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Math in Focus Elementary Grades Efficacy Study

Houghton Mifflin Harcourt

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Abstract

The focus of this study was the effectiveness of Math in Focus © 2015 a mathematics program for elementary grade students published by Houghton Mifflin Harcourt. The study included students from 11 different schools in 4 different states. The overall demographics of the study sample are representative of the demographics of students enrolled in public schools in the United States in terms of students eligible for free/reduced lunch programs and below national averages for non-Caucasian students.

The study was conducted with over 1,359 students enrolled in grades 3, 4, and 5. All of these students completed both a pretest at the beginning of the program and a post-test at the end. A few students who did not complete both tests were not included in the data analysis. Teachers used the program for their math instruction five days per week and more than 25 minutes per day. The program was being used by the teachers for the first time. All of the teachers had at least five years of teaching experience and most had 10 to 15 years of teaching experience.

Instruction included the entire program. Pretests and post-tests were written by math specialists based on the instructional units included at each grade level. In addition to analyzing the gain scores for the total group of students at each grade, analyses were conducted separately for higher and lower scoring mathematics students. Higher and lower scoring students were identified by the students' pretest scores. Those scoring highest on the pretests were designated as the high scoring mathematics students and those scoring lowest on the pretests were designated as the lower scoring math students. The average gain scores for the total group of students at each grade were statistically significant. The effect sizes for all students at all three grades were large.

In addition, the average gain scores for the low and high scoring groups at each grade level were also statistically significant. The effect sizes for the high and low scoring groups were also large at all grades.

All the effect sizes at every grade exceeded by a large margin the effect sizes needed to determine a substantively important level.

Overview of the Study

Houghton Mifflin Harcourt, School Publishers contracted with Educational Research Institute of America (ERIA) to conduct a full academic year study to evaluate the effectiveness of the Math in Focus Program for elementary school students. The study compared assessments administered to students in mid-September 2016 to assessments administered in mid-June 2017.

Research Questions

The following research questions guided the design of the study and the data analyses:

- Does the implementation of *Math in Focus Elementary Program* in grades 3-5 program lead to improved student mathematics achievement?
- Does the implementation of *Math in Focus Elementary Program in grades* 3-5 lead to differential effects on student achievement as a function of student ability level?

Design of the Study

The design of the program called for the implementation of the Math in Focus® program for Grade 3, 4, and 5 students during the 2016–2017 academic year. The schools had not used the program prior to this time.

A total of 59 teachers in 4 different states participated in the study. The number of teachers at each grade included:

- Grade 3: 24 teachers.
- Grade 4: 18 teachers.
- Grade 6: 17 teachers.

Program Overview

The Math is Focus program is described by HMH on their website as follows:

> **Math in Focus** is an authentic Singapore Math® curriculum—with problem solving as the center of math learning and concepts taught with a concrete–pictorial–abstract learning progression through real-world, hands-on experiences. Beyond the digital learning tools and apps that are native to the core program, **Math in Focus® Digi+™**offers a complete online teaching and learning environment for students in Grades 1–5.

Math in Focus K–6

Incorporates Mathematical Practices in every lesson so students develop the mathematical thinking they need.

Features exploration-driven lessons that begin with problem-based situations and build to more abstract problems.

Elevates depth of understanding so students are ready for the rigor of the Common Core State Standards.

Description of the Assessments

The pretest and post-test used in the study were developed by ERIA mathematics curriculum experts. Tests were developed to match the content of the Math in Focus chapters used in the study as well as to emphasize the National Council of Teachers of Mathematics (NCTM) Standards.

The tests were developed to respond to the following emphases:

Innovative items that call for actual performance on the part of students that encourage divergent thinking and problem solving, emphasize on thinking skills, and align with the NCTM Standards and the State Common Core Standards.

Table 1 provides the basic test statistics. The table shows that the reliabilities of the tests are high and provide adequate stability to assess mathematics achievement. Of importance is the fact that the test reliabilities are higher for the post-tests than for the pretests. This is almost certainly the result of instruction which resulted in less random guessing on the post-tests than on the pretests.

