Educational Research
Institute of America
www.eriaonline.com • email: info@eriaonline.com
An affiliate of Beck Evaluation & Testing Associates, Inc.

A STUDY OF THE INSTRUCTIONAL EFFECTIVENESS OF Math in Focus ©2012

Houghton Mifflin Harcourt

Report Number 466

July 2013

Contents

ABSTRACT

To help secondary school students develop better skills, knowledge, and problem solving in Mathematics, *Houghton Mifflin Harcourt* has published, ***Math in Focus 2012©.***

Math in Focus® is adapted from Singapore's My Pals Are Here! Maths. The underpinning philosophy of both series is the same, and their goal is to ensure children's ability to achieve mastery of mathematics concepts, computational skills, problem solving skills, and application of mathematics to daily life activities.

In order to evaluate the program's effectiveness, *Houghton Mifflin Harcourt* contracted with the *Educational Research Institute of America* (ERIA) to conduct a one year study to test the effectiveness of the program. The study was conducted during the 2012/2013 academic year.

A control group and tryout group of second and third grade classes from a large urban school district. For grade 2 the tryout included 7 different schools with 18 classes taught by 18 different teachers. The grade 2 control group included 2 different schools with 10 classes taught by 10 different teachers. For grade 3 the tryout included 5 different schools with 19 classes taught by 19 different teachers. The grade 3 control group included 5 different schools with 14 classes taught by 14 different teachers.

The Iowa Test of Basic Skills: Mathematics published by Riverside Press was used for pretesting and post-testing. At grade 2 the Iowa Form E, Level 8 was used and at grade 3 Form E, Level 9 was used. The ***Math in Focus*** had not been previously used in the schools by any classes.

The results showed that the ***Math in Focus*** classes and the control classes both made statistically significant gains over the course of the year. The results also showed the ***Math in Focus*** program made statistically significant greater gains than did the control classes. When the higher and lower pretest students were compared to the ***Math in Focus*** classes the results indicated that the lower pretest students made gains as great as the higher pretest scoring students.

Overview of the Study

This report describes a full year study conducted to determine the impact of the ***Math in Focus*** program at grades 2 and 3. *Houghton Mifflin Harcourt* contracted with the *Educational Research Institute of America* (ERIA) to conduct a one academic year study to determine the program's effectiveness.

The study was to have taken place over an entire school year; however due to severe weather problems in September in the area in which the study was to take place the study pretesting was completed in November 2013 and the posttesting was conducted at the end of May 2013. Actual classroom instruction was also delayed in the fall due to the closing of schools because of severe weather.

Research Questions

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

1. Is ***Math in Focus*** more effective than an alternative mathematics program in improving the mathematics skills, knowledge, and problem solving of grade 2 and grade 3 students?
2. Is ***Math in Focus*** effective in improving the mathematics skills, knowledge and problem solving skills in lower performing as well as higher performing grade 2 and grade 3 students?

Design of the Study

The program's efficacy was evaluated using a pretest/posttest design and included comparable control group classes. The study took place during the 2012/2013 academic year. All of the students in the study were enrolled in grade 2 or grade 3. For grade 2 the tryout included 7 different schools with 18 classes taught by 18 different teachers. The grade 2 control group included 2 different schools with 10 classes taught by 10 different teachers. For grade 3 the tryout included 5 different schools with 19 classes taught by 19 different teachers. The grade 3 control group included 5 different schools with 14 classes taught by 14 different teachers. The study took place over a full academic year.

Before the program instruction started, students were administered the Iowa Test of Basic Skills: Mathematics. At the end of May the Iowa Test of Basic Skills was again administered to the students. Pretest and post-test administration was under the direction of the classroom teacher. All tests were returned to Riverside Publishing Company for scoring. The data was then sent to ERIA for all analyses.

