Progressive Mathematics Initiative: Adams 50 Evaluation

Prepared for the Center for Teaching and Learning

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In the following report, Hanover Research studies the effects of implementing the Progressive Mathematics Initiative (PMI) in the schools of Westminster, Adams County 50 (Adams 50), in Colorado. This study combines two forms of analyses on the effects of PMI implementation on mathematical assessment outcomes: longitudinal analysis evaluating student progress after one year of PMI participation and regression analysis comparing Adams 50 to non-PMI districts in Colorado.

HANOVER RESEARCH

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Executive Summary and Key Findings

In this report, Hanover Research studies the effects of implementing the Center for Teaching and Learning's (CTL's) Progressive Mathematics Initiative (PMI) in the schools of the Westminster, Adams County 50 (Adams 50) School District, in Colorado. This study combines two forms of analysis on the effects of PMI implementation on mathematical assessment outcomes. Section II discusses student-level longitudinal analyses that evaluate the progress of Adams 50 students on the Transitional Colorado Assessment Program (TCAP) and Scantron Math assessments after one year of PMI participation. Section III analyzes the school-grade level effects of PMI implementation on students' TCAP outcomes in Adams 50 relative to other Colorado public school districts that have not implemented PMI.

Key Findings

- **Over the past three years, Adams 50 students who scored at or above the "proficient" level on the TCAP Math assessment has increased relative to similar districts in the state.** Specifically, 43 percent of Adams 50 students scored at or above "proficient" in 2012, growing to 46 percent in 2013 and 48 percent in 2014. Meanwhile, math proficiency in the rest of the state and among similar districts that have not implemented PMI remained unchanged, at approximately 60 percent and 48 percent, respectively.
- **On average, PMI implementation has increased the percentage of Adams 50 students at or above "proficient" on the TCAP by 5.8 percentage points relative to peer districts in Colorado.** However, there is no significant effect of PMI implementation on this outcome when comparing Adams 50 to all other districts in Colorado.
- **Adams 50 students at the elementary and middle school levels progressed significantly on the TCAP Math assessment after participating in PMI.** In the elementary grades (Grades 3-5), PMI implementation increased the percentage of students that scored at or above "proficient" by 10.5 percentage points and at or above "partially proficient" by 4.8 percentage points. In the middle school grades (Grades 6-8), PMI implementation increased the percentage of students that scored at or above "proficient" by 8.8 percentage points and at or above "partially proficient" by 5.5 percentage points. However, we find no effect of PMI on math performance at the high school level.
- **Students in earlier grades exhibited higher levels of progress on the TCAP and Scantron math assessments following PMI participation than students in later grades.** Notably, students in Grades 6 and 9 made the least progress on these assessments after PMI participation. Although the measured growth is positive for these grade levels, the results were not statistically significant.

SECTION I: DATA AND METHODOLOGY

DATA OVERVIEW

This study uses both student-level Adams 50 data, provided by CTL, and school-grade-level data of all Colorado public school districts, collected from the Colorado Department of Education (CDE).[1] The student-level data from CTL includes Transitional Colorado Assessment Program (TCAP) and Scantron scaled scores, enrollment, and demographic information. We apply longitudinal analyses to these data to study how students in different grades and various subgroups are progressing in the mathematical components of these two assessments after participating in the Progressive Mathematics Initiative (PMI).

When compared to data provided by CTL, the publically available data contains broader measures of performance and student demographics. Specifically, student performance is only measured in terms of proficiency levels (percentages of students who are categorized as "unsatisfactory", "partially proficient", "proficient", or "advanced") on the TCAP math assessment. Demographic measures are given as the percentage of students who fall into a subgroup, at the school and grade level.[2] However, the CDE data encompasses all schools in Colorado, not just those in Adams 50. We take advantage of this availability to create a school-level comparison group to study whether there are additional gains in Adams 50 relative to other Colorado districts.

Finally, it is important to note that all schools within Adams County School District 50 participate in the Competency-Based System of learning (CBS), rather than traditional education in which content is structured primarily according to a student's grade level. The CBS model "is organized around engaging students in 21st century skills, working at their developmental levels and advancing only when they have demonstrated proficiency or mastery."[3] In other words, students in CBS primarily engage with content that is tailored to their *developmental* level rather than their *grade* level. For this reason, some students in Adams 50 may engage with PMI modules that are either slightly more or less advanced than other students at their grade level, based on their mastery of individual concepts within the PMI curriculum.

