Educational Research
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Math in Focus®: Singapore Math®

Middle Grades

Efficacy Study

Houghton Mifflin Harcourt

Report Number 547
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Abstract

The focus of this academic year study was the effectiveness of *HMH Math in Focus®: Singapore Math®* by Michael Cavendish®, a mathematics program for students in kindergarten to grade 8, published by Houghton Mifflin Harcourt, School Publishers ©2018. This study included students in grades 6 to 8 and included 9 different schools located in 4 different states.

The demographics of the participating schools showed that the percentage of non-Caucasian students was about 24% while the percentage of U.S. non-Caucasian students is reported as 48%. The percentage of students enrolled in National School Lunch programs was about 17% compared to a U.S. national average of about 52%.

The study was conducted with 794 students enrolled in grades 6, 7, and 8. Only those students who took both a pretest and post-test were included in the data analysis. Teachers used the program for their math instruction five days per week and about 40 to 45 minutes per day. The program was being used by the teachers for the first time. All the teachers had at least five years of teaching experience and most had 10 to 15 years of teaching experience.

Pretests and post-tests were written by math specialists based on the instructional units taught 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 students with higher and lower pretest scores.

The average gain scores for the total group of students at each grade were statistically significant. The effect sizes for all students at grades 6, 7, and 8 were large.

In addition, the average gain scores for the low and high scoring groups at each grade level were statistically significant. The effect sizes for the high and low scoring groups were large at grades 6 and 8. At grade 7 the effect size was large for the low scoring students and medium for the high scoring students. *All the effect sizes at every grade exceeded 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 *HMH Math in Focus*® program for middle school students. The study compared assessments administered to students in September 2017 to assessments administered in May 2018.

Research Questions

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

- Does the implementation of *HMH Math in Focus*® program in grades 6 to 8 result in improved student mathematics achievement?
- Does the implementation of *HMH Math in Focus*® in grades 6 to 8 lead to differential student achievement as a function of student ability level?

Design of the Study

The design of the program called for the implementation of the *HMH Math in Focus*® program for grade 6, 7, and 8 students during the 2017–2018 academic year. The schools had not used the program prior to this time.

A total of 20 teachers in 4 different states participated in the study. The number of teachers at each grade included:

- Grade 6: 8 schools; 11 teachers.
- Grade 7: 3 schools; 3 teachers.
- Grade 8: 3 schools; 6 teachers.

Teachers reported using the program 5 days a week with an average usage time of about 40 to 45 minutes per day. All the teachers had at least five years of teaching experience and most had 10 to 15 years of teaching experience.

Program Overview

The Math in Focus® program description was provided on the following website:

http://www.hmhco.com/shop/education-curriculum/math/math-in-focus-singapore-math

> 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® Dig^{+TM} *offers a complete online teaching and learning environment for students in Grades K to 8..*
>
> ***Math in Focus® in your classroom***
>
> - *Supports the goals of the Common Core State Standards for mathematics*
> - *Is research-based and focuses on classroom learning, discussion, and practice*
> - *Balances conceptual understanding, visual learning, and problem solving.*

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 *HMH 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.

The tests included both multiple choice and open-ended written responses. The make-up of items types on each of the three assessments were the same:

Grade	*Multiple-Choice Items*	*Student Supplied Answers*	*Total*
6	15	15	30
7	15	15	30
8	15	15	30

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 difference is often found and is usually the result of instruction which would result in less random guessing on the post-tests than on the pretests.

Table 1
Pretest and Post-test Statistics for the *HMH Math in Focus*® Students
Grades 6, 7, and 8

Test	***Mean Score***	***Standard Deviation***	***KR 20***	***SEm****
Grade 6 Pretest	268	28.2	.46	27.2
Grade 6 Post-test	332	47.0	.70	20.7
Grade 7 Pretest	278	46.1	.49	25.7
Grade 7 Post-test	323	42.4	.67	32.9
Grade 8 Pretest	268	28.2	.39	24.3
Grade 8 Post-test	332	45.5	.72	22.0

**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 6% to 48% and averaged 17% 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 52%.