Project Background

The following focus for the program as put forth by the publisher it highlights the importance of a research/best practices based program:

> ***Math in Focus™: The Singapore Approach*** *brings to U.S. classrooms Singapore's top-ranking approach to teaching mathematics in grades K–5. This problem-based approach thoughtfully builds on a concrete-to-pictorial-to-abstract progression for greater depth of instruction and mastery of math concepts. Visualization strategies including model drawing allow students to master more complex problems. The program also uses powerful number bond models to enhance the instruction for mental math, number sense, and computation. The program is aligned with the National Council of Teachers of Mathematics (NCTM) Curriculum Focal Points.* ***Math in Focus*** *provides a concrete-to-visual progression of instruction and focuses on fewer topics in greater depth to give students a more comprehensive understanding of critical math topics.*

Timeline and Program Use

The teachers used ***Math in Focus*** **© 2012** text as the primary mathematics instructional program. Teachers reported using the program 5 days per week for 35 minutes or more per day. Pretests were administered at the middle of November, 2012 and posttests were administered the end of May, 2013.

As part of the Math in Focus program, the treatment teachers had the opportunity to attend six professional development sessions throughout the course of the academic year. These professional development sessions are typical courses offered to new schools that have adopted the Math in Focus program. However, not all teachers attended all of sessions.

Description of the Research Sample

Table 1 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.

Table 1
Demographic Characteristics
Of the Schools Included in the Study

Location	Grades	Enrollment	% Minority	% Free/Reduced Lunch	%Limited English Proficient
Grade 2 *Math in Focus* Schools					
Urban	K-5	467	91%	94%	26%
Urban	K-5	692	16%	28%	2%
Urban	K-5	538	42%	59%	9%
Urban	K-5	205	8%	20%	4%
Urban	K-5	361	49%	37%	10%
Urban	K-5	146	100%	77%	UNK
Urban	K-4	803	98%	72%	11%
AVERAGES		459	58%	55%	10%
Grade 3 *Math in Focus* Schools					
Urban	K-5	467	91%	94%	26%
Urban	K-5	692	16%	28%	2%
Urban	K-5	538	42%	59%	9%
Urban	K-4	205	8%	20%	4%
Urban	K-5	361	49%	37%	10%
AVERAGES		459	58%	55%	10%
Grade 2 Control Schools					
Urban	K-05	593	98%	81%	4%
Urban	K-05	900	37%	52%	6%
AVERAGES		747	68%	67%	5%
Grade 3 Control Schools					
Urban	K-05	543	15%	31%	4%
Urban	K-05	467	91%	94%	26%
Urban	K-05	205	8%	20%	4%
Urban	K-05	538	42%	59%	9%
Urban	PK-05	803	98%	72%	11%
AVERAGES		511	51%	55%	11%

Description of the Assessment

The pretest and posttest used in the study were the Iowa Tests of Basic Skills: Mathematics. The descriptions of each of the two tests as reported in the test manual are as follows:

LEVEL 8 (GRADE 2)

The test is administered in two separate sessions and all 46 questions are read aloud to the students by the teacher.

In Part 1, the response options for each question are either pictorial or numerical. Students are required to demonstrate their understanding of, and ability to apply, a variety of concepts in the areas of:

- number sense and operations
- geometry
- measurement
- number sentences

In Part 2, some questions involve the interpretation of data presented in graphs or tables: students locate data, compare amounts, or develop generalizations.

For some other questions, brief word problems are presented, students solve the problems, and then record their answers according to the choices provided. One choice in each set is N, meaning that the problem's solution is not given among the choices presented. For some other questions, students select a number sentence that could be used to solve the problem.

LEVEL 9 (GRADE 3)

The test includes two parts.

Students must demonstrate an understanding of mathematics concepts, relationships, visual representations, and problem solving.

The 50 questions cover:

- number sense and operations
- algebraic patterns and connections
- data analysis
- probability
- statistics
- geometry
- measurement

Data Analyses

Data analyses and descriptive statistics were computed for the standard scores from the Iowa Tests of Basic Skills: Mathematics assessments and were provided by Riverside Publishing. The ≤.05 level of significance was used as the level at which increases would be considered statistically significant for all of the statistical tests.