LONGITUDINAL STUDENT-LEVEL DATA

The data supplied by CTL contain student-level assessment and demographic information for Adams 50 students. To perform the longitudinal analysis, we restrict the analytic sample to students who were present in Adams 50 in both 2013 and 2014. This restriction ensures

[1] "CSAP/TCAP – Data and Results." Colorado Department of Education. http://www.cde.state.co.us/assessment/coassess-dataandresults

[2] This information is suppressed by the CDE if the number of students in a subgroup is less than 16. All analyses using the CDE data are restricted to school-grade observations with unsuppressed information.

[3] "Our Competency Based System (CBS). Adams County School District 50. http://www.cbsadams50.org/2011/09/ourcbs/

that we analyze progress across the two years for the same set of students, yielding a final sample of 4,137 students with valid TCAP assessment scores and 2,245 students with valid Scantron assessment scores in 2013 and 2014.

Figure 1.1 describes the average TCAP and Scantron scaled scores in Adams 50 and the percentage of students who fall into various demographic subgroups. For example, the average TCAP math scale score in 2013 among all Adams 50 students is about 489.9, and 49.2 percent of Adams 50 students are female. Notably, since students in Grades 3-10 take the TCAP, studying TCAP progress from 2013 and 2014 restricts our data to students who are in Grades 4-10 in 2014. For the Scantron assessment, Grades K-9 are sufficiently populated for analysis, so our study of Scantron progress focuses on students who are in Grades 1-9 in 2014.

Figure 1.1: Summary Statistics, Longitudinal Student Data[4]

OUTCOME VARIABLE	NO. OF OBSERVATIONS	MEAN
2013 TCAP scale score	4,176	489.9
2014 TCAP scale score	4,759	498.2
Spring 2013 Scantron scale score	2,634	2340.2
Spring 2014 Scantron scale score	4,143	2434.0
DEMOGRAPHIC VARIABLE	**NO. OF OBSERVATIONS**	**PERCENTAGE**
Female[5]	6,073	49.2%
Hispanic[6]	6,073	74.2%
Other minorities[7]	6,073	8.7%
Individualized Education Program	6,073	8.3%
Free or Reduced Lunch	6,073	78.5%
English as a Second Language[8]	6,073	40.6%
Gifted	6,073	6.3%

Note that in order to process the data into a working analytic file, student demographic variables were recoded according to the following processing rules. Categorical variables for Individualized Education Program (IEP), Free or Reduced Lunch (FRL) status, English as a Second Language (ESL) status, and gifted status were recoded as binary variables. For instance, a student is considered FRL if their record indicates a numerical value greater than zero and is not blank. Blank observations are coded to indicate that students did not belong to a given subgroup or demographic category.

COLORADO DEPARTMENT OF EDUCATION SCHOOL-LEVEL DATA

The data collected from CDE is available at the school and grade level for Grades 3-10 across all Colorado public school districts. TCAP data is only available starting in the 2011-12 academic year (represented as "2012") which includes performance level measures rather

[4] Student-level data
[5] Reference group: male
[6] Reference group (same for "Other minorities"): white
[7] "American Indian", "Asian/Pacific Islander", "black", or "multi-racial" students fall into this subgroup.
[8] Includes students categorized as "FEP", "LEP", or "NEP".

than scaled scores. To parallel the CDE's convention, we study the percentage of students who scored at or above the "proficient" level as the outcome of interest. In addition, we also consider the percentage of students who score at the "partially proficient" level or higher, which may reflect whether PMI implementation has helped some students approach proficiency, if not quite achieving it.

Figure 1.2 summarizes these performance outcomes and the percentage of students in various demographic subgroups at the school and grade level. For example, on average, 60.1 percent of students scored at or above the "proficient" level in TCAP Math, 67.1 percent of students scored at or above the "partially proficient" level, and 49.2 percent of students are female. Notably, we measure race/ethnicity as white or non-white to ensure that we study a large, representative sample of Colorado students. The CDE suppresses TCAP data for subgroups with fewer than 16 students. As such, the available data are less accurate for less-populated student subgroups.