The percentage of students classified as minority students (non-Caucasian) ranged from 15 to 38% with an average of 24%. By comparison, 48% 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

					Percent Enrolled	
School	**State**	**Location**	**Grades**	**Enrollment**	**Non-Caucasian**	**NSLP***
1	CT	Suburban: Large	K-6	392	22%	9%
2	CT	Suburban: Large	K-6	371	24%	7%
3	CT	Suburban: Large	K-6	609	23%	8%
4	CT	Suburban: Large	K-6	284	28%	24%
5	CT	Suburban: Large	K-6	370	23%	11%
6	CT	Suburban: Large	7-8	710	20%	9%
7	ID	Town: Distant	5-8	533	27%	48%
8	NJ	Suburban: Large	6-8	604	15%	6%
9	NY	Suburban: Large	6-8	755	38%	32%
Average				**514**	**24%**	**17%**

**National School Lunch Program*

[1] *The National Center for Educational Statistics* (NCES) reported that for the 2014-2015 school year, 51.8% of public school students were enrolled in free/reduced lunch programs. Also, the NCES reported that for the 2014-2015 school year, 48% of public school students were classified as minority (non-Caucasian) students.

Data Analyses and Results

Standard scores were used for all data analyses. Raw scores were converted to standard scores with a mean of 300 and a standard deviation of 50. Data analyses and descriptive statistics were computed using the students' standard scores.

For most of the comparisons, 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 *HMH Math in Focus® September 2017* (pretest) and the *HMH Math in Focus® May 2018* (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. In addition to reporting the level considered to be substantively important, interpretations of effect sizes were calculated and can be interpreted using the following guidelines:

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

Grade 6 Results

Table 3 shows that the average scores of the 650 grade 6 students participating in the study increased their average test scores at a statistically significant level. The effect size was substantively important and is classified as large.

Table 3
Grade 6 Total Group Paired Comparison *t*-test Results
Pretest/Post-test Standard Score Comparisons

	Number Students	***Mean Standard Score***	***SD***	***t*-test**	***Significance***	***Effect Size***
Pretests	650	268	28.2	39.570	≤.0001	1.651
Post-tests	650	332	47.0			

The total group of 650 grade 6 students was divided into two approximately equal sized groups based on their pretest scores. The 325 students scoring lowest on the pretest were considered lower achieving mathematics students while the 325 scoring highest on the pretest were considered higher achieving mathematics students.

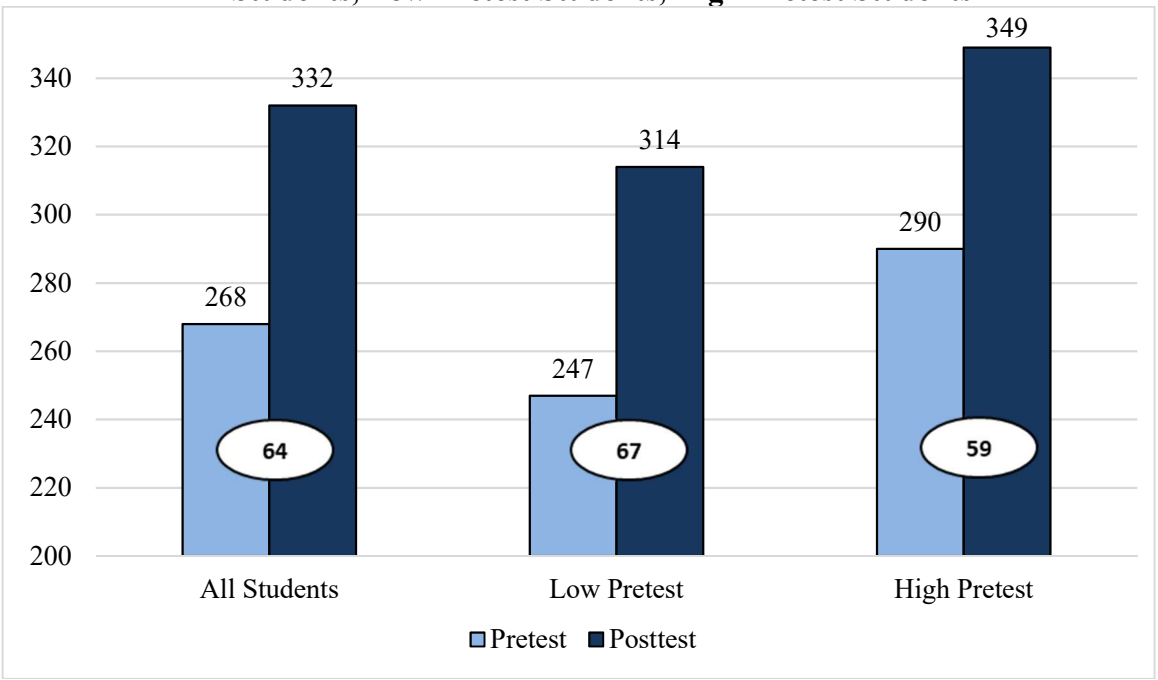
Table 4 shows that both groups made statistically significant gains. The effect sizes for both groups were substantively important and are classified as large.

