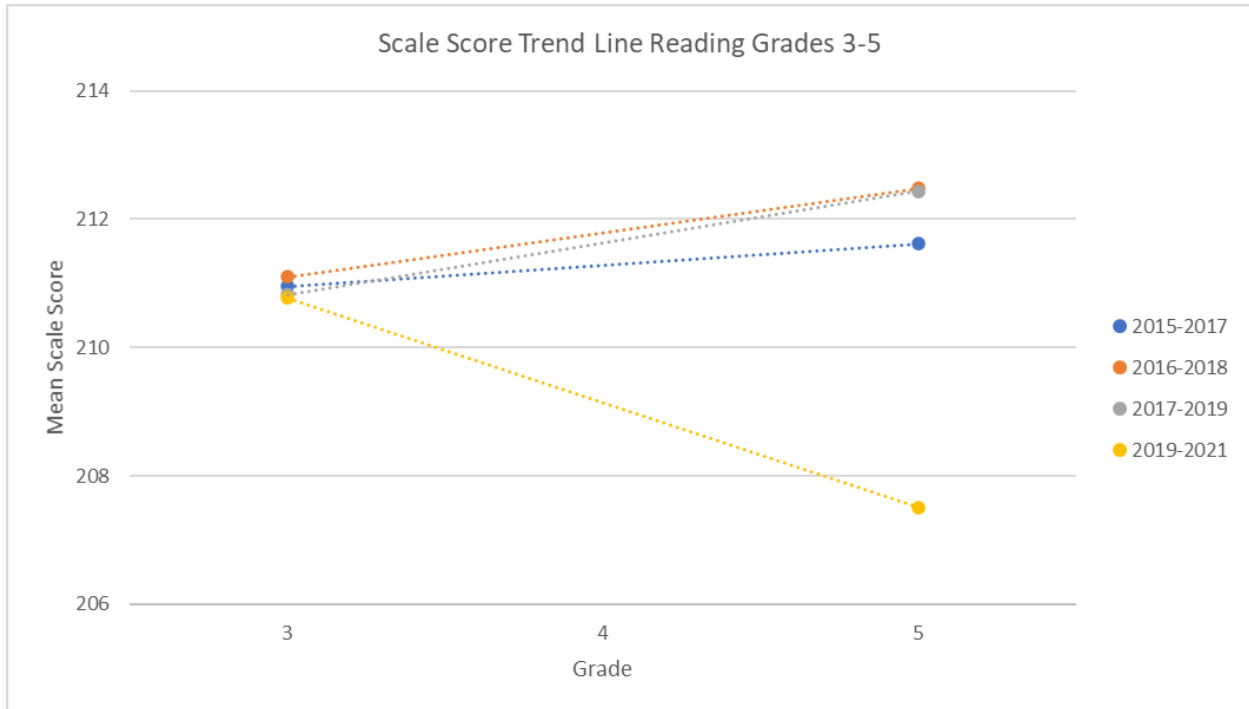
**Figure B-6. State level mathematics grade 5-7 cohort proficient and above trendlines**



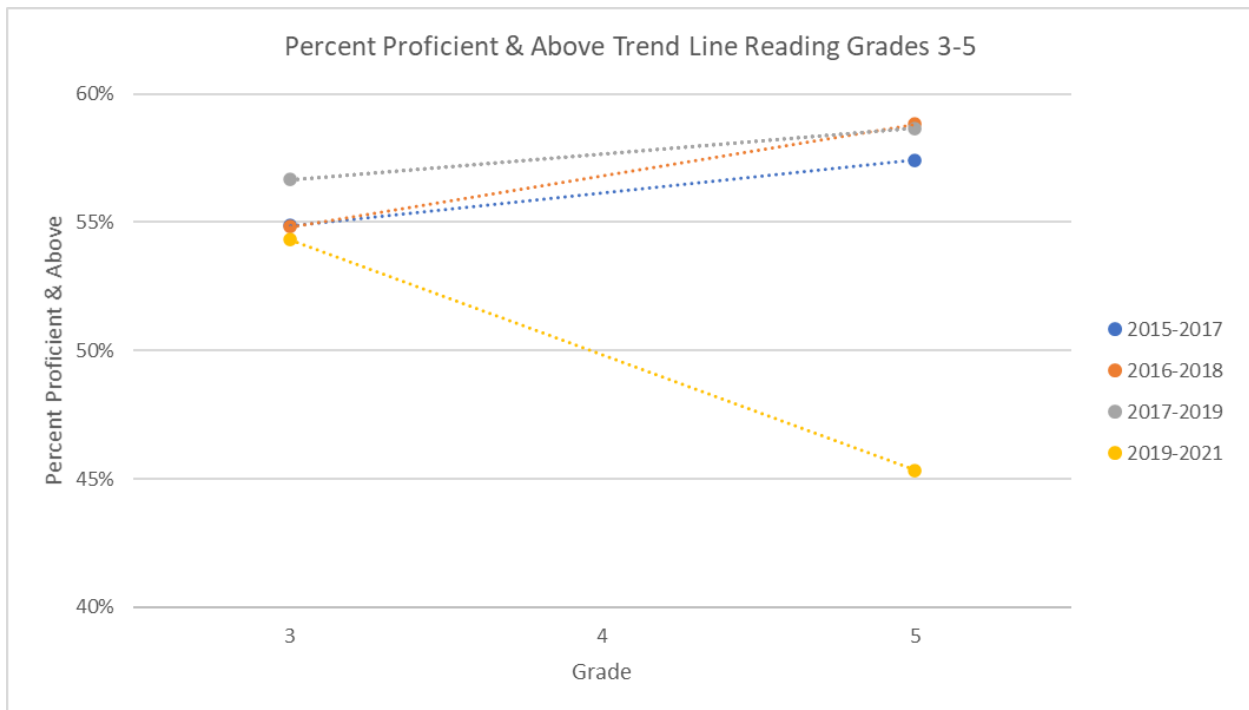
**Figure B-7. State level mathematics grade 6-8 cohort proficiency trendlines**



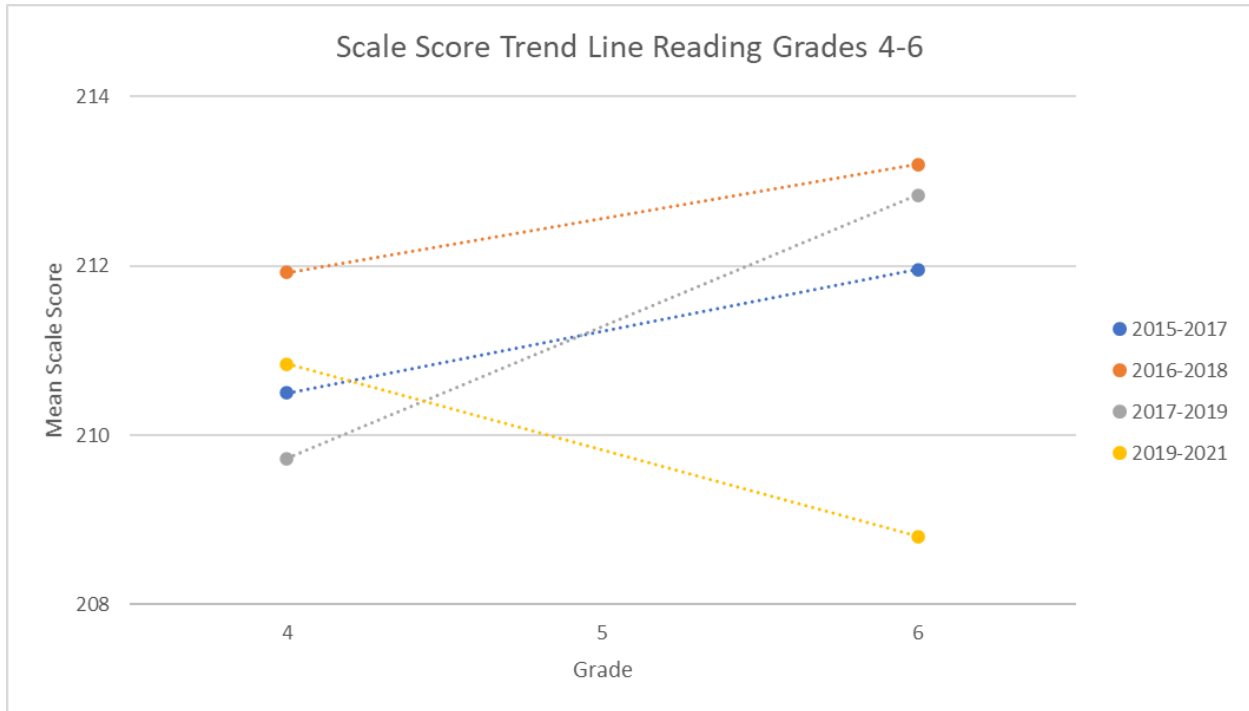
**Figure B-8. State level mathematics grade 6-8 cohort proficient and above trendlines**



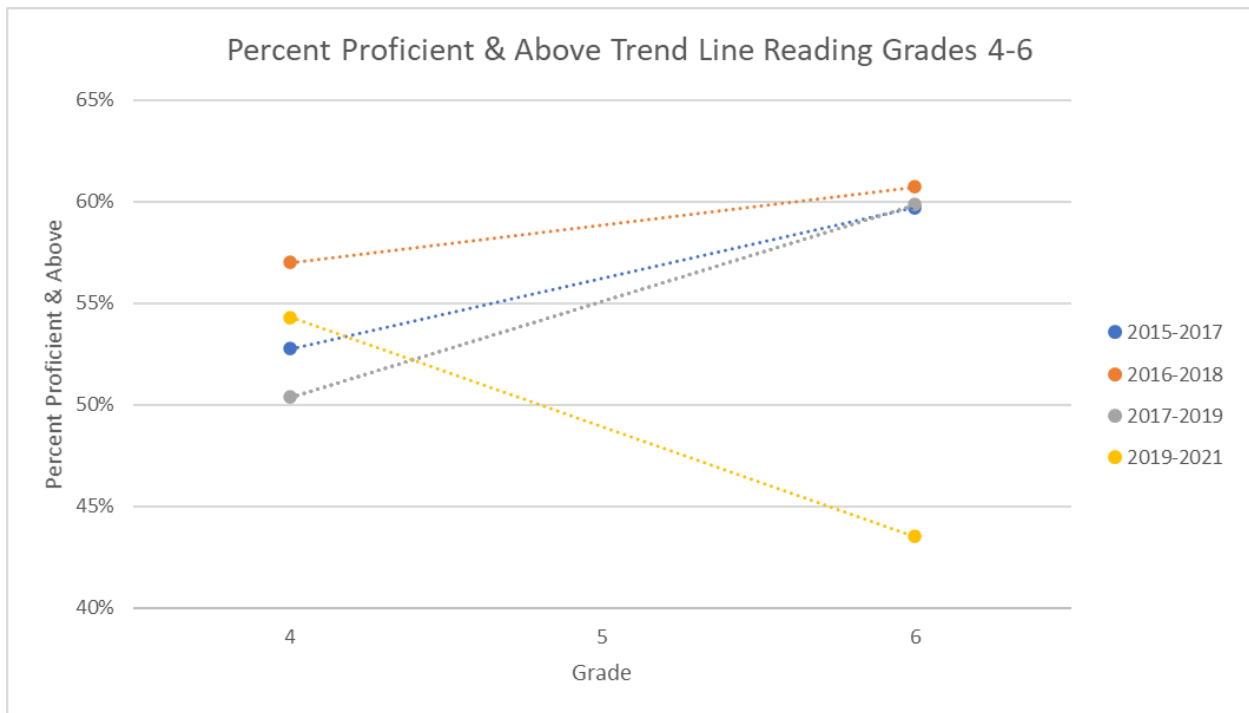
**Figure B-9. State level reading grade 3-5 cohort proficiency trendlines**



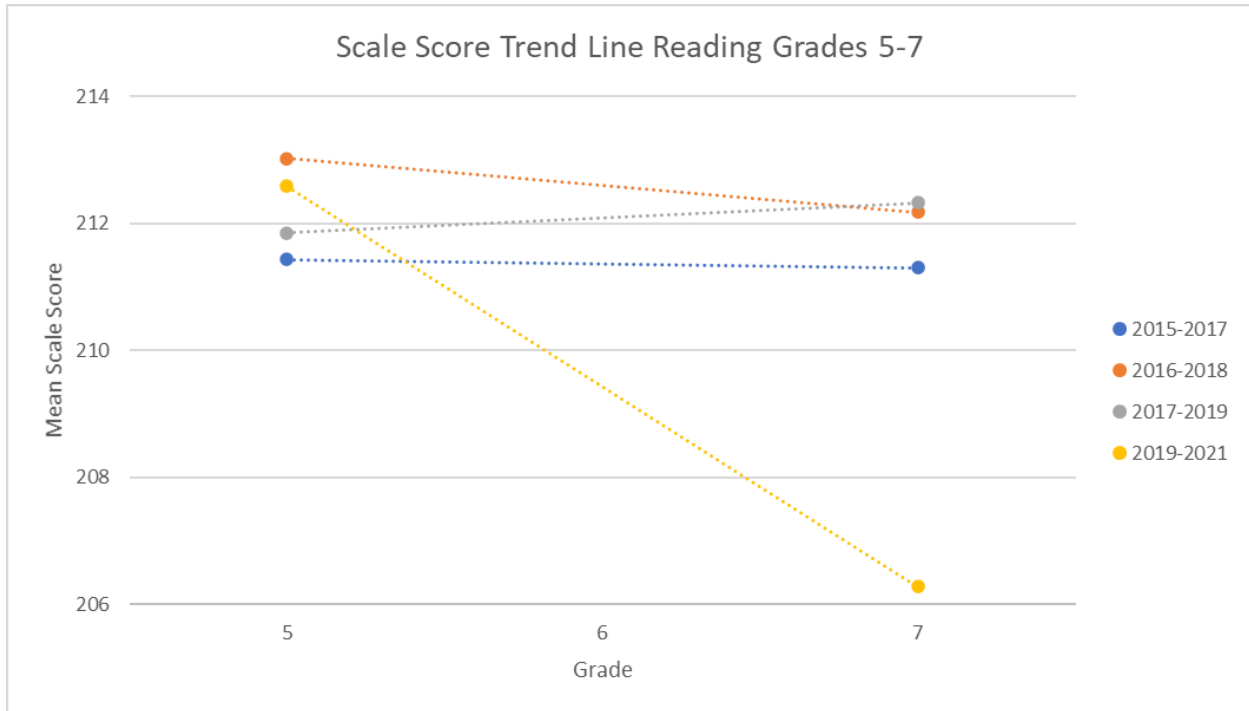
**Figure B-10. State level reading grade 3-5 cohort proficient and above trendlines**



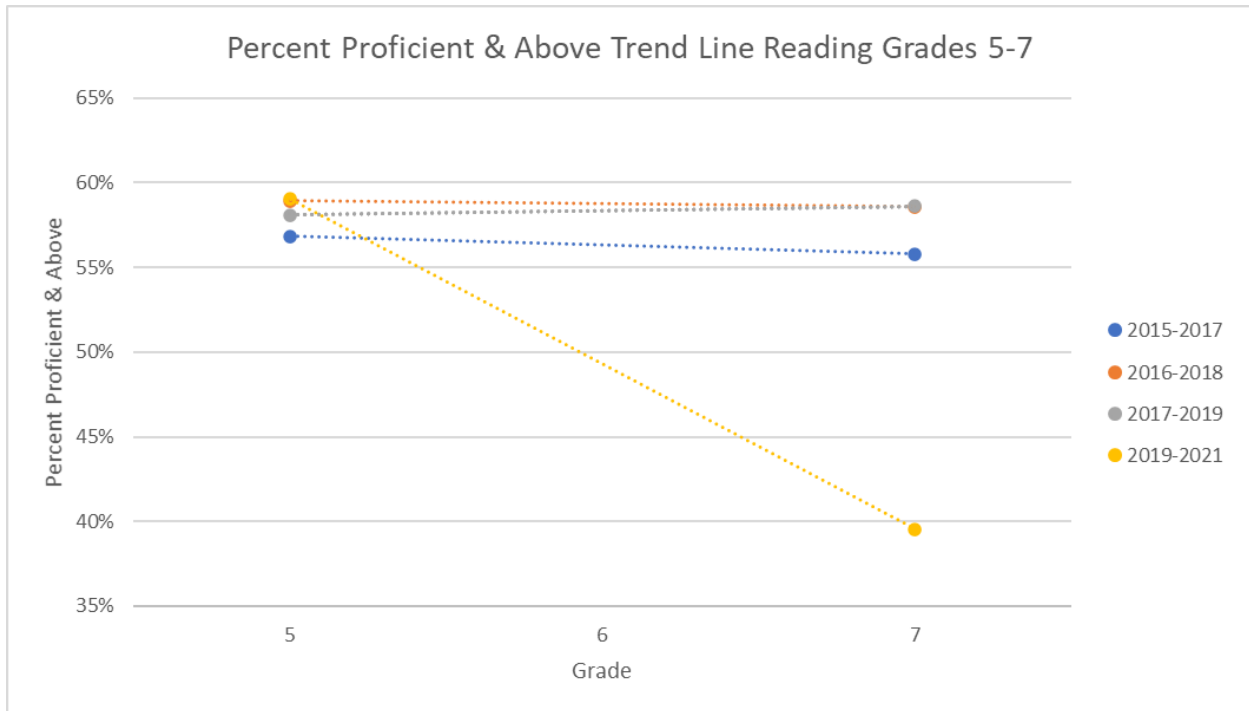
**Figure B-11. State level reading grade 4-6 cohort proficiency trendlines**