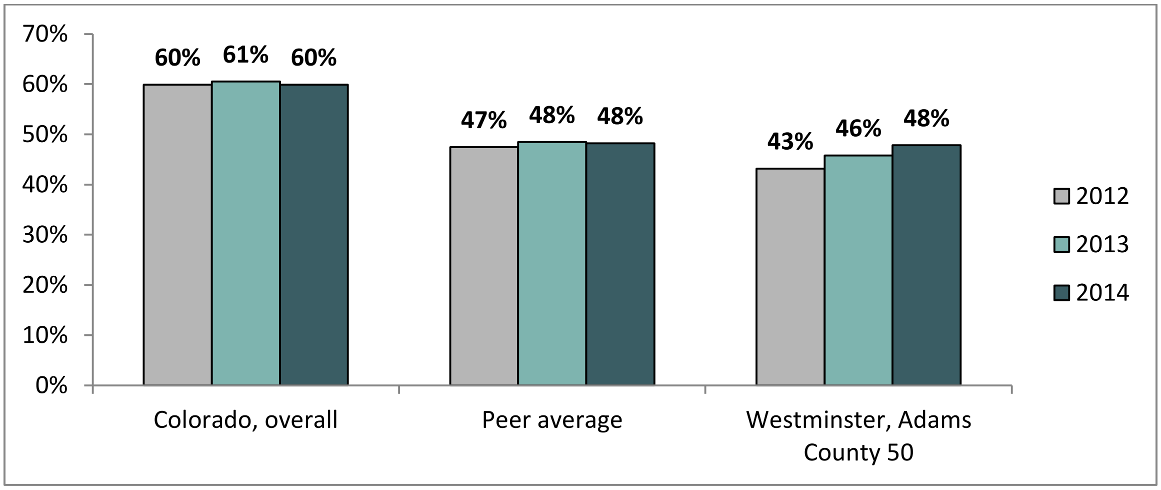
Figure 1.2: Summary Statistics, School-Grade-Level Data

VARIABLE	NO. OF OBSERVATIONS	MEAN
Percent proficient or better	13,584	60.1%
Percent partially proficient or better	17,360	67.1%
Percent female	12,430	49.2%
Percent minority[9]	10,411	36.3%
Percent FRL	10,302	35.1%
Percent IEP	12,473	9.7%
Percent ESL	12,272	18.8%
Percent migrant	12,447	1.1%
Percent gifted	12,432	9.7%
Peer district	17,360	4.2%

Figure 1.3 provides a broad comparison of the outcome of interest among all public school students in Colorado (Grades 3-10), peer districts to Adams 50, and Adams 50 itself. These peer districts are Adams County 14, El Paso County 8 (Fountain), Adams County 1 (Mapleton), and El Paso County 3 (Widefield).[10] Peer status is determined using the Education Finance Statistics Center at the National Center for Education Statistics (NCES) and is based on similarities in the total number of students, student/teacher ratio, percentage of children in poverty, district type, and locale code.[11] The purpose of identifying these peer districts is to utilize their students' performance as a benchmark to compare math performance in Adams 50 relative to similar districts in Colorado.

[9] Here, "minority" is defined as any student who does not identify as white.
[10] Overall peer district characteristics are presented in the Appendix.
[11] "Peer Search Tool." Education Finance Statistics Center, National Center for Education Statistics. http://nces.ed.gov/edfin/search/search_intro.asp

Figure 1.3: Percentage of Students "Proficient" or "Advanced", 2012 to 2014



Source: Colorado Department of Education TCAP – Data and Results

The figure displays a fairly constant percentage of "proficient" or "advanced" level students across the rest of the state (approximately 60 percent) and in the peer districts (about 48 percent), and a growing percentage of "proficient" or "advanced" students in Adams 50 between 2012 and 2014. This result provides some preliminary insight into the efficacy of PMI in improving student math performance.

Methodology

Longitudinal Analysis

We examine the performance of Adams 50 PMI students in 2012-2013 (denoted 2013) and 2013-2014 (denoted 2014), comparing the growth in students' TCAP and Scantron scores from before implementation of PMI to the end of the first year of implementation. We disaggregate our analysis by grade and school, allowing us to determine whether changes in academic performance vary within the District. The students' TCAP progress is computed as the difference between the 2014 and 2013 scores, while Scantron progress is computed as the difference between the Spring-term assessments in these years.

The longitudinal analysis is further segmented by the usage of scale scores and z-scores. We vertically scale TCAP and Scantron scores to ensure comparability in student math performance across different grade levels and across different administration years. The vertically scaled z-scores are computed relative to the mean TCAP/Scantron scaled score divided by the standard deviation, in each grade and year. Therefore, z-scores can be interpreted as student math performance relative to the average student in the district, in each grade and year. Comparing z-score growth is thus more meaningful when analyzing outcomes across demographic subgroups, over time.

A key limitation of this longitudinal analysis is the inability to distinguish whether growth is occurring due to students' participation in the PMI program versus growth that would occur due to other factors, such as having completed an additional year of school, increased maturity, participation in other programs implemented by the school, etc. Nonetheless, it provides a gauge of student progress over the period in which the District implemented the program. A more rigorous approach would be to compare math test score growth for PMI students at Adams 50 to similar non-PMI students from other districts.