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

Test	*Number of Students*	*Mean Standard Score*	*SD*	*t-test*	*Significance*	*Effect Size*
Lower Scoring Group						
Pretest	325	247	11.6	32.775	≤0001	2.461
Post-test	325	314	36.7			
Higher Scoring Group						
Pretest	325	290	23.1	24.365	≤0001	1.530
Post-test	325	349	49.4			

Figure 1 provides a graphic representation of the gains achieved by the grade 6 students. In one school year, the grade 6 students increased their average scores by 64 standard score points. The low achieving mathematics students increased their scores 67 standard score points while the high achieving mathematics students increased their scores by 59 standard score points.

Figure 1
Grade 6 Pretest/Post-test Gain Comparison
All Students, Low Pretest Students, High Pretest Students



Grade 7 Results

Table 5 shows that the average scores of the 295 grade 7 students participating in the study increased their average test scores at a statistically significant level. The effect size was substantively important and is classified as large.

Table 5
Grade 7 Total Group Paired Comparison *t*-test Results
Pretest/Post-test Standard Score Comparisons

	Number Students	*Mean Standard Score*	*SD*	*t*-test	*Significance*	*Effect Size*
Pretests	295	277	46.1	13.535	≤.0001	1.038
Post-tests	295	323	42.4			

Based on their pretest scores, the total group of 295 grade 7 students was divided into two equal sized groups of 147 and 148 students. The students scoring lowest on the pretest were considered lower achieving mathematics students while the students scoring highest on the pretest were considered higher achieving mathematics students.