**Figure B-12. State level reading grade 4-6 cohort proficient and above trendlines**

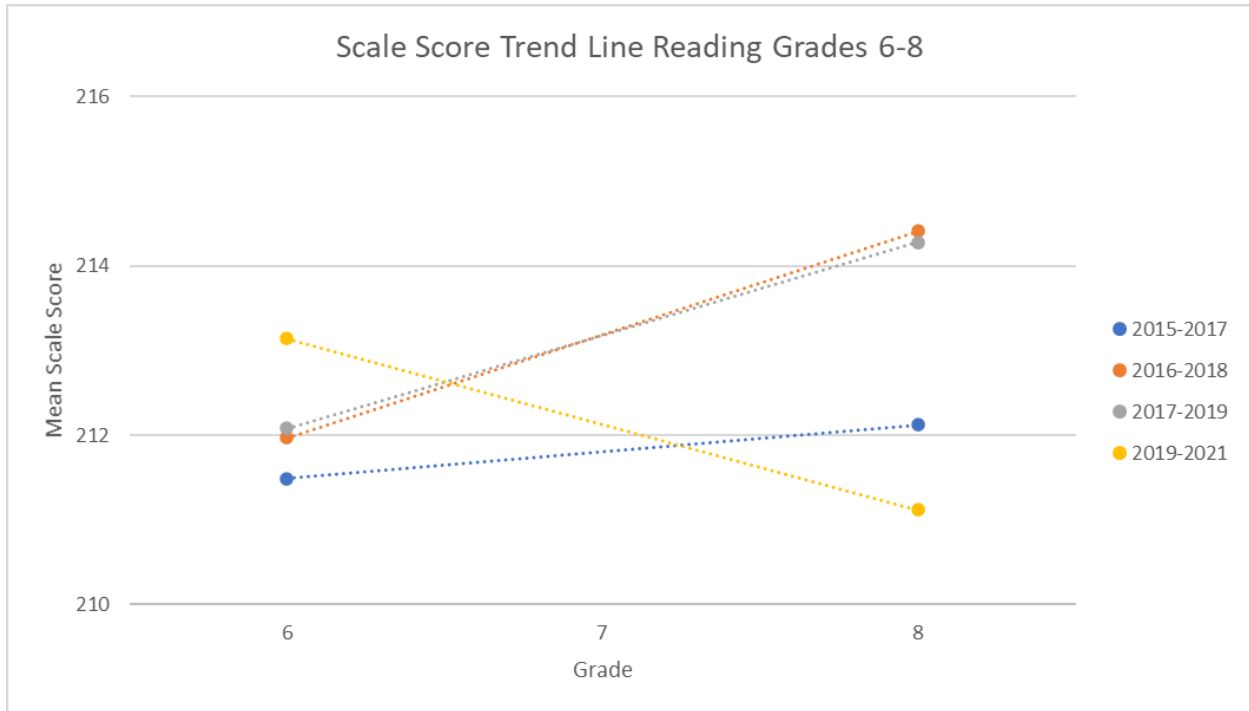


**Figure B-13. State level reading grade 5-7 cohort proficiency trendlines**

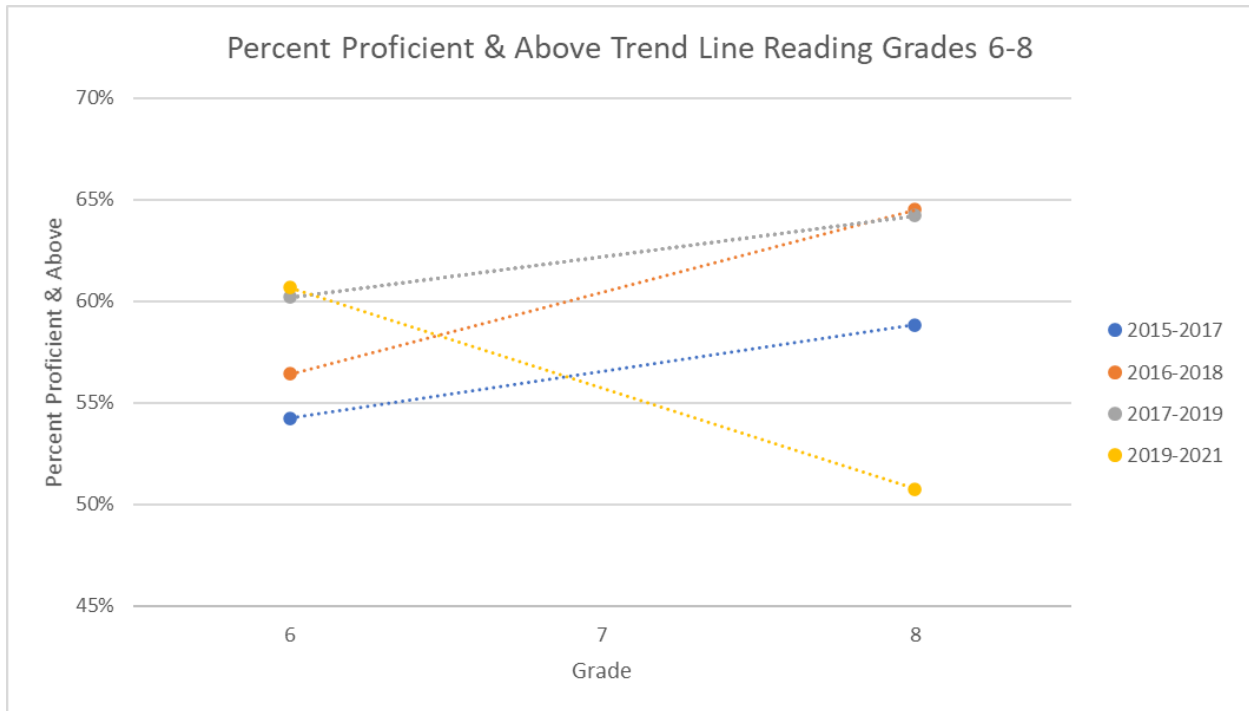


**Figure B-14. State level reading grade 5-7 cohort proficient and above trendlines**



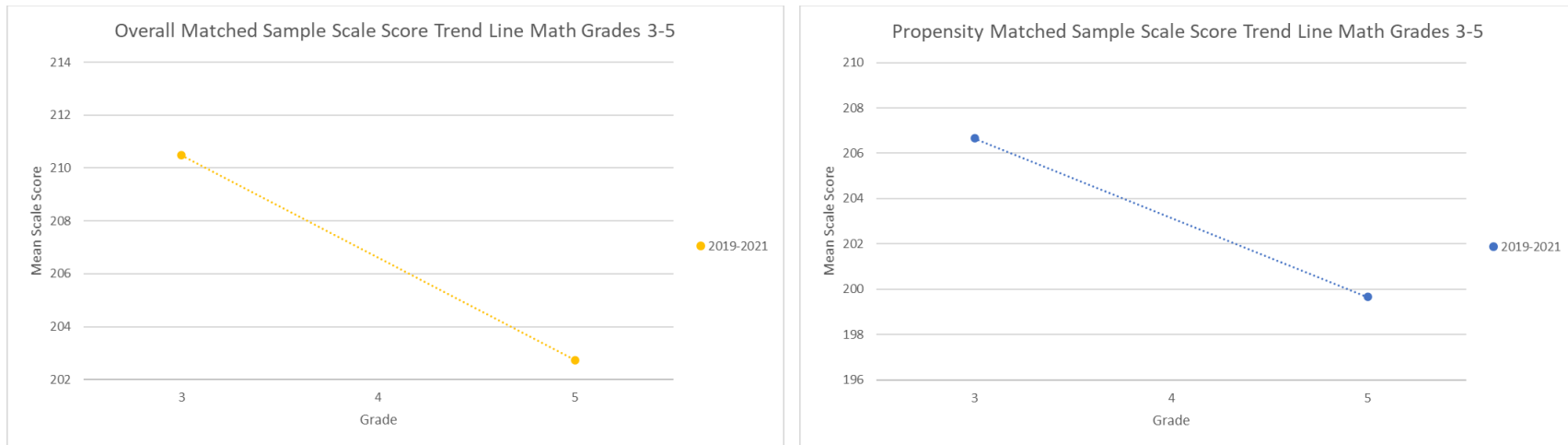


**Figure B-15. State level reading grade 6-8 cohort proficiency trendlines**

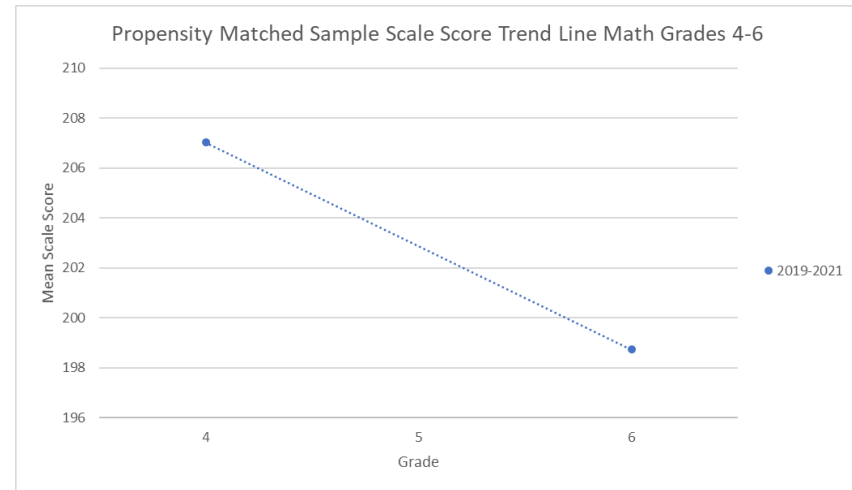
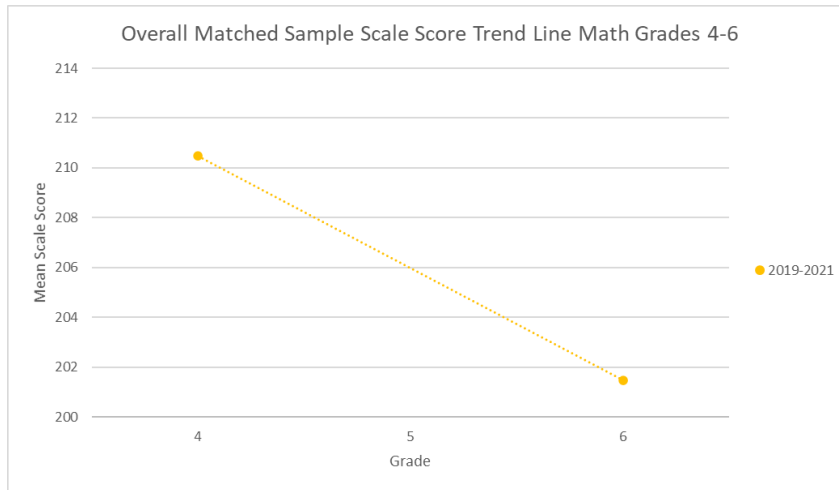


**Figure B-16. State level reading grade 6-8 cohort proficient and above trendlines**

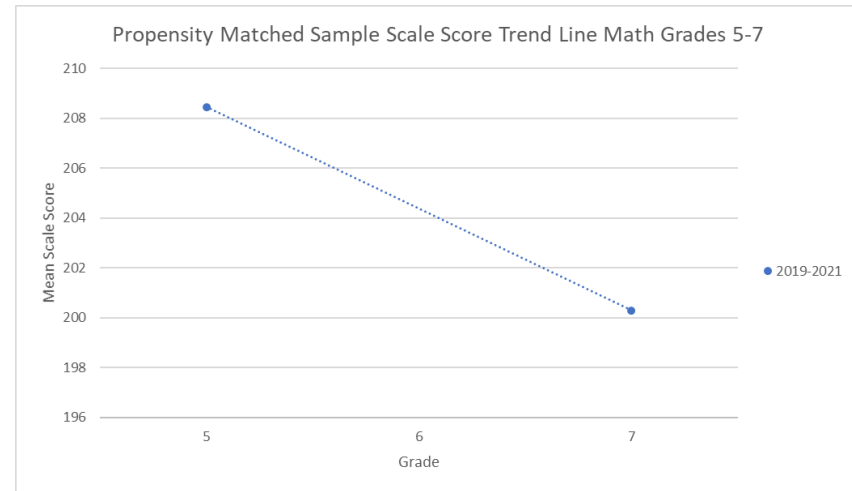
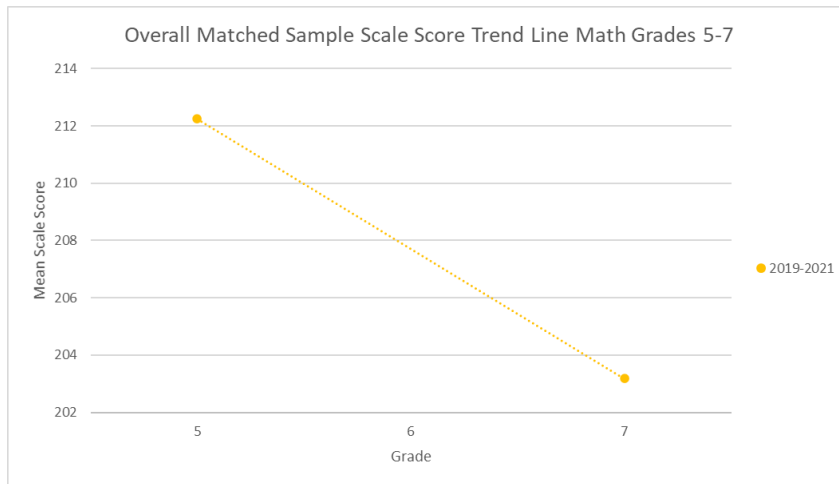
## Appendix C



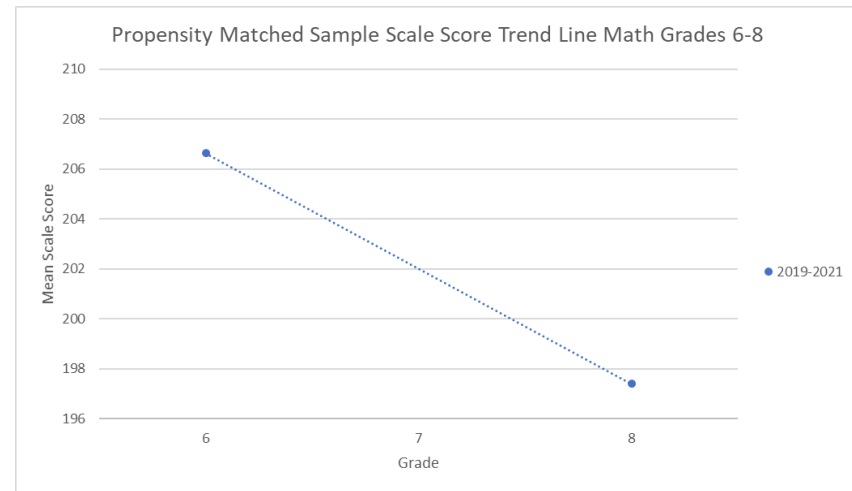
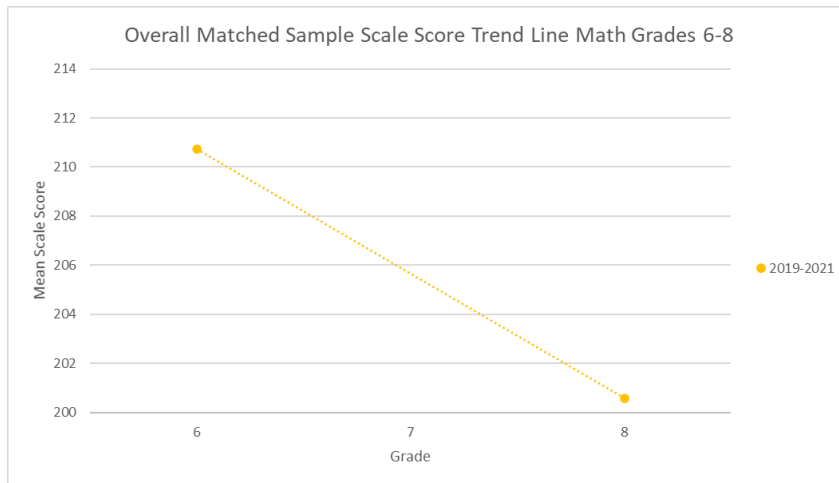
**Figure C-1. Comparison of 2019-2021 performance of propensity matched mathematics grade 3-5 cohort with full mathematics grade 3-5 cohort**



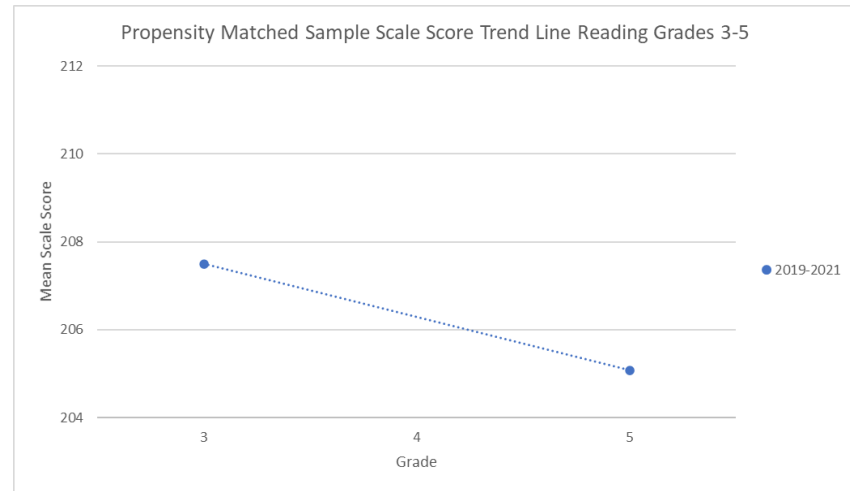
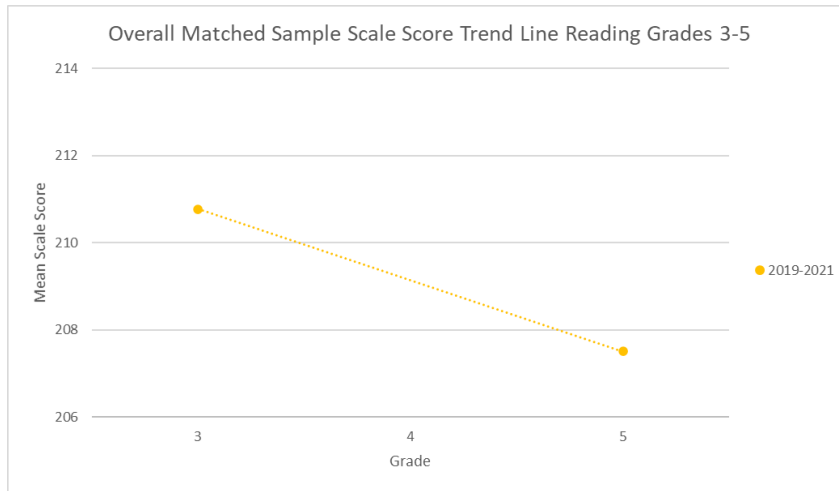
**Figure C-2. Comparison of 2019-2021 performance of propensity matched mathematics grade 4-6 cohort with full mathematics grade 4-6 cohort**



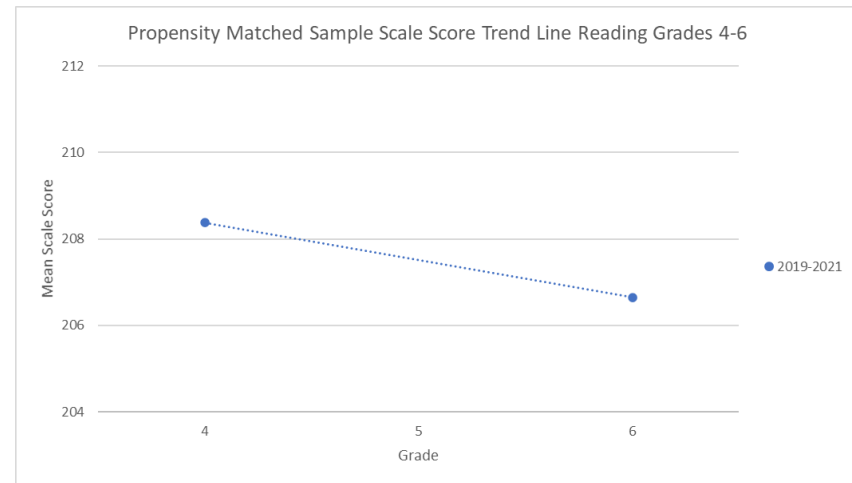
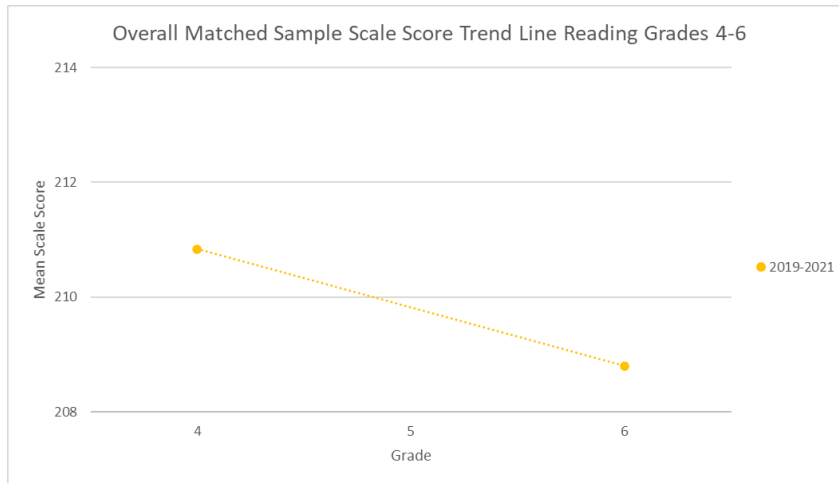
**Figure C-3. Comparison of 2019-2021 performance of propensity matched mathematics grade 5-7 cohort with full mathematics grade 5-7 cohort**



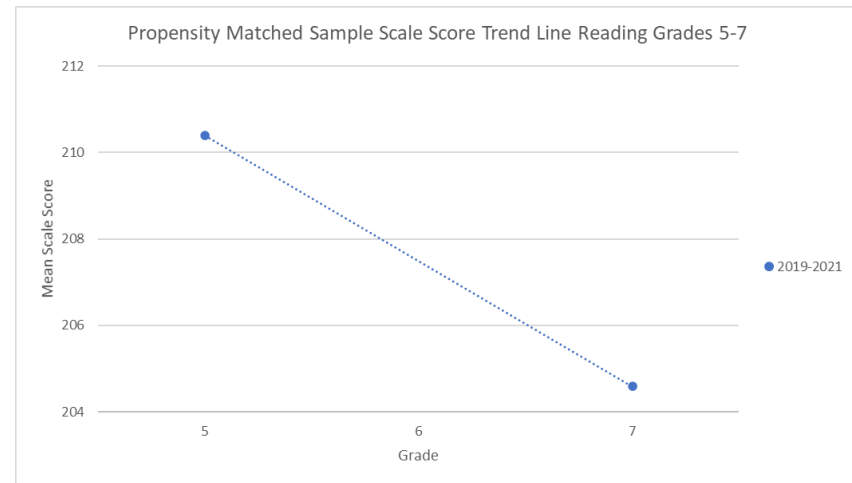
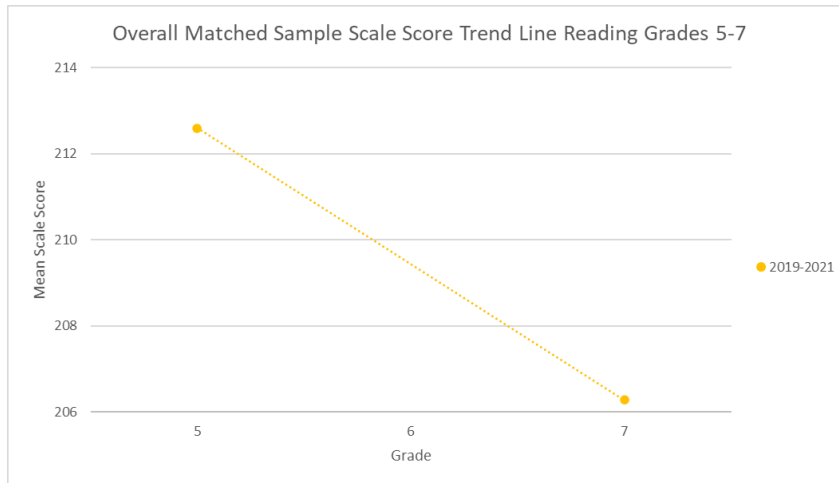
**Figure C-4. Comparison of 2019-2021 performance of propensity matched mathematics grade 6-8 cohort with full mathematics grade 6-8 cohort**



**Figure C-5. Comparison of 2019-2021 performance of propensity matched reading grade 3-5 cohort with full reading grade 3-5 cohort**

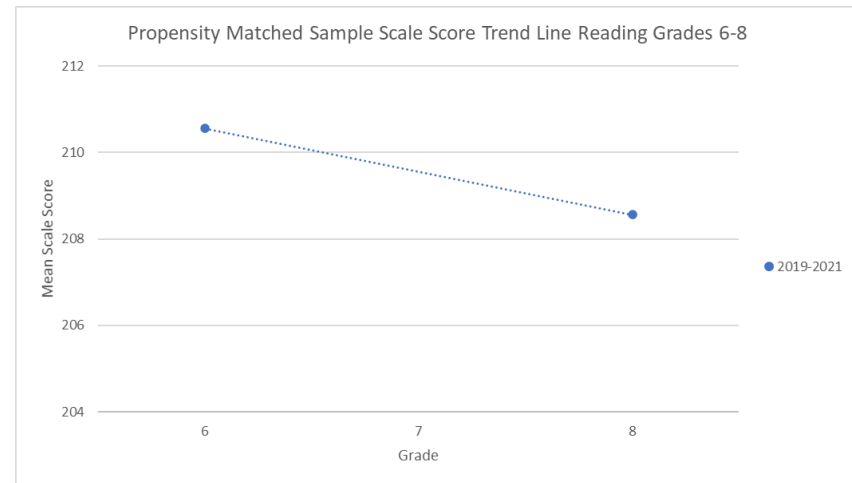
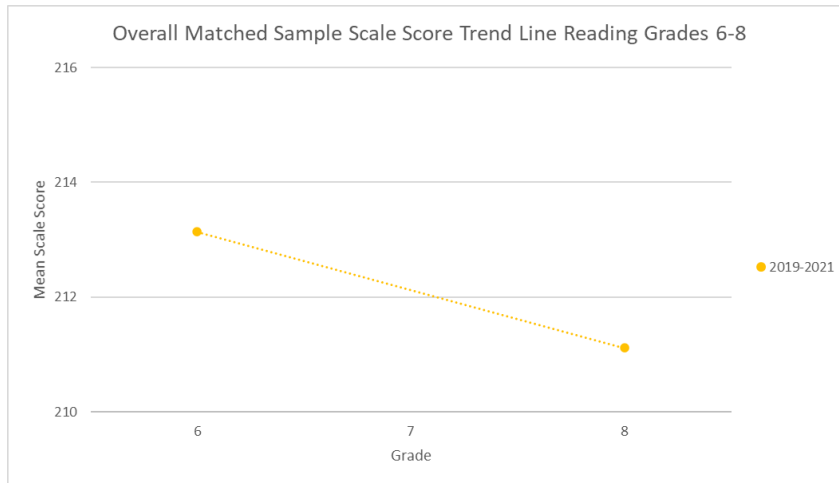


**Figure C-6. Comparison of 2019-2021 performance of propensity matched reading grade 4-6 cohort with full reading grade 4-6 cohort**



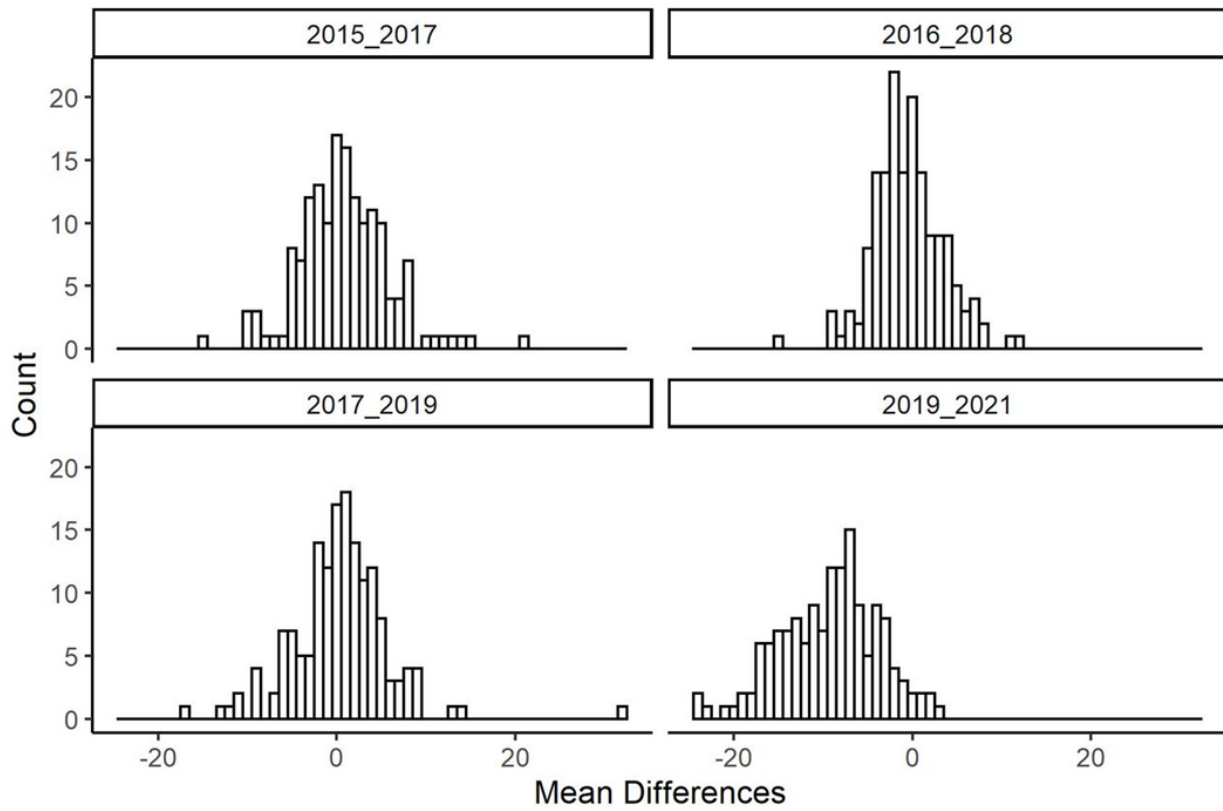
**Figure C-7. Comparison of 2019-2021 performance of propensity matched reading grade 5-7 cohort with full reading grade 5-7 cohort**