SCHOOL-LEVEL ANALYSIS

The school-level analysis is based on TCAP mathematics outcomes from districts across the state of Colorado, drawn from the CDE. These data are further disaggregated by various student demographics, including gender, ethnicity, free/reduced-price lunch eligibility, ESL status, IEP status, migrant status, and gifted or talented status.

We are able to compare the performance of Adams 50 students with the state-wide results in 2012, 2013[12] (prior to PMI implementation) and 2014 (at the end of the first year of PMI implementation). This variation in implementation allows us to determine whether the performance of Adams 50 students has *changed relative to the state* following implementation. For example, if Adams 50 lagged the state by 10 percentage points with respect to the proportion of students who were proficient or better on the TCAP mathematics assessment in 2012-2013 and then only lagged the state by 5 percentage points in 2013-2014, this would indicate that District performance has improved relative to the state following PMI implementation.

As highlighted in Figure 1.2, we are interested in the percentage of students, at the school-grade-level, who scored at least at the "proficient"- or the "partially proficient"-level on the TCAP math assessment. We disaggregate these data by key demographics in order to see if changes from 2012 and 2013 to 2014 vary by student group. Equation [1] provides an algebraic representation of our linear regression model:

[1] $$Y_{ijkt} = PMI_{ij} \cdot \beta_1 + PMI_{ij} \cdot post_{jt} \cdot \beta_2 + peer_i \cdot \gamma + X_{ijk} \cdot \delta + Z_{ijkt} \cdot \phi + \varepsilon_{ijkt},$$

where Y_{ijkt} represents the percentage of students who scored at or above the "proficient" level in district *i*, school *j*, grade *k*, and year *t*, PMI_{ij} is an indicator for Adams 50 schools that implement PMI, post_{jt} is a school-year-specific indicator for post-implementation outcomes at these schools (since some the outcome data are from before implementation), peer_i indicates peer districts, X_{ijk} contains school-grade-level demographics, Z_{ijkt} captures district-level, grade-level, and year fixed effects, and ε_{ijkt} is the idiosyncratic error term. The interaction term between PMI_{ij} and post_{jt} represents the predictor of interest, capturing the effect of PMI implementation (the change in outcome after implementation) at the Adams 50 schools relative to other schools in the state.

[12] Adams 50 schools that implemented PMI in 2012-2013, one year earlier than other schools in the District, are Flynn Elementary, Mesa Elementary, Skyline Vista Elementary, Iver C. Ranum Middle, M. Scott Carpenter Middle, and Shaw Heights Middle.

Therefore, the coefficient of interest is β_2 where a positive and statistically significant estimate indicates evidence of PMI's efficacy in improving student math test score performance. As an added robustness measure, we perform the same analysis by restricting the sample only to Adams 50 and its peer districts. In addition to analyzing the effects of PMI implementation for all districts in CO and all peer districts, we segment the analysis to observe any difference in effects by school level: elementary (Grades 3-5), middle (Grades 6-8), and high school levels (Grades 9, 10).

Section II: Longitudinal Analysis

This section analyzes the longitudinal student-level data to see whether PMI implementation aided the progress of Adams 50 students in TCAP and Scantron Math assessments. The analysis is segmented by grade level and by demographic subgroups. We analyze TCAP and Scantron outcomes for Grades 3-10 and Grades K-9, respectively. Analyses of one-year growth in these outcomes are thus restricted to Grades 4-10 and Grades 1-9, respectively.

Scale Score Analysis

Overall, TCAP and Scantron Math scale scores both increased significantly between 2013 and 2014, when PMI was first implemented (Figure 2.1 and 2.2). Scale score growth in both assessments appears to decrease for higher grade levels. The asterisks indicate whether and to what degree the growth in average scale scores (positive or negative) are significantly different from zero.

Figure 2.1: Comparison of Average TCAP Math Scale Scores, 2013 versus 2014

2014 Grade	N	2013 TCAP Scale Score	2014 TCAP Scale Score	TCAP Scale Score Growth
4	684	439.2	466.3	27.1***
5	625	463.8	492.8	29.0***
6	600	487.4	493.3	5.8
7	626	494.7	518.4	23.7***
8	583	515.5	537.5	21.9***
9	486	528.1	518.3	-9.8**
10	532	526.6	534.8	8.1*
Total	4,136	490.8	507.1	16.3***

Note: Asterisks denote statistical significance as follows. *** p<0.01, ** p<0.05, * p<0.1.