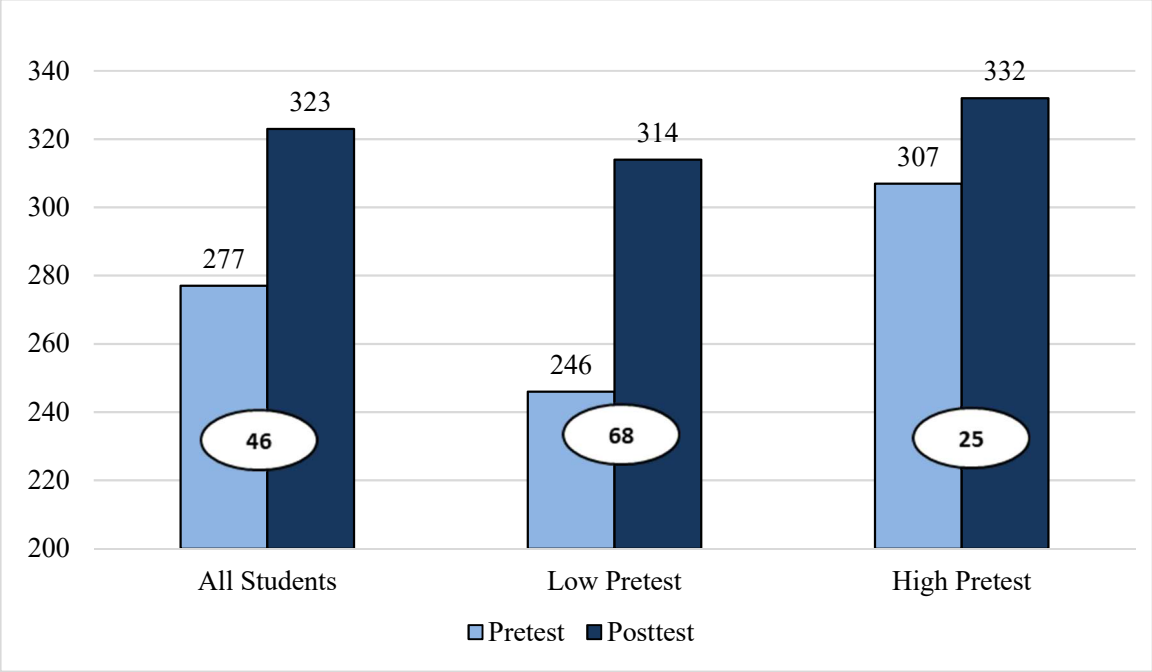
Table 6 shows that both groups made statistically significant gains. The effect sizes for both groups were substantively important and are classified as large for the low scoring group and medium for the high scoring group.

Table 6
Grade 7 Paired Comparison *t*-test Results
High- and Low-Scoring Pretest Groups

Test	*Number of Students*	*Mean Standard Score*	*SD*	t-*test*	*Significance*	*Effect Size*
Lower Scoring Group						
Pretest	147	246	45.1	12.939	≤.0001	1.584
Post-test	147	314	40.6			
Higher Scoring Group						
Pretest	148	307	18.1	6.860	≤.0001	.766
Post-test	148	332	42.4			

Figure 2 provides a graphic representation of the gains achieved by the grade 7 students. In one school year, the grade 7 students increased their average scores by 46 standard score points. The low achieving mathematics students increased their scores by 68 standard score points while the high achieving mathematics students increased their scores by 25 standard score points.

Figure 2
Grade 7 Pretest/Post-test Gain Comparison
All Students, Low Pretest Students, High Pretest Students



Grade 8 Results

Table 7 shows that the average scores of the 348 grade 8 students participating in the study increased their average test scores at a statistically significant level. The effect size was substantively important and is classified as large.

Table 7
Grade 8 Total Group Paired Comparison t-test Results
Pretest/Post-test Standard Score Comparisons

	Number Students	*Mean Standard Score*	*SD*	*t-test*	*Significance*	*Effect Size*
Pretests	348	268	28.2	24.527	≤.0001	1.677
Post-tests	348	332	46.0			

The total group of 348 grade 8 students was divided into two equal sized groups based on their pretest scores. The 174 students scoring lowest on the pretest were considered lower achieving mathematics students while the 174 scoring highest on the pretest were considered higher achieving mathematics students.