Table 1
Pretest and Post-test Statistics for the *Math in Focus* Students
Grades 3, 4, and 5

Test	*Mean Score*	*Standard Deviation*	*KR 20*	*SEm**
Grade 3 Pretest	11.81	4.40	.72	2.33
Grade 3 Post-test	18.09	4.62	.78	2.17
Grade 4 Pretest	9.23	3.29	.56	2.18
Grade 4 Post-test	16.06	5.00	.80	2.24
Grade 5 Pretest	11.76	3.80	.63	2.31
Grade 5 Post-test	16.72	4.97	.76	2.43

**SEm stands for Standard Error of Measurement.*

Description of the Study Sample

Table 2 provides the demographic characteristics of the schools included in the study. It is important to note that the school data does not provide a description of the make- up of the classes that

participated in the study. However, the data does provide a general description of the schools and, thereby, an estimate of the make-up of the classes included in the study.

The percentage of students enrolled in free/reduced lunch programs ranged from 27% to 67% and averaged 53% across the sample of schools. By comparison, the reported national average for students enrolled in free/reduced lunch programs in public schools was reported as 48.1%.

The percentage of students classified as minority students (non-Caucasian) ranged from 1% to 53% with an average of 16%. By comparison, 49.8% of the students enrolled in U.S. public schools were classified as non-Caucasian.[1]

Table 2
Demographic Description of the Schools Included in the Study

School	State	Location	Grades	Enrollment	Non-Caucasian	FRLP*
1	ME	Rural	K-4	150	1%	61%
2	ME	Rural	5-8	258	1%	35%
3	WI	Town	PK-5	572	11%	51%
4	WI	Rural	PK-3	79	7%	47%
5	WI	Rural	PK-3	93	10%	66%
6	WI	Town	PK-3	152	9%	58%
7	WI	Town	PK-3	304	18%	56%
8	WI	Town	PK-5	572	11%	51%
9	NY	City	PK-4	758	53%	62%
10	NY	City	5-8	612	49%	67%
11	MA	Suburban	3-5	407	10%	27%
Average				**360**	**16%**	**53%**

**Free Reduced Lunch Program*

[1] *The National Center for Educational Statistics* (NCES) reported that for the 2011–2012 school year, 48.1% of public school students were enrolled in free/reduced lunch programs. No free/reduced lunch data were available for the 2012–2013 school year. Also, the NCES reported that for the 2012–2013 school year, 49.8% of public school students were classified as minority (non-Caucasian) students.

Data Analyses and Results

Percent correct scores were used for all data analyses. Raw scores were converted to percent correct scores. Data analyses and descriptive statistics were computed for the students' percent correct scores.

Paired comparison *t*-tests were used to determine if differences in pretest and post-test scores were significantly different. The comparisons were conducted for differences between the *Math in Focus Mid-September 2016* (pretest) and the *Math in Focus Mid-June 2017* (post-test). The ≤.05 level of significance was used as the level at which differences would be considered statistically significant.

In addition, effect size (Cohen's *d*) was computed for each of the comparisons. This statistic provides an indication of the strength of the effect of the treatment regardless of the statistical significance. The interpretation of Cohen's *d* statistic as guided by the American Institute for Research (AIR) states that "Per guidelines from the *What Works Clearinghouse*, an effect size of .25 or greater is 'substantively important'." Beyond the level considered to be substantively important, interpretations of effect sizes in this report include the following guidelines:

.20 to .49 = small
.50 to .79 = medium
.80+ = large

Grade 3 Results

Table 3 shows that the average scores of the 460 grade 3 students participating in the study increased their average percent correct test scores at a statistically significant level. The effect size was substantively important and is classified as large.

Table 3
Grade 3 Total Group Paired Comparison *t*-test Results
Pretest/Posttest Percent Correct Score Comparisons

	Number Students	***Mean Percent Correct***	***SD***	***t*-test**	***Significance***	***Effect Size***
Pretests	460	30%	11%	31.967	≤.0001	1.50
Post-tests	460	46%	11%			

The total group of 460 Grade 3 students was divided into two equal sized groups based on their pretest scores. The 230 students scoring lowest on the pretest were lower achieving mathematics students while the 230-scoring highest on the pretest were higher achieving mathematics students.