Figure 2.2: Comparison of Average Scantron Math Scale Scores, 2013 versus 2014[13]

2014 Grade	N	2013 Scantron Scale Score	2014 Scantron Scale Score	Scantron Scale Score Growth
1	59	1770.3	2016.0	245.7***
2	252	1978.2	2196.7	218.5***
3	334	2158.9	2328.3	169.4***
4	522	2317.0	2438.4	121.4***
5	427	2434.6	2542.9	108.3***
6	313	2507.1	2543.3	36.2**
7	139	2523.8	2604.6	80.8***
8	124	2570.9	2654.2	83.3***
9	65	2643.6	2688.4	44.8
Total	2,235	2326.3	2447.8	121.5***

Note: Asterisks denote statistical significance as follows. *** p<0.01, ** p<0.05, * p<0.1.

[13] We analyze the Spring-term Scantron assessments.

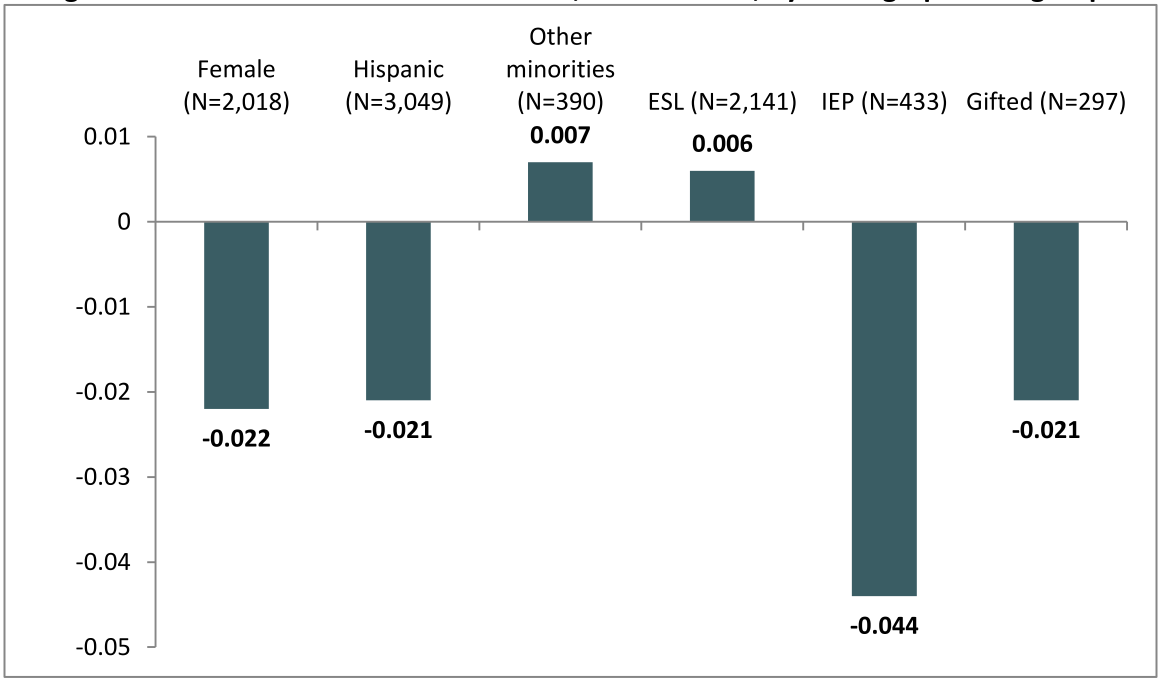
Z-SCORE ANALYSIS

Figures 2.3 and 2.4, on the following page, illustrate z-score growth by demographic subgroups. If the z-score growth for a specific subgroup is lower than the overall z-score growth, then students in this subgroup did worse, on average, than students not in this subgroup. For example on the TCAP Math assessment, female students' z-score growth is, on average, 0.022 standard deviations below the grade-level average growth. Since this value is less than zero, the overall z-score growth, female students, on average, was not as high as that of male students, relative to the average for that grade level. Selected findings from our analysis include:

- Female students demonstrated less progress than male students on the TCAP Math assessment but more progress than male students on the Scantron Math assessment.
- Hispanic students demonstrated less progress than non-Hispanic students on the TCAP but slightly more on the Scantron.
- Students who fall into "Other minorities" (e.g. American Indian, Asian/Pacific Islander, black, and multi-racial) demonstrated more progress on the TCAP than students in other racial subgroups, but less on the Scantron.
- ESL students demonstrated more progress on the TCAP than non-ESL students, and progressed about as equally on the Scantron.
- IEP students demonstrated much less progress on the TCAP than non-IEP students and much more progress on the Scantron.
- Gifted students demonstrated less progress on the TCAP than non-gifted students and much less on the Scantron.[14] It is possible that gifted students were already performing at a very high level before PMI, and, therefore, participating in the program did not aid in their progress as much as it did for non-gifted students.