The following statistical analyses were conducted to compare students' pretest scores to posttest scores:

- For both grade 2 and grade 3 scores *Repeated Measure Analysis of Variance* (ANOVA) analyses were used to determine if there were any effects due to ***Math in Focus*** and control group scores.
- For both grade 2 and grade 3 scores Independent Sample t-Tests were used when the Repeated Measure ANOVA resulted in significant differences
- For both grade 2 and grade 3 students in the ***Math in Focus*** group scores were split into two groups based on pretest scores. Paired comparison *t*-tests were used with the group that scored higher and the group that scored lower on the pretest to determine if the program was equally effective with lower pretest performers and higher pretest performers.

An effect-size analysis was computed for each of the paired *t*-tests. Cohen's *d* statistic was used to determine the effect size. This statistic provides an indication of the strength of the effect of the treatment regardless of the statistical significance. Cohen's *d* statistic is interpreted as follows:

.2 = small effect
.5 = medium effect
.8 = large effect

Data Results and Analyses

Grade Two Analyses

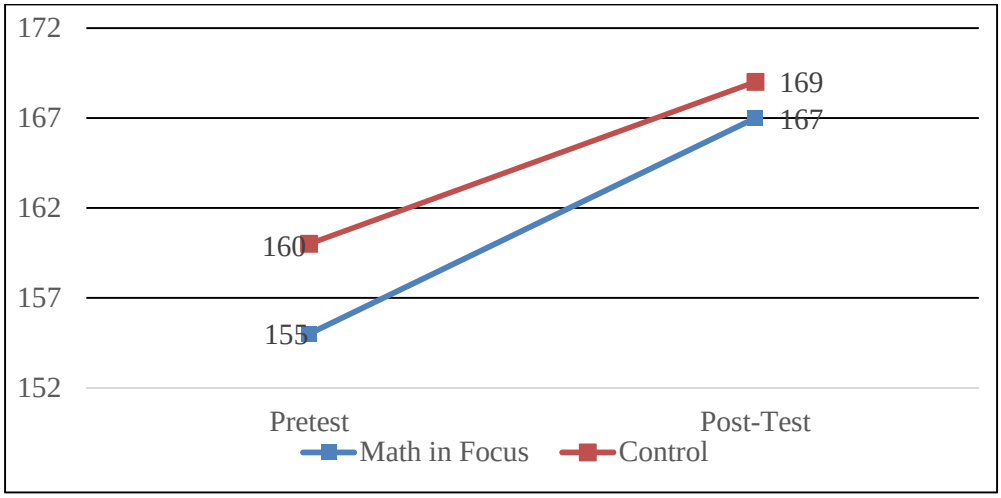
In order to test for the significance of the effect of the ***Math in Focus*** program compared to a control group, a repeated measure ANOVA was used. The group was the between subject variable and pretest and posttest scores as the within subject variable. Table 2 shows that the scores for the total group from pretesting to post-testing were statistically significant. In addition, the effect due to group was also statistically significant.

Table 2
Grade 2 and Repeated Measure Analysis of Variance
To Test the Effects of Program on Test Scores

Test	***Mean Square***	**F-*test***	***Significance***
Time	26504.391	238.473	≤.0001
Group	2025.374	8.396	≤.004
Group x Time	732.913	6.594	≤.01

Figure 1 shows that the statistical difference in the scores between groups was on the pretests. That is, the control group scored significantly higher than the ***Math in Focus*** group on the pretests. However, the ***Math in Focus*** group gained more than the control group and by the time of post-testing there was no statistically significant difference between the two groups.

Figure 1
Grade 2 Pre/Post Iowa Test of Basic Skill: Mathematics



Based on the finding there was a significant effect due to group, Independent Sample t-Tests were computed for both the pretests and the post-tests. The difference between pretests for the ***Math in Focus*** and control group was significant showing that there was statistically significant advantage for the control group at pretesting. The effect size was medium.

However, at post-testing the Independent Sample t-test showed there was no statistically significant difference indicating that the ***Math in Focus*** group gained more than did the control group.