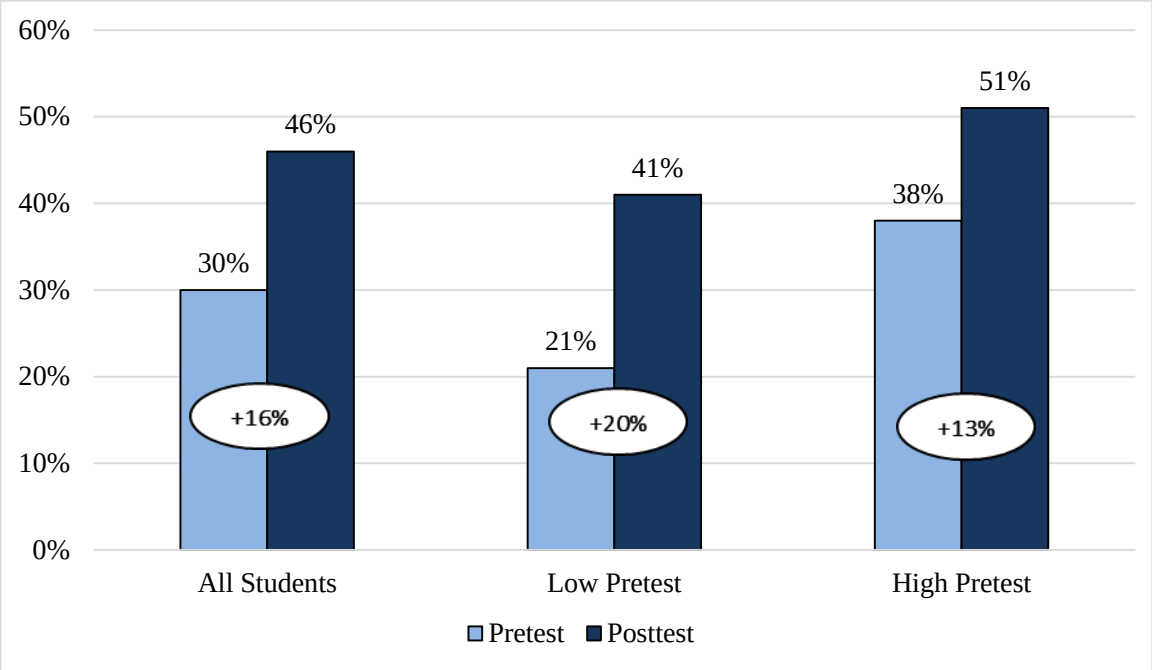
Table 4 shows that both groups made statistically significant gains. The effect sizes for both groups were substantively important and are classified as large.

Table 4
Grade 3 Paired Comparison *t*-test Results
High- and Low-Scoring Pretest Groups

Test	*Number of Students*	*Average Percent Correct Score*	*SD*	*t-test*	*Significance*	*Effect Size*
Lower Scoring Group						
Pretest	230	21%	6%	26.115	≤0001	2.31
Post-test	230	41%	11%			
Higher Scoring Group						
Pretest	230	38%	7%	21.935	≤0001	1.57
Post-test	230	51%	9%			

Figure 1 provides a graphic representation of the gains achieved by the Grade 3 students. The total group of Grade 3 students increased their average percent correct scores by 16%. The low achieving mathematics students increased their average percent correct scores by 20% percent while the high achieving mathematics students increased their average percent correct scores by 13%.

Figure 1
Grade 3 Pretest/Post-test Gain Comparison
All Students, Low Pretest Students, High Pretest Students



Grade 4 Results

Table 5 shows that the average percent correct scores of the 474 grade 4 students participating in the study increased their average percent correct scores at a statistical significant level. The effect size was substantively important and is classified as large.

Table 5
Grade 4 Total Group Paired Comparison *t*-test Results
Pretest/Post-test Average Percent Correct Score Comparisons

	Number Students	***Average Percent Correct Score***	***SD***	***t*-test**	***Significance***	***Effect Size***
Pretests	474	23%	8%	31.850	≤.0001	1.66
Post-tests	474	41%	12%			

Based on their pretest scores, the total group of 474 grade 4 students was divided into two equal sized groups of 237 students. The students scoring lowest on the pretest were lower achieving mathematics students while the students scoring highest on the pretest were higher achieving mathematics students.

