

# Texas Math Outcomes Analysis 2016/17

Grade Levels: 3, 4, 5

ST Math Program: Gen-4

Analysis Type: Z-score of scale score

Treatment-Years: 2014/15, 2015/16, and 2016/17

Baseline-Year: 2013/14

Subgroup: All Students

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### **Abstract**

This analysis evaluates grades using ST Math in Texas in 2016/17. It identifies those grades with nominal or better implementation of the ST Math program, and matches them to randomly selected, similar math-performance comparison grades. The nominal ST Math users are an aggregation of 48 grades, consisting of grades 3, 4, and 5 at 16 schools. Refer to Figures 2 and 3 for the math performance and demographic distributions. They were matched to 48 similar, randomly selected control grades at 47 schools that never used ST Math. Grade-wise growth in math proficiency was evaluated (i.e. growth in same grade, same school, from 2013/14 to 2016/17) on the percentage proficient, scale scores, and Z-scores of the scale scores (see Section 3.1). Grades 3, 4, and 5 aggregated showed an ST Math effect of 6.75 points at the Satisfactory or Advanced levels, 1.29 points at the Satisfactory Level, 5.46 points at the Advanced Level, and Z-score of 0.31.

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# 1 Introduction

## 1.1 Background

This is a quasi-experimental analysis at the grade-mean level. Entire grades represent the units of analysis, and outcome measures are the 3-year changes in grade-mean STAAR Satisfactory or Advanced percentages. The treatment grades used the ST Math program for 3 years, beginning in the 2016/17 school year. The study hypothesis is treatment grades using ST Math will outperform similar matched control grades, using their “business as usual” conditions of instructional content and professional development. The control grades were selected to have similar demographic and math attributes (See Figures 2 and 3) to the treatment grades during the baseline year (2013/14), and did not use ST Math in 2016/17, and 2016/17. The treatment grades’ selection pool was all schools using ST Math in grades 3, 4, and 5 in Texas. The control grades’ pool was all schools not using ST Math in grades 3, 4, and 5 in Texas. This study method measures effectiveness of the ST Math program when nominally implemented.

## 1.2 Program Description

The ST Math program is a supplemental math program covering grade-level Texas math standards. The ST Math content consists of visual representations of math standards, concepts, and procedures, presented to students as “Puzzles” of virtual manipulatives, with which they interact to pose solutions. Each time the student poses a solution, the computer visually animates the Puzzle, diagram, or symbols to show why the posed solution correctly solves, or why it does not solve, the math problem (puzzle). The Puzzles are arranged into sequential groups, called “Levels”. To proceed to the next Level in sequence, the student needs to master his/her current Level. Mastering a Level requires solving 100% of the math problems, or Puzzles correctly. In this way, the program is self-paced. Students must correctly solve approximately 4-12 Puzzles, with only 1 failure and retry allowed, to proceed. Levels are sequenced together into Games and, again, the student must master each Game to get to the next Game in sequence. Games are sequenced into “Learning Objectives” (e.g. ‘Fractions Concepts’). The ST Math curriculum of approximately 20-25 Learning Objectives can be rearranged in a year-long, grade-level syllabus to match district math pacing through the school year.

The Puzzles typically start with concrete representations of the math, without abstract symbols, math vocabulary, or even English words. Gradually, through subsequent Levels or Games, abstractions are introduced. For example, a Puzzle might start with “n” green blocks on the screen, and then at a subsequent Level may represent the quantity with the numeral for “n” (no green blocks anymore). In this way, three things are accomplished: i) language proficiency prerequisites to engage with the program are minimal, ii) non-mathematical distractions (e.g. back-stories for word problems) are minimized or eliminated – thereby reducing load on working memory, and iii) the actual math in the problem can be represented clearly, simply, and unambiguously.

Besides the self-paced progress made by students in their one-to-one environment, the program is designed to be referenced by teachers during their regular math instruction. It is supplemental to core or basal math instruction and instructional materials. As the great majority of grade-level math standards are covered in the ST Math digital curriculum, completion of 100% of the entire ST Math curriculum (i.e. completing every Game) is required to cover all grade-level math standards.

Teachers receive initial training, either face to face or through self-guided online instruction. The training covers account startup, as well as math learning and growth mindset goals, the pedagogical

approach to learning in a visual experiential game, monitoring and intervention of the student 1:1 game play, and connecting of ST Math content to classroom content and pacing.

To achieve nominal progress through the program, there is a time-on-task requirement. While student progress rates through the program vary, MIND Research Institute has found that consistent application of 90 minutes per week throughout the school year is sufficient to get most students through at least half of the ST Math Learning Objectives. Students are recommended to use the program in school for at least two 45-minute sessions per week, or 90 minutes per week, over about 35 weeks. Analyses of ST Math usage have shown that consistently following this schedule throughout the school year is usually sufficient to achieve 50% or more Progress through ST Math content. Progress is a percentage of ST Math content coverage, and is defined as Levels completed by the student, divided by the total number of Levels in the curriculum. In addition, MIND's historical analyses have shown that it is necessary to complete at least 50% of the program in order to expect significantly higher performance compared to non-users.

## 2 Data Collection

Since this analysis uses grades as the unit of analysis, and states publish grade-mean state standardized test scores, the data for student math outcomes is collected from each state education agency’s research files (retrieved from state websites). The treatment students use ST Math student accounts served by MIND. Student ST Math usage data is aggregated to grade-level means by MIND.

### 2.1 Proficiency Levels Definition

The following (Tables 1 and 2) is Texas’s proficiency level descriptions:

Proficiency Level	State Proficiency Level Name
L1	Unsatisfactory
L2	Satisfactory
L3	Advanced

Table 1: Proficiency Level Naming (2013/14-2015/16)

Proficiency Level	State Proficiency Level Name
L1	Did Not Meet
L2	Approaches
L3	Meets
L4	Masters

Table 2: Proficiency Level Naming (2016/17)

In order to compare changes in proficiency levels over time, this analysis maps the four new proficiency levels into the three old proficiency levels. Based on their definitions, for 2016/17, the new L1 (Unsatisfactory) is equal to the sum of L1 (Did Not Meet) and L2 (Approaches). Subsequently, the new L2 (Satisfactory) for 2016/17 is equal to L3 (Meets) and the new L3 (Advanced) is equal to L4 (Masters). Moving forward, this analysis will only be comparing proficiency levels L1, L2, L3, as defined by the old STAAR.

### 2.2 Treatment Grades Pool and Selection

The Treatment grades pool originated with all schools and grades using ST Math in Texas. From these schools, every grade that had used the ST Math program for the years 2014/15, 2015/16, and 2016/17 was identified. They comprise the Treatment grades pool for this evaluation of 4-year usage.

#### 2.2.1 Enrollment Filter

Because the analysis uses grade-mean data, such as grade-mean scale scores or grade-mean proficiency level percentages, it is necessary that the program also be a grade-wide treatment, with the great majority of students in each grade receiving treatment. Otherwise, the grade-means reported



by the state of 100% of *tested* students would not be valid measures of a smaller fraction of *treatment* students. MIND’s site implementation requirement is that an entire grade, including all teachers and all classes within that grade, use the ST Math program. We validate how closely this is the case for each individual treatment grade by comparing the number of ST Math student accounts at a grade level to the Texas’s reported enrollment at that grade level. We discard from the Treatment pool any grade with a ratio of ST Math student accounts to reported grade enrollment lower than 85%.

### 2.2.2 Content Coverage Filter

Furthermore, the outcomes measure is a summative year-end test, i.e. Texas’s standardized math assessment (STAAR). The math assessment thus covers all the math standards for that entire grade level. Meanwhile, the ST Math program curriculum (arranged into Learning Objectives) is also aligned to Texas math standards. To infer that the ST Math content is having a valid effect on student outcomes on the summative assessment, we discard any grade with grade-mean of ST Math Progress for its students lower than 50% by year-end.

Progress is a percentage, and is defined as Levels completed by the student, divided by the total number of Levels in the grade-level curriculum. Note that student achievement of at least 50% progress in ST Math is accomplished primarily by teacher assignment of computer session time to students. With sufficient time on task, students make progress. The program helps them self-pace through providing real-time informative feedback for each puzzle.

## 2.3 Control Grades Pool and Selection

The control grades are randomly selected from a control pool of schools in Texas. Though they are randomly selected, they are also matched to be similar to the Treatment grades’ math attributes and demographics during the baseline 2013/14 year. The matched attributes include:

- scale score
- student percentages at each math proficiency level
- percentage of students receiving free or reduced lunch (using the demographic data from MDR).

To mitigate the risk of randomly picking a set of Control grades that generates an outlier for effect, a Monte Carlo approach is used to perform many random picks. The control pool’s size is large enough that there are many possible “picks” of closely matched control grades.

One hundred randomly matched picks are made and sets of matched control grades are generated. For each set, the quality of the match as well as the math growth of the potential control set is evaluated. Some picked sets have high average math growth, some have low average math growth. From the set of all picks, a median pick is chosen. This avoids either an unlikely overestimate, or underestimate, of the Control grades’ growth. When multiple median picks exist, the control set with the minimal math score differences in the baseline year is chosen.

### 3 Data Analysis

The set of all schools and grades using ST Math in Texas is evaluated for Enrollment percentage and Progress percentage parameters. A filtered Treatment set (TRT) of all ST Math grades with  $\geq 85\%$  Enrollment and  $\geq 50\%$  Progress is identified. State math assessment data is tabulated. A matching set of Control grades based on baseline year state math assessment is selected.

Changes in math performance, i.e. the difference in math performance of a grade from a baseline year to the final year, are evaluated and tabulated. Statistical tests of the significance of the difference in math performance changes between Treatment grades and Control grades are performed. Finally, a grade-by-grade disaggregation is performed.

#### 3.1 Z-scores

When states change their state assessment throughout the years, they also change the range of possible scale scores achieved on the exam. This makes it difficult to compare changes in grade mean scale scores across years with a different exam. To deal with this issue, a new Z-score is calculated. For each year being analyzed, by grade, a Z-score takes the difference of the grade mean scale score and the mean of all scale scores statewide for that year, and then divides it by the standard deviation of all scale scores statewide for that year. Here is a fictional example to illustrate the calculation of a Z-score for the 2015/16 exam:

$$\begin{aligned} &\text{School A, Grade 3, Mean scale score: } 300 \\ &\text{Average across all schools statewide, Grade 3: } 350 \\ &\text{Standard deviation across all schools statewide, Grade 3: } 30 \\ \text{Z-score} &= ((\text{School A, Grade 3, Mean scale score}) - (\text{Average across all schools, Grade 3})) / (\text{Standard} \\ &\quad \text{deviation across all schools, Grade 3}) \\ \text{Z-score} &= \frac{300 - 350}{30} = -1.67 \end{aligned}$$

The Z-score is calculated for every grade across all years being analyzed, using the full state data set of Texas schools for the averages and standard deviations. The use of Z-scores is a valid statistical method to normalize any dataset and to enable analysis across otherwise uncomparable exams. In this report, we will include both mean scale scores and their accompanying Z-scores.

#### 3.2 Percentile Ranking

These newly calculated z-scores can then be converted into a percentile ranking. Each percentile ranking shows the grade's performance relative to the others in that year and grade. For example, for a specific grade 3, a percentile ranking of 50 shows that this grade 3 performed at the average of all third grades in the state for that testing year.

### 3.3 Final Treatment and Control

#### 3.3.1 ST Math Grade-Aggregated Implementation ( $\geq 85\%$ Enrollment Grades Only)

**ST Math Percent Grade Mean Progress Distribution – 2016/17**

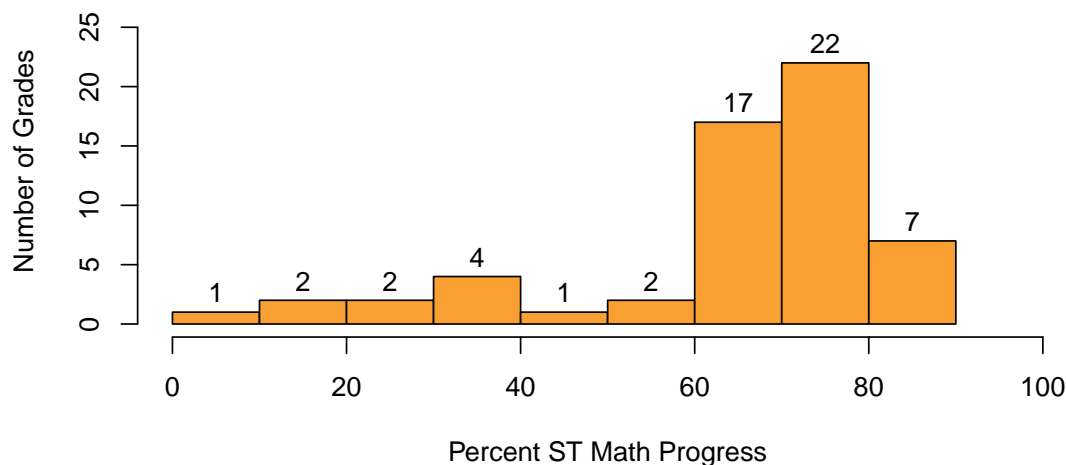


Figure 1: Histogram of ST Math Percent Progress for  $\geq 85\%$  Enrollment Grades 2016/17

For all ST Math grades with Enrollment  $\geq 85\%$ , Figure 1 shows the frequency distribution of grade-average Progress percentage through the program. Note that we will only be using grades with  $\geq 50\%$  Progress as the Treatment Group.

Table 3 provides descriptive statistics of the Progress distribution. Table 4 shows the number of remaining treatment grades after applying enrollment and progress filters.

	Min.	Max.	Average	S.D.
ST Math % Progress	8.8	88.0	64.1	18.7

Table 3: Descriptive Statistics of ST Math Percent Progress for  $\geq 85\%$  Enrollment Grades

Grades with $\geq 85\%$ Enrollment:	58
Grades with in addition $\geq 50\%$ Progress:	48

Table 4: Number of ST Math Grades with  $\geq 85\%$  Enrollment and with  $\geq 50\%$  percent progress

### 3.3.2 Filtering Treatment and Controls

Table 5 shows the total number of grades in the Treatment pool, the number of grades that exceeded the 85% Enrollment figure, and also the 50% Progress filter. Other rows in the table indicate counts of numbers of students (2016/17 from state testing count) and counts of number of schools represented. The number of matched Control (CTRL) grades, students, and schools is also shown.

	Grade 3	Grade 4	Grade 5	Total
ST Math Using Grades	20	21	17	58
ST Math Using Schools	20	21	17	21
ST Math Students	2198	2181	1721	6100
ST Math Grades (Enroll $\geq$ 85%)	20	21	17	58
TRT Grades (Enroll $\geq$ 85% & Prog $\geq$ 50%)	16	16	16	48
TRT Schools (Enroll $\geq$ 85% & Prog $\geq$ 50%)	16	16	16	16
TRT Students (Enroll $\geq$ 85% & Prog $\geq$ 50%)	2045	1957	1846	5848
CTRL Grades	16	16	16	48
CTRL Schools	16	16	15	47
CTRL Students	1659	1448	1867	4974

Table 5: Treatment Pool Filtering and Controls: Counts of Grades, Schools, and Students

### 3.3.3 Match of Controls to Treatment

Figure 2 shows the density plot of the baseline STAAR Math scale scores (left plot) and baseline percent students at STAAR Satisfactory or Advanced (right plot) for treatment grades overlaid on control grades, showing the closeness of the match obtained between Treatment and Control sets of grades in the baseline year, 2013/14.

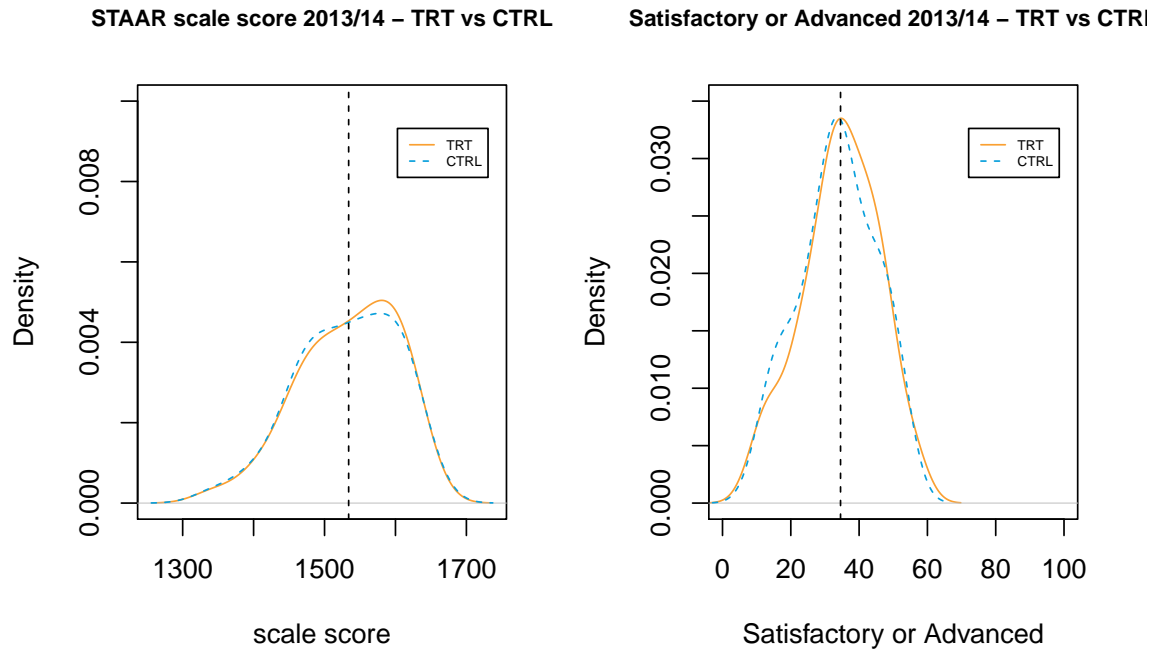


Figure 2: Baseline Year Density Plots Showing Math Scores Match between TRT and CTRL - 2013/14, with the dotted line showing the mean of the TRT set.

Similarly, figure 3 shows the density plot of the percentage of students needing free or reduced lunch for treatment grades overlaid on control grades.

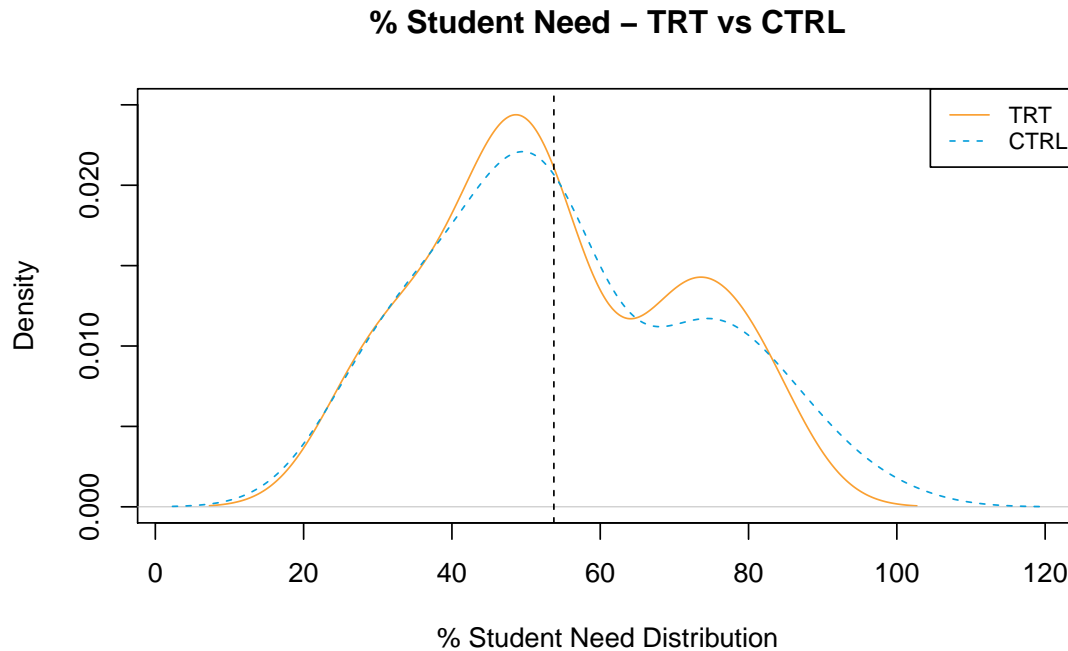


Figure 3: Baseline Year Density Plot Showing Student Need Match between TRT and CTRL, with the dotted line showing the mean of the TRT set.

Table 6 shows the difference of the means of Treatment versus Control in the baseline year, with accompanying p-values, for percent Satisfactory or Advanced, for mean scale score, and for percent of students receiving free or reduced lunch. The large p-values show the differences between the Treatment and Control grades are not statistically significant.

	Mean(TRT)	SD(TRT)	Mean(CTRL)	SD(CTRL)	Estimate	P-Value
Satisfactory or Advanced - 2013/14	34.56	11.35	33.71	11.20	0.85	0.71
Scale score - 2013/14	1534.02	70.08	1531.88	70.88	2.15	0.88
Percent Free or Reduced Lunch	53.75	16.63	54.92	18.23	-1.17	0.74

Table 6: Matching TRT and CTRL

### 3.4 Grade-Aggregated Analysis

Table 7 shows for both Treatment (TRT) and Control (CTRL) aggregation across grades of scale scores, Z-scores, and proficiency level distributions. The far right column also shows the average ST Math Progress for the TRT set.

	# Grades	# Schools	# Students	Scale score	Z-score	Percentile	L1	L2	L3	Satisfactory or Advanced	ST Math Per Comp.
TRT.13.14	48	16	4764	1534.0	0.02	51.35	65.44	19.35	15.21	34.56	-
TRT.14.15	48	16	4792	1549.0	0.45	65.12	55.19	25.42	19.40	44.81	78.55
TRT.15.16	48	16	4934	1566.8	0.48	65.58	49.96	26.96	23.08	50.04	74.86
TRT.16.17	48	16	5226	1574.0	0.37	61.88	47.50	24.33	28.21	52.54	71.77
TRT.Delta	-	-	-	40.0	0.35	10.52	-17.94	4.98	13.00	17.98	-
CTRL.13.14	48	47	4708	1531.9	-0.01	50.29	66.29	17.42	16.29	33.71	-
CTRL.14.15	48	47	4593	1528.0	0.11	53.56	61.75	22.29	15.96	38.25	-
CTRL.15.16	48	47	4676	1541.5	0.07	52.79	58.00	22.79	19.21	42.00	-
CTRL.16.17	48	47	4974	1551.9	0.03	51.67	55.06	21.10	23.83	44.94	-
CTRL.Delta	-	-	-	20.0	0.04	1.38	-11.23	3.69	7.54	11.23	-

Table 7: Yearly Math Proficiency and Counts for TRT and CTRL Grade-Aggregated Datasets

The following chart (Figure 4) shows the changes in percentage of students at each math proficiency level for the grade-aggregated Treatment and Control sets (TRT.delta and CTRL.delta).

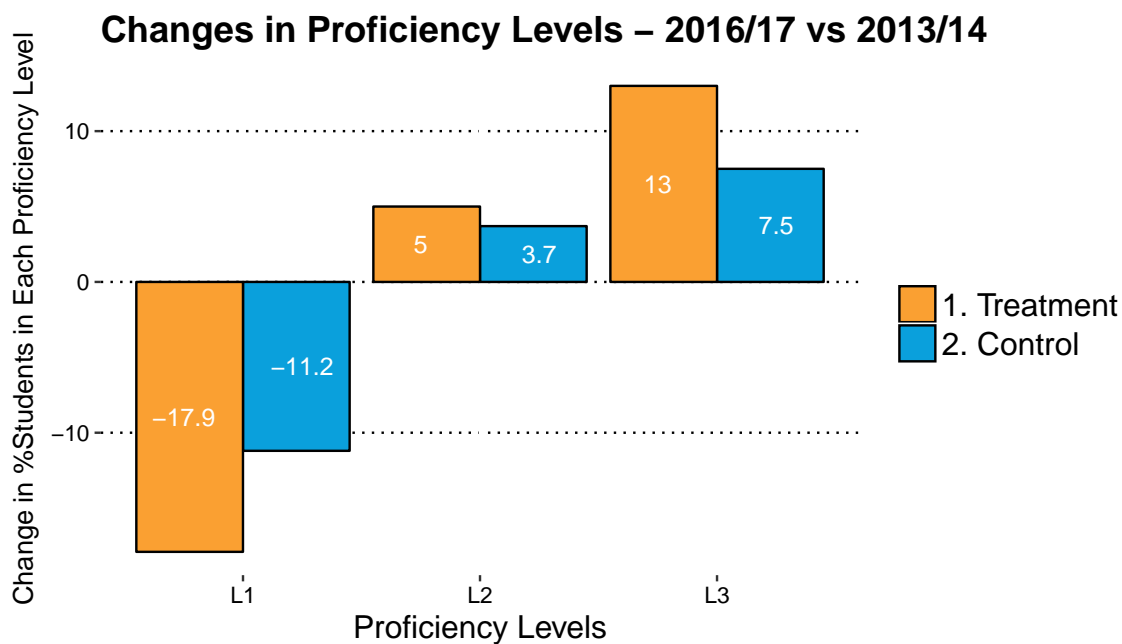


Figure 4: Change at each Proficiency Level for Grade-Aggregated TRT and CTRL Datasets between 2013/14 and 2016/17

Similarly, Figure 5 shows the changes in STAAR Math scale scores and changes in Z-scores for the grade-aggregated Treatment and Control sets.

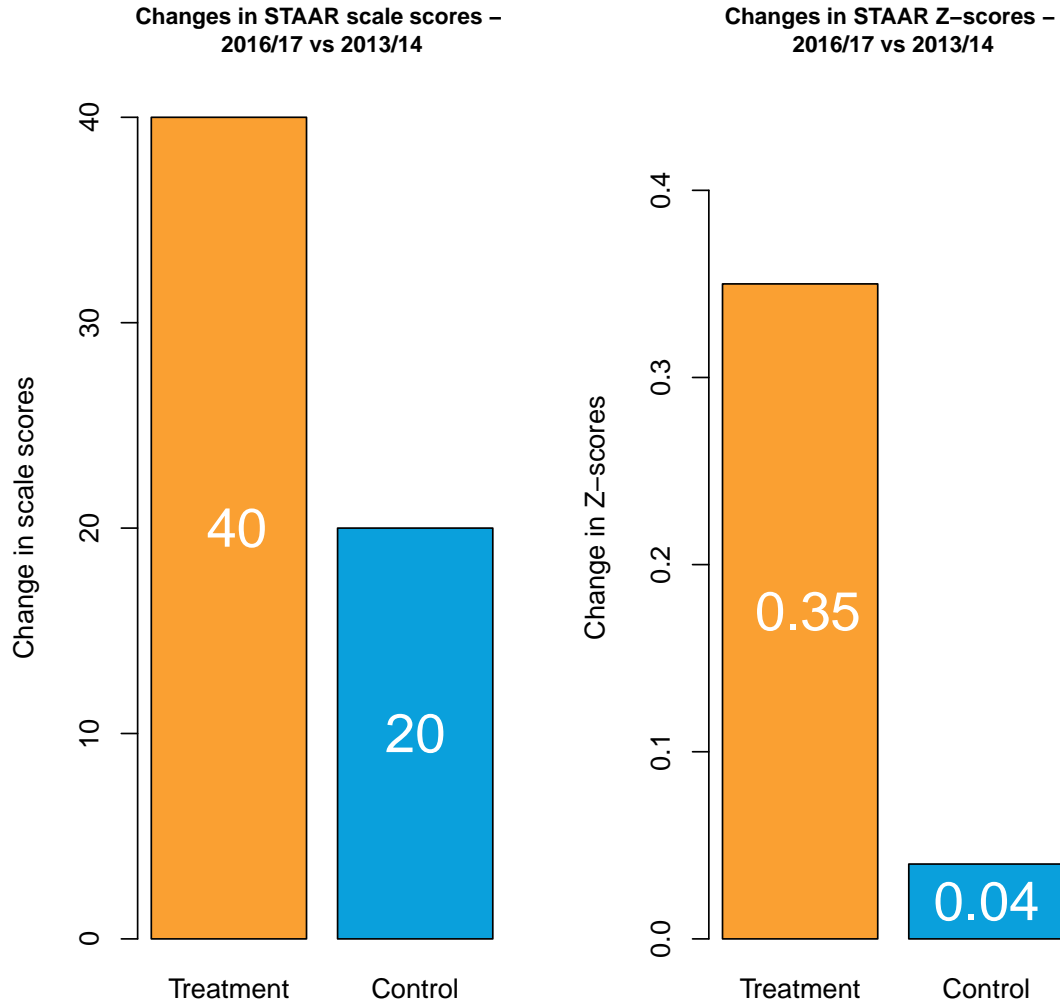


Figure 5: Changes in STAAR Math scale scores and Z-scores (See Section 3.1) for Grade-Aggregated TRT and CTRL datasets between 2013/14 and 2016/17



Further, Figure 6 shows the changes in percent of students at STAAR Satisfactory or Advanced for the grade-aggregated Treatment and Control sets.

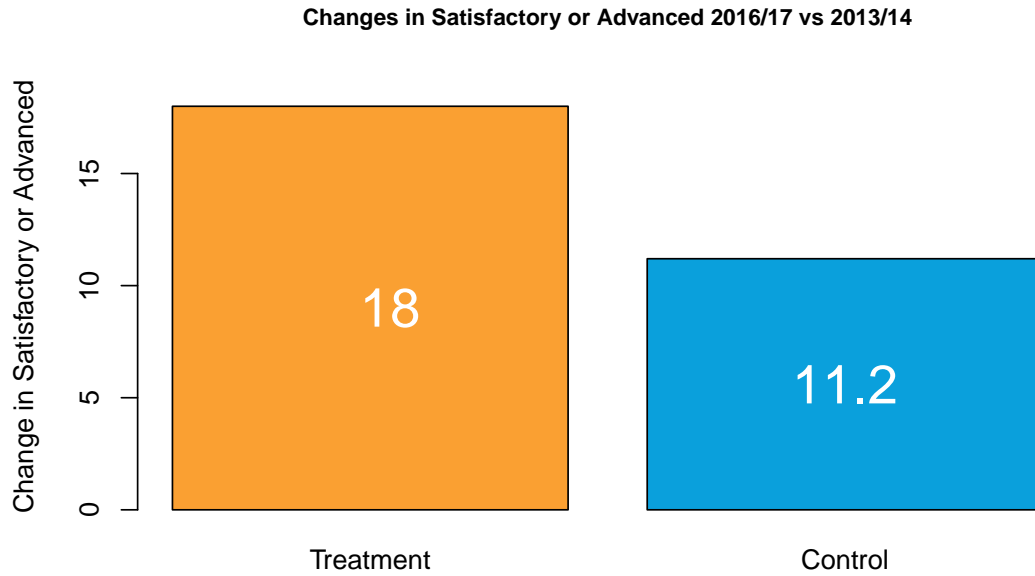


Figure 6: Changes in Satisfactory or Advanced for Grade-Aggregated TRT and CTRL datasets between 2013/14 and 2016/17

Finally, Table 8 shows the statistics for the *differences* in changes between TRT and CTRL (Treatment - Control) for these same STAAR math proficiency and scale score changes as in the above figures. <sup>1</sup>

	Estimate	P-Value	Int.Low	Int.High
Satisfactory or Advanced	6.75	0.03*	0.84	12.66
scale score	20.00	0.04*	0.93	39.07
Z-score	0.31	0.04*	0.02	0.61
L1	-6.71	0.03*	-12.62	-0.80
L2	1.29	0.44	-1.99	4.58
L3	5.46	0.02*	0.89	10.03

Table 8: Statistics for the Differential Changes in Math Scores Growth (TRT - CTRL)

<sup>1</sup>\* statistically significant  $p < 0.05$

Finally, Figure 7 shows the changes in mean percentile ranking between TRT and CTRL.

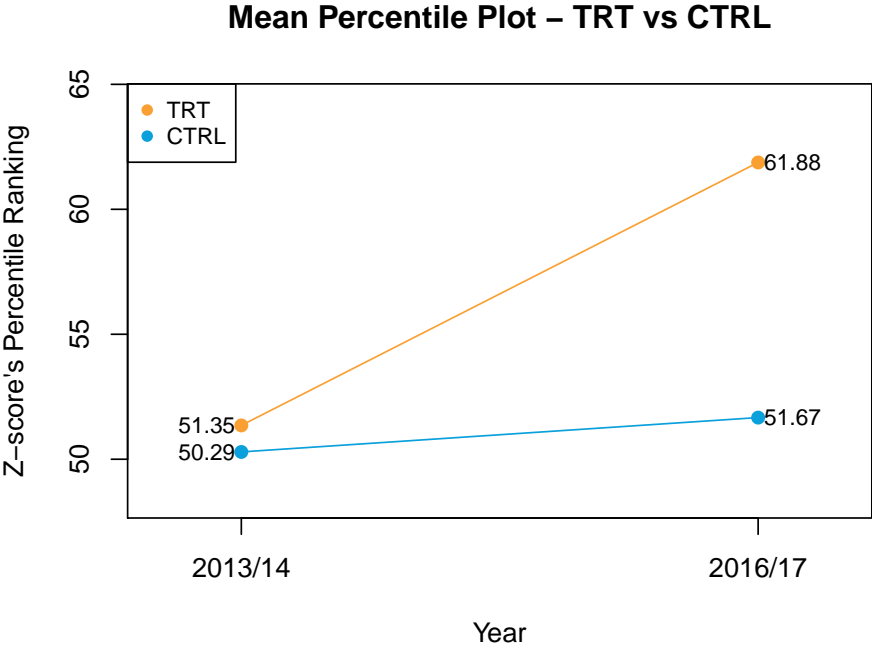


Figure 7: Changes in Percentile Ranking for TRT and CTRL Datasets between 2013/14 and 2016/17

### 3.5 Grade-Level Analysis

#### 3.5.1 Grade Level Result Tables

The following tables (Table 9, 10, and 11) present a disaggregation of results by grade level. The far right column in each table also shows the average ST Math Progress for the TRT set.

	# Grades	# Schools	# Students	Scale score	Z-score	Percentile	L1	L2	L3	Satisfactory or Advanced	ST Math Per Prog.
TRT.13.14	16	16	1628	1457.6	-0.02	50.81	70.12	17.38	12.50	29.88	-
TRT.14.15	16	16	1644	1474.8	0.53	67.19	50.56	30.25	19.19	49.44	-
TRT.15.16	16	16	1668	1496.0	0.61	68.19	46.00	29.75	24.25	54.00	-
TRT.16.17	16	16	1785	1494.6	0.44	62.69	46.12	26.19	27.75	53.94	72.05
TRT.Delta	-	-	-	37.0	0.46	11.88	-24.00	8.81	15.25	24.06	-
CTRL.13.14	16	16	1762	1457.2	-0.02	50.69	70.50	16.94	12.56	29.50	-
CTRL.14.15	16	16	1544	1458.4	0.26	59.25	54.94	28.38	16.69	45.06	-
CTRL.15.16	16	16	1567	1461.6	0.04	51.56	55.31	28.50	16.19	44.69	-
CTRL.16.17	16	16	1659	1469.1	0.03	50.88	54.06	21.19	24.75	45.94	-
CTRL.Delta	-	-	-	11.8	0.05	0.19	-16.44	4.25	12.19	16.44	-

Table 9: Grade 3 - Yearly Math Performance and Counts for TRT and CTRL Datasets

	# Grades	# Schools	# Students	Scale score	Z-score	Percentile	L1	L2	L3	Satisfactory or Advanced	ST Math Per Prog.
TRT.13.14	16	16	1579	1542.6	-0.03	49.00	66.75	19.00	14.25	33.25	-
TRT.14.15	16	16	1629	1561.7	0.55	67.81	59.00	20.19	20.81	41.00	-
TRT.15.16	16	16	1692	1573.1	0.38	62.94	55.19	21.88	22.94	44.81	-
TRT.16.17	16	16	1765	1581.2	0.28	59.25	50.88	20.62	28.56	49.19	72.94
TRT.Delta	-	-	-	38.6	0.32	10.25	-15.88	1.62	14.31	15.94	-
CTRL.13.14	16	16	1254	1535.7	-0.14	45.50	69.50	14.31	16.19	30.50	-
CTRL.14.15	16	16	1348	1531.0	0.05	51.00	68.56	16.50	14.94	31.44	-
CTRL.15.16	16	16	1321	1558.5	0.15	56.00	62.12	15.25	22.62	37.88	-
CTRL.16.17	16	16	1448	1561.3	-0.02	52.06	59.19	17.12	23.69	40.81	-
CTRL.Delta	-	-	-	25.6	0.12	6.56	-10.31	2.81	7.50	10.31	-

Table 10: Grade 4 - Yearly Math Performance and Counts for TRT and CTRL Datasets

	# Grades	# Schools	# Students	Scale score	Z-score	Percentile	L1	L2	L3	Satisfactory or Advanced	ST Math Per Prog.
TRT.13.14	16	16	1557	1601.9	0.11	54.25	59.44	21.69	18.88	40.56	-
TRT.14.15	16	16	1519	1610.5	0.28	60.38	56.00	25.81	18.19	44.00	-
TRT.15.16	16	16	1574	1631.1	0.44	65.62	48.69	29.25	22.06	51.31	-
TRT.16.17	16	16	1676	1646.4	0.40	63.69	45.50	26.19	28.31	54.50	70.32
TRT.Delta	-	-	-	44.4	0.28	9.44	-13.94	4.50	9.44	13.94	-
CTRL.13.14	16	15	1692	1602.7	0.13	54.69	58.88	21.00	20.12	41.12	-
CTRL.14.15	16	15	1701	1594.6	0.03	50.44	61.75	22.00	16.25	38.25	-
CTRL.15.16	16	15	1788	1604.2	0.02	50.81	56.56	24.62	18.81	43.44	-
CTRL.16.17	16	15	1867	1625.3	0.07	52.06	51.94	25.00	23.06	48.06	-
CTRL.Delta	-	-	-	22.6	-0.05	-2.62	-6.94	4.00	2.94	6.94	-

Table 11: Grade 5 - Yearly Math Performance and Counts for TRT and CTRL Datasets

### 3.5.2 Grade-Level Analysis of Changes in Math Satisfactory or Advanced

Figure 8 shows the difference in the growth of percentages of students at math Satisfactory or Advanced, for the TRT and CTRL datasets, disaggregated by grade:

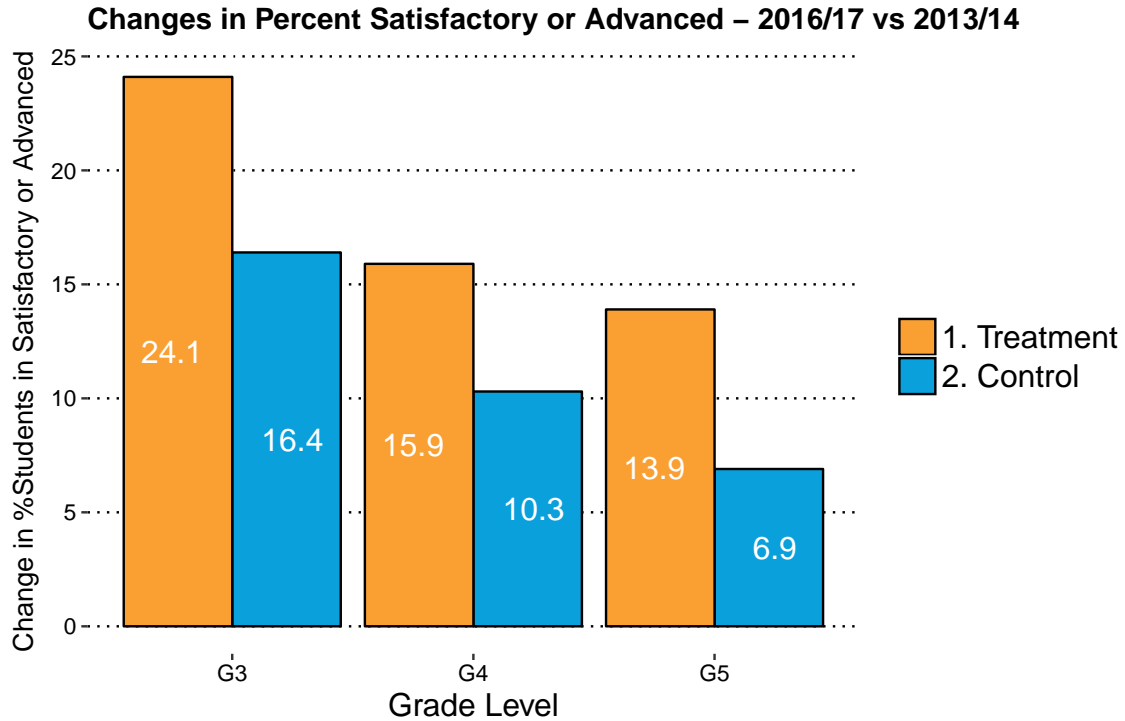


Figure 8: Changes in Percent of Students at Satisfactory or Advanced for TRT and CTRL Datasets between 2013/14 and 2016/17

Table 12 shows the statistics for the *differences* in changes between TRT and CTRL (Treatment - Control) for these same Satisfactory or Advanced math proficiency changes as shown in Figure 8.

	Estimate	P-Value	Int.Low	Int.High
Grade 3	7.62	0.12	-2.07	17.32
Grade 4	5.62	0.35	-6.61	17.86
Grade 5	7.00	0.11	-1.78	15.78

Table 12: Statistics for the Differential Changes in Satisfactory or Advanced, (TRT - CTRL)

### 3.5.3 Grade-Level Analysis of Changes in STAAR Math scale scores

Figure 9 shows the changes in the grade-mean math scale scores of students for the TRT and CTRL datasets, disaggregated by grade:

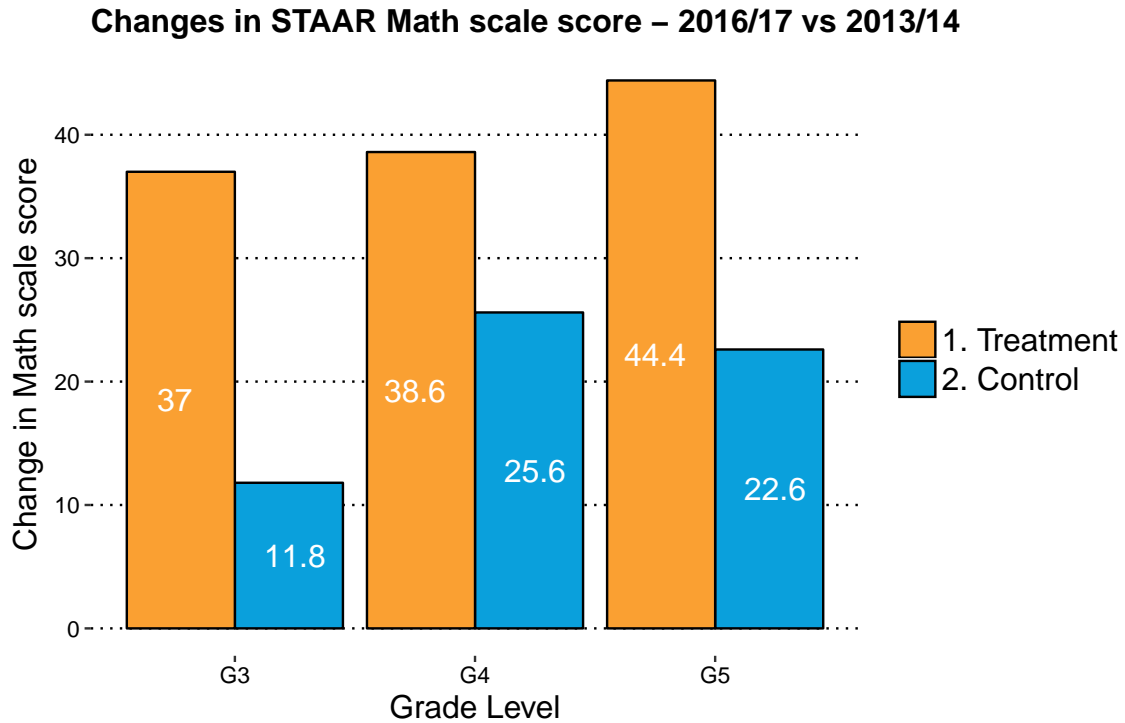


Figure 9: Changes in Grade-Mean STAAR Math scale score for TRT and CTRL Datasets between 2013/14 and 2016/17

Table 13 shows the statistics for the differences between TRT and CTRL (Treatment - Control) for these same STAAR math scale score changes as shown in Figure 9.

	Estimate	P-Value	Int.Low	Int.High
Grade 3	25.19	0.18	-11.94	62.32
Grade 4	13.00	0.49	-25.56	51.56
Grade 5	21.81	0.11	-5.32	48.95

Table 13: Statistics for the Differential Changes in STAAR Math scale scores Growth, (TRT - CTRL)

### 3.5.4 Grade-Level Analysis of Changes in STAAR Z-scores of scale scores

Figure 10 shows the changes in the grade-mean Z-scores of students for the TRT and CTRL datasets, disaggregated by grade:

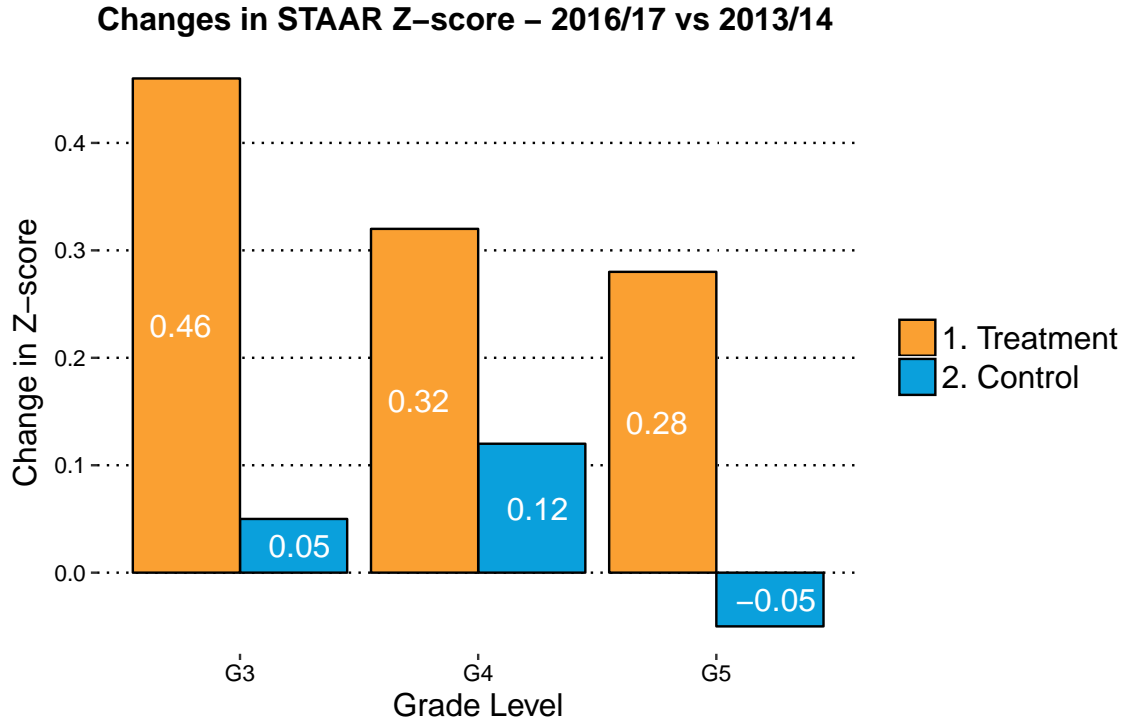


Figure 10: Changes in Grade-Mean STAAR Z-score (See Section 3.1) for TRT and CTRL Datasets between 2013/14 and 2016/17

Table 14 shows the statistics for the differences between TRT and CTRL (Treatment - Control) for these same STAAR Z-score changes as shown in Figure 10.

	Estimate	P-Value	Int.Low	Int.High
Grade 3	0.40	0.17	-0.18	0.98
Grade 4	0.20	0.49	-0.39	0.80
Grade 5	0.33	0.11	-0.08	0.75

Table 14: Statistics for the Differential Changes in STAAR Z-scores (See Section 3.1) Growth, (TRT - CTRL)

## 4 Effect Size

The following table shows the effect sizes for Satisfactory or Advanced, STAAR scale score, and accompanying Z-score.

	Scale score Effect Size	Z-score Effect Size	Satisfactory or Advanced Effect Size
Grade 3	0.53	0.56	0.70
Grade 4	0.33	0.34	0.51
Grade 5	0.84	0.82	0.87
All Grades	0.28	0.53	0.60

Table 15: Cohen’s d Effect Size

## 5 Findings Summary

Texas grades 3, 4, and 5 using ST Math for the year 2016/17 averaged 64.1% ST Math Progress. 48/58 grades (83%) averaged covering more than 50% of ST Math content. Statistically significant differences were found in this analysis for grade-aggregated results. Looking at Table 7, statistically significant differences were found for grade-aggregated Z-score, with an estimate of 0.31 points favorable for the ST Math treatment set, as well as for grade-aggregated Satisfactory or Advanced proficiency levels, with a 6.75 point favorable differential for the ST Math treatment set. Further, in Table 7, grade-aggregated ST Math treatment set outperformed their matched controls at the Advanced level, with a statistically significant difference of 5.46.

## 6 Confounders

Despite best efforts in minimizing confounders to the results of this analysis, there still remain a few input variables that could be significant in affecting differences of state test score outcomes between the Treatment and Control sets. One issue is the lack of randomization of grades chosen to receive the ST Math treatment. Instead of randomized selection, Treatment grades are self-selected. Self-selection can be an indication of districts or schools with a focus on math, an appetite for change, and with a spotlight on math training. Furthermore, not all grades using the ST Math program are chosen for analysis. Each grade must pass two specific filters to be considered for the Treatment set: the first being an enrollment filter of at least 85% of students in each grade using the program, and the second being a progress filter of at least 50% of the program completed on average by students in that grade. These filters might indicate relatively high-functioning schools with a team of relatively effective teachers in that grade, thus resulting in better instruction overall. A mitigation of this possible confounder is our selection of treatment groups on the grade level, rather than the teacher level, so there is no cherry picking of teachers: the full range of teachers in each grade is included. Moreover, the specific teachers may often be the same in the baseline year as in the current year, so the Treatment growth is not due to teacher differences. Finally, a possible confounder lies in the “business as usual” conditions at the matched control grades chosen for each analysis. It’s unknown whether these control grades used other programs that could affect the comparison of the two sets of grades. The Monte Carlo Method is used to mitigate the possibility of control picks being favorable or unfavorable (see Section 2.3).

## 7 Reference Tables Grouped By School Year

The following tables show grade-level details, grouped by school year and for treatment (Table 16) and controls (Table 17) separately.

	# Grades	# Schools	# Students	Scale score	Z-score	Percentile	L1	L2	L3	Satisfactory or Advanced	ST Math Per Comp.
Grade 3 (13.14)	16	16	1628	1457.6	-0.02	50.81	70.12	17.38	12.50	29.88	-
Grade 4 (13.14)	16	16	1579	1542.6	-0.03	49.00	66.75	19.00	14.25	33.25	-
Grade 5 (13.14)	16	16	1557	1601.9	0.11	54.25	59.44	21.69	18.88	40.56	-
All Grades (13.14)	48	16	4764	1534.0	0.02	51.35	65.44	19.35	15.21	34.56	-
Grade 3 (14.15)	16	16	1644	1474.8	0.53	67.19	50.56	30.25	19.19	49.44	-
Grade 4 (14.15)	16	16	1629	1561.7	0.55	67.81	59.00	20.19	20.81	41.00	-
Grade 5 (14.15)	16	16	1519	1610.5	0.28	60.38	56.00	25.81	18.19	44.00	-
All Grades (14.15)	48	16	4792	1549.0	0.45	65.12	55.19	25.42	19.40	44.81	78.55
Grade 3 (15.16)	16	16	1668	1496.0	0.61	68.19	46.00	29.75	24.25	54.00	-
Grade 4 (15.16)	16	16	1692	1573.1	0.38	62.94	55.19	21.88	22.94	44.81	-
Grade 5 (15.16)	16	16	1574	1631.1	0.44	65.62	48.69	29.25	22.06	51.31	-
All Grades (15.16)	48	16	4934	1566.8	0.48	65.58	49.96	26.96	23.08	50.04	74.86
Grade 3 (16.17)	16	16	1785	1494.6	0.44	62.69	46.12	26.19	27.75	53.94	72.05
Grade 4 (16.17)	16	16	1765	1581.2	0.28	59.25	50.88	20.62	28.56	49.19	72.94
Grade 5 (16.17)	16	16	1676	1646.4	0.40	63.69	45.50	26.19	28.31	54.50	70.32
All Grades (16.17)	48	16	5226	1574.0	0.37	61.88	47.50	24.33	28.21	52.54	71.77

Table 16: TRT Grades Detail Sorted by Year

	# Grades	# Schools	# Students	Scale score	Z-score	Percentile	L1	L2	L3	Satisfactory or Advanced	ST Math Per Comp.
Grade 3 (13.14)	16	16	1762	1457.2	-0.02	50.69	70.50	16.94	12.56	29.50	-
Grade 4 (13.14)	16	16	1254	1535.7	-0.14	45.50	69.50	14.31	16.19	30.50	-
Grade 5 (13.14)	16	15	1692	1602.7	0.13	54.69	58.88	21.00	20.12	41.12	-
All Grades (13.14)	48	47	4708	1531.9	-0.01	50.29	66.29	17.42	16.29	33.71	-
Grade 3 (14.15)	16	16	1544	1458.4	0.26	59.25	54.94	28.38	16.69	45.06	-
Grade 4 (14.15)	16	16	1348	1531.0	0.05	51.00	68.56	16.50	14.94	31.44	-
Grade 5 (14.15)	16	15	1701	1594.6	0.03	50.44	61.75	22.00	16.25	38.25	-
All Grades (14.15)	48	47	4593	1528.0	0.11	53.56	61.75	22.29	15.96	38.25	-
Grade 3 (15.16)	16	16	1567	1461.6	0.04	51.56	55.31	28.50	16.19	44.69	-
Grade 4 (15.16)	16	16	1321	1558.5	0.15	56.00	62.12	15.25	22.62	37.88	-
Grade 5 (15.16)	16	15	1788	1604.2	0.02	50.81	56.56	24.62	18.81	43.44	-
All Grades (15.16)	48	47	4676	1541.5	0.07	52.79	58.00	22.79	19.21	42.00	-
Grade 3 (16.17)	16	16	1659	1469.1	0.03	50.88	54.06	21.19	24.75	45.94	-
Grade 4 (16.17)	16	16	1448	1561.3	-0.02	52.06	59.19	17.12	23.69	40.81	-
Grade 5 (16.17)	16	15	1867	1625.3	0.07	52.06	51.94	25.00	23.06	48.06	-
All Grades (16.17)	48	47	4974	1551.9	0.03	51.67	55.06	21.10	23.83	44.94	-

Table 17: CTRL Grades Detail Sorted by Year



## 8 Lists of Schools

### 8.1 Treatment Schools

The following table lists the treatment schools and grades (after 85% enrollment and 50% progress filtering) used in the analysis.

PID	IID	District	School Name	GRADE
4027634	CED5WM	KILLEEN ISD	CEDAR VALLEY EL	3, 4, 5
996459	CLI5WM	KILLEEN ISD	CLIFTON PARK EL	3, 4, 5
2128581	DUN5WM	KILLEEN ISD	DUNCAN EL	3, 4, 5
996497	HAR5WM	KILLEEN ISD	HARKER HEIGHTS	3, 4, 5
2897213	HAY5WM	KILLEEN ISD	HAY BRANCH EL	3, 4, 5
11718474	HAY5WN	KILLEEN ISD	HAYNES EL	3, 4, 5
996540	MEA5WM	KILLEEN ISD	MEADOWS EL	3, 4, 5
3051503	MOU5WM	KILLEEN ISD	MOUNTAIN VIEW E	3, 4, 5
996564	NOL5WN	KILLEEN ISD	NOLANVILLE EL	3, 4, 5
996576	PEE5WM	KILLEEN ISD	PEEBLES EL	3, 4, 5
3244700	REE5WM	KILLEEN ISD	REECES CREEK EL	3, 4, 5
11449336	RIC5WN	KILLEEN ISD	RICHARD E CAVAZ	3, 4, 5
10030736	SKI5WM	KILLEEN ISD	SKIPCHA EL	3, 4, 5
10002052	TIM5WM	KILLEEN ISD	TIMBER RIDGE EL	3, 4, 5
4806571	TRI5WM	KILLEEN ISD	TRIMMIER EL	3, 4, 5
4368799	VEN5WM	KILLEEN ISD	VENABLE VILLAGE	3, 4, 5

Table 18: Treatment Schools (TRT Dataset)

## 8.2 Control Schools

The following table lists the control schools and grades (matched control grades to treatment grades) used in the analysis.

PID	District	School Name	GRADE
996980	ALAMO HEIGHTS I	WOODRIDGE EL	3
1001447	ALVIN ISD	E C MASON EL	3
4949317	ARLINGTON ISD	BECKHAM EL	4
1056777	AUSTIN ISD	ZILKER EL	3
1017006	BLUFF DALE ISD	BLUFF DALE EL	4
5101192	BOLES ISD	BOLES MIDDLE	5
4914805	CHINA SPRING IS	CHINA SPRING IN	4
3051345	CLINT ISD	DESERT HILLS EL	3
1039406	CORPUS CHRISTI	WILSON EL	3
1015503	EL PASO ISD	ALTA VISTA EL	4
1015864	EL PASO ISD	SCHUSTER EL	5
1525998	FORT BEND ISD	DULLES EL	3
4868543	FRISCO ISD	CHRISTIE EL	3
1010553	GARLAND ISD	BULLOCK EL	5
4010760	GLEN ROSE ISD	GLEN ROSE INT	4
1025819	HOUSTON ISD	BURBANK EL	4
1025211	HOUSTON ISD	GARDEN VILLAS E	5
1025522	HOUSTON ISD	GOLFCREST EL	5
1025534	HOUSTON ISD	HARRIS J R EL	4
1024126	HOUSTON ISD	KENNEDY EL	3
1025699	HOUSTON ISD	PLEASANTVILLE E	4
1026100, 11104110	HOUSTON ISD, NORTHSIDE ISD	SCARBOROUGH EL	5, 5
2893085	JOSHUA ISD	PLUM CREEK EL	4
11561570	JUDSON ISD	ROLLING MEADOWS	5
3249114	KATY ISD	LORAIN T GOLBO	5
4918112	LIBERTY HILL IS	LIBERTY HILL IN	5
1050670	LINDALE ISD	E J MOSS INT	4
1045663	LITTLE CYPRESS-	LITTLE CYPRESS	3
1038359	LLANO ISD	LLANO EL	3
2202096	LUBBOCK ISD	WHITESIDE EL	5
1054133	MANSFIELD ISD	ERMA NASH EL	3
1000704	MERIDIAN ISD	MERIDIAN EL	4
1041655	MIDLAND ISD	SOUTH EL	4
997790	NORTH EAST ISD	HARMONY HILLS E	3
1007518	NORTHSIDE ISD	VALLEY HI EL	4
1036703	PARIS ISD	CROCKETT INT	5
1824110	PLANO ISD	THOMAS EL	5
1020625	SHERMAN ISD	JEFFERSON EL	4
2199516	SOCORRO ISD	HORIZON HEIGHTS	3
1027491	SPRING ISD	JOHN WINSHIP EL	4
1526045	SPRING ISD	MILDRED JENKINS	5
1824263	SPRING ISD	PEARL M HIRSCH	3
4748333	TIMPSON ISD	TIMPSON EL	3
1015319	WAXAHACHIE ISD	NORTHSIDE EL	5
3380988	WHITE OAK ISD	WHITE OAK INT	3
1016533	YSLETA ISD	PRESA EL	4
1545261	YSLETA ISD	VISTA HILLS EL	5

Table 19: Matched Control Schools (CTRL Dataset)