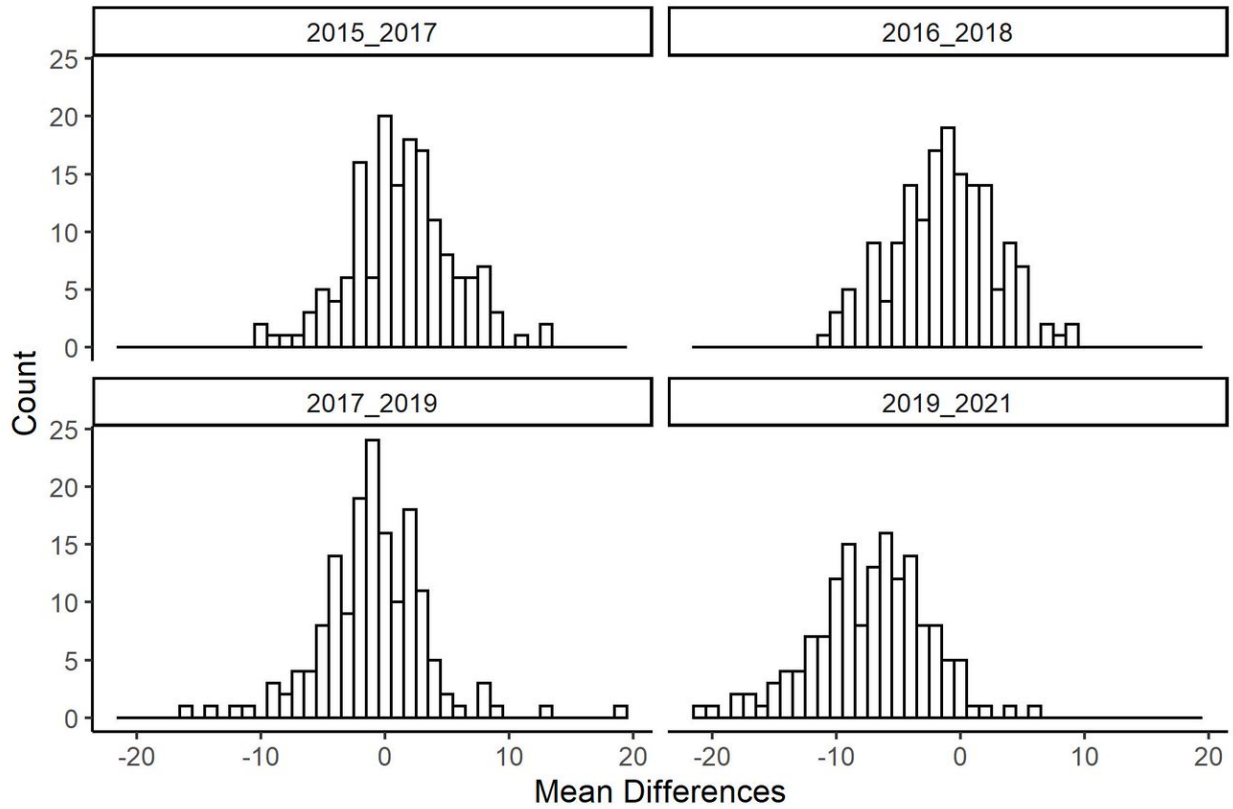


**Figure C-8. Comparison of 2019-2021 performance of propensity matched reading grade 6-8 cohort with full reading grade 6-8 cohort**

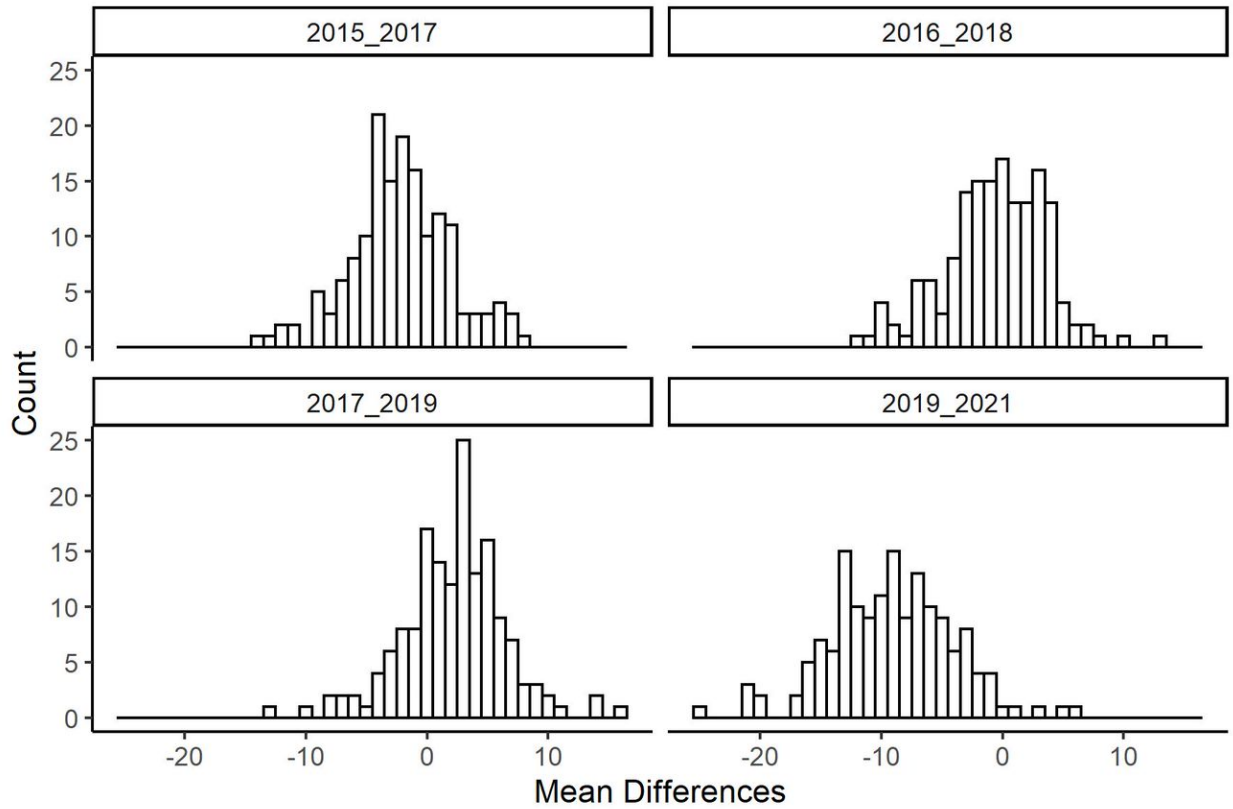
### Appendix D



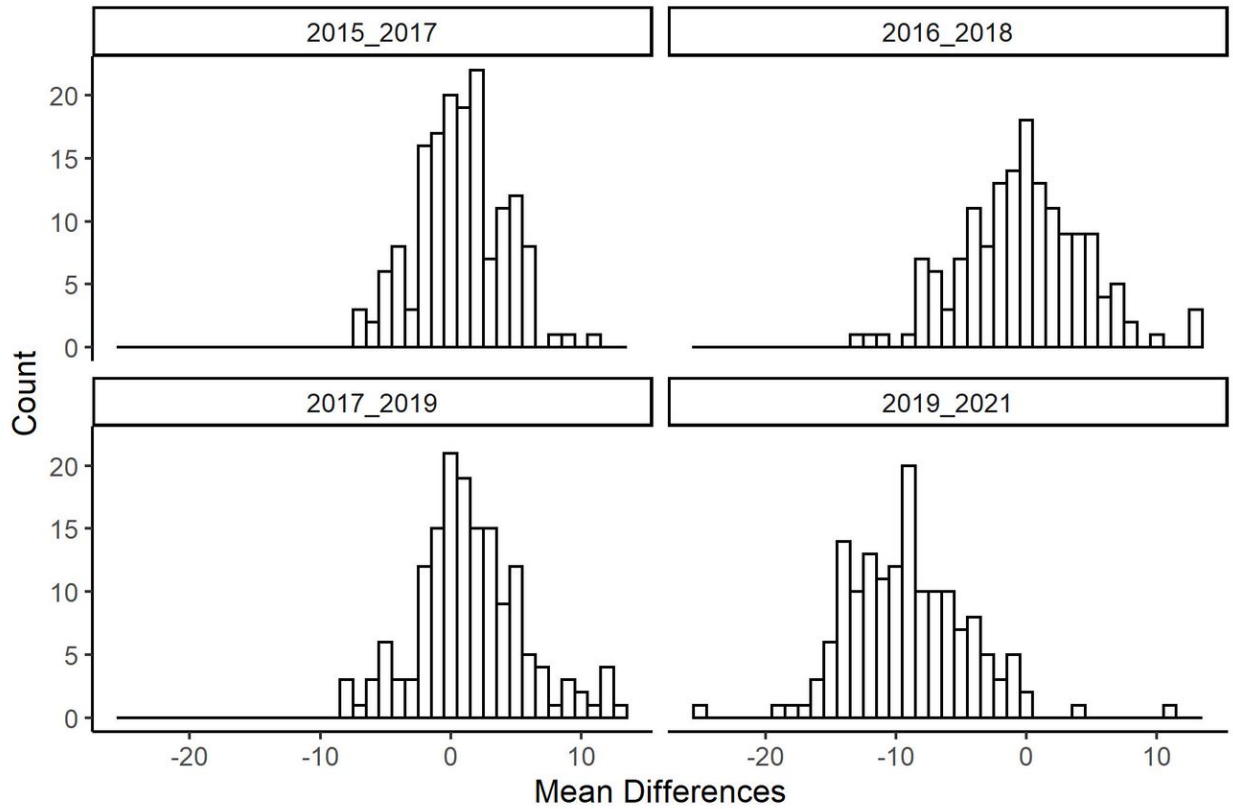
**Figure D-1. Comparison of district-level score changes: Grade 3 mathematics**



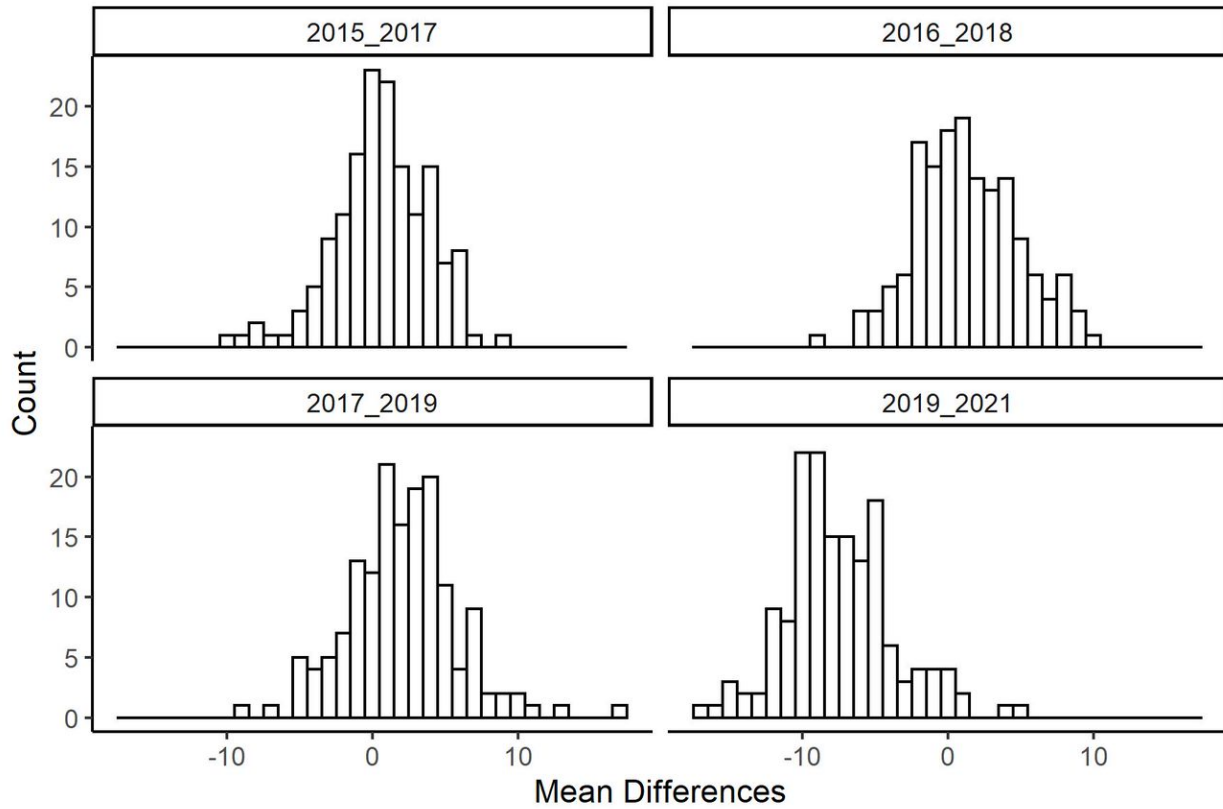
**Figure D-2. Comparison of district-level score changes: Grade 4 mathematics**



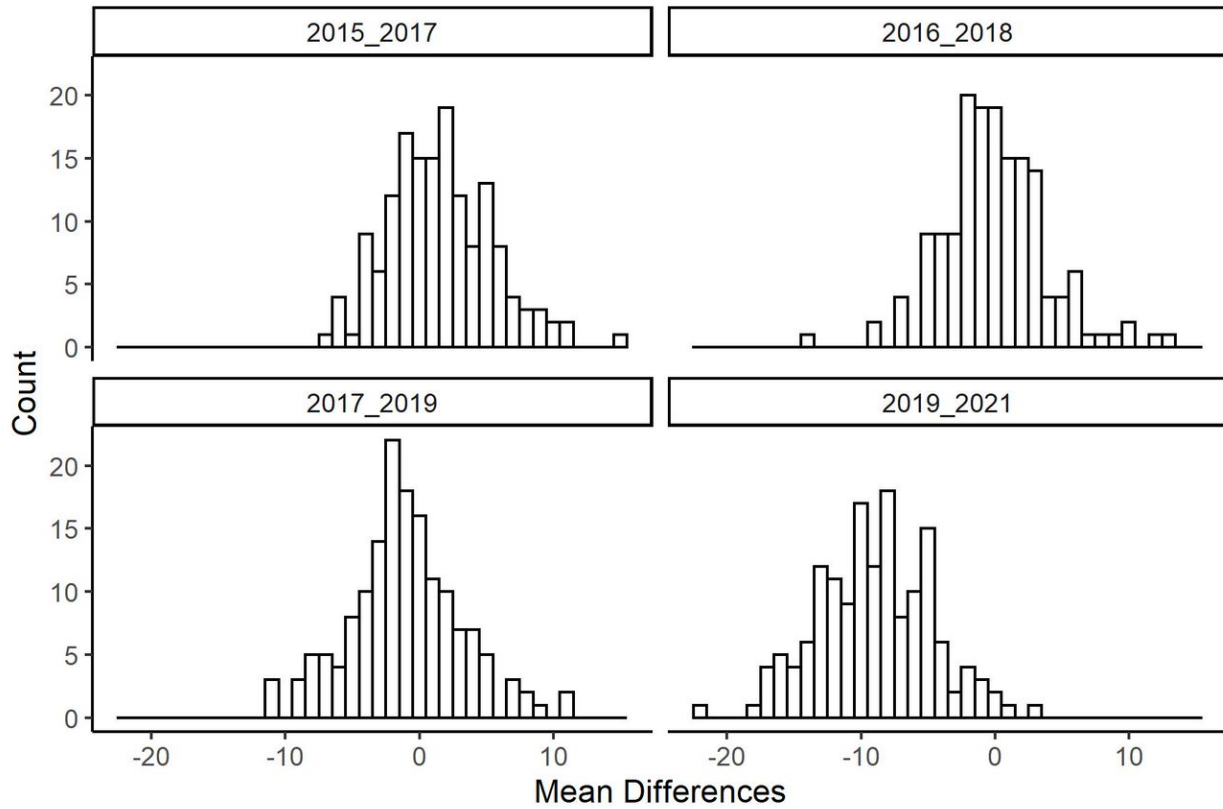
**Figure D-3. Comparison of district-level score changes: Grade 5 mathematics**



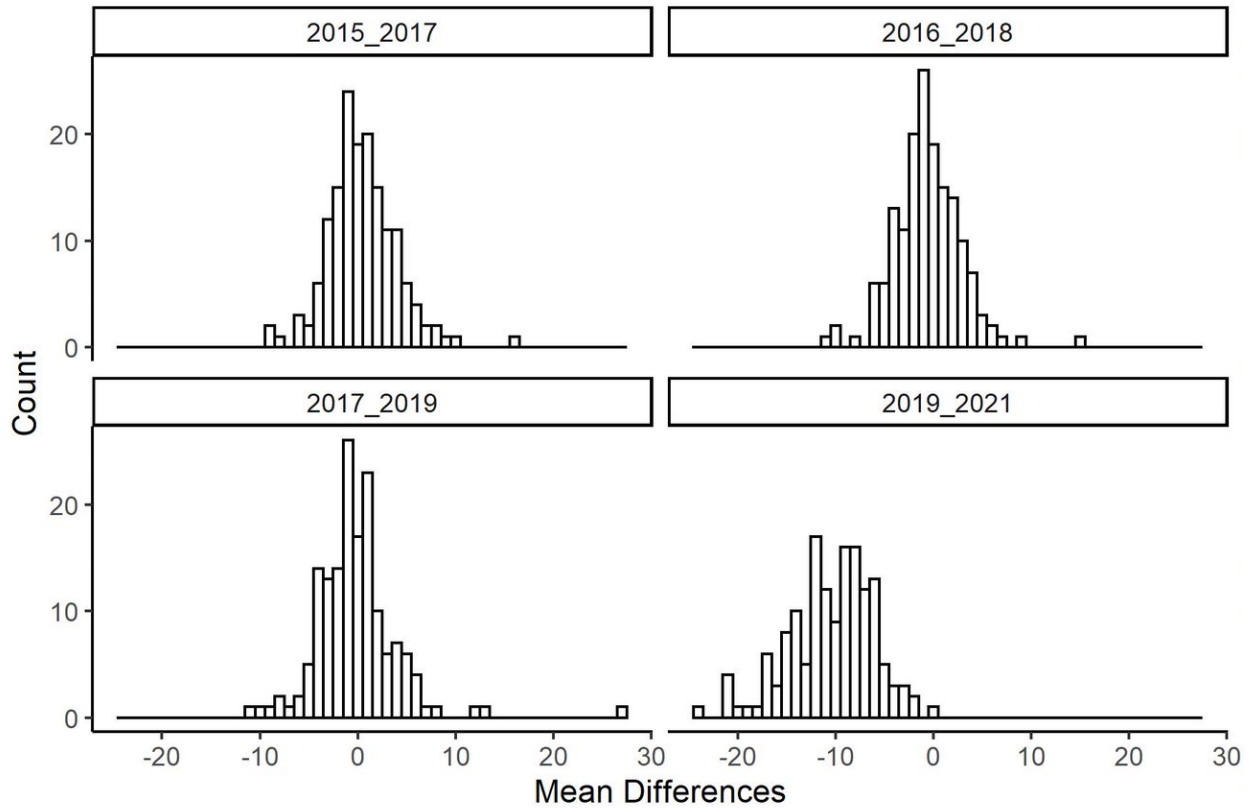
**Figure D-4. Comparison of district-level score changes: Grade 6 mathematics**