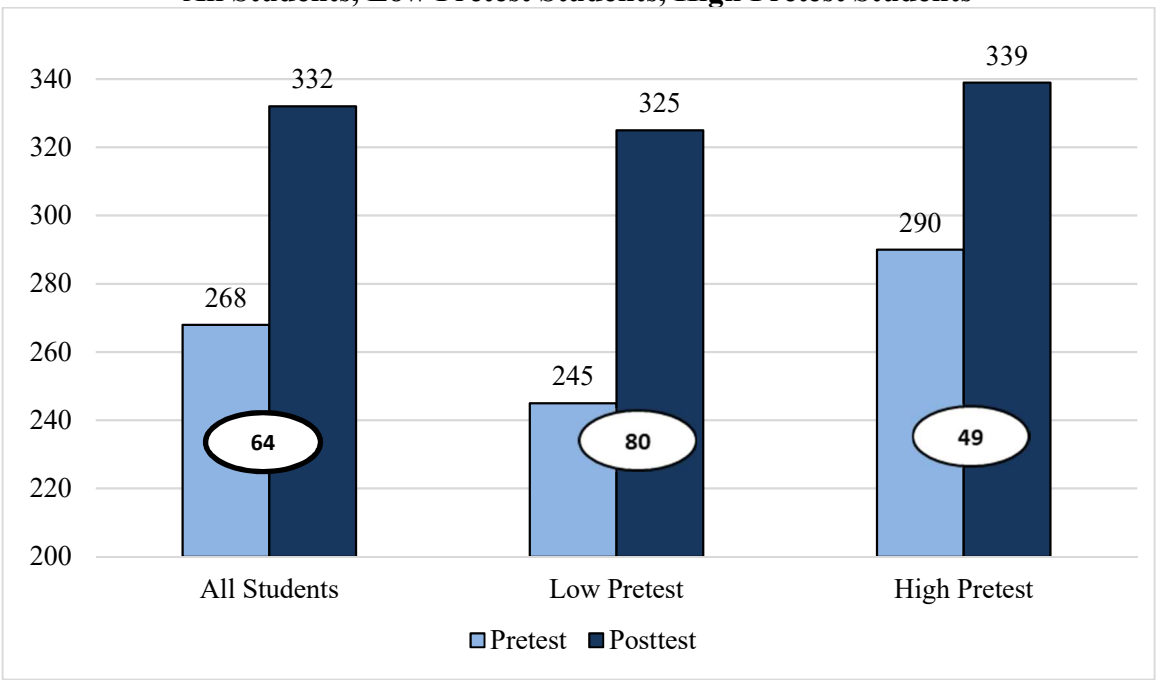
Table 8 shows that both groups made statistically significant gains. The effect sizes for both groups were substantively important and are classified as large for both the low scoring group and the high scoring group.

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

Test	Number of Students	Mean Standard Score	SD	t-test	Significance	Effect Size
Lower Scoring Group						
Pretest	174	245	17.2	21.881	≤0001	2.330
Post-test	174	325	45.4			
Higher Scoring Group						
Pretest	174	290	17.4	14.341	≤0001	1.422
Post-test	174	339	45.5			

Figure 3 provides a graphic representation of the gains achieved by the grade 8 students. In one school year, the grade 8 students increased their average scores by 64 standard score points. The low achieving mathematics students increased their scores 80 standard score points while the high achieving mathematics students increased their scores by 49 standard score points.

Figure 3
Grade 8 Pretest/Post-test Gain Comparison
All Students, Low Pretest Students, High Pretest Students



Conclusions

This study sought to determine the effectiveness of the *HMH Math in Focus*® mathematics program by comparing growth on reliable and valid pretests and post-tests. The study took place during the 2017 – 2018 academic year and was carried out in 4 states and included 14 different schools and 20 teachers.

Seventeen percent of the student population of the research schools were eligible for free or reduced-price lunch programs. This compares to about 52% of the total U.S. population who are eligible for those programs. Twenty-four percent of the students in the research schools were classified as non-Caucasians. The national percentage of non-Caucasian students is about 48%.

Two research questions guided the study and the conclusions:

Research Question 1

- Does the implementation of *HMH Math in Focus*® program in grades 6 to 8 result in 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 grades.

Research Question 2

- Does the implementation of *HMH Math in Focus*® in grades 6 to 8 lead to differential 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 grades 6, 7, and 8 were large for the low pretest scoring groups. For the high pretest scoring groups the results were also statistically significant for all three groups. The effect size for the higher scoring students was large for students in grades 6 and 8, and medium for the high scoring grade 7 students.

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

For students in grades 6-8, the results of the use of the *HMH Math in Focus*® program were statistically significant and the effect sizes were large.

The *HMH Math in Focus*® program for middle grade students showed significant growth for both higher pretest and lower pretest scoring students. The effect sizes for lower pretest scoring students in grades 6 to 8 were large. The effect sizes were also large for the higher pretest scoring grade 6 and 8 students. At grade 7 the effect size for the higher pretest scoring students was medium.