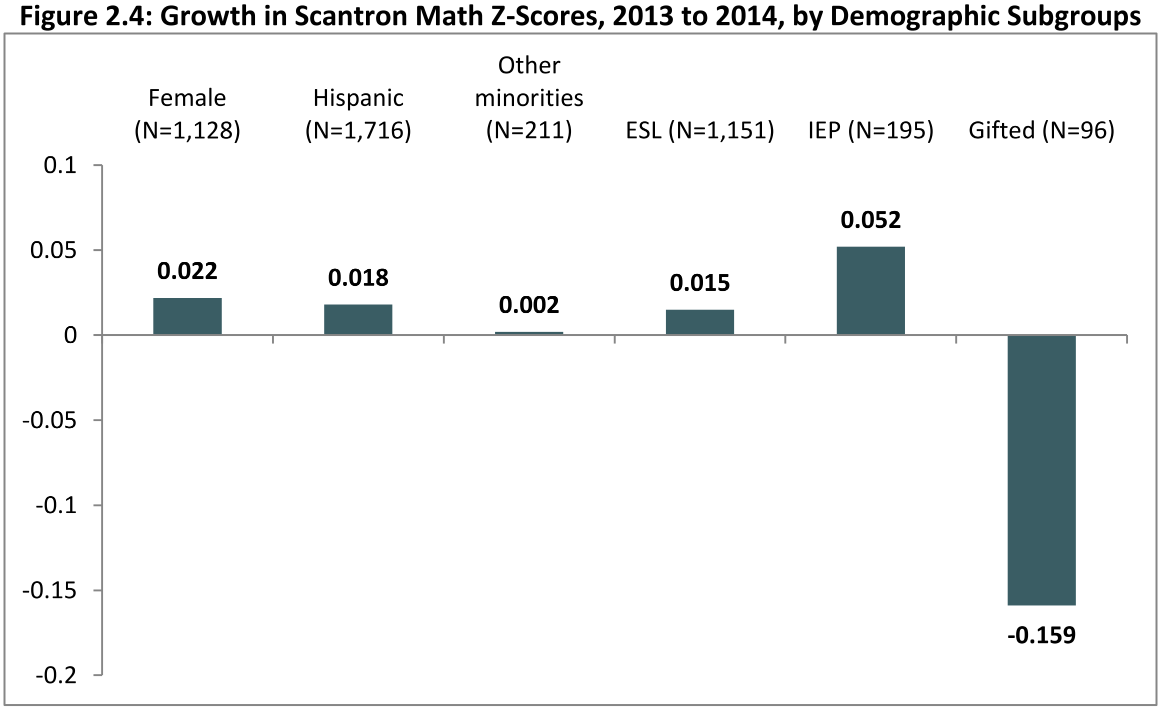
[14] We are unable to separate math-gifted students from those who are language-gifted but not math-gifted.

Figure 2.3: Growth in TCAP Math Z-Scores, 2013 to 2014, by Demographic Subgroups



Note: the reference group for “Hispanic” and “Other minorities” is “white”.

Figure 2.4: Growth in Scantron Math Z-Scores, 2013 to 2014, by Demographic Subgroups



Note: the reference group for “Hispanic” and “Other minorities” is “white”.

SECTION III: SCHOOL-GRADE-LEVEL ANALYSIS

This section applies linear regression analysis to school-grade-level TCAP data that Hanover collected from the CDE. As described in Section I, we use variation in both PMI implementation and the timing of implementation to isolate the effect of PMI on TCAP Math outcomes for Adams 50 students, relative to the rest of Colorado public school districts. Much of the analysis focuses on comparing the progress of Adams 50 to that of Colorado districts that are similar in total number of students, student/teacher ratio, percentage of children receiving free or reduced price lunch, district type, and locale code. We also separately model TCAP outcomes by school level: elementary (Grades 3-5), middle (Grades 6-8), and high school (Grades 9, 10). Control variables measure the percentage of students in each grade at the school-level who identify as being in various demographic subgroups. All regression specifications include district, grade, and year fixed effects.

MAIN TAKEAWAYS

- We find that growth in math proficiency is higher among PMI schools in Adams 50 relative to non-PMI schools from peer districts.
- PMI is most effective in increasing math proficiency on TCAP assessments in the elementary and middle school levels.
- PMI is most effective among students who are partially proficient and improving their math performance to become proficient.

POOLED ANALYSIS – ALL GRADES

Figure 3.1 presents the pooled analysis of TCAP math outcomes in all grades. Broadly, these results show that PMI implementation increased the percentage of Adams 50 students who scored at a "proficient" level or higher relative to comparable districts in Colorado that did not implement PMI. Specifically, PMI implementation increased Adams 50's TCAP Math performance at "proficient" or better by 5.8 percentage points. The coefficient estimate is found to be statistically significant at the 95 percent confidence level. However, we do not find a statistically significant effect of PMI implementation on this outcome when comparing Adams 50 to all other Colorado public school districts. Further, PMI implementation did not have a significant overall effect on performance at or above the "partially proficient" level. This provides us with some indication that PMI is most effective among students who need a boost to move from being partially proficient to proficient.

It is important to note that when considering all districts, we are comparing schools from Adams 50 to schools with different student compositions. As such, these comparisons may result in erroneous estimation of the true impact of PMI on student performance. For instance, comparing Adams 50 with a more affluent school district may distort the analysis and bias our results. Restricting Adams 50's comparison group to only the peer districts allows us to isolate the impact of PMI on math performance from potential confounding factors such as varying learning growth trajectories for different student subpopulations.

Figure 3.1: Regression Estimates, All Grades

Predictor	Percent Proficient or Better		Percent Partially Proficient or Better	
	All Districts	Peer Districts Only	All Districts	Peer Districts Only
PMI Implementation Variables				
Implemented PMI	0.116***	0.0667***	0.0644***	0.0476***
Post implementation	**0.0437**	**0.0575****	**0.0240**	**0.0266**
Peer district	-0.161***	-	-0.174***	-
District Characteristics				
Percent female	-0.0131	0.0101	0.00477	-0.0339
Percent minority	-0.122***	0.0426	-0.0788***	0.0368
Percent FRL	-0.310***	-0.0744	-0.111***	-0.0479
Percent IEP	-0.555***	-0.536***	-0.380***	-0.291***
Percent ESL	-0.0991***	-0.424***	-0.112***	-0.352***
Percent migrant	0.172**	-0.284	-0.212***	-0.973**
Percent gifted	0.281***	0.489***	0.0947***	0.300***
Constant	0.963***	0.734***	1.100***	0.940***
District-level fixed effects	Yes	Yes	Yes	Yes
Grade-level fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
R-squared	**0.81**	**0.88**	**0.73**	**0.89**
Observations	**9,635**	**315**	**9,635**	**315**

Note: Asterisks denote statistical significance as follows. *** p<0.01, ** p<0.05, * p<0.1.

Grade-Level Segments

Figures 3.2 and 3.3 present the regression results segmented at the elementary, middle, and high school level of the effect of PMI implementation on TCAP math performance level outcomes. In these segmented analyses, we focus on the comparison of Adams 50 and peer districts, where we found a significant effect of PMI implementation (Figure 3.1).

For both outcomes, the percentage of students scoring at or above "proficient" and at or above "partially proficient," participating in PMI had a beneficial effect on elementary (Grades 3-5) and middle school (Grades 6-8) Adams 50 students. For Grades 3-5, Adams 50 has a significantly greater percentage of students that score at or above "proficient" (by 10.5 percentage points) and a significantly greater percentage that score at or above "partially proficient" (by 4.8 percentage points). For Grades 6-8, Adams 50 has a significantly greater percentage of students that score at above "proficient" (by 8.8 percentage points) and a significantly greater percentage that score at or above "partially proficient" (by 5.5 percentage points). However, PMI implementation did not have a significant effect, positive or negative, on TCAP Math performance in Grades 9 and 10 at Adams 50 schools.

Figure 3.2: Regression Estimates for Percent Proficient or Better, by School Level

PREDICTOR	GRADES 3-5	GRADES 6-8	GRADES 9, 10
PMI Implementation Variables			
Implemented PMI	0.183***	0.0834***	0.000914
Post implementation	**0.105****	**0.0878*****	**-0.0135**
Percent female	0.00831	0.190	-0.478***
District Characteristics			
Percent minority	-0.116	0.306**	-0.531***
Percent FRL	-0.0474	-0.238***	0.00478
Percent IEP	-0.535***	-0.828***	0.406
Percent ESL	-0.298*	-0.661***	0.196
Percent migrant	0.900	1.548**	-0.817
Percent gifted	0.190	0.841***	0.381
Constant	0.740***	0.378***	0.617***
District-level fixed effects	Yes	Yes	Yes
Grade-level fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
R-squared	**0.58**	**0.88**	**0.92**
Observations	**158**	**108**	**49**

Note: Asterisks denote statistical significance as follows. *** p<0.01, ** p<0.05, * p<0.1. Peer districts only.

Figure 3.3: Regression Estimates for Percent Partially Proficient or Better, by School Level

PREDICTOR	GRADES 3-5	GRADES 6-8	GRADES 9, 10
PMI Implementation Variables			
Implemented PMI	0.0838***	0.0628***	-0.0370
Post implementation	**0.0477***	**0.0546****	**0.00994**
Percent female	-0.0327	0.130	-0.775***
District Characteristics			
Percent minority	-0.0255	0.272**	-0.902***
Percent FRL	-0.0305	-0.155**	0.00714
Percent IEP	-0.196**	-0.951***	0.986**
Percent ESL	-0.0263	-0.551***	0.342
Percent migrant	-0.0610	1.018*	-0.0485
Percent gifted	0.0376	0.539***	-0.00183
Constant	0.916***	0.760***	1.210***
District-level fixed effects	Yes	Yes	Yes
Grade-level fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
R-squared	**0.42**	**0.88**	**0.92**
Observations	**158**	**108**	**49**

Note: Asterisks denote statistical significance as follows. *** p<0.01, ** p<0.05, * p<0.1. Peer districts only.

SECTION IV: CONSIDERATIONS FOR FURTHER RESEARCH

In this section, we highlight potential ways in which the analysis of PMI implementation in Adams 50 can be improved in subsequent years. First, it is important to note that in order to conduct the most rigorous study that provides the most detailed findings regarding PMI's impact on student learning, we recommend repeating this study in subsequent years and assessing how student outcomes have matured over time. As PMI has only recently been implemented in Adams 50, this present analysis only examines a single year's worth of data. Hanover notes that a more rigorous study would analyze *at least three years'* worth of data to provide the most actionable information about student learning gains.

Regarding this present study, in analyzing the impact of PMI on student math outcomes, using only student-level data, we are able to compute students' progress on TCAP and Scantron math assessments between 2013 and 2014. However, we note in our methodology that the ideal research design would include the same computation for similar students who were not exposed to PMI over the same timeframe. We are aware that PMI was implemented fully across the entire district in 2014. As such, we are unable to construct a valid comparison group from within Adams 50. Therefore, we are constrained to using publicly available data, aggregated at the school and grade level from the Colorado Department of Education to create a comparison group for Adams 50 schools that have implemented PMI.

IDEAL RESEARCH DESIGN

It is important to note that although we are able to infer some impacts of PMI on student math performance at an aggregated level (school and grade), we are unable to estimate the impact of the program on individual students' test score performance. This constraint limits the amount of information available for a more robust evaluation of PMI. Further, this constraint may potentially lower the precision of our estimates since we are relying on school-level aggregates rather than granular student-level data.

Student-level data will be of particular use when attempting to estimate the impact of PMI among high school students or other student subgroups where a school-level comparison may not capture the similarity between students who participated in PMI and students who did not. Therefore, the ideal research design would include drawing similar student-level data from other school districts in Colorado who have not implemented the Progressive Mathematics Initiative. This will provide us with the ability to draw a viable comparison group of students who are as similar as possible in their observed characteristics to students from Adams 50. The additional data required would follow a similar format to the student-level TCAP and Scantron assessment data that are currently available for Adams 50 students.

INCORPORATING TEACHER AND ADMINISTRATOR SURVEYS

Hanover acknowledges that student-level data are difficult to extract from other school districts. Our second best approach would be to incorporate teacher and administrator survey results into the quantitative evaluation as indicators of program fidelity and implementation level. Currently, the PMI teacher and administrator surveys contain adequate information to correlate program implementation levels and fidelity with student math learning outcomes. However, in the current format of the surveys, teacher and administrator respondents are not linked to any specific school locations or classrooms. In order to appropriately link teacher and administrator survey results to student outcomes, we would require that respondents provide indicators for their school of employment as well as indicators for specific math classes taught. Similarly, the school and classroom linkages are required at the student level as well to successfully complete the data merge. Augmenting the teacher and administrator surveys in this manner will allow us to estimate the impact of varying levels of implementation and program fidelity on student outcomes while controlling for potential confounding factors. This will enhance the current longitudinal analysis, using student level data and staff surveys, as well as potentially reinforce the importance of full program implementation.

Appendix – Colorado Peer Districts

Figure A.1: Adams County School District 50 – Colorado Peer List

District Name	Total Enrollment	Total FTE Teachers	Number of Schools	Pct. Minority	Pct. IEP	Pct. ELL	Pct. FRPL
Adams County School District 50	**10,124**	**543**	**19**	75%	**10%**	**35%**	**81%**
Adams County School District 1	7,760	372	17	67%	11%	28%	69%
Adams County School District 14	7,321	364	13	87%	13%	37%	84%
El Paso County School District 3	9,184	514	17	44%	15%	2%	43%
El Paso County School District 8	7,702	461	12	43%	14%	5%	45%

Source: National Center for Education Statistics – Common Core of Data 2012.

Project Evaluation Form

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