**Figure D-5. Comparison of district-level score changes: Grade 7 mathematics**

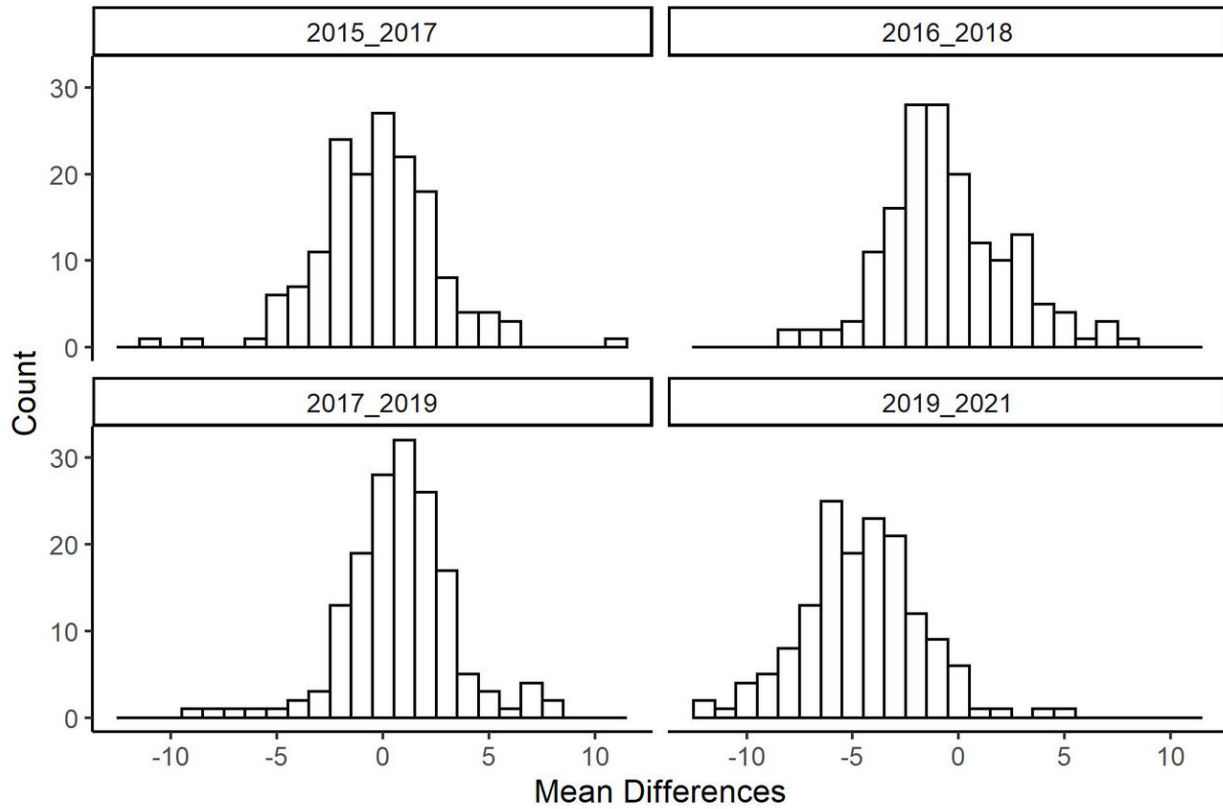


**Figure D-6. Comparison of district-level score changes: Grade 8 mathematics**

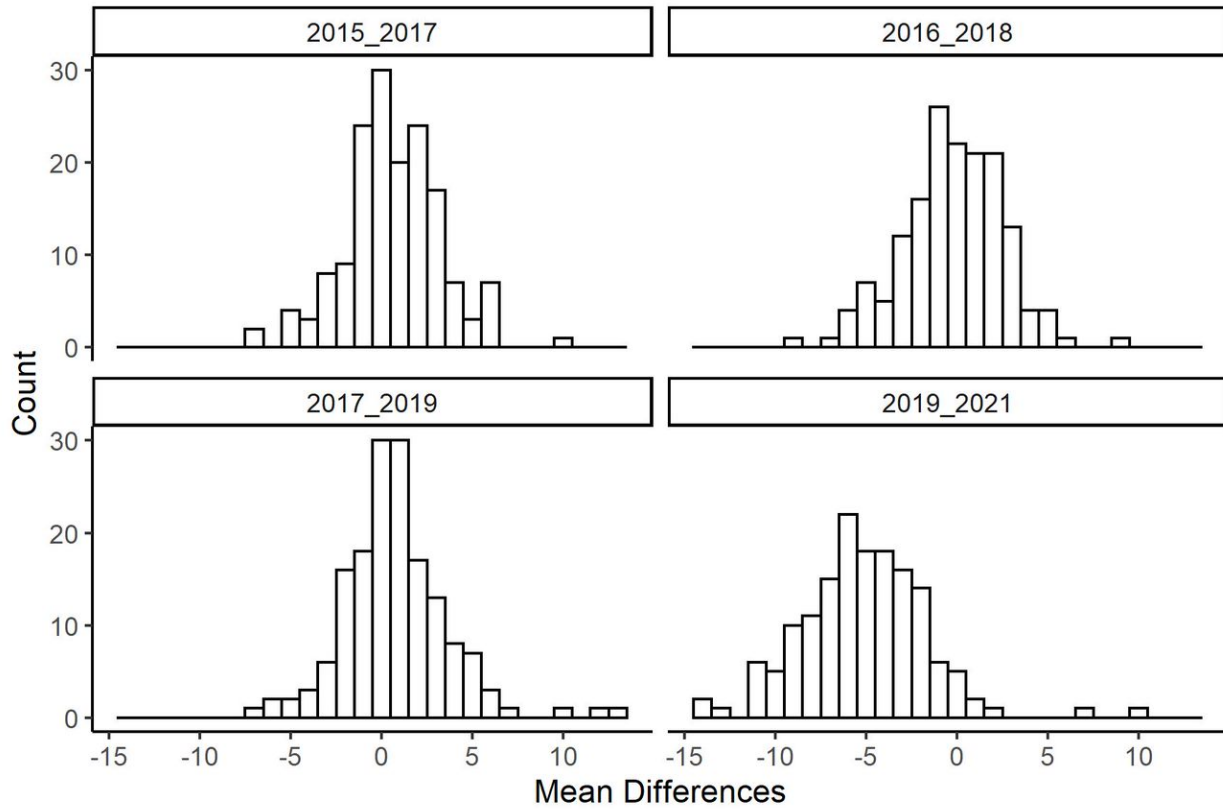


**Figure D-7. Comparison of district-level score changes: Grade 3 reading**

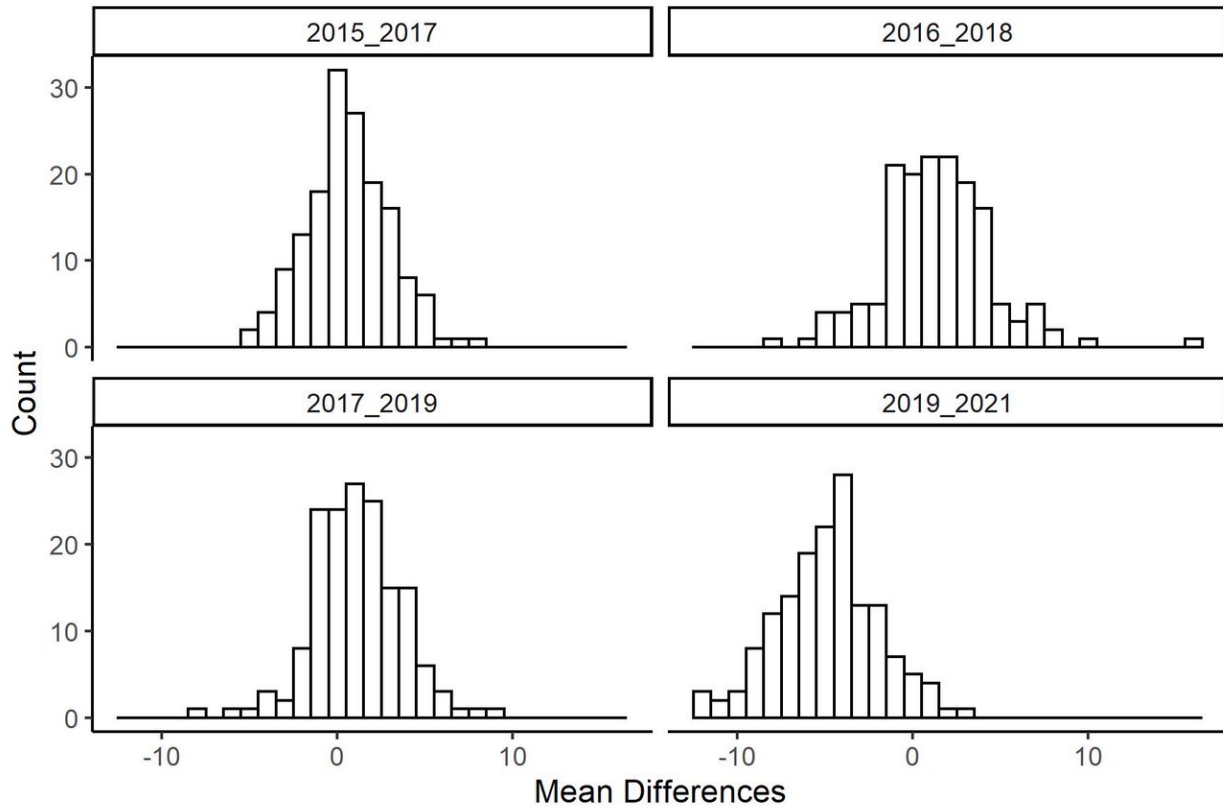




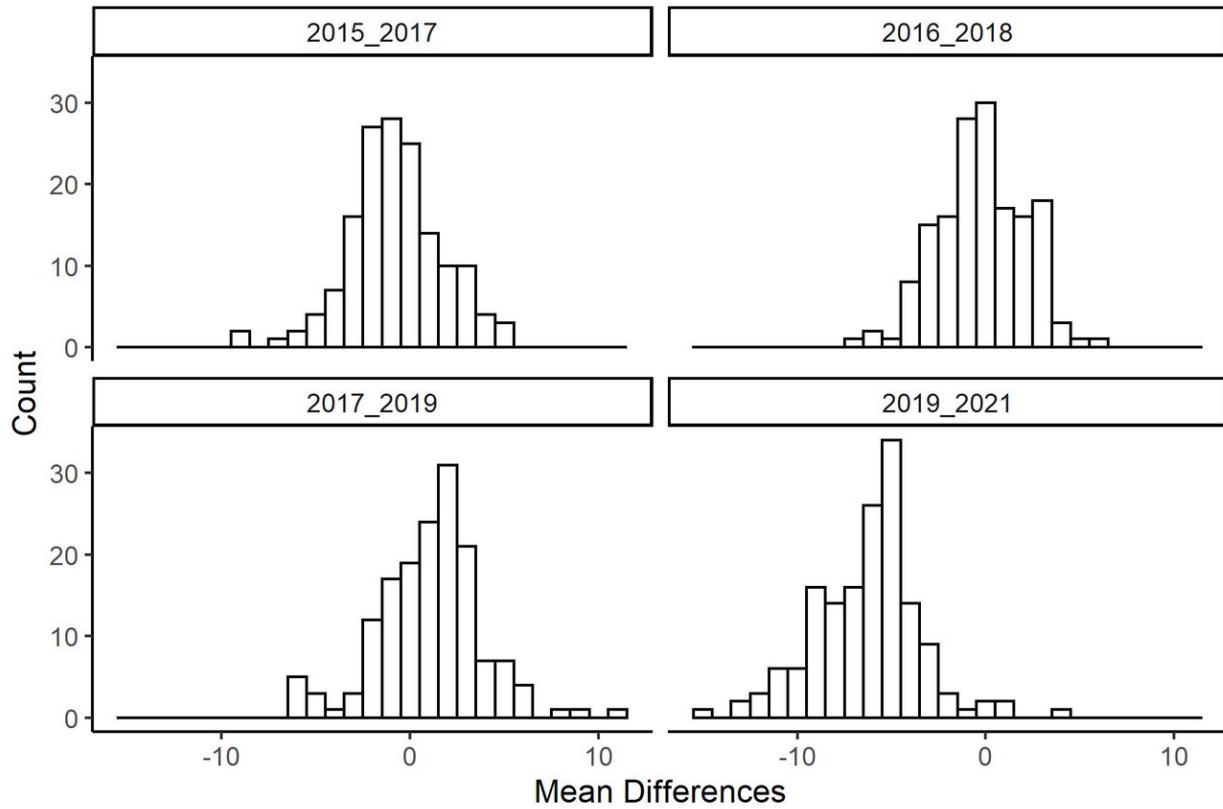
**Figure D-8. Comparison of district-level score changes: Grade 4 reading**



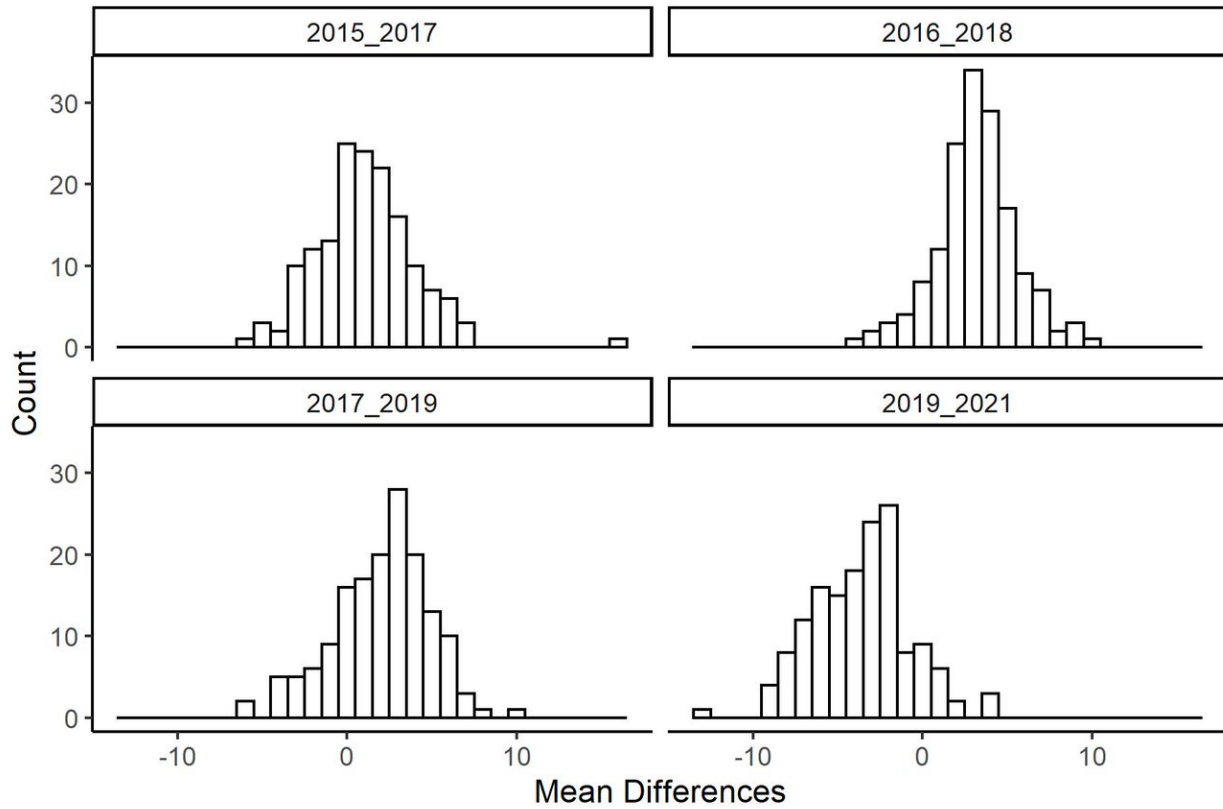
**Figure D-9. Comparison of district-level score changes: Grade 5 reading**