Table 3
Grade 2 Independent Sample *t*-test Results
Pretest Comparison of Standards Scores

Test	*Number Students*	*Mean Standard Score*	*SD*	*t-test*	*Significance*	*Effect Size*
Math in Focus	379	155	17.4	3.866	≤.0001	.50
Control	165	161	14.7			

Table 4
Grade 2 Independent Sample *t*-test Results
Post-test Comparison of Standards Scores

Test	*Number Students*	*Mean Standard Score*	*SD*	*t-test*	*Significance*	*Effect Size*
Math in Focus	379	167	18.2	1.449	Not Significant	None
Control	165	169	17.0			

Higher and Lower Scoring Students

An additional analysis was conducted to determine if students who scored lower on the pretest made gains as great as those students who scored higher on the pretest. For this analysis the ***Math in Focus*** students were ranked in order on the basis of their pretest standard scores. The group of 379 students was divided into two approximately equal groups of 189 and 190 students. The first group included those students who scored lower on the pretest with a mean of 143 with scores ranging from 116 to 154. The higher scoring group scored an average standard score on the pretest of 166 with scores ranging from 154 to 196.

Pretest-to-posttest comparisons are shown in Table 5 for the lower and higher pretest scoring students. Scores were analyzed using a paired comparison *t*-test to determine if both groups made significant gains.

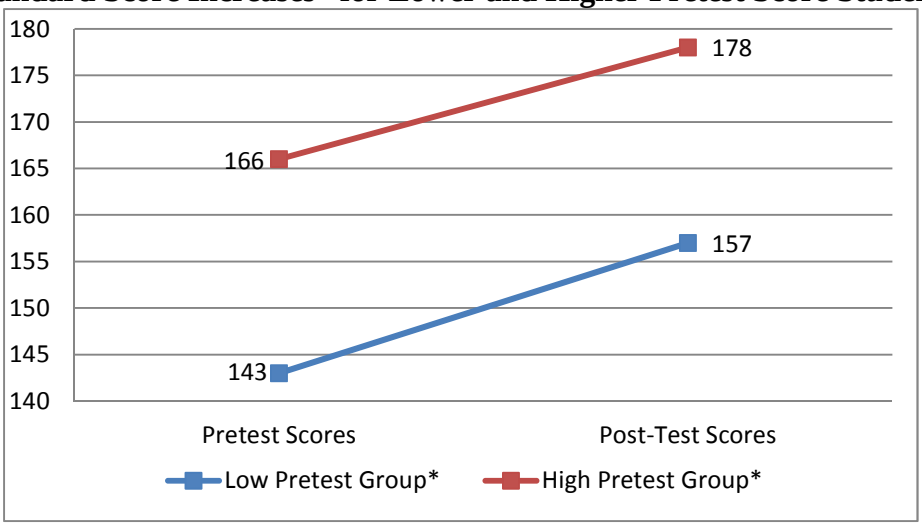
For both the higher and the lower scoring group, the average scores increased. The increase for both groups was statistically significant (≤.0001). The effect size for the lower scoring group was medium and the effect size for the higher scoring group was large.

Table 5
Paired Comparison *t*-test Results for Pretest/Posttest Standard Scores for the High- and Low-Scoring Pretest Groups

Test	*Test Form*	*Number of Students*	*Mean Standard Score*	*SD*	*t-test*	*Significance*	*Effect Size*
Lower Scoring Group							
Total	Pretest	190	143	16.3	9.468	≤.0001	.72
Total	Posttest	190	157	13.7			
Higher Scoring Group							
Total	Pretest	189	166	8.9	12.954	≤.0001	1.88
Total	Posttest	189	178	16.0			

Figure 2 provides a pretest-to-posttest comparison of the standard scores of lower and higher scoring pretest students.