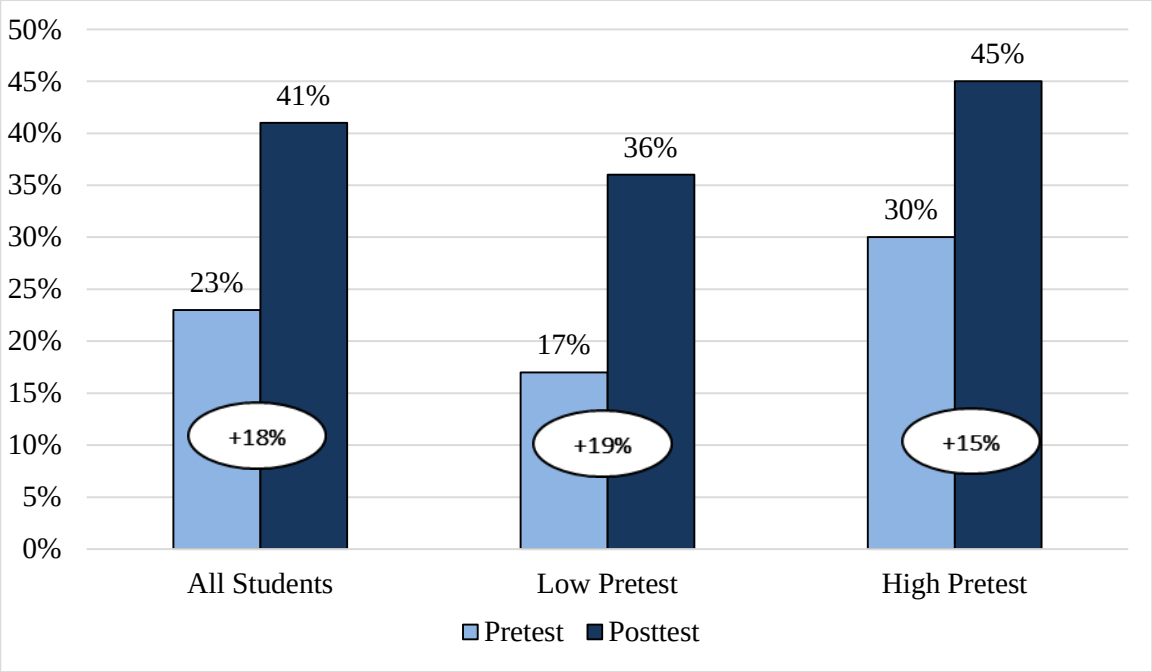
Table 6 shows that both groups made statistically significant gains. The effect sizes for both groups were substantively important and are classified as large.

Table 6
Grade 4 Paired Comparison *t*-test Results
High- and Low-Scoring Pretest Groups

Test	***Number of Students***	***Average Percent Correct Score***	***SD***	***t-test***	***Significance***	***Effect Size***
Lower Scoring Group						
Pretest	237	17%	4%	24.371	≤0001	2.25
Post-test	237	36%	11%			
Higher Scoring Group						
Pretest	237	30%	6%	21.201	≤0001	1.65
Post-test	237	45%	12%			

Figure 2 provides a graphic representation of the percent gains achieved by the grade 4 students. The total group of grade 4 students increased their average percent correct scores by 18%. The low achieving mathematics students increased their average percent correct scores by 19% while the high achieving mathematics students increased their average percent correct scores by 15%.

Figure 2
Grade 4 Pretest/Post-test Gain Comparison
All Students, Low Pretest Students, High Pretest Students



Grade 5 Results

Table 7 shows that the average scores of the 425 grade 5 students participating in the study increased their average test scores at a statistical significant level. The effect size was substantively important and is classified as large.

Table 7
Grade 5 Total Group Paired Comparison t-test Results
Pretest/Post-test Average Percent Correct Score Comparisons

	Number Students	***Average Percent Correct Score***	***SD***	***t-test***	***Significance***	***Effect Size***
Pretests	425	30%	10%	27.747	≤.0001	1.28
Post-tests	425	43%	12%			

The total group of 425 grade 5 students was divided into two equal sized groups based on their pretest scores. The 212 students scoring lowest on the pretest were lower achieving mathematics students while the 213-scoring highest on the pretest were higher achieving mathematics students.

Table 8 shows that both groups made statistically significant gains. The effect sizes for both

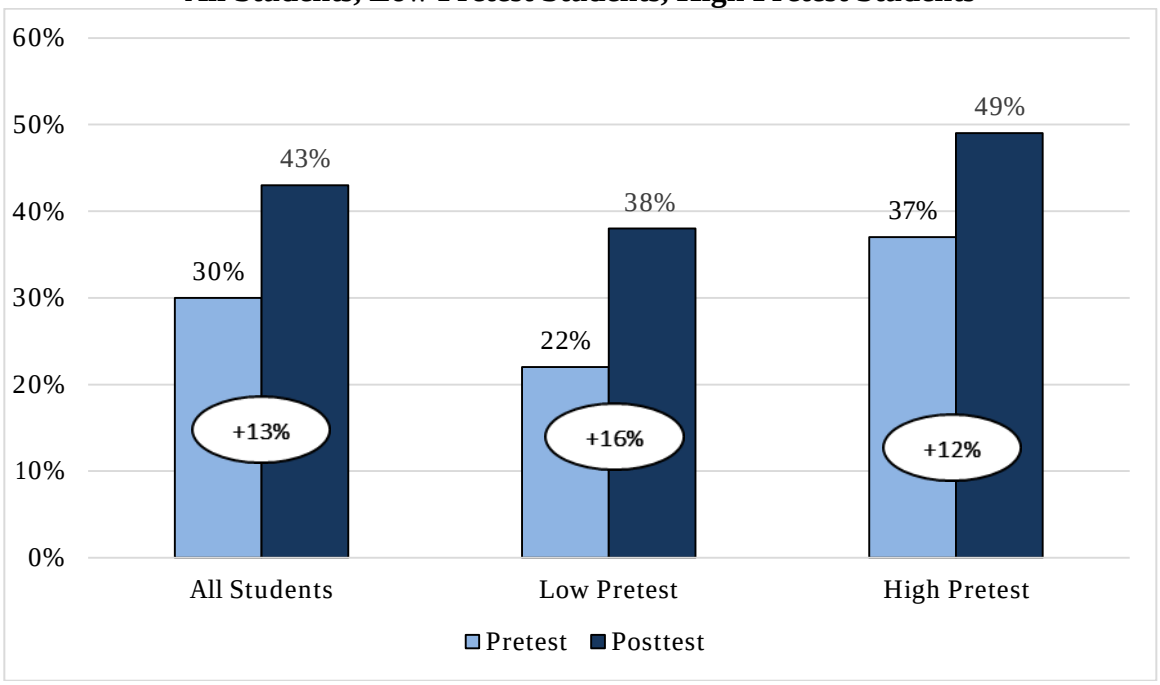
groups were substantively important and are classified as large for both groups.

Table 8
Grade 5 Paired Comparison *t*-test Results
High- and Low-Scoring Pretest Groups

Test	Number of Students	*Average Percent Correct Score*	SD	t-test	Significance	Effect Size
Lower Scoring Group						
Pretest	212	22%	5%	21.239	≤0001	1.92
Post-test	212	38%	11%			
Higher Scoring Group						
Pretest	213	37%	6%	18.944	≤0001	1.38
Post-test	213	49%	10%			

Figure 3 provides a graphic representation of the gains achieved by the grade 5 students. The total group increased their average percent scores by 13%. The low achieving mathematics students increased their average percent scores by 16% and the high achieving mathematics students increased their scores by 12%.

Figure 3
Grade 5 Pretest/Post-test Gain Comparison
All Students, Low Pretest Students, High Pretest Students



Conclusions

This study sought to determine the effectiveness of the Math in Focus K-6 grades mathematics program by comparing growth on reliable and valid pretests and post-tests. The study took place during the 2016-2017 academic year and was carried out in 4 states and included 11 different schools and 59 teachers. The student population included about 5% more students eligible for free/reduced price lunch programs as the national average. The percentage of non-Caucasian students was about 33% lower than the national average.

Two research questions guided the study and the conclusions for each are reported below.

Research Question 1

Does the implementation of Math in Focus Elementary Program in grades 3 to 5 lead to improved student mathematics achievement?

Across all three grades mathematics student growth was statistically significant. The effect sizes at all three grades were above a substantively important level and were large at all three grade levels.

Research Question 2

Does the implementation of Math in Focus Elementary Program in grades 3 to 5 lead to differential effects on student achievement as a function of student ability level?

Across all three grades mathematics student growth for the high achieving and low achieving students was statistically significant. The effect sizes at all grades were large. The lower achieving pretest groups increased their scores more than the high scoring pretest students.

Based on this study, both research questions can be answered positively:

The *Math in Focus* program results for students in grades 3 to 5, showed statistically significant test score increase and the effect sizes were large.

The *Math in Focus* program for elementary grade students showed significant growth for both higher ability and lower ability students in grades 3 to 5. The effect sizes for both groups of students at grades 3, 4, and 5 were large.