**Figure D-10. Comparison of district-level score changes: Grade 6 reading**

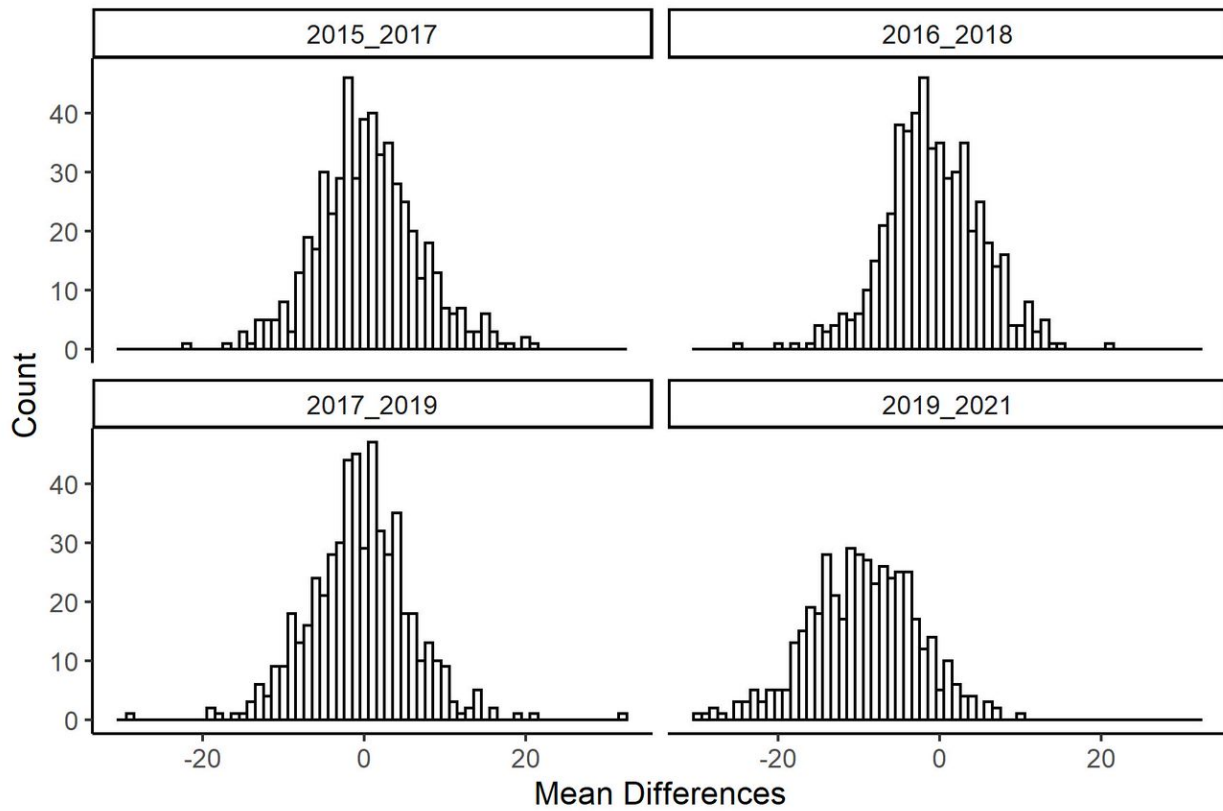


**Figure D-11. Comparison of district-level score changes: Grade 7 reading**

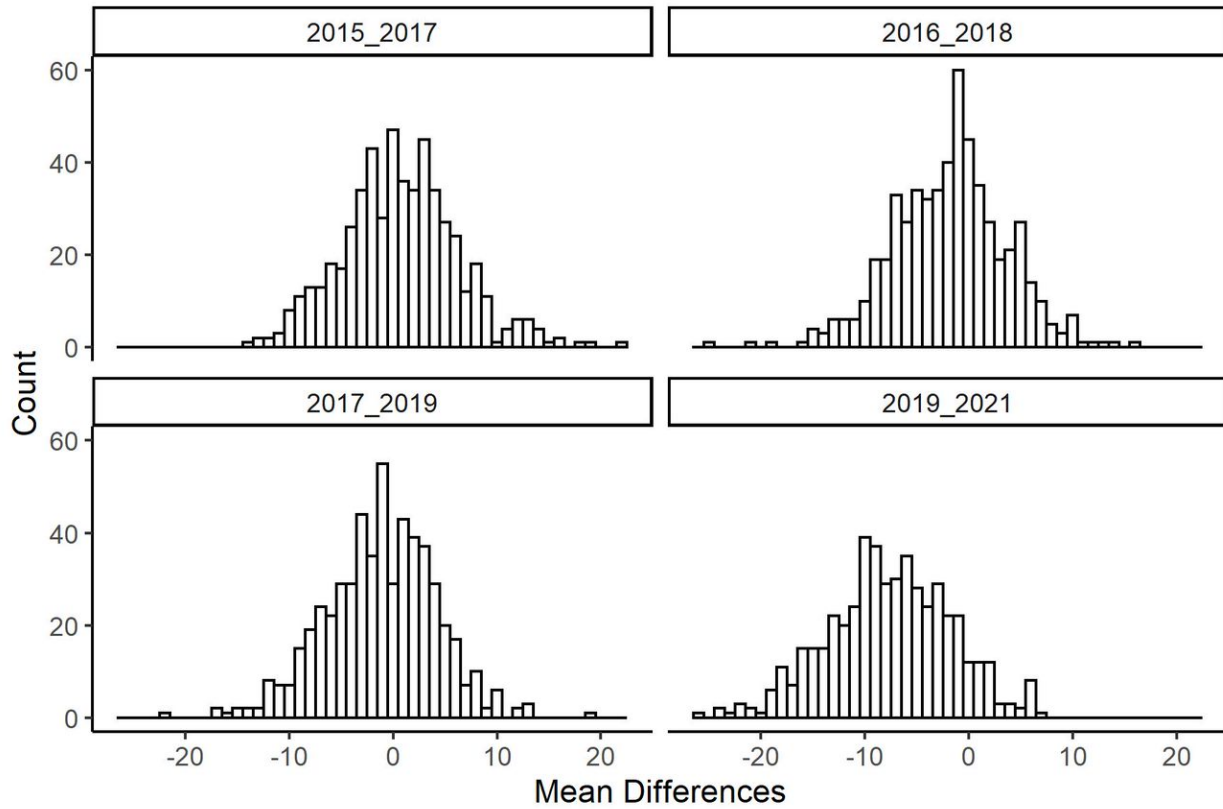


**Figure D-12. Comparison of district-level score changes: Grade 8 reading**

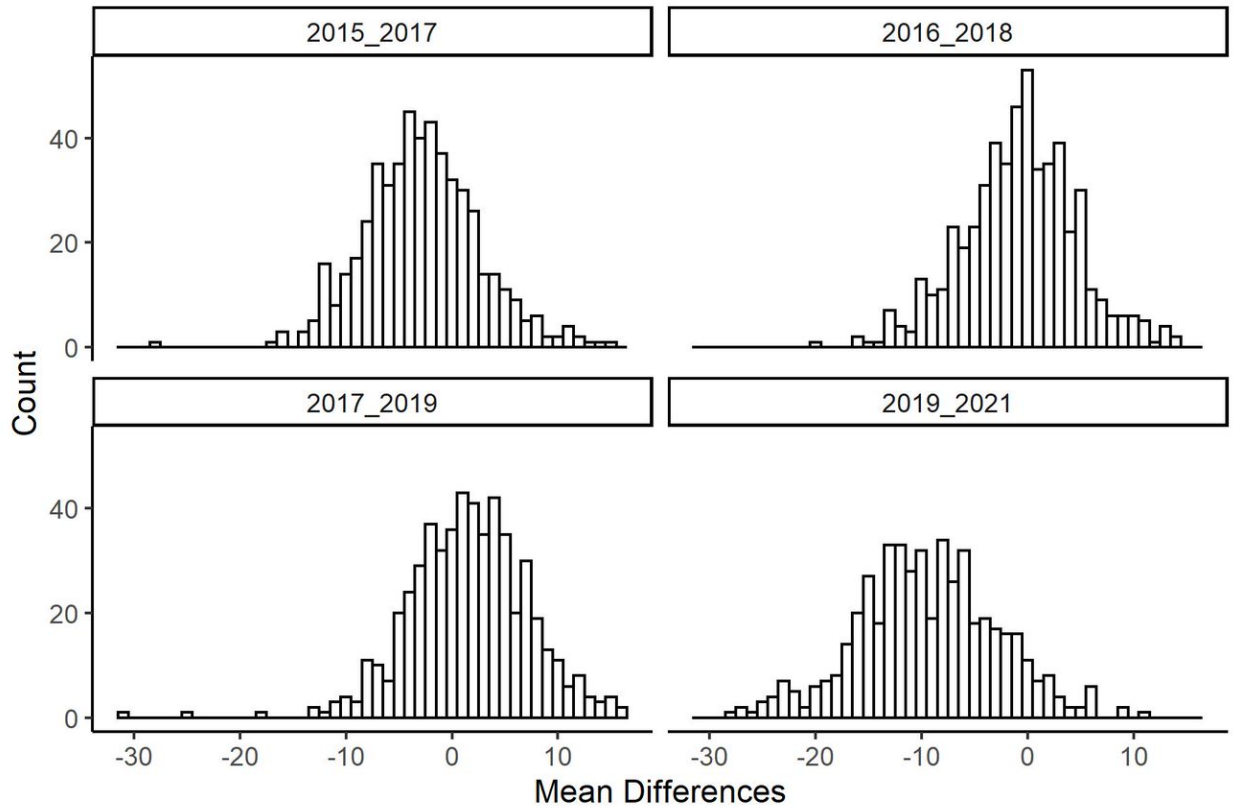
## Appendix E



**Figure E-1. Comparison of school-level score changes: Grade 3 mathematics**

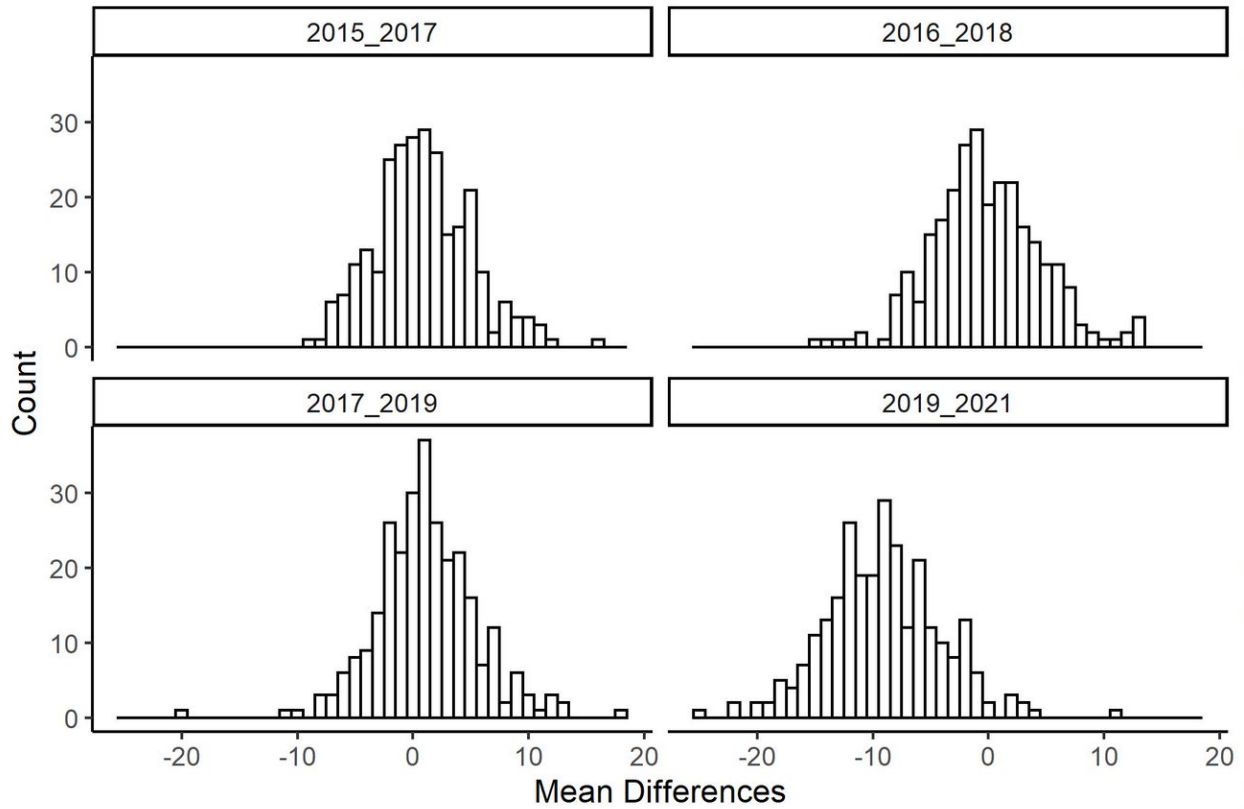


**Figure E-2. Comparison of school-level score changes: Grade 4 mathematics**

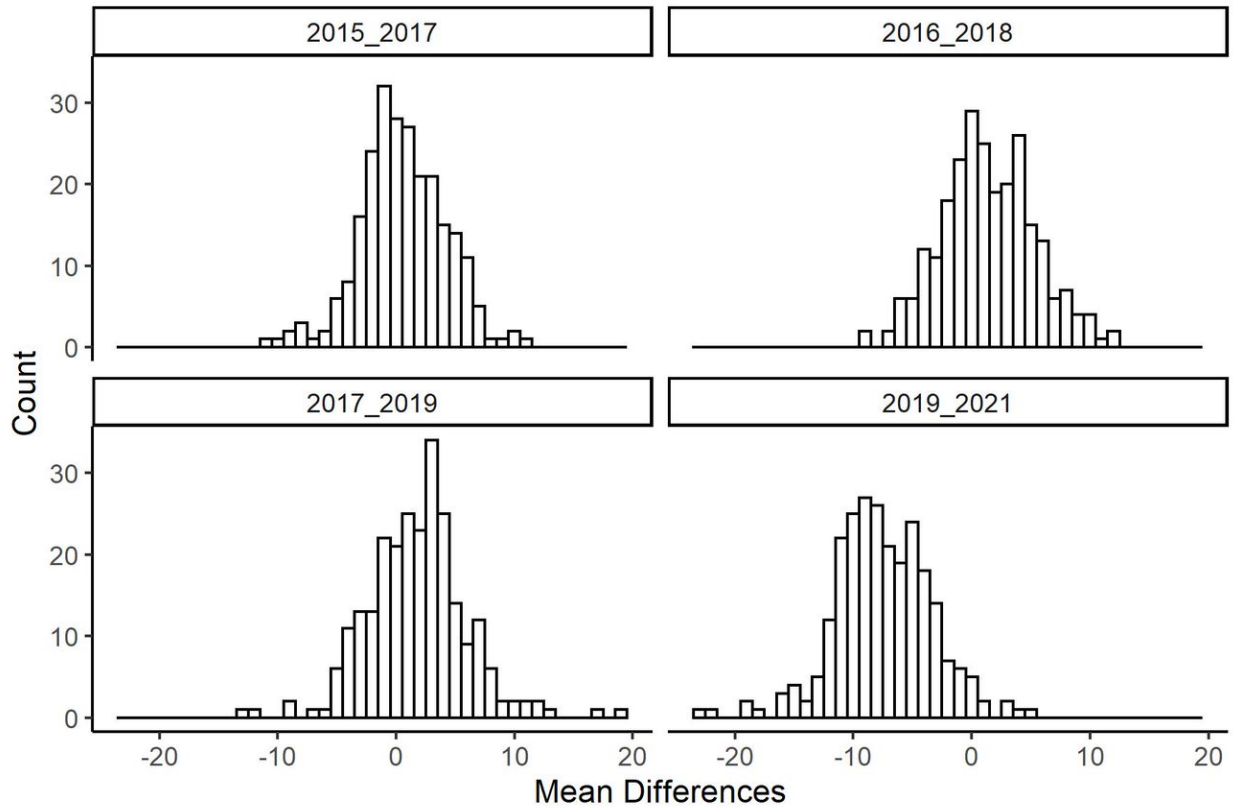


**Figure E-3. Comparison of school-level score changes: Grade 5 mathematics**

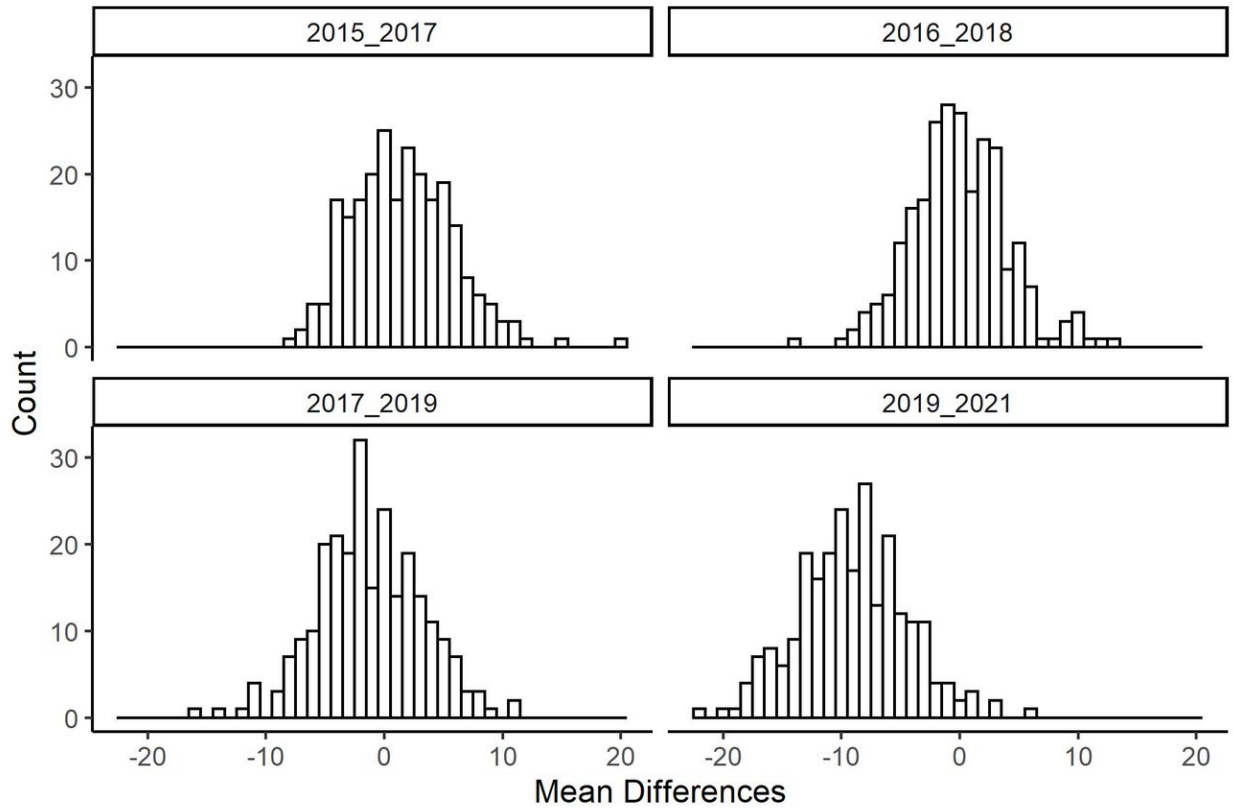




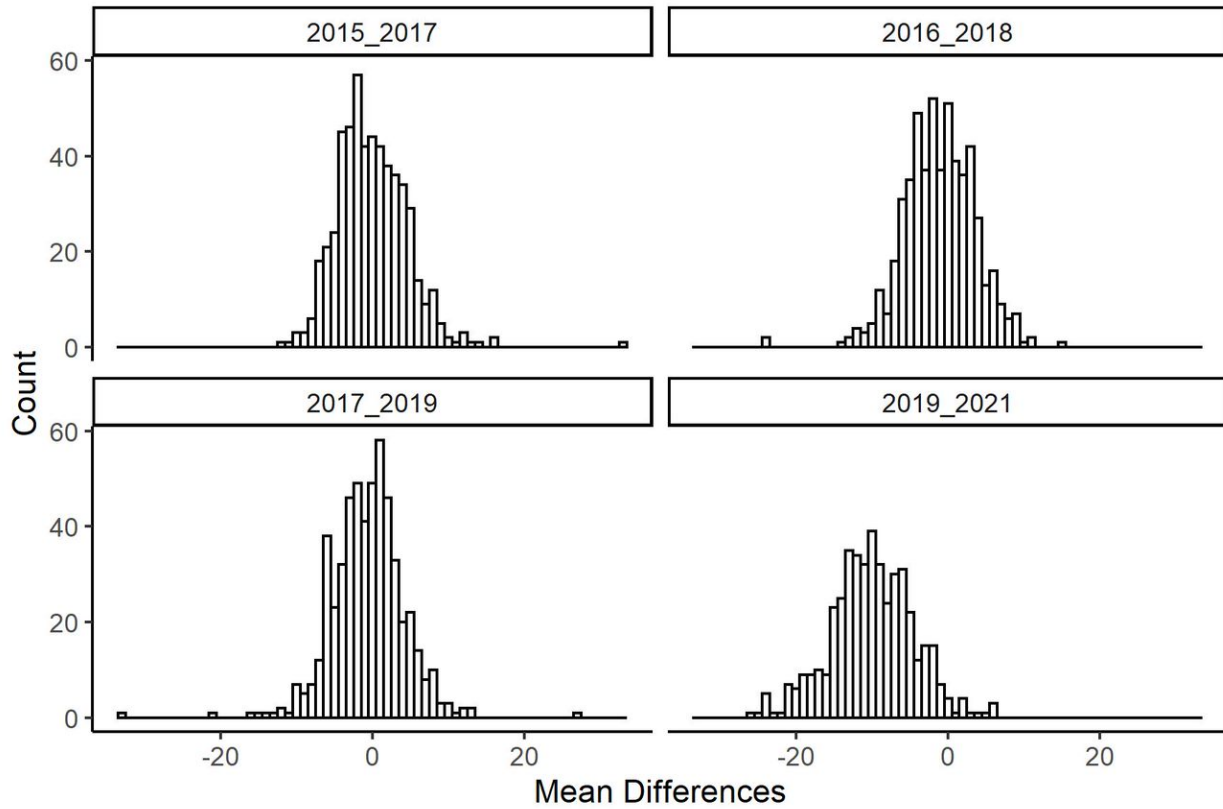
**Figure E-4. Comparison of school-level score changes: Grade 6 mathematics**



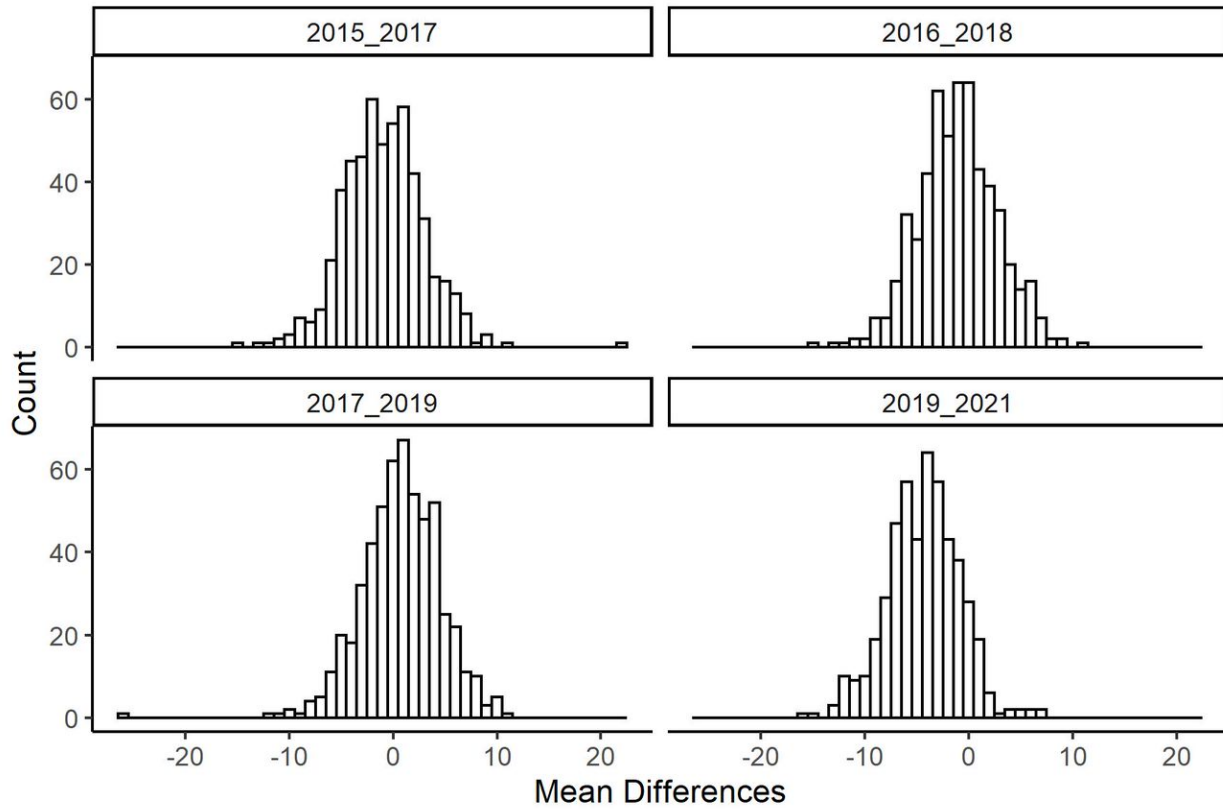
**Figure E-5. Comparison of school-level score changes: Grade 7 mathematics**



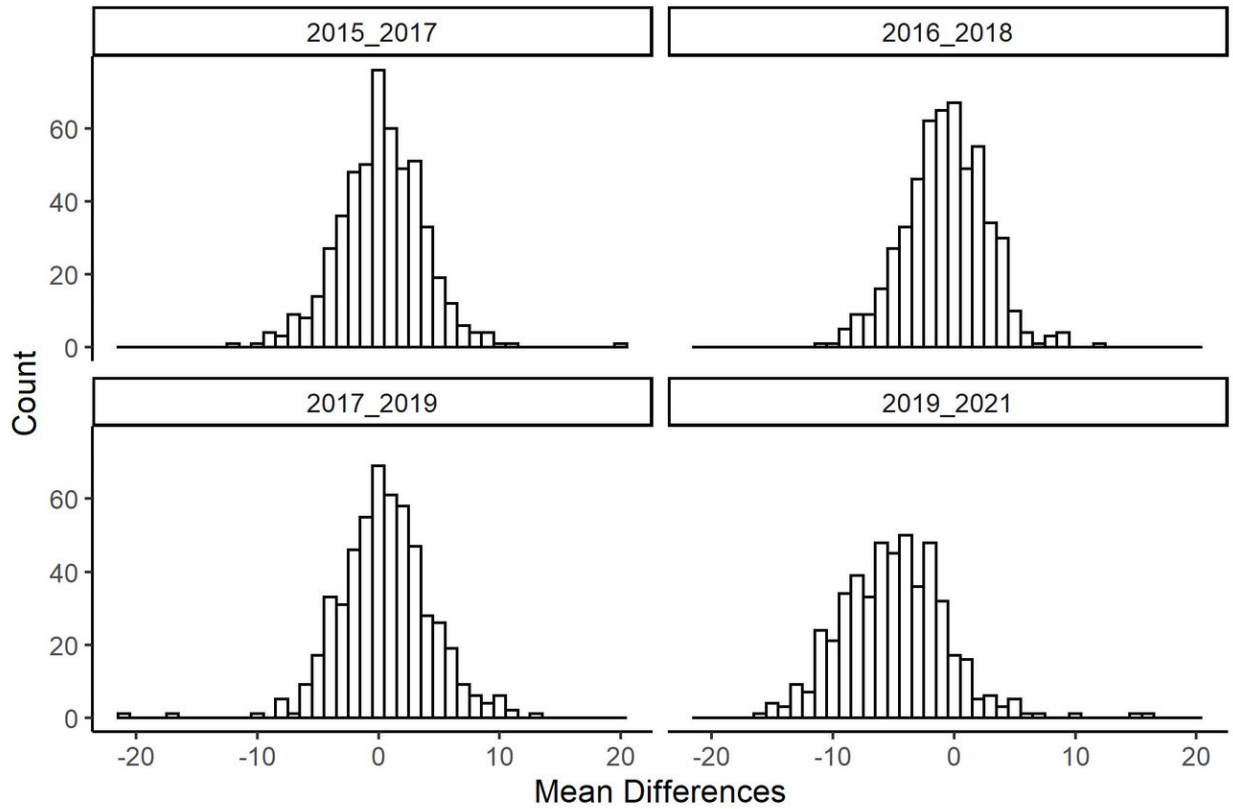
**Figure E-6. Comparison of school-level score changes: Grade 8 mathematics**



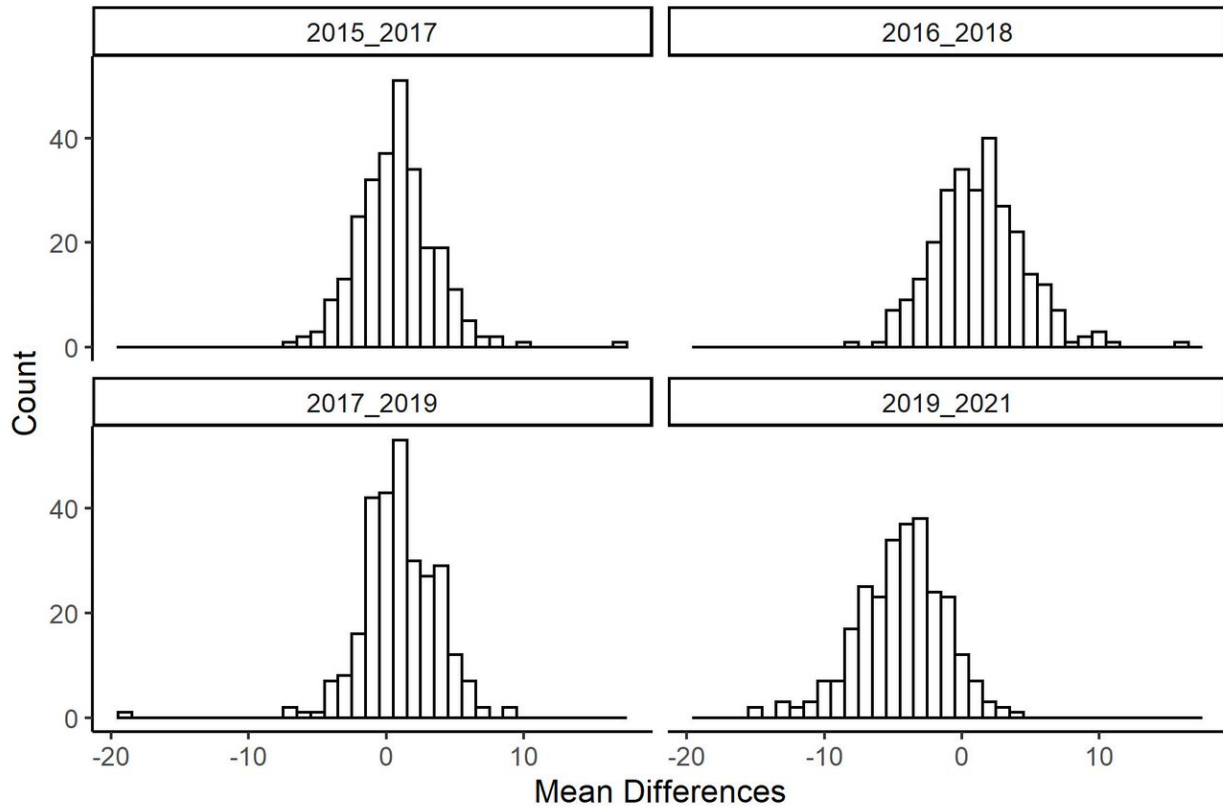
**Figure E-7. Comparison of school-level score changes: Grade 3 reading**



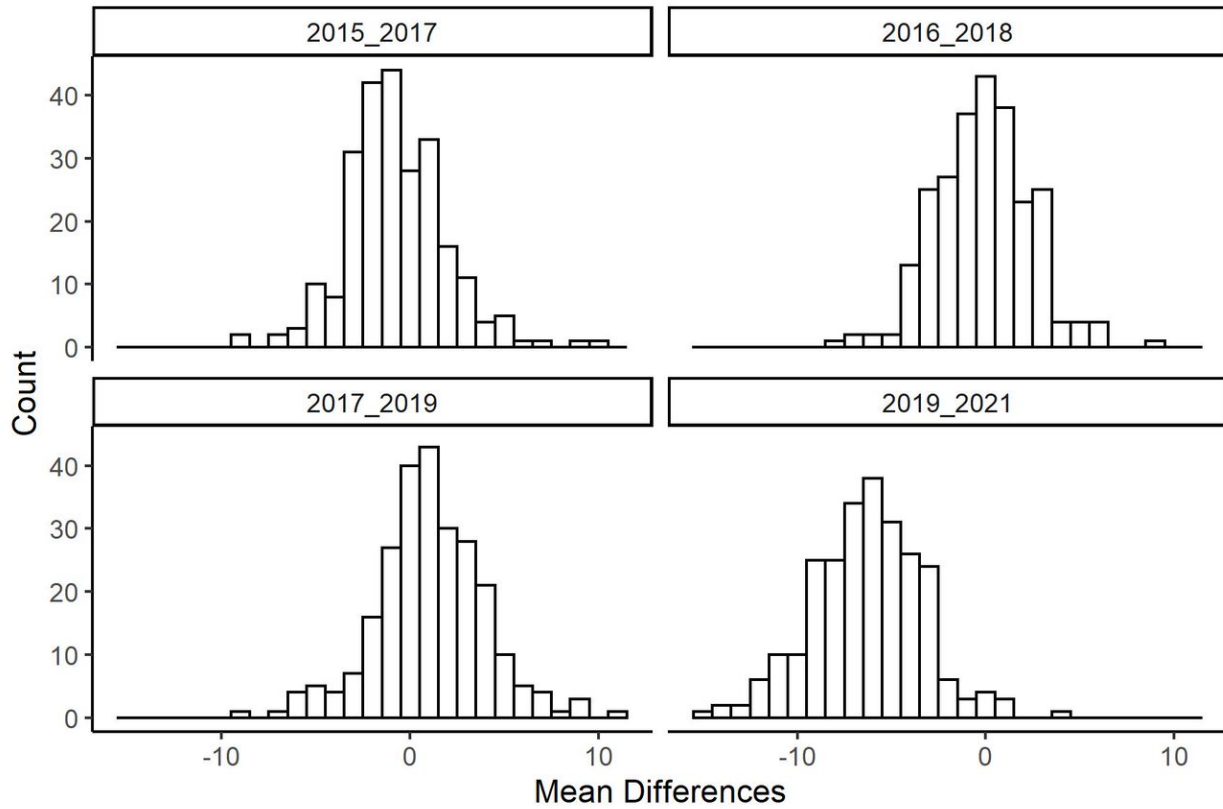
**Figure E-8. Comparison of school-level score changes: Grade 4 reading**



