The Impact of TenMarks Math Premium:
Evidence from Florida

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Executive Summary

Purpose: This study evaluates the impact of providing TenMarks Math Premium on student achievement using evidence from the 2016 Florida Standards Assessments in mathematics (FSA).

Findings: Providing students with TenMarks Math Premium is associated with an average improvement of 4.5 percentage points in the pass rate on the 2016 mathematics FSA (Figure 1). These additional gains are equivalent to moving a group of students from the 52nd to the 60th percentile of classes in the state. The study also finds an average improvement of 4.4 percentage points in the pass rate associated with providing TenMarks Math Premium in schools with significant enrollments of English Language Learners and an average improvement of 6.0 percentage points in schools with significant enrollments of students eligible for a free or reduced-priced lunch (Figure 2). The findings are statistically significant and are based on an analysis that accounts for two years of prior achievement and a rich set of school-level characteristics. The study sample consists of 274 classes, representing approximately 33,000 students in grades 3 through 8.[1]

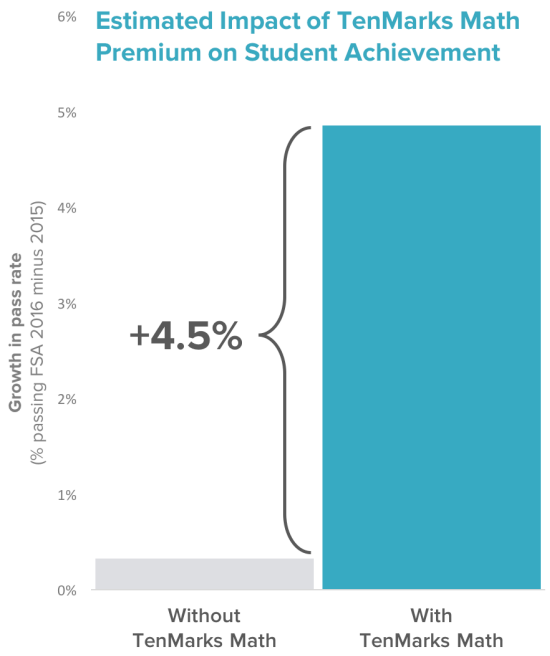

Figure 1. Estimated impact of TenMarks Math Premium on the student achievement growth. The bars represent the average change in the class pass rate (2016 versus 2015) for the TenMarks Math Premium group (right) and the matched comparison group (left), statistically adjusted at the means of the TenMarks Math Premium group for all baseline characteristics. The difference between the bars (+4.5%) is the estimated impact—i.e., the average improvement in the class pass rate—associated with providing TenMarks Math Premium during the 2015–16 school year. The impact estimate is statistically significant at the .01 level and is based on a matched comparison research design that accounts for two years of prior achievement in math and ELA as well as for school-level characteristics such as school size, student demographics, and the percentage of students eligible for a free or reduced-price lunch

I. Research Design

This study provides evidence on the impact of TenMarks Math Premium on student achievement using statewide data from the Florida Standards Assessment and a matched comparison research design. The design uses a technique called *propensity score matching* to compare math achievement on the 2016 FSA between classes provided with TenMarks Math Premium during the 2015–16 school year and a matched set of classes not provided with TenMarks Math Premium.[1] The study sample consists of 274 classes, representing approximately 33,000 Florida students in grades 3 through 8.

The goal of the matching design is to make an apples-to-apples comparison between the TenMarks Math Premium and comparison groups. It does so by ensuring the two groups have "baseline equivalence" of observable characteristics, including two years of prior achievement (see the What Works Clearinghouse (2014) and the Technical Appendix of this document). Crucially, the matching design in this study ensures baseline equivalence in math and ELA performance on the FSA for the two years prior to the study period. The matching design also ensures that the TenMarks Math Premium and comparison groups are apples-to-apples in terms of school characteristics, including total enrollment, student-teacher ratio, charter school status, magnet school status, percentage of students eligible for a free or reduced-price lunch, percentage of African American students, percentage of Hispanic students, and percentage of Asian students. A regression model was used to account for residual 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 of this document.

The main limitation of matching designs is they do not guarantee equivalence of unobserved characteristics such as curricular decisions or student motivation. Nevertheless, researchers have demonstrated that matching 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).

II. Findings

Impact in the Full Sample

The estimated impact on the pass rate associated with providing TenMarks Math Premium during the 2015–16 school year is a 4.5 percentage-point improvement. The estimate is statistically significant at the .01 level and is based on a matched comparison of 274 classes, representing approximately 33,000 students (Table 1, Column 1).

The left panel of Figure 1 displays the impact estimate and provides a simple representation of the research design. The bars represent the average change in math proficiency from 2015 to 2016 for the TenMarks Math Premium group (+4.8%) and the matched comparison group (+0.3%), statistically adjusted at the means of the TenMarks Math Premium group for all baseline characteristics. Given that the two groups started from an equivalent baseline, including math performance the prior two years, and given that the gains are statistically adjusted for a substantial number of potentially confounding

[1] The study focuses on a paid version of TenMarks Math Premium 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 students at XYZ Elementary.

variables, the differential gains between the groups (+4.5 percentage points) are interpreted as the impact of providing TenMarks Math Premium. That is, it's the additional improvement in the pass rate associated with providing TenMarks Math Premium.

Impact estimates of TenMarks Math Premium on class pass rates			
	Full sample	**ELL**	**FRL**
Impact estimate (standard-error)	4.53 (1.35)**	4.44 (1.92)*	6.02 (1.86)**
Tested students (classes)	33,000 (N = 274)	13,300 (N = 122)	12,300 (N = 124)
Grade levels	3, 4, 5, 6, 7, 8	3, 4, 5	3, 4, 5, 6

Table 1. Impact estimates for providing TenMarks Math Premium on the class pass rate.
Notes: ** significant at the .01 level * significant at the .05 level. Standard errors are cluster-adjusted at the school level to account for within-school correlations. Sample sizes reflect the total number of groups: classes provided with TenMarks Math Premium and the matched comparisons. The number of students tested is rounded to the nearest hundred. All grade levels with sufficient data were included in the analysis: grades 3 through 8 in the full sample analysis, grades 3 through 5 in the ELL analysis, and grades 3 through 6 in the FRL analysis.

How significant is a 4.5 percentage-point improvement in the pass rate? Imagine all classes in the state (the 4th grade at XYZ Elementary, the 7th grade at ABC Middle, and so on) lined up by math proficiency on the 2016 mathematics FSA. The group of students in the middle of that line (the class at the 50th percentile in the state) had 54% of students passing. The improvement associated with providing TenMarks Math Premium is about equivalent to moving a group of students from the 52nd to the 60th percentile in the state, ahead of the next 8% of classes in the state.

Subgroup Analyses

This section presents estimates for the impact of providing TenMarks Math Premium in schools with significant populations of English Language Learners (ELL) and significant populations of students eligible to receive a free or reduced-price lunch (FRL). Schools with over 16% of enrolled students classified as English Language Learners (ELL) are identified as having significant ELL populations. This represents the top 25% of schools in the state in terms of ELL enrollment (the median is 7% ELL). Schools in which over 81% of enrolled students are eligible for FRL are identified as having significant populations of students living in poverty. This represents the top 25% of schools in the state in terms of the enrollment of students eligible for FRL (the median is 64%).

Providing TenMarks Math Premium in schools with significant ELL populations is estimated to have improved the pass rate by 4.4 percentage points on the 2016 mathematics FSA. The estimate is statistically significant at the .05 level and is based on a matched comparison of 122 classes, representing approximately 13,300 students (Table 1, Column 2). Providing TenMarks Math Premium in schools with significant FRL populations is estimated to have improved the pass rate by 6.0 percentage points on the 2016 mathematics FSA. The estimate is statistically significant at the .01 level and is based on a matched comparison of 124 classes, representing approximately 12,300 students (Table 1, Column 3).

The left panel of Figure 2 displays the impact estimates and provides a simple representation of the research design for the subgroup analysis of schools with significant ELL populations. The bars represent the average change in math proficiency from 2015 to 2016 for the TenMarks Math Premium group (+5.3%) and the matched comparison group (+0.9%), statistically adjusted at the means of the TenMarks Math Premium group for all baseline characteristics. The difference between them (+4.4 percentage points) is interpreted as the impact of providing TenMarks Math Premium in schools with significant ELL populations. That is, it's the additional improvement in the pass rate associated with providing TenMarks Math Premium in these schools and is about equivalent to moving a group of students from the 47th to the 54th percentile, ahead of the next 7% of classes in the state.

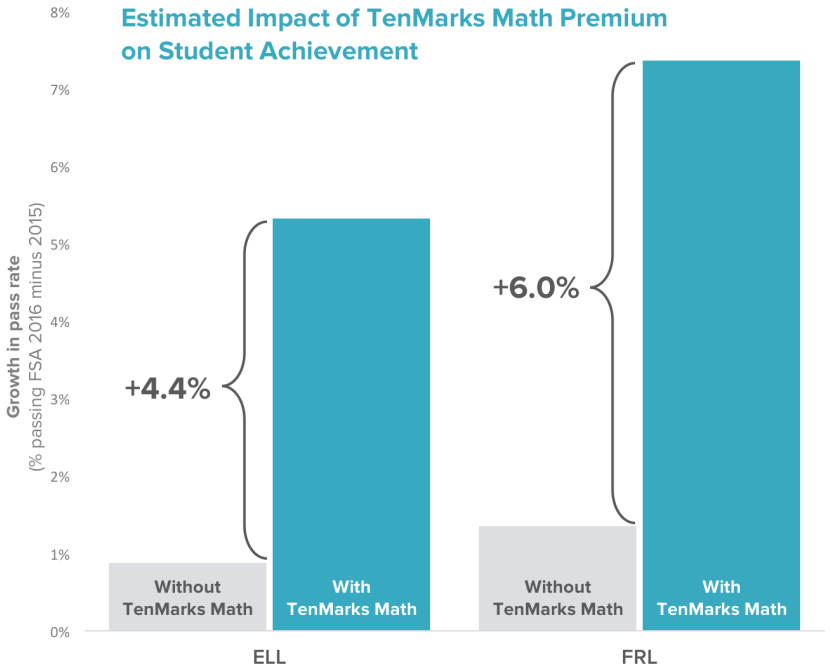

Figure 2. Estimated impact on student achievement growth of providing TenMarks Math Premium in schools with significant ELL enrollments (left) and FRL enrollments (right). The bars represent the change in the class FSA pass rates (2016 versus 2015) for the TenMarks Math Premium group (right bar within each panel) and the comparison group (left bar within each panel), statistically adjusted at the means of the TenMarks Math Premium group for all baseline characteristics. The difference between the bars (+4.4% in the ELL panel, +6.0% in the FRL panel) is the estimated impact—i.e., the average improvement in the class pass rate—associated with providing TenMarks Math Premium during the 2015–16 school year. The impact estimates are statistically significant at the .05 level (ELL) and .01 level (FRL) and are based on a matched comparison research design that accounts for prior achievement in math and ELA, prior growth in math and ELA, and a rich set of school-level characteristics.

The right panel of Figure 2 displays the impact estimates and provides a simple representation of the research design for the subgroup analysis of schools with significant FRL populations. The bars represent the average change in math proficiency from 2015 to 2016 for the TenMarks Math Premium group (+7.4%) and the matched comparison group (+1.4%), statistically adjusted at the means of the TenMarks Math Premium group for all baseline characteristics. The difference between them (+6.0 percentage points) is interpreted as the impact associated with providing TenMarks Math Premium in schools with

significant FRL populations. That is, it's the additional improvement in the pass rate associated with providing TenMarks Math Premium in these schools and is about equivalent to moving a group of students from the 32nd to the 42nd percentile, ahead of the next 10% of classes in the state.

Assessing Baseline Equivalence

The What Works Clearinghouse (WWC) considers comparison groups as meeting baseline equivalence if the standardized mean difference (SMD) for pre-test measures is within 0.25 standard deviations and a statistical adjustment is applied in the analysis (WWC Procedures and Standards Handbook Version 3.0; WWC Review Protocol for Primary Mathematics Version 3.1). This study's analytic sample meets the baseline equivalence standard by ensuring the SMD for pre-test measures are well within 0.25 standard deviations. The study exceeds the WWC standard by also ensuring that the SMD for *every* school-level characteristic considered in the model is within 0.5 standard deviations: total enrollment, the student-teacher ratio, charter school status, magnet school status, percentage of students eligible for a free or reduced-price lunch, percentage of African American students, percentage of Hispanic students, and percentage of Asian students at the school level. Baseline equivalence was assessed separately for the full sample and each of the two subgroup analyses. Table 3 in the Technical Appendix provides the SMDs for two years of prior achievement in math and ELA as well as for the propensity scores.

III. Technical Appendix

A. Data Sources and Definitions

Florida Standards Assessment

The Florida Standards Assessment in Mathematics (FSA) is administered to students in grades 3–8 each spring. The Florida Department of Education (FDOE) provides publically available data sets of FSA results for each grade, within every school in the state (e.g., 4th grade students at XYZ Elementary, 5th grade students at XYZ Elementary, and so on). These FSA data sets constitute the primary source of information on student achievement.[2]

Level 1	Level 2	Level 3	Level 4	Level 5
Inadequate: Highly likely to need substantial support for the next grade or course.	**Below Satisfactory:** Likely to need substantial support for the next grade or course.	**Satisfactory**: May need additional support for the next grade or course.	**Proficient**: Likely to excel in the next grade or course.	**Mastery**: Highly likely to excel in the next grade or course.

Table 2. Performance levels and descriptions for the Florida Standards Assessment. Student performance falls into one of five performance levels, based on score ranges determined by the state. Source: http://www.fsassessments.org

Student performance on the FSA is measured as a scale score, which is then used to determine each student's achievement level based on cut scores. The FSA defines five achievement levels, and considers

[2] http://www.fldoe.org/accountability/assessments/k-12-student-assessment/results/2016.stml

a student with the minimum scale score in the Level 3 achievement as a passing score.[3] Consistent with the state's definition of Levels 3 through 5 as constituting a passing score, the measure of student achievement used in this study is the percentage of students passing the mathematics FSA. 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 Premium

Consistent with the state's reporting of student performance at the class level, the analyses in this study define TenMarks Math Premium provision at the class as well (e.g., for the 4th grade at XYZ Elementary, the 5th grade at XYZ elementary, and so on). A class is considered to have been provided with TenMarks Math Premium if TenMarks Math Premium licenses were provided to at least 85% of tested students in that class. On average, the TenMarks Math Premium students in the TenMarks Math Premium classes completed just over one 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 Premium provision (treatment status) and FSA 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).[4] The study uses the following school-level variables from the NCES CCD data set:

- **Institutional characteristics:** 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, urban locale
- **Demographic characteristics**: percentage of African American students, percentage of Hispanic students, percentage of Asian students

School-level statistics on ELL enrollment were drawn from databases provided by the Florida DOE.[5]

B. Matching Design and Statistical Model

The study uses caliper matching that combines propensity score and Mahalanobis distance metrics, following Rosenbaum and Rubin (1985) and Rubin and Thomas (2000). 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 2014 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

[3] http://www.fsassessments.org/wp-content/uploads/2015/09/Understanding-FSA-Reports-2016-051016-Final.pdf
[4] https://nces.ed.gov/ccd/pubschuniv.asp includes the data sets and variable definitions.
[5] http://www.fldoe.org/accountability/data-sys/edu-info-accountability-services/pk-12-public-school-data-pubs-reports/archive.stml includes the data sets and variable definitions.

1:1 (one comparison unit for each TenMarks Math Premium 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). The balance statistics are reported in Table 3.

Balance between TenMarks Math Premium and matched comparison groups

	Full sample	ELL	FRL
Prior math achievement (% passing 2015)	0.01	–0.001	0.04
Prior math achievement (% passing 2014)	0.03	0.03	0.06
Prior ELA achievement (% passing 2015)	–0.04	–0.09	0.05
Prior ELA achievement (% passing 2014)	–0.03	–0.11	0.06
Propensity Score	0.03	0.08	0.08

Table 3. Balance Statistics for Prior Achievement and Propensity Scores. Balance statistics are reported as the standardized mean difference (SMD) between the TenMarks Math Premium and the comparison groups, based on the variance of the treatment observations for prior achievement and the pooled variance for propensity scores. The What Works Clearinghouse (WWC) considers comparison groups as meeting baseline equivalence if the standardized mean difference (SMD) for pre-test measures is within 0.25 standard deviations and a statistical adjustment is applied in the analysis (WWC Procedures and Standards Handbook Version 3.0; WWC Review Protocol for Primary Mathematics Version 3.1).

The impact on 2016 FSA pass rates was estimated via an OLS regression using 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 also interpreted as an impact on growth 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.

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