Figure 2
Standard Score Increases* for Lower and Higher Pretest Score Students



*Statistically significant

Grade Three Analyses

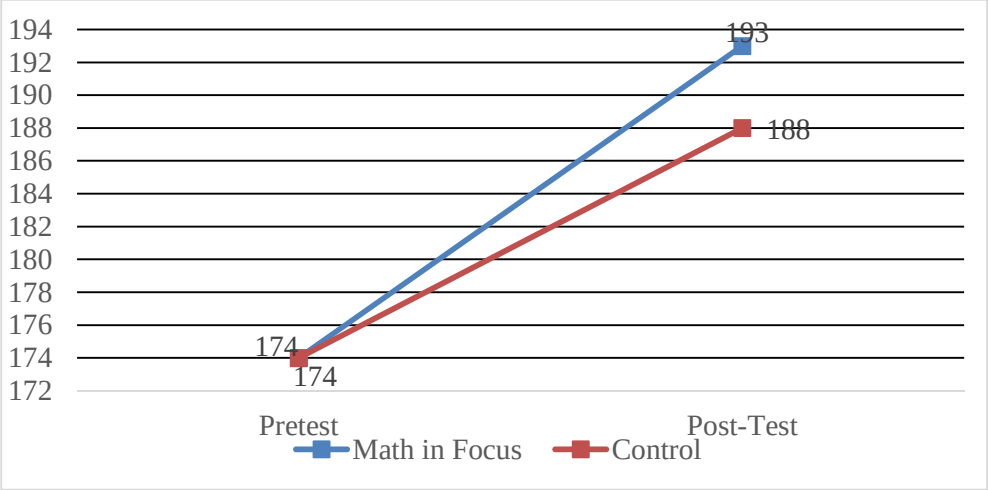
In order to test for the significance of the effect of the ***Math in Focus*** program compared to a control group, a repeated measure ANOVA was used. The group was the between subject variable and pretest and posttest scores as the within subject variable. Table 6 shows that the scores for the total group from pretesting to post-testing were statistically significant. In addition, the effect due to group was also statistically significant.

Table 6
Grade 3 and Repeated Measure Analysis of Variance
To Test the Effects of Program on Test Scores

Test	***Mean Square***	***F-test***	***Significance***
Time	89517.182	1255.044	≤.0001
Group	929.908	3.953	≤.05
Group x Time	2288.251	32.082	≤.0001

Figure 3 shows that the statistical difference in the scores between groups was on the post-tests. On the pretests there was no statistically significant difference between the two groups. However, the ***Math in Focus*** group gained more than the control group and the post-tests ***Math in Focus*** group scored statistically significantly higher.

Figure 3
Grade 3 Pre/Post Iowa Test of Basic Skill: Mathematics



Based on the finding that there was a significant effect due to group, Independent Sample t-Tests were computed for both the pretests and the post-tests. The difference between pretests for the *Math in Focus* and control group was not showing that there was no statistically significant advantage for either group on the pretests.

However, on the post-tests the Independent Sample t-test showed there was a statistically significant difference indicating that the ***Math in Focus*** group gained more than did the control group from pretesting to post-testing. The effect size was small.

Table 7
Grade 3 Independent Sample *t*-test Results
Pretest Comparison of Standards Scores

Test	*Number Students*	*Mean Standard Score*	*SD*	*t-test*	*Significance*	*Effect Size*
Math in Focus	362	174	15.2	.219	Not Significant	None
Control	317	174	15.2			

Table 8
Grade 3 Independent Sample *t*-test Results
Post-test Comparison of Standards Scores

Test	*Number Students*	*Mean Standard Score*	*SD*	*t-test*	*Significance*	*Effect Size*
Math in Focus	362	193	18.1	3.652	≤.0001	.40
Control	317	188	17.0			

Higher and Lower Scoring Students

An additional analysis was conducted to determine if students who scored lower on the pretest made gains as great as those students who scored higher on the pretest. For this analysis the ***Math in Focus*** students were ranked in order on the basis of their pretest standard scores. The group of 362 students was divided into two equal groups of 181 students. The first group included those students who scored lower on the pretest with a mean of 162 with scores ranging from 129 to 173. The higher scoring group scored an average standard score on the pretest of 186 with scores ranging from 173 to 223.

Pretest-to-posttest comparisons are shown in Table 9 for the lower and higher pretest scoring students. Scores were analyzed using a paired comparison *t*-test to determine if both groups made significant gains.

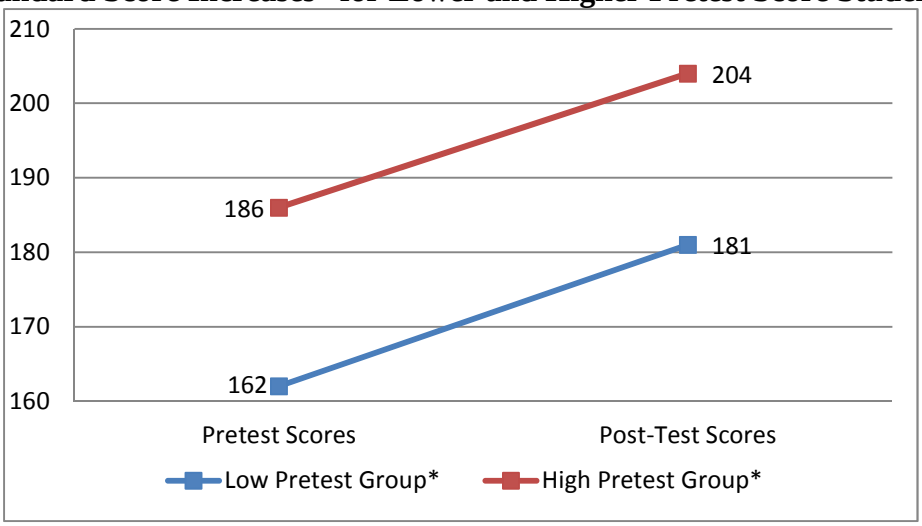
For both the higher and the lower scoring group, the average scores increased. The increase for both groups was statistically significant (≤.0001). The effect sizes for both groups were large.

Table 9
Paired Comparison *t*-test Results for Pretest/Posttest Standard Scores for the High- and Low-Scoring Pretest Groups

Test	*Test Form*	*Number of Students*	*Mean Standard Score*	*SD*	*t-test*	*Significance*	*Effect Size*
Lower Scoring Group							
Total	Pretest	181	162	8.8	21.399	≤.0001	1.70
Total	Posttest	181	181	14.8			
Higher Scoring Group							
Total	Pretest	181	186	9.8	22.140	≤.0001	1.71
Total	Posttest	181	204	13.5			

Figure 4 provides a pretest-to-posttest comparison of the standard scores of lower and higher scoring pretest students.

Figure 4
Standard Score Increases* for Lower and Higher Pretest Score Students



*Statistically significant

Conclusions

This study sought to determine the effectiveness of ***Math in Focus* © 2012,** an elementary school math program published by Houghton Mifflin Harcourt. A control group and ***Math in Focus*** tryout group of second and third grade classes from a large urban school district participated in the study. The ***Math in Focus*** teachers were using the program for the first time.

Two research questions guided the study:

1. Is ***Math in Focus*** more effective than an alternative mathematics program in improving the mathematics skills, knowledge, and problem solving of grade 2 and grade 3 students?
2. Is ***Math in Focus*** effective in improving the mathematics skills, knowledge and problem solving skills in lower performing as well as higher performing grade 2 and grade 3 students?

Question 1: Is Math in Focus more effective than an alternative mathematics program in improving the mathematics skills, knowledge, and problem solving of grade 2 and grade 3 students?

The *Iowa Test of Basic Skills: Mathematics* was used to assess the mathematic knowledge and skills at the beginning and end of the school year. Statistical analyses of students' scores showed that the Math in Focus students at both grades 2 and 3 increased their scores statistically significantly and the gains were statistically significant when compared to the control group. The effect size was medium at grade 2 and small at grade 3.

Question 2: Is Math in Focus effective in improving the mathematics skills, knowledge and problem solving in lower performing as well as higher performing grade 2 and grade 3 students?

Statistical analyses of the Math in Focus students showed that for both the lower and higher pretest scoring students the increases were statistically significant. For the lower and higher pretest scoring students at both grades the effect sizes were large.

On the basis of this study, both research questions can be answered positively.

- ***The Math in Focus program is more effective than an alternative mathematics program in improving the mathematics skills, knowledge, and problem solving of grade 2 and grade 3 students.***
- ***The Math in Focus program effectively improves the mathematics skills, knowledge and problem solving in lower performing as well as higher performing grade 2 and grade 3 students?***