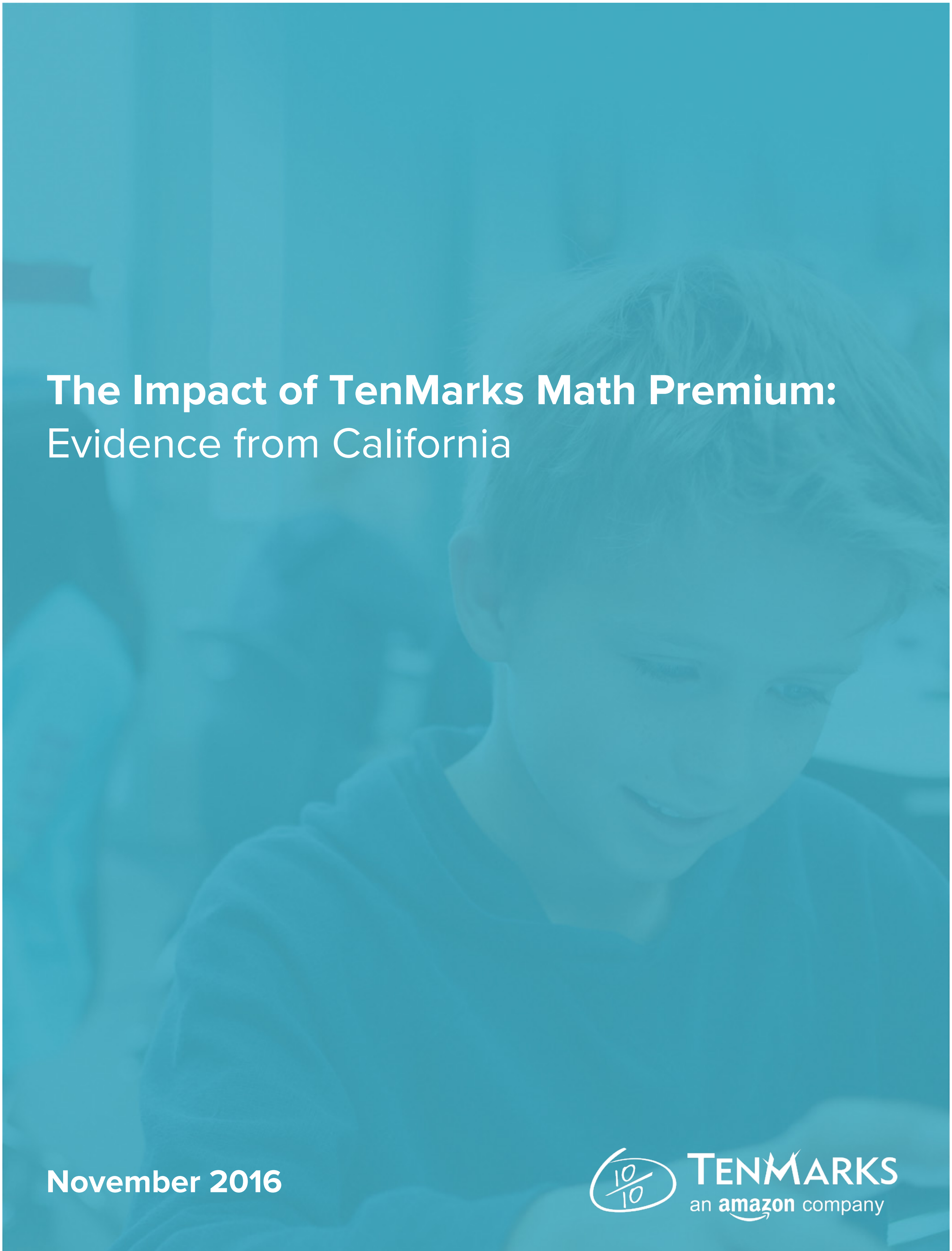

# The Impact of TenMarks Math Premium:
## Evidence from California

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TENMARKS
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# Executive Summary

**Purpose**: This study evaluates the impact of TenMarks Math on student achievement using evidence from TenMarks Math Premium implementations throughout California in the 2015–16 school year and the California Assessment of Student Performance and Progress in mathematics (CAASPP).

**Findings**: The study's findings suggest that providing TenMarks Math Premium raised the proficiency rate on the CAASPP mathematics assessment by 1.7 percentage-points. The findings also suggest that TenMarks Math Premium raised the proficiency rate 5.8 percentage-points in classes that completed at least 2 assignments per week on average during the school year (see Figure 1). For context, the state-wide proficiency rate in California improved four percentage points between 2015 (33% passing) and 2016 (37% passing). The improvement in the pass rate associated with providing TenMarks Math represents a significant amount of *additional* growth in comparison, especially in classes that completed at least 2 assignments per week on average during the school year.

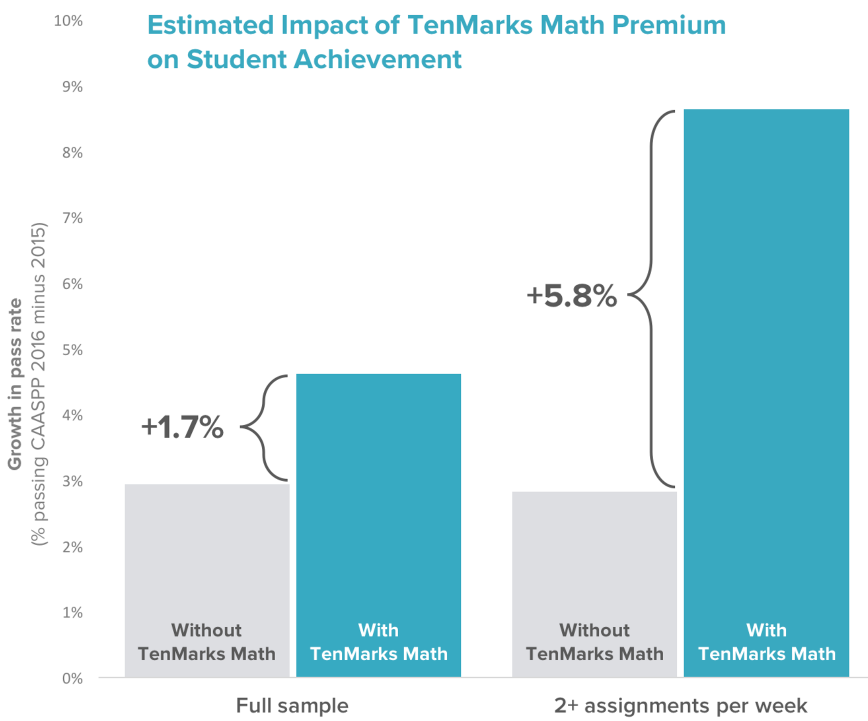


**Figure 1. Estimated impact of TenMarks Math on student achievement growth.** The bars represent the change in the average class-level pass rate on the CAASPP (2016 vs 2015) for the TenMarks Math group (right within each panel) and the comparison group (left within each panel), statistically adjusted at the means of the TenMarks Math group for all baseline characteristics. The difference between the bars (+1.7% for classes provided with TenMarks Math, +5.8% for classes that completed 2+ assignments per week on average) is the estimated impact. That is, it's the additional growth in the average pass rate associated with TenMarks Math. The impact estimates are statistically significant at the 0.1 level (providing TenMarks Math) and .05 level (2+ assignments per week) and are based on an analysis that accounts for two years of prior achievement in math and ELA and a rich set of school-level characteristics.

# I. Research Design

This study provides evidence on the effect TenMarks Math has on raising student achievement using statewide student performance data from the California Assessment of Student Performance and Progress in mathematics (CAASPP). The analysis uses a propensity score matching to compare the average proficiency rate on the CAASPP between classes provided with TenMarks Math during the 2015-16 school year and a matched set of classes not provided with TenMarks Math.[1] The matching design ensures that the TenMarks Math and comparison groups are virtually equivalent in terms of prior achievement in both math and ELA, and that they come from schools that are virtually equivalent in terms of observable school-level characteristics such as the student demogaphics. The research design does not account for potential differences in unobserved characteristics, e.g., potential curricular changes. Nevertheless, researchers have demonstrated that matched comparison designs such as the one employed in this study can provide unbiased, causal estimates of a program's impact, especially when they take prior performance into account (e.g., Dehejia and Wahba 1999).

The matching design works as follows. Groups of students provided with TenMarks Math were matched to groups of students not provided with TenMarks Math. The propensity score matching procedure ensures the two groups are balanced in terms of observable characteristics. The TenMarks Math and comparison groups were matched to balance prior achievement in both math and ELA, prior growth in both math and ELA (based on 2014 and 2015 CAASPP pass rate for the same grade in the same school) and a rich set of school-level characteristics to account for the institutional, demographic and economic profiles of the schools. A regression model was then used to estimate the differential achievement between the TenMarks Math and matched comparison groups. The regression-based adjustment is used to account for any remaining imbalance between the two groups and to increase the precision of the estimates. See Ho, Imai, King & Stuart (2007), Rosenbaum and Rubin (1985) and the Technical Appendix for additional details.

# II. Findings

## Impact Estimates for Providing TenMarks Math

The estimated increase in the pass rate on the 2016 mathematics CAASPP associated with providing TenMarks Math during the 2015-16 school year is 1.7 percentage points. This estimate is based on the provision of TenMarks Math regardless of actual usage or engagement levels by students or teachers. The estimate is statistically significant at the 0.1 level and is based on a matched comparison that is strongly balanced on observed covariates (Table 1, Column 1). The finding is robust to alternative specifications of the matching and regression models.

To better understand the impact of providing TenMarks Math when used with a minimum level of fidelity, a second analysis focuses on the groups of students (classes) in which at least 2 assignments were completed per week, on average. The estimated increase in the pass rate associated with providing TenMarks Math among these higher fidelity groups is 5.8 percentage points. The estimate is statistically significant at the 0.05 level and is based on a matched comparison that is strongly balanced

[1] The study focuses on a paid version of TenMarks Math that includes differentiated student assignments, assessments, and just-in-time interventions embedded into assignments. The unit of analysis in the study is a "class," defined as the entire grade level within a particular school, e.g., the 4th grade at XYZ Elementary.

on observed covariates (Table 1, Column 2). The finding is robust to alternative specifications of the matching and regression models.

Figure 1 displays the impact estimates and provides a simple representation of the matched comparison research design. The bars represent the change in the class CAASPP pass rate (2016 vs 2015) for the TenMarks Math group (right within each panel) and the comparison group (left within each panel), statistically adjusted at the means of the TenMarks Math group for all baseline characteristics. The difference between the bars is the estimated impact. That is, it is the additional growth in the class pass rate associated with TenMarks Math during the 2015-16 school year (+1.7% in the full sample provided with TenMarks Math, +5.8% when the TenMarks Math group completed 2+ assignments per week on average).

In order to gauge the substantive importance of this finding, it is useful to compare the estimated impact of providing TenMarks Math to the actual state-wide pass rates in 2015 and 2016. The state-wide pass rate in California improved four percentage points between 2015 (33% passing) and 2016 (37% passing). The increase in year-on-year growth associated with providing TenMarks Math represents a significant amount of *additional* growth in comparison, especially when students complete at least 2 assignments per week.

**Impact estimates of TenMarks Math on class-level pass rates**

| | Full sample | 2+ assignments |
|---|---|---|
| Impact estimate (standard-error) | 1.68 (0.99)$^{+}$ | 6.92 (2.85)* |
| Tested students (classes) | 49,000 (N = 428) | 5,000 (N = 62) |
| Grade levels | 3,4,5,6,7 | 3,4,5,6 |
| **Balance between TenMarks Math and matched comparison groups** | | |
| Prior math achievement (% passing 2015) | 0.00 | -0.01 |
| Prior math achievement (% passing 2013) | 0.00 | 0.00 |
| Prior ELA achievement (% passing 2015) | 0.04 | -0.01 |
| Prior ELA achievement (% passing 2013) | 0.04 | 0.08 |

**Table 1. Impact estimates and balance statistics for selected covariates.** Notes: ** significant at the 0.01 level * significant at the 0.05 level, $^{+}$ significant at the 0.1 level. Standard errors are cluster-adjusted at the school level to account for within-school correlations. Balance statistics are reported as the standardized mean difference (SMD) between TenMarks Math and the comparison group. Sample sizes reflect the total number of groups: classes provided with TenMarks Math and the matched comparisons. The number of students tested in 2016 within these groups is rounded to the nearest hundred. All grade levels with sufficient data were included in the analysis: grades 3 through 7 in the full sample analysis and grades 3 through 6 in the analysis of grades-within-schools averaging 2+ assignments per week.

### Assessing Baseline Equivalence

The What Works Clearinghouse (WWC) considers comparison groups as meeting baseline equivalence if the standardized mean difference (SMD) for each of their baseline characteristics is below 0.25 and a statistical adjustment is applied in the analysis (WWC Version 3.0). The SMD between the TenMarks Math and comparison groups meets the WWC baseline equivalence standard for every characteristic considered in the model: achievement in both math and ELA in 2014 and 2015 at the class level, and total enrollment, the student-teacher ratio, charter school status, magnet school status percentage of students eligible for a FRL, percentage of African American students, percentage of Hispanic students, and percentage of Asian students at the school level. Table 1 displays the SMD between the TenMarks Math and comparison group for prior achievement and prior growth in both math and ELA.

# III. Technical Appendix

## A. Data Sources and Definitions

**California Assessment of Student Performance and Progress (CAASPP)**

The CAASPP is California's assessment system for student achievement. CAASPP administers the Smarter Balanced (SBAC) tests to assess mathematics and ELA achievement in grades 3-8 and 11 each spring.

The California Department of Education (CDE) provides publically available datasets of CAASPP results for each grade, within every school in the state (e.g., 4$^{th}$ grade students at XYZ Elementary, 5$^{th}$ grade students at XYZ Elementary, and so on). These CAASPP datasets constitute the primary source of information on student achievement.[2]

Students performance on the CAASPP is measured as a scale score, which is then used to determine each student's achievement level based on cut scores determined by the state. The CAASPP defines four achievement levels, and considers achievement at Level 3 (meeting the standard) or Level 4 (exceeding the standard) as a passing score (see Table 2).

| Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|
| The student **did not meet** the grade standard for mathematics needed for likely success in future coursework. | The student **nearly met** the grade standard for mathematics needed for likely success in future coursework. | The student has made progress and **met** the grade standard for mathematics. | The student has made progress and **exceeded** the grade standard for mathematics. |

**Table 2. Achievement levels and descriptions for the CAASPP mathematics assessment.**
Source: http://caaspp.cde.ca.gov/sb2016/UnderstandingCAASPPReports

Consistent with the state's definition of Levels 3 and 4 as meeting the standard, the measure of student achievement used in this study is the percentage of students passing the mathematics CAASPP.

[2] http://caaspp.cde.ca.gov/sb2016/ResearchFileList

Consistent with the state's reporting format, the unit of analysis is the class (e.g., 4th grade students at XYZ Elementary, 5th grade students at XYZ Elementary, and so on).

**TenMarks Math**

Since the CDE reports CAASPP performance for each grade within every school rather than for each classroom within every school, the analysis defines the provision and use of TenMarks Math at the class level (e.g., the 4th grade at XYZ Elementary). A class is considered to have been provided with TenMarks Math if TenMarks Math licenses were provided to at least 85% of the students in that grade. On average, the TenMarks Math students in these grades completed just over 1 assignment per week during the 2015-16 school year.

A class provided with TenMarks Math is considered to have higher fidelity usage if TenMarks Math users in that grade averaged 2 or more assignments completed per week. On average, the TenMarks Math students in these grades completed just over 2.5 assignment per week during the 2015-16 school year.

**School-level covariates**

The analysis accounts for institutional, economic, and demographic factors at the school level that are potentially correlated with both TenMarks Math provision (treatment status) and CAASPP performance. School-level data are drawn from the most recent Public Elementary/Secondary School Universe Survey (2013-14) provided by the National Center for Education Statistics (NCES) Common Core of Data (CCD).[3] The study uses the following school-level variables from the NCES CCD data set:

- **Institutional characteristics:** school size (total enrollment), student-teacher ratio, charter school status, magnet school status
- **Economic characteristics:** percentage of students eligible for a free lunch, percentage of students eligible for a reduced lunch
- **Demographic characteristics**: percentage of African American students, percentage of Hispanic students, percentage of Asian students

## B. Matching Design and Statistical Model

The study combines propensity score and Mahalanobis distance metrics based on Rosenbaum and Rubin (1985) and Rubin and Thomas (2000) as follows. The propensity score was estimated using a logistic regression on the full set of covariates listed above. Potential matches were identified as having an exact match by grade level and falling within a caliper of 0.25 standard deviations on the propensity score. Matches were then created using Mahalanobis distance matching on math achievement in 2013 and 2015 in order to improve balance on these covariates in particular, since they are the most highly correlated with the outcome measure. Prior achievement is taken as the class pass rate for the same grade the prior year (i.e., an analysis of repeated cross-sections). Matching was done 1:1 (one comparison unit for each TenMarks Math unit), with replacement (the same comparison unit can be used more than once) and with ties broken deterministically, using the Matching package in R (Sekhon 2011).

[3] https://nces.ed.gov/ccd/pubschuniv.asp includes the datasets and variable definitions.

The impact on 2016 CAASPP pass rates was estimated via an OLS regression using the matched sample and the covariates listed above to provide additional bias adjustments and improve the precision of the estimates. Standard errors were clustered to account for within-school correlation. Because the matching and regression-based adjustments account for prior scores, the impact on 2016 achievement can be interpreted as impact on growth in the pass rate from the 2015 baseline. As in the matching procedure, prior achievement in the regression model is defined as the class pass rate for the same grade the prior year.

A cohort analysis that accounts for the class pass rate for the *prior* grade in the prior year in both the matching and regression stages (i.e., a panel analysis) was also conducted and led to substantively similar findings. An analysis of repeated cross-sections was preferred, however, given its advantage of accounting for multiple years of prior performance.

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