**Figure E-9. Comparison of school-level score changes: Grade 5 reading**

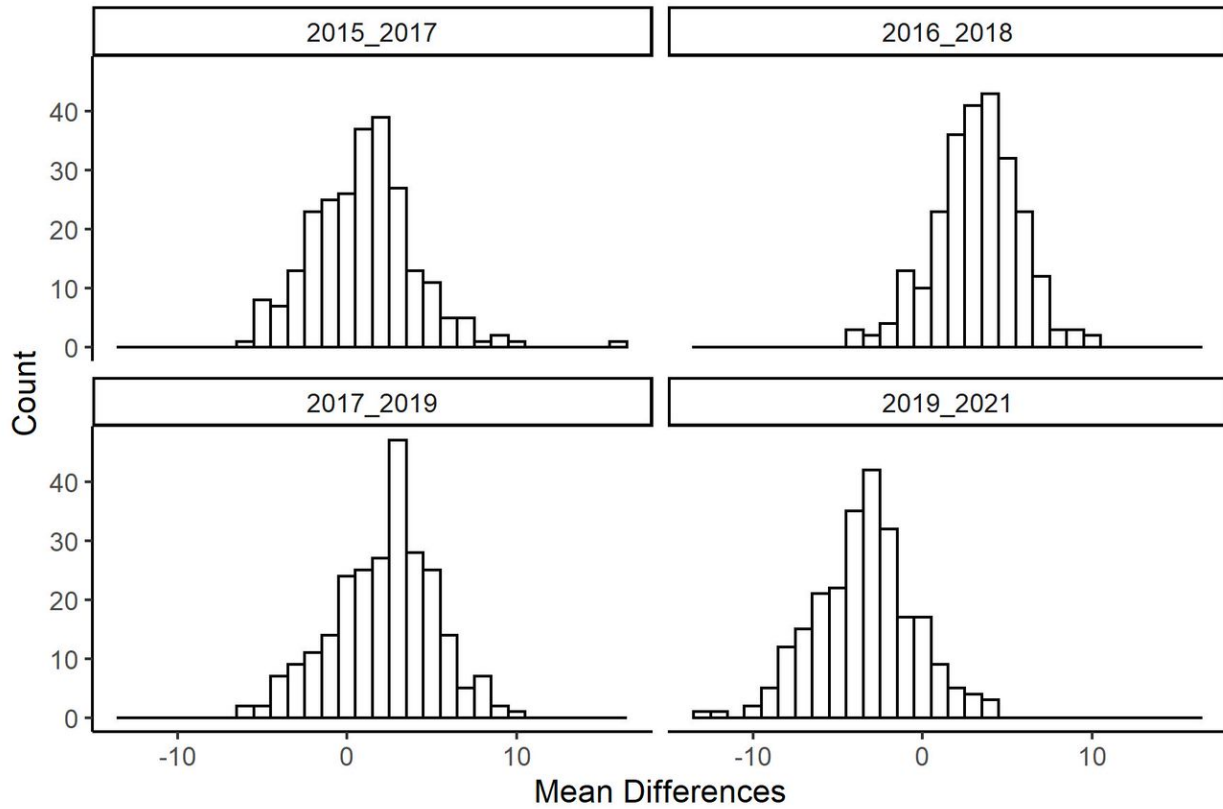


**Figure E-10. Comparison of school-level score changes: Grade 6 reading**



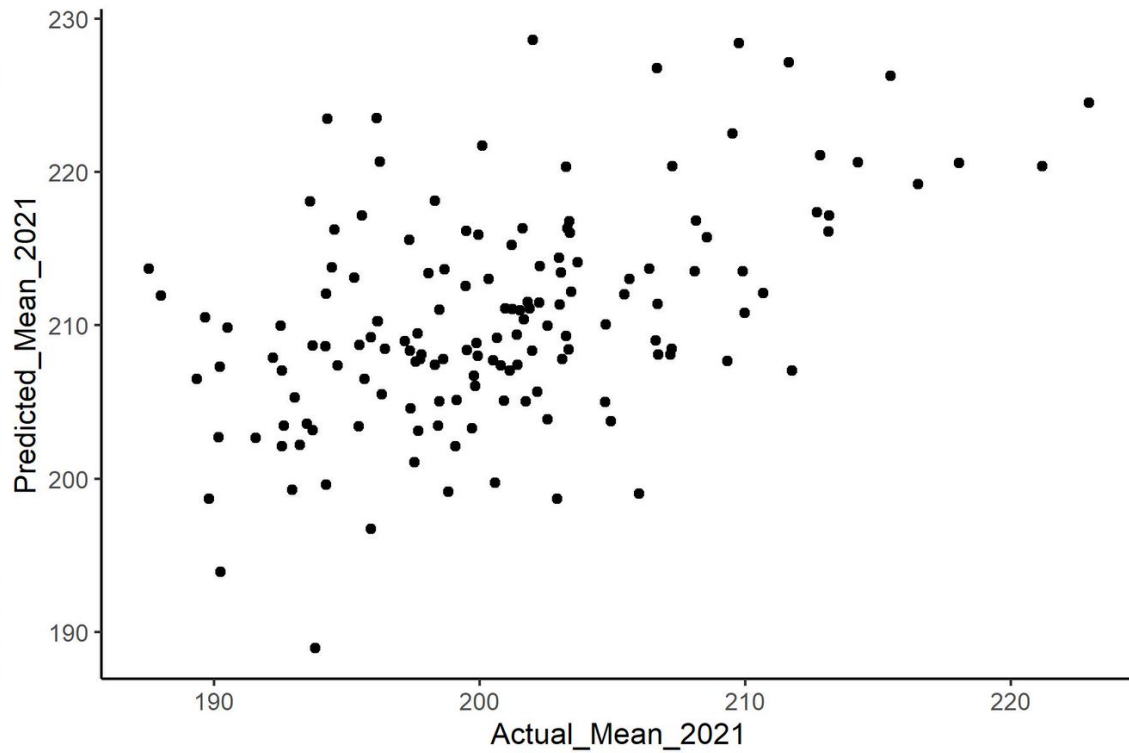
**Figure E-11. Comparison of school-level score changes: Grade 7 reading**



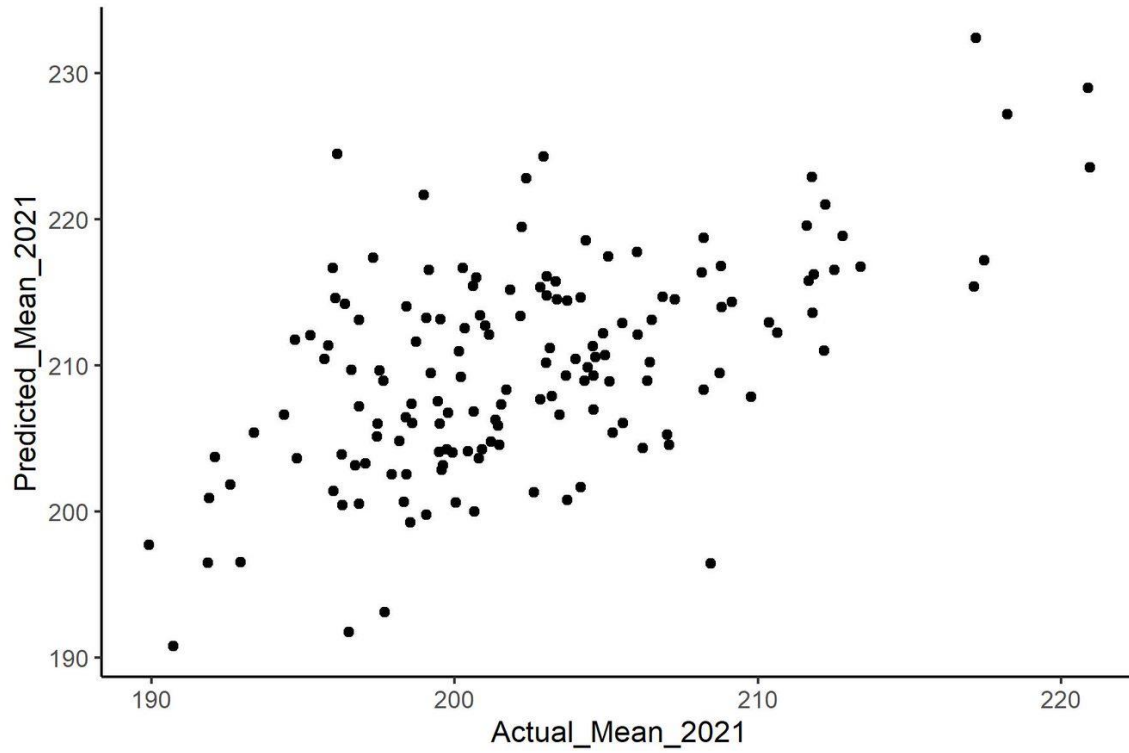


**Figure E-12. Comparison of school-level score changes: Grade 8 reading**

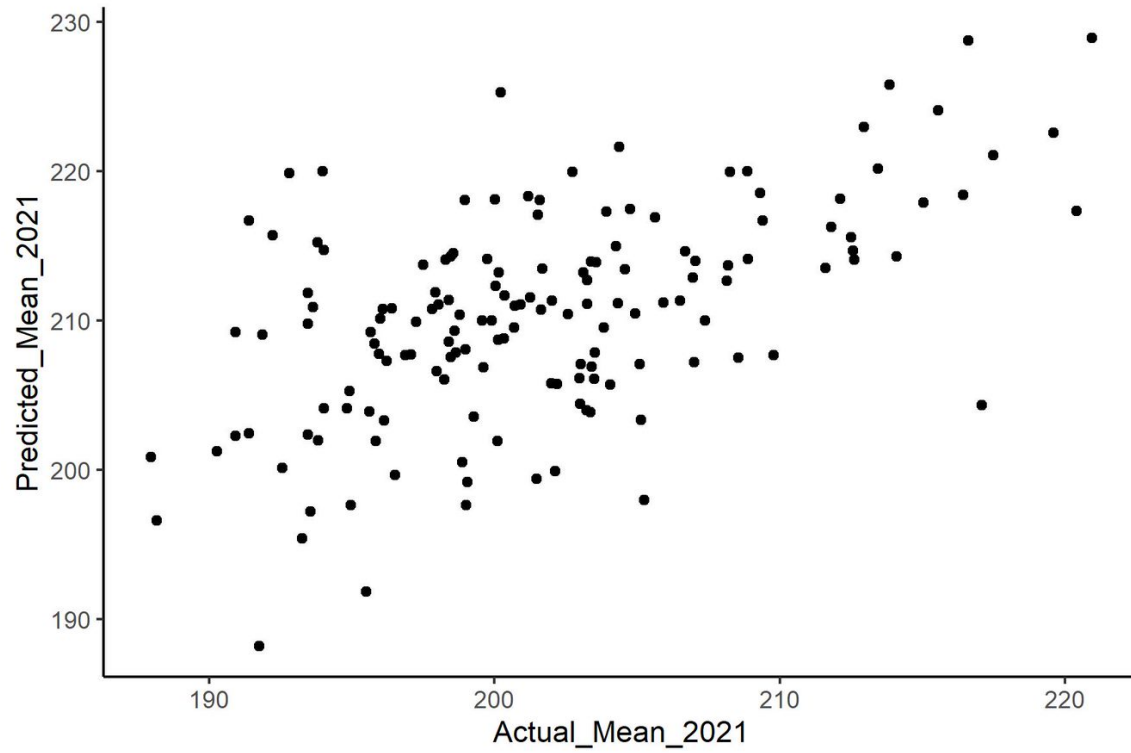
### Appendix F



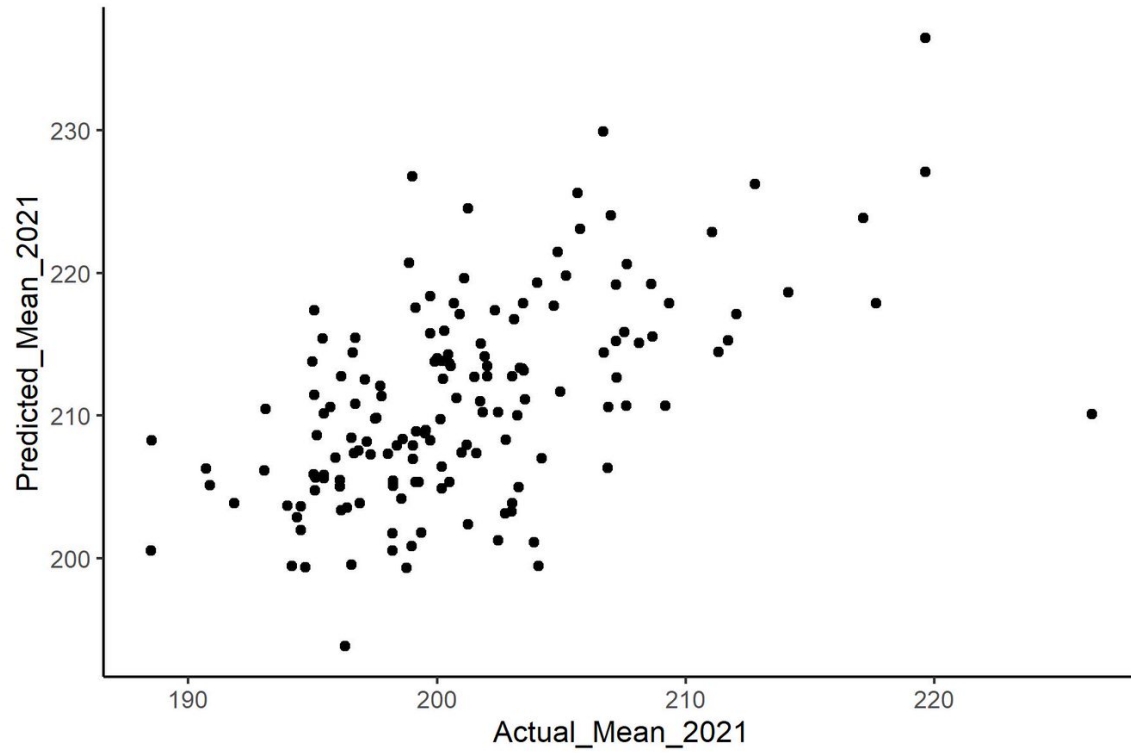
**Figure F-1. Comparison of observed and expected district-level scores: Grade 3 mathematics**



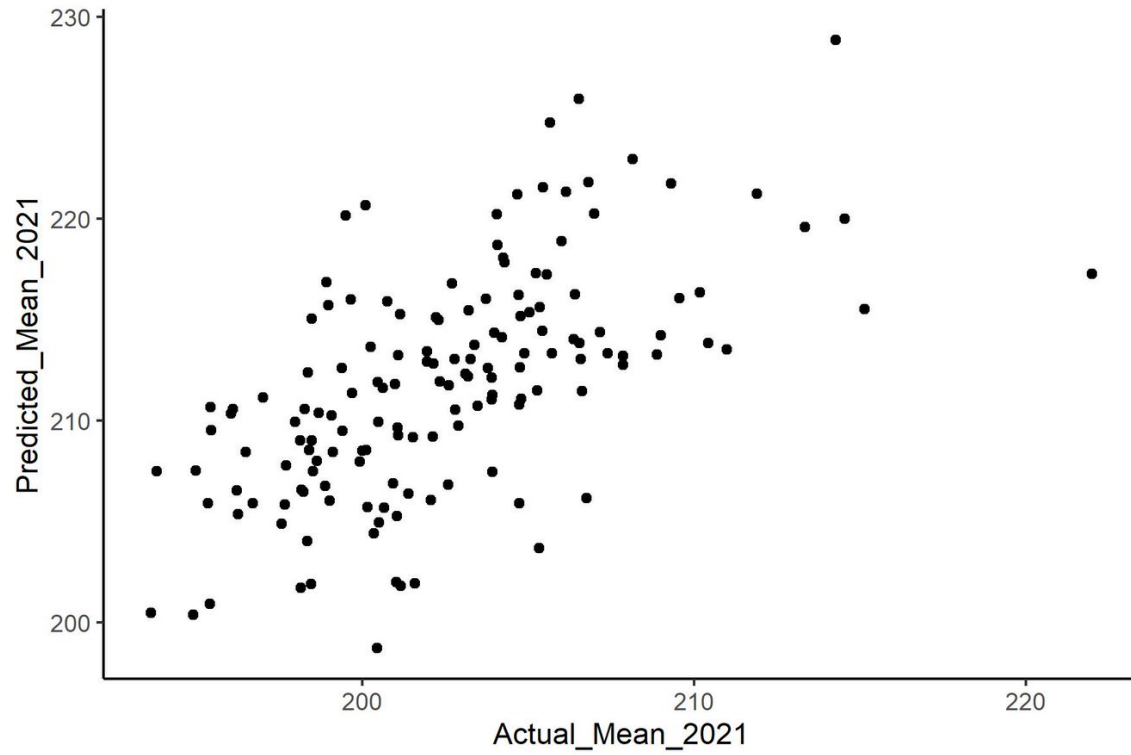
**Figure F-2. Comparison of observed and expected district-level scores: Grade 4 mathematics**



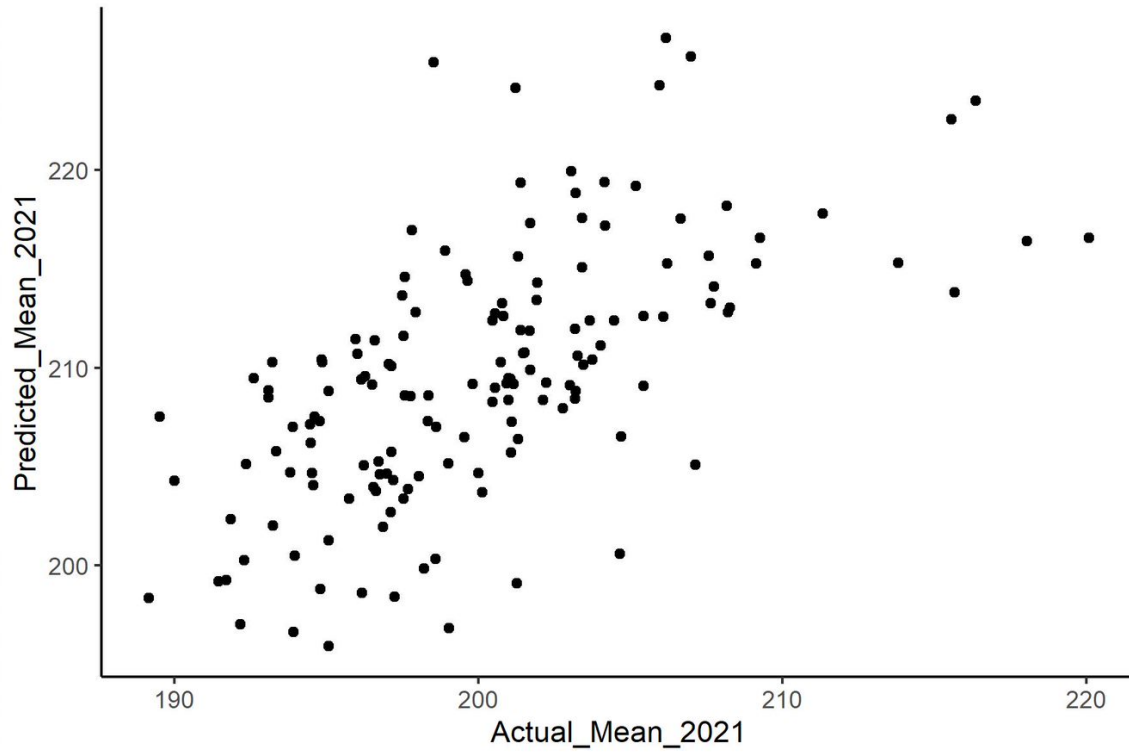
**Figure F-3. Comparison of observed and expected district-level scores: Grade 5 mathematics**



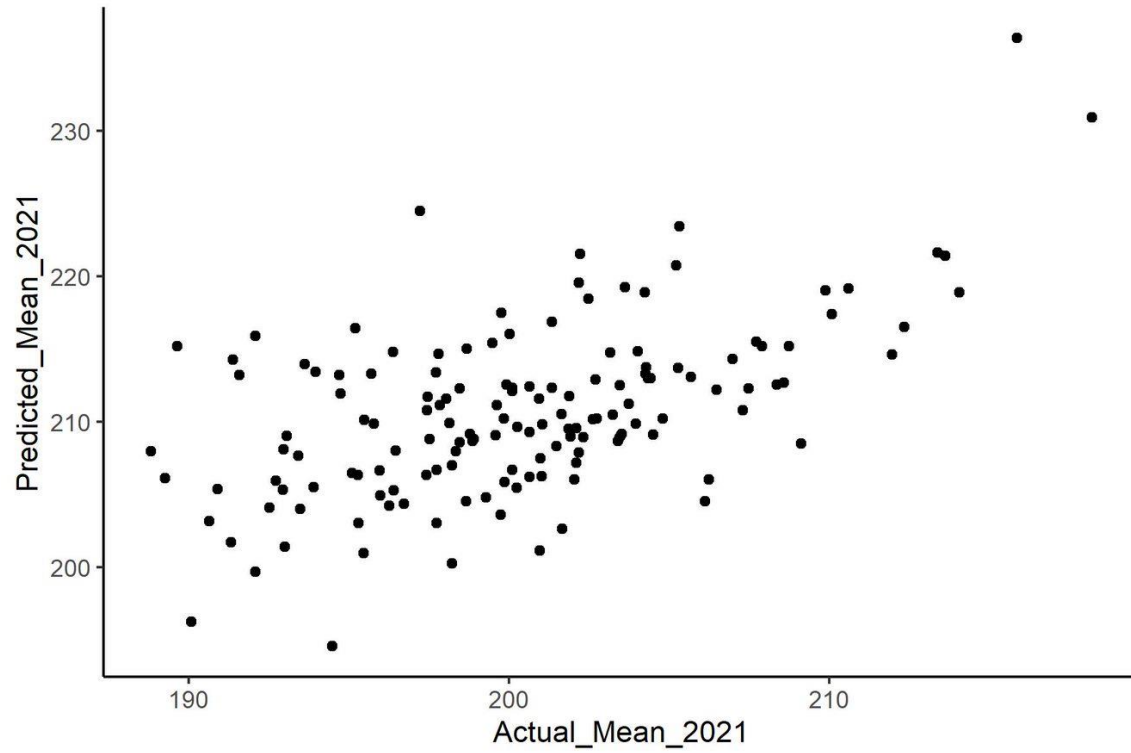
**Figure F-4. Comparison of observed and expected district-level scores: Grade 6 mathematics**



**Figure F-5. Comparison of observed and expected district-level scores: Grade 7 mathematics**

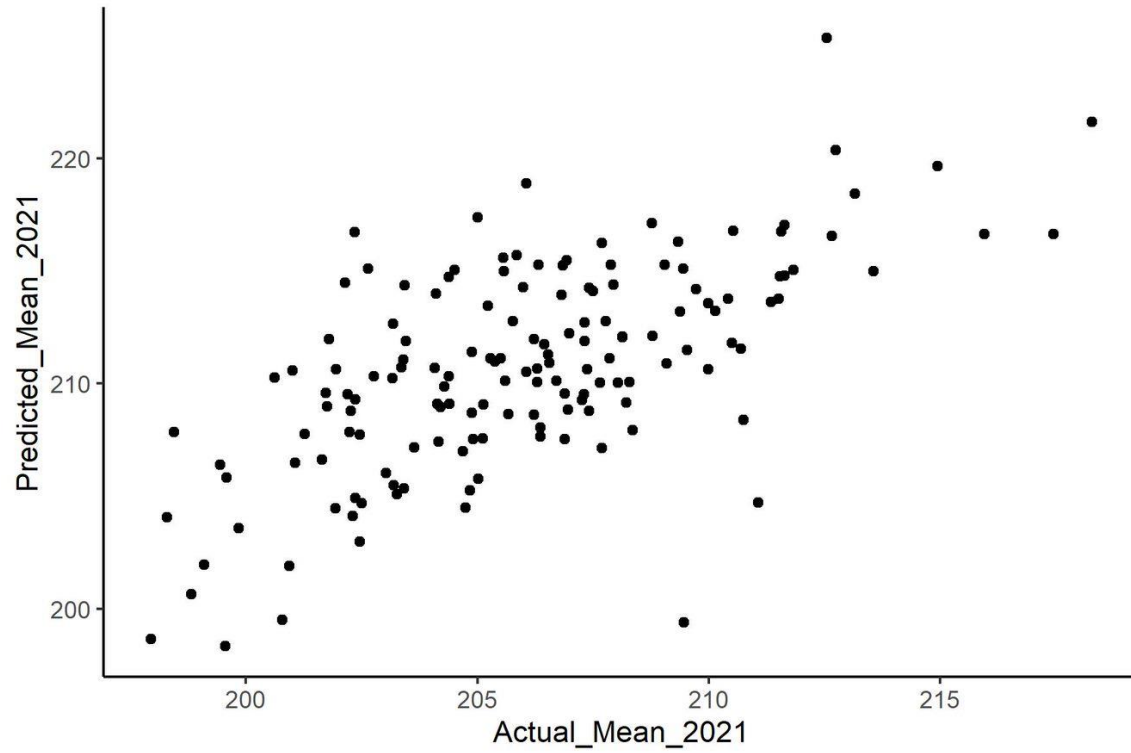


**Figure F-6. Comparison of observed and expected district-level scores: Grade 8 mathematics**

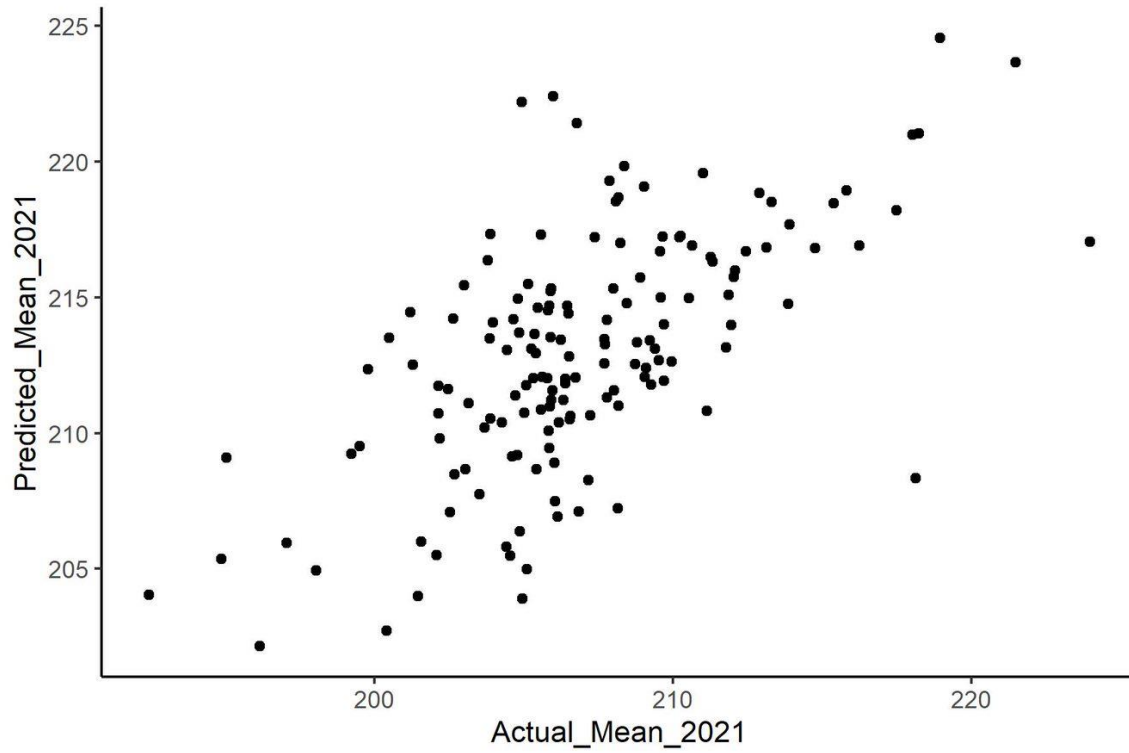


**Figure F-7. Comparison of observed and expected district-level scores: Grade 3 reading**

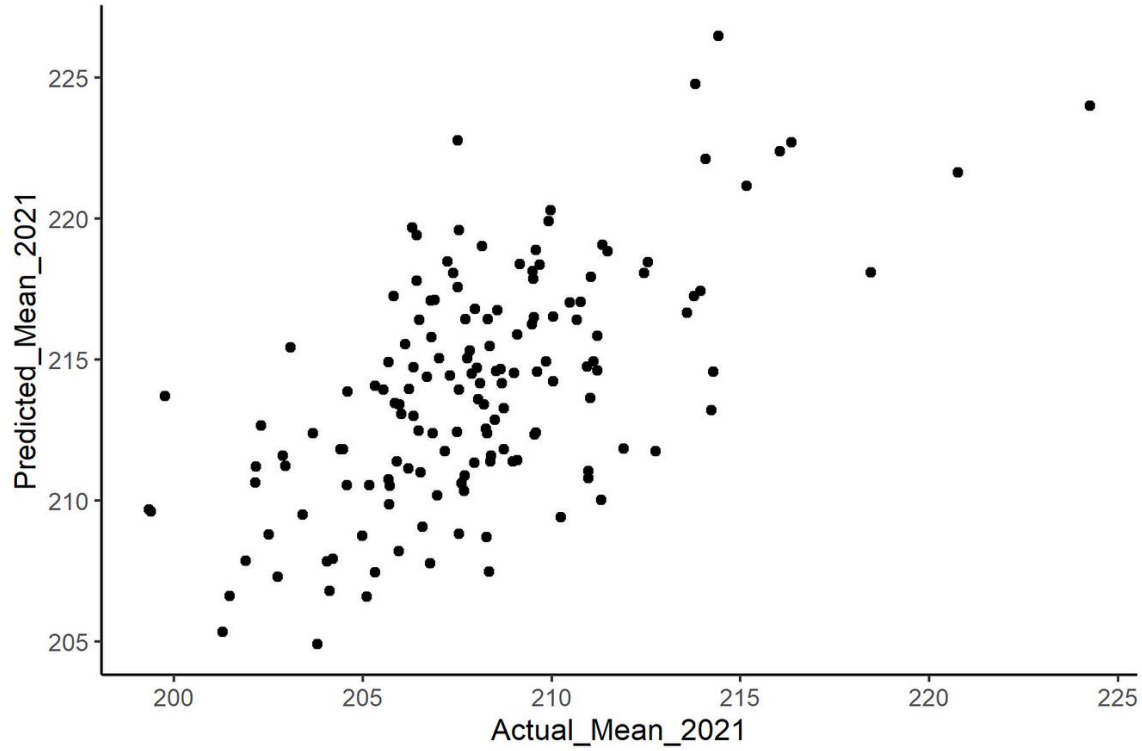




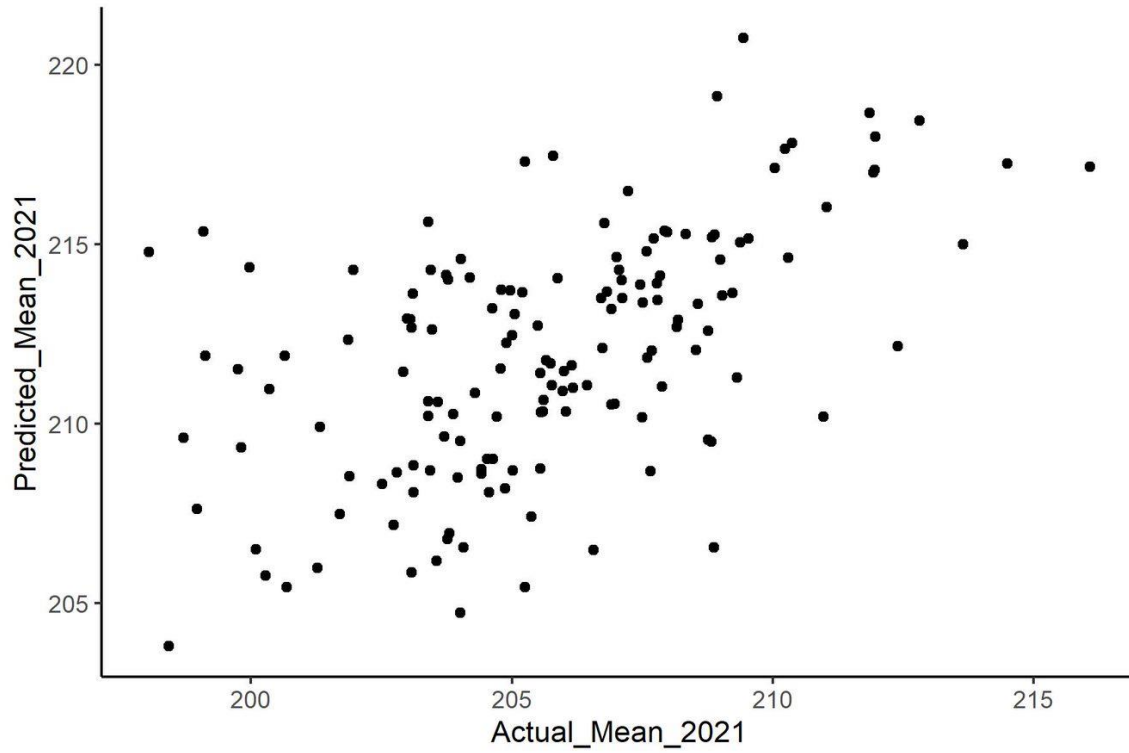
*Figure F-8. Comparison of observed and expected district-level scores: Grade 4 reading*



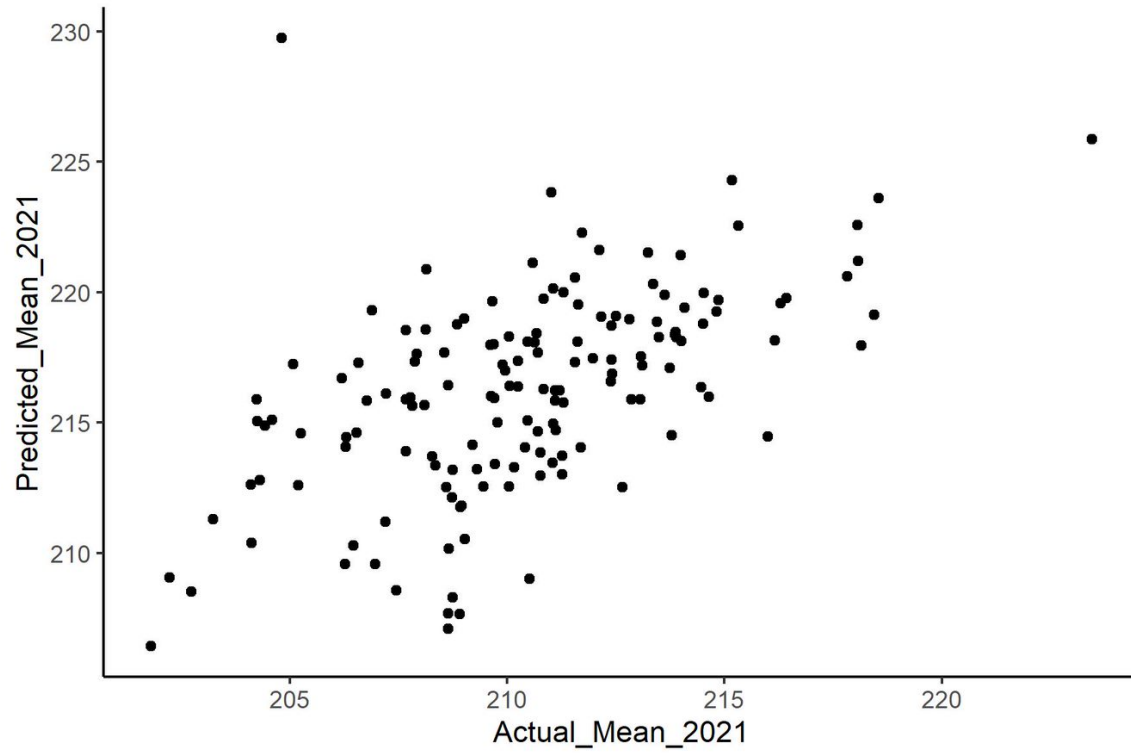
*Figure F-9. Comparison of observed and expected district-level scores: Grade 5 reading*



**Figure F-10. Comparison of observed and expected district-level scores: Grade 6 reading**

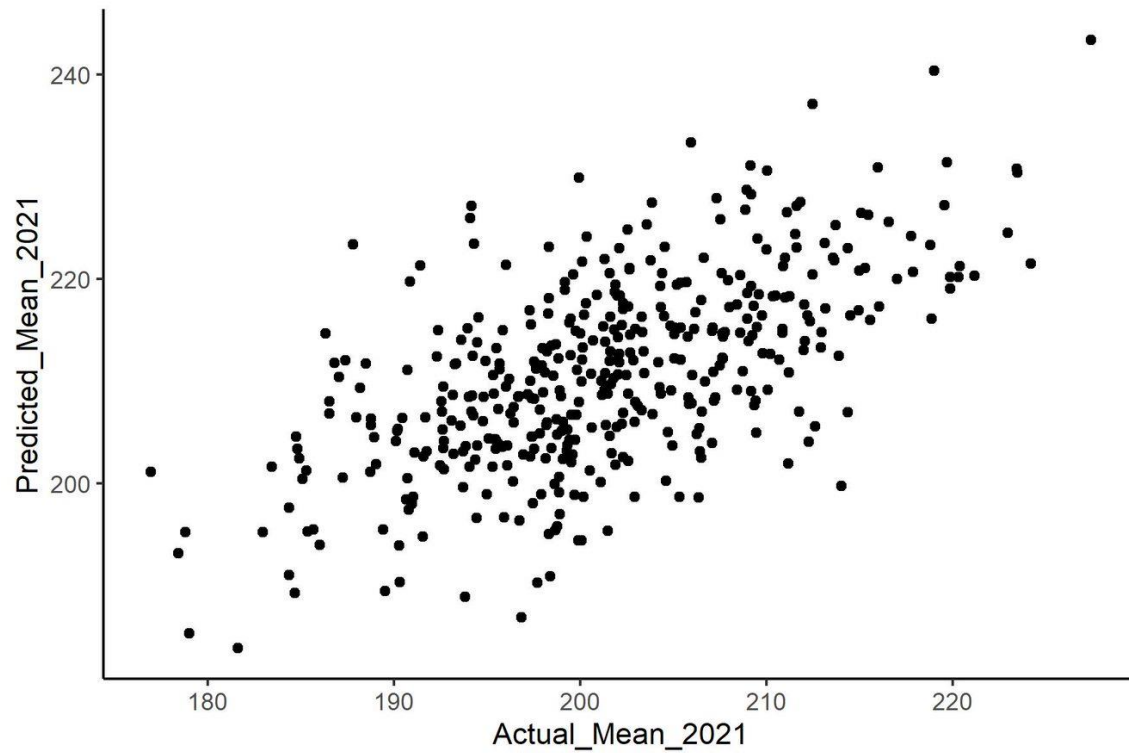


**Figure F-11. Comparison of observed and expected district-level scores Grade 7 reading**

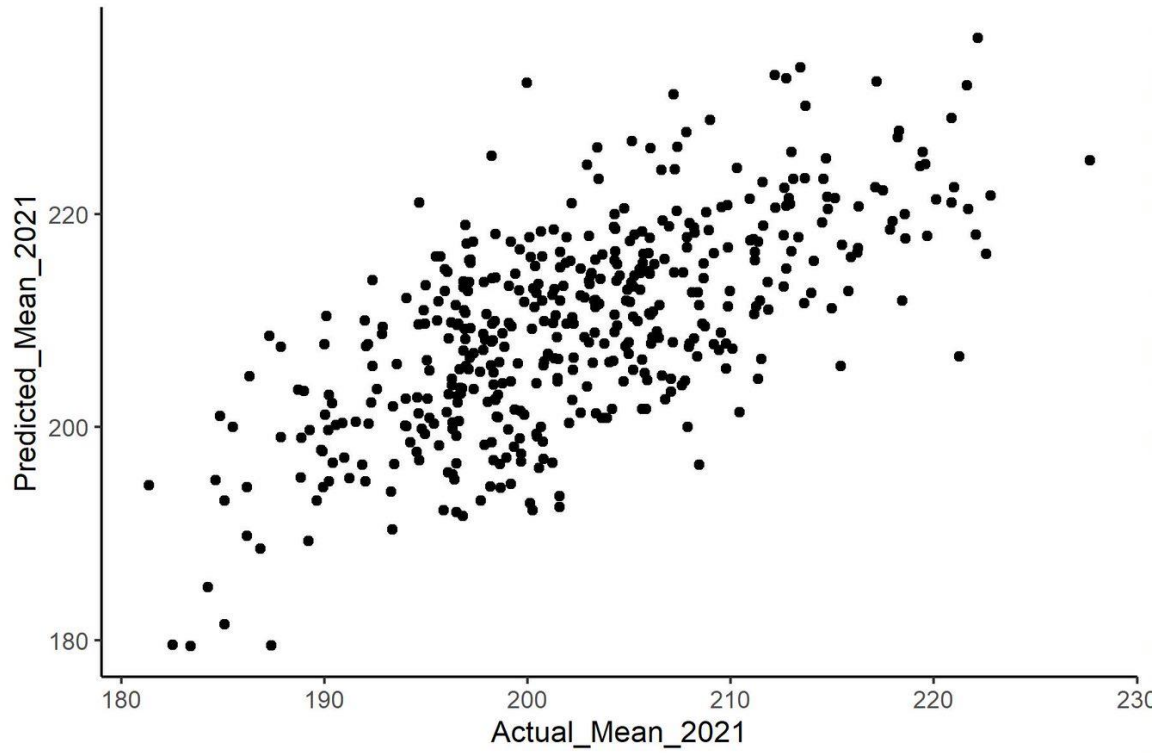


**Figure F-12. Comparison of observed and expected district-level scores: Grade 8 reading**

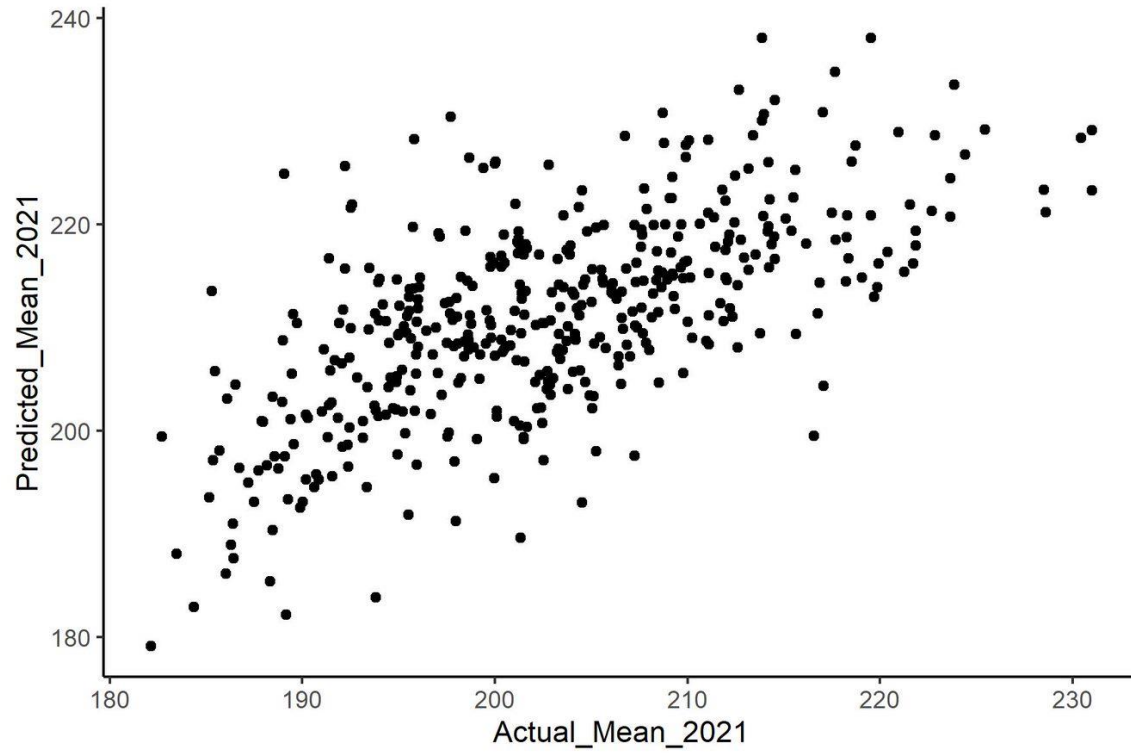
## Appendix G



**Figure G-1. Comparison of observed and expected school-level scores: Grade 3 mathematics**

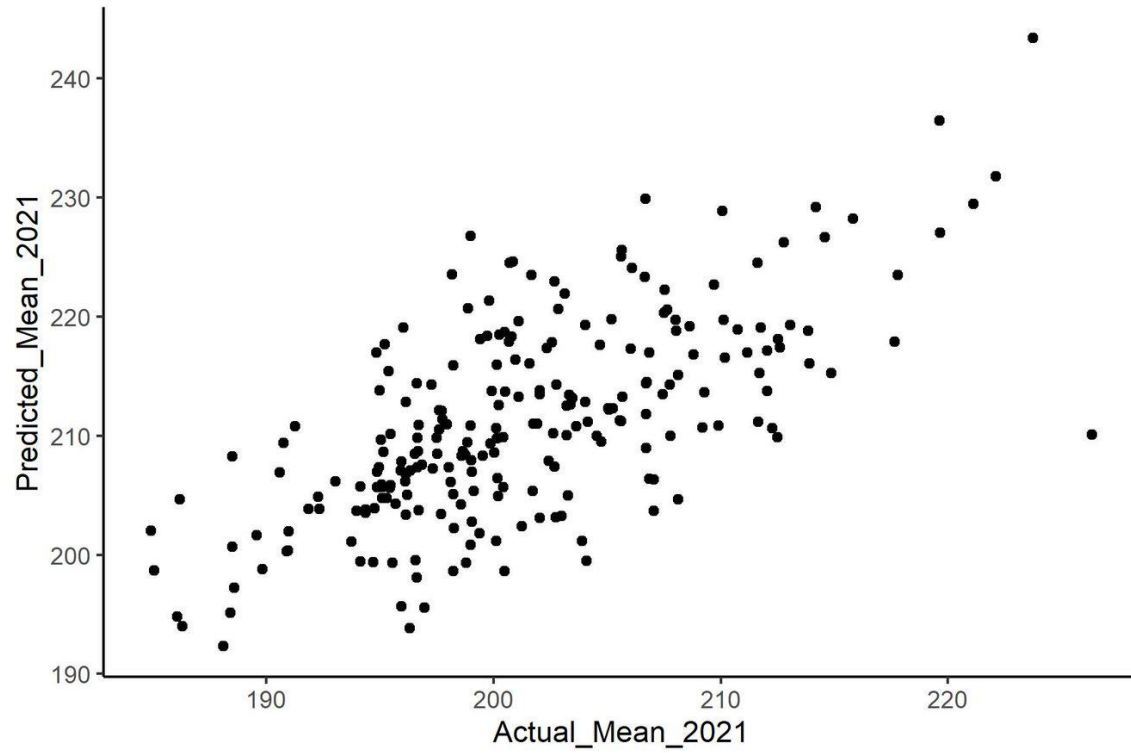


**Figure G-2. Comparison of observed and expected school-level scores: Grade 4 mathematics**

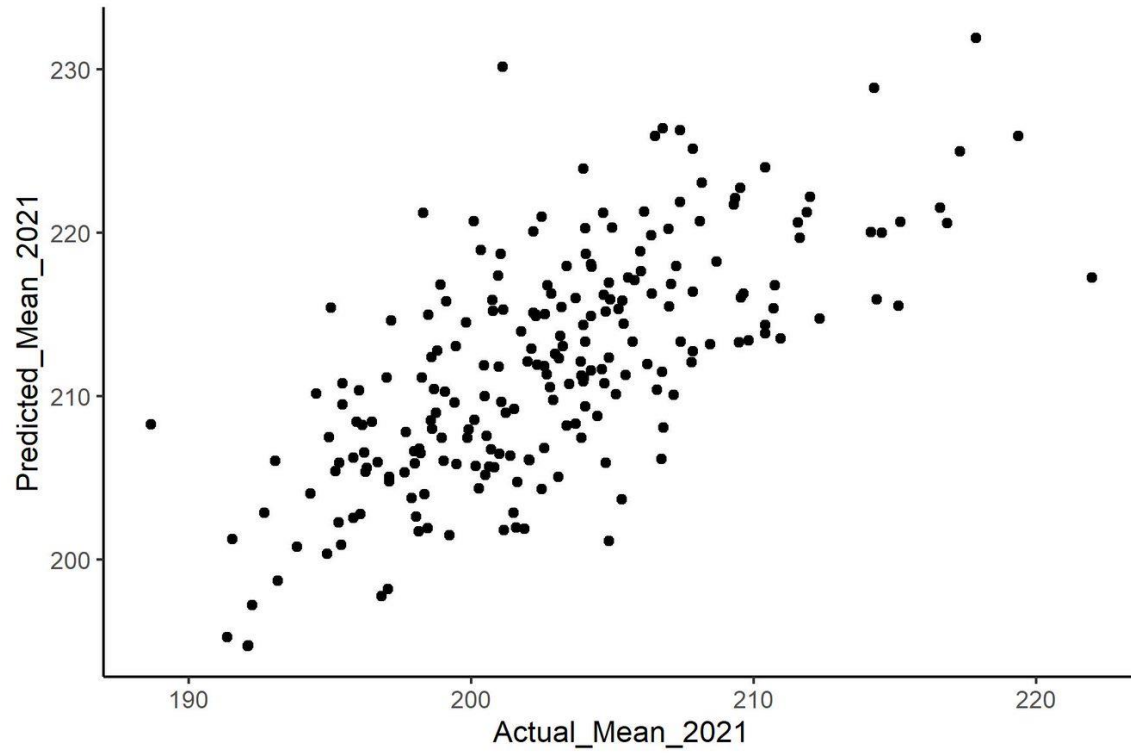


**Figure G-3. Comparison of observed and expected school-level scores: Grade 5 mathematics**

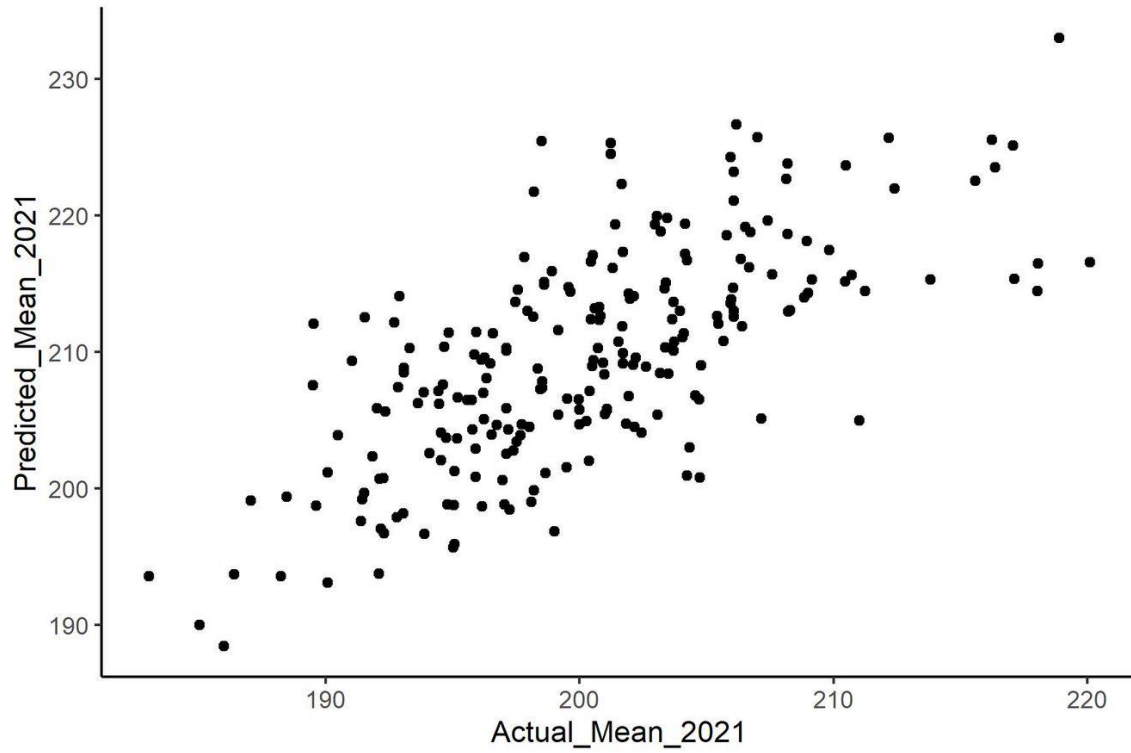




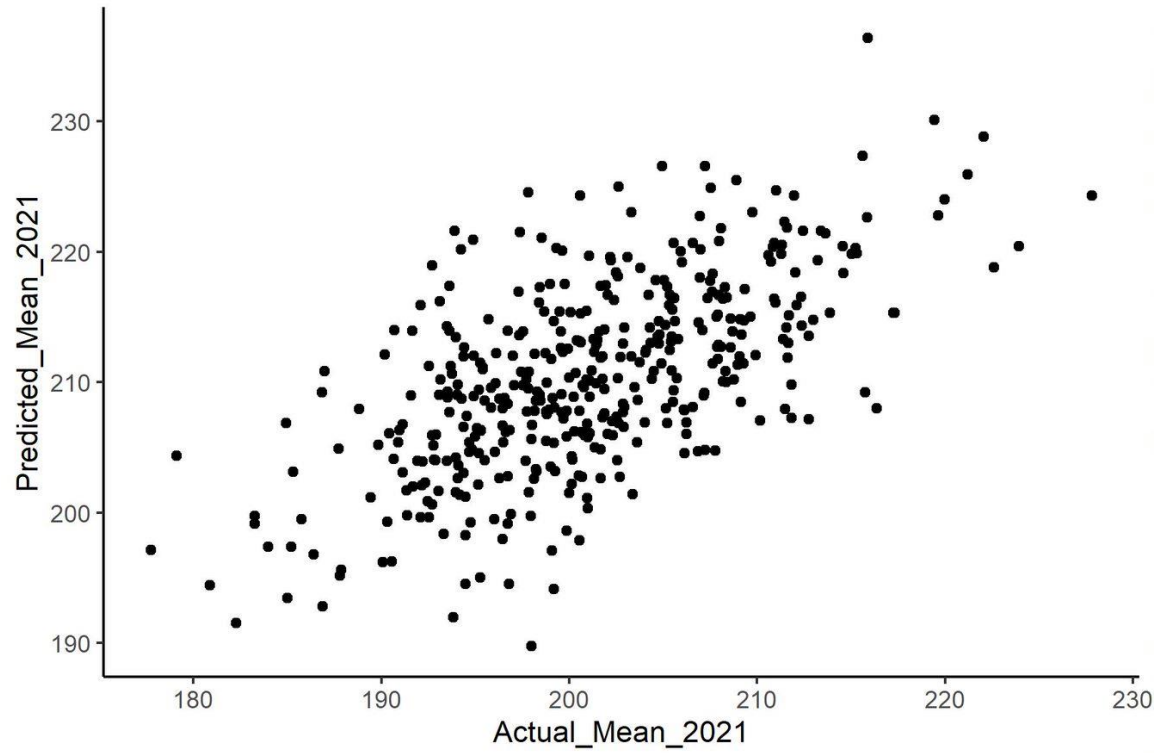
**Figure G-4. Comparison of observed and expected school-level scores: Grade 6 mathematics**



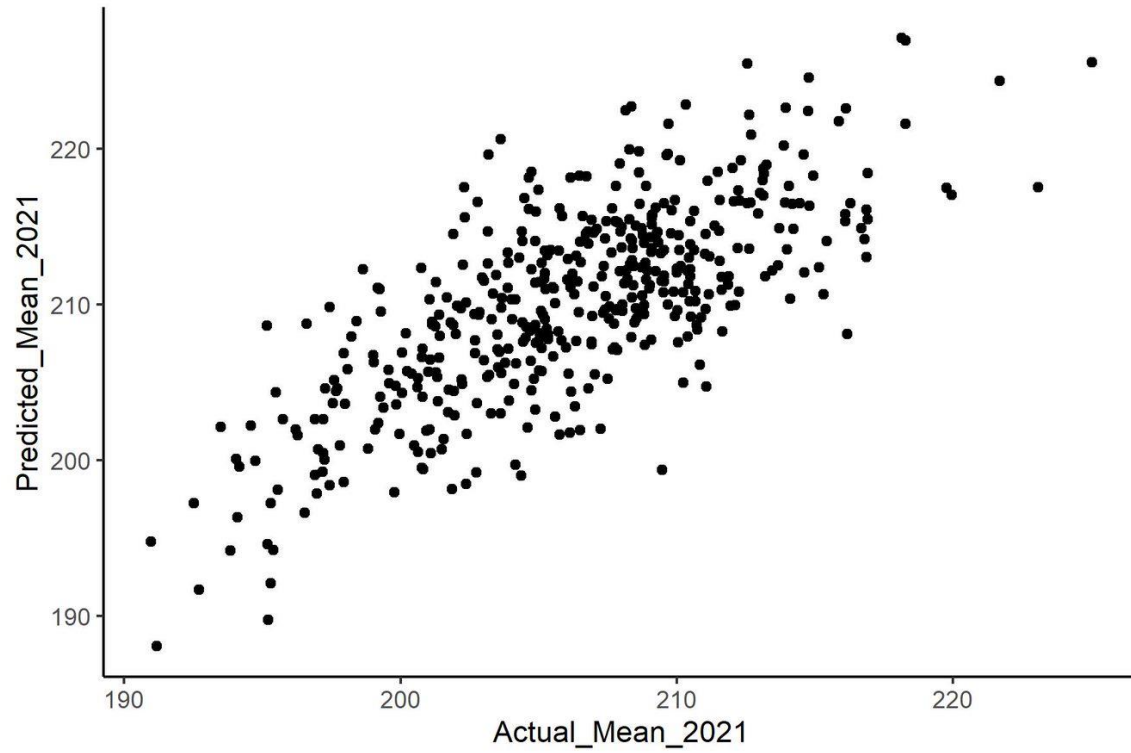
**Figure G-5. Comparison of observed and expected school-level scores: Grade 7 mathematics**



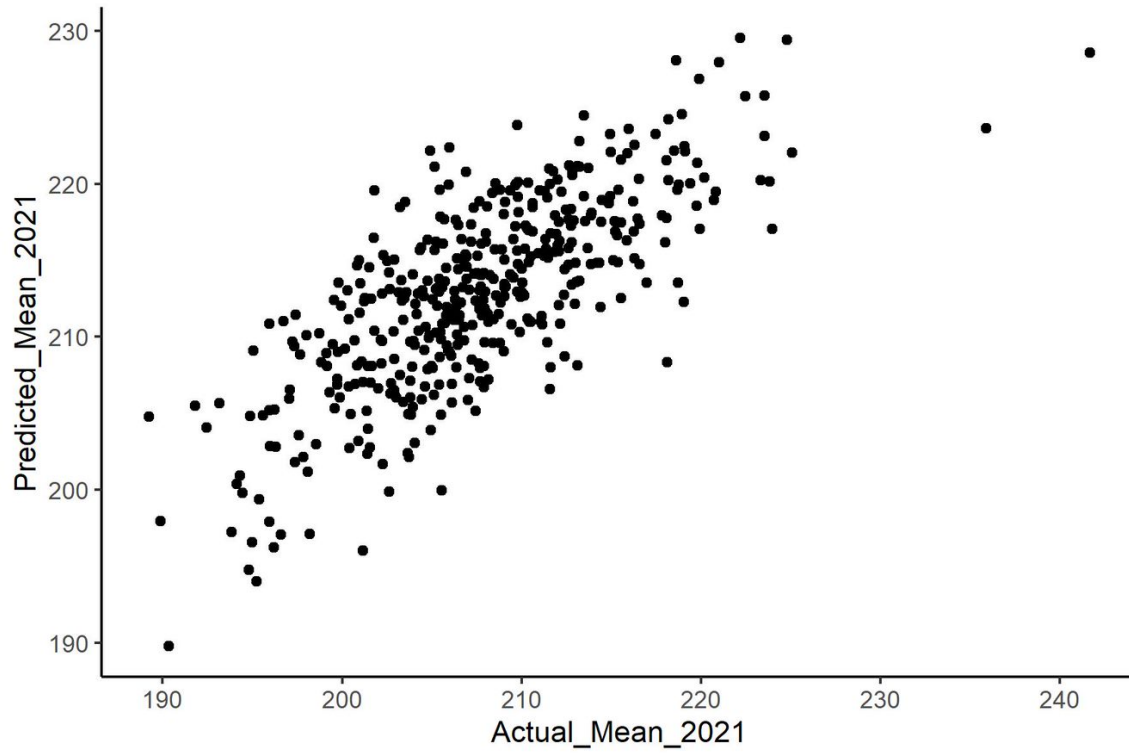
**Figure G-6. Comparison of observed and expected school-level scores: Grade 8 mathematics**



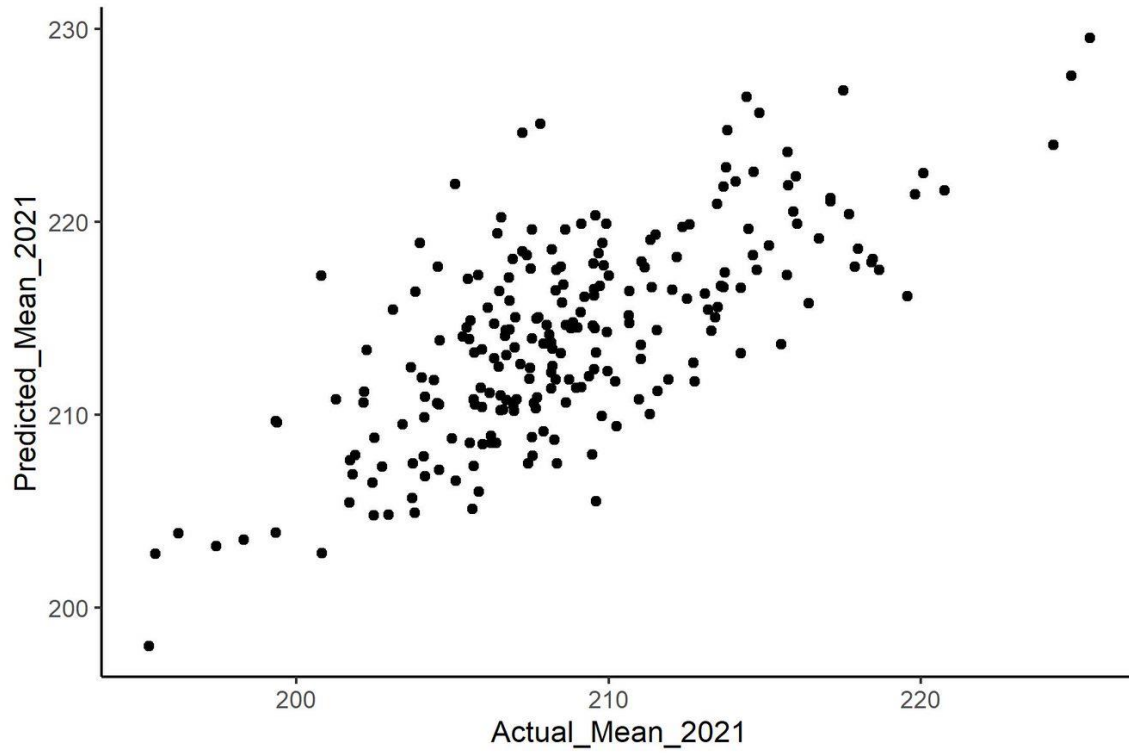
*Figure G-7. Comparison of observed and expected school-level scores: Grade 3 reading*



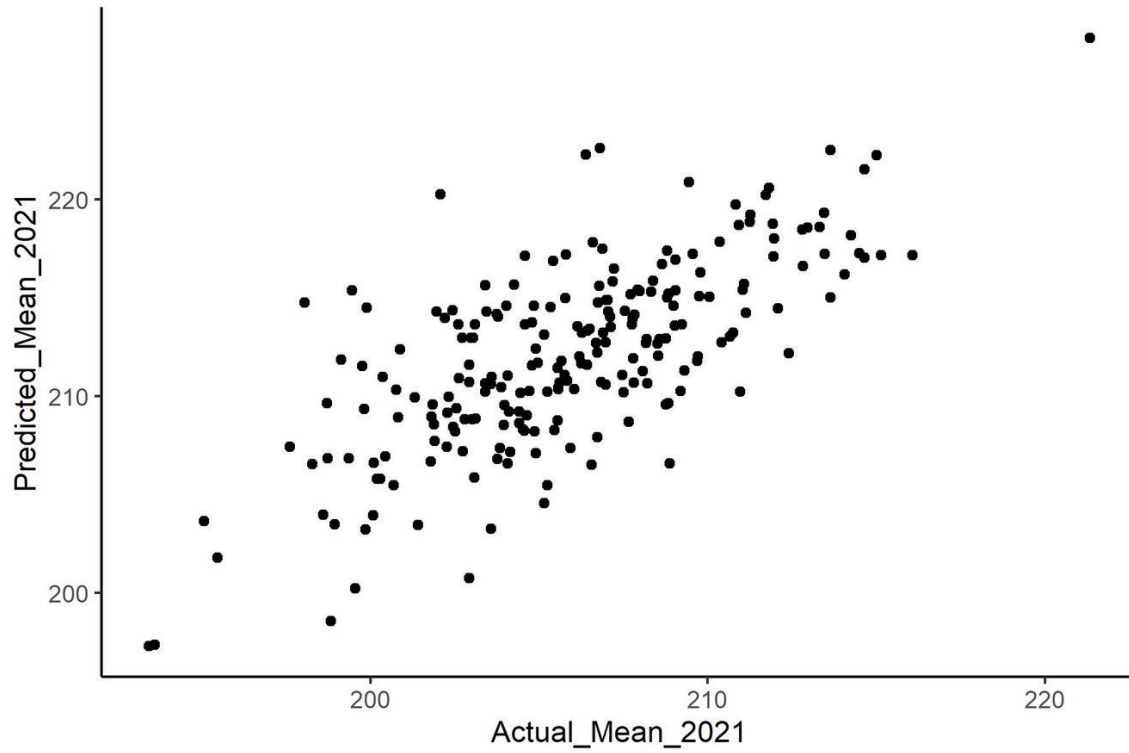
**Figure G-8. Comparison of observed and expected school-level scores: Grade 4 reading**



*Figure G-9. Comparison of observed and expected school-level scores: Grade 5 reading*

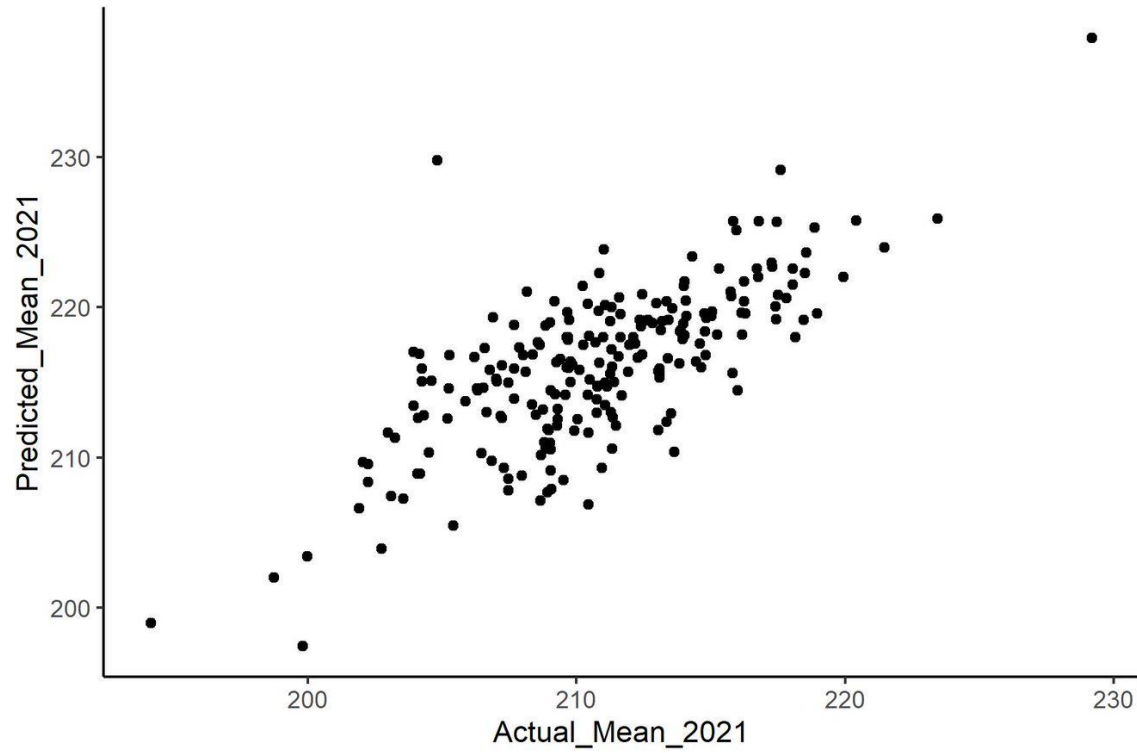


**Figure G-10. Comparison of observed and expected school-level scores: Grade 6 reading**



**Figure G-11. Comparison of observed and expected school-level scores Grade 7 reading**





**Figure G-12. Comparison of observed and expected school-level scores: Grade 8 reading**