

**A STUDY OF THE INSTRUCTIONAL EFFECTIVENESS OF
Explorations in Core Math Algebra 1 © 2014**

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ABSTRACT

To help school students develop better mathematics knowledge and analysis skills and strategies, *Houghton Mifflin Harcourt* has published, ***Holt McDougal Explorations in Core Math***© 2014. ***Explorations in Core Math*** for Grades 6–12 is a complete program for transitioning to the *Common Core State Standards* with interactive, real-world applications that help students deepen their understanding of crucial math concepts, while addressing the *Common Core Curriculum* and the *Standards for Mathematical Practice*. This program allows students to not just “do the math” but also to “understand and explain” their math.

The study focuses only on the ***Explorations in Core Math: Algebra 1***. In order to evaluate the program’s effectiveness, *Houghton Mifflin Harcourt* contracted with the *Educational Research Institute of America* (ERIA) to conduct semester long study to test the effectiveness of the program. Since the program was only recently published, the study was designed as a one semester study and was conducted during the second semester of the 2013-2014 academic year with students in grades 9 and 10.

A test was designed to assess students’ understanding, knowledge, and analysis skills and strategies. The **Holt McDougal Explorations in Core Mathematics: Algebra 1** program had not been previously used in the schools by any classes.

The results showed that the **Holt McDougal Explorations in Core Mathematics: Algebra 1** classes made statistically significant gains over the course of the semester long study. The results also showed the **Holt McDougal Explorations in Core Mathematics: Algebra 1** program proved effective with both higher and lower pretest scoring students with both groups showing statistically significant gains. The lower pretest scoring students did not, however, make gains as great as the higher pretest scoring group.

Overview of the Study

This report describes a semester long study during the second semester of the 2013-2014 academic year to determine the impact of the *Holt McDougal Explorations in Core Mathematics: Algebra 1* © 2014 program. The Holt McDougal Mathematics Explorations in Core Math for Common Core is designed to provide a strong Common Core support for teachers implementing the new Common Core State Standards and can be used either while still teaching from existing secondary mathematics programs currently in use or on its own. For this semester long study *Holt McDougal Explorations in Core Mathematics: Algebra 1* © 2014 was the primary instructional program in the tryout classes. Houghton Mifflin Harcourt school publishers contracted with the Educational Research Institute of America (ERIA) to conduct a semester long study to determine the program's effectiveness.

The program is described by the publisher on the Houghton Mifflin Harcourt web site as follows:

Explorations in Core Math for Grades 6–12 is a complete program for transitioning to the Common Core State Standards with interactive, real-world applications that help students deepen their understanding of crucial math concepts, while addressing the Common Core Curriculum and the Standards for Mathematical Practice. This program allows students to not just “do the math” but also to “understand and explain” their math.

Research Questions

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

1. Is *Holt McDougal Explorations in Core Math: Algebra 1* effective in improving the algebra skills and knowledge of high school students?
2. Is *Holt McDougal Explorations in Core Math: Algebra 1* effective in improving the algebra skills and knowledge of lower performing as well as higher performing high school students?

Design of the Study

The program's efficacy was evaluated using a pretest/posttest design. The study took place during the second semester of the 2013/2014 academic year in one school with two different teachers. Both teachers used for one semester with several classes. The classes included students in grades 9 and 10.

Before the program instruction started, students were administered a comprehensive test designed to cover the content of the second half of the *Holt McDougal Exploration in Core Math: Algebra 1* textbook. A similar posttest was used at the end of the study.

Pretest and post-test administration was under the direction of the classroom teacher. All tests were returned to ERIA for scoring and analyses.

Timeline and Program Use

The teachers used the *Holt McDougal Explorations in Core Mathematics: Algebra 1* text as their primary instructional program. The teachers reported using the program from 5 days per week and from 40 to 50 minutes per day over the entire semester. Pretests for the one semester study were administered the beginning of February, 2014 and posttests were administered the middle of May.

Description of the Research Sample

Table 1 provides the demographic characteristics of the school 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 school and, thereby, an estimate of the make-up of the classes included in the study.

Table 1
Schools Included in the Study: Demographic Characteristics

School	State	Location	Grades	Enrollment	% Minority	% Free/Reduced Lunch
1	KY	Rural	9-12	820	3%	66%

Description of the Assessment

The pretest and posttest used in the study were developed to assess standards-based algebra instruction across the second half of the textbook. Based on these standards a 40 item multiple-choice assessment was developed focusing on the skills, strategies, and knowledge necessary for effective understanding of algebra.

Table 2 provides the statistical results for the administration of the pretest and the post-test. The KR 20 reliability and the Standard Error of Measurement for the post-test indicates both the pretest score results and the posttest score results were reliable for arriving at decisions regarding the achievement of the students to whom the tests were administered. However, the pretest reliability was lower than posttest reliability. The lower pretest reliability indicates students were somewhat unfamiliar with the concepts assessed by the test and they were having to do some guessing of correct answers. The higher reliability for the post-test indicates students went from guessing to making more knowledgeable responses.

Table 2
Pretest and Post-Test Test Statistics

Test	Reliability*	SEM**
Pretest	.80	3.39
Post-test	.91	3.25

*Reliability computed using the Kuder-Richardson 20 formula.

** SEM is the Standard Error of Measurement.

Data Analyses

Standard scores were developed in order to provide a more normal distribution of scores. The standard scores were a linear transformation of the raw scores. A mean raw score was translated to a mean standard score of 300 and the standard deviation of the raw scores was translated to 50. Standard scores were then used for the statistical analyses.

Data analyses and descriptive statistics were computed for the standard scores from the *Holt McDougal Explorations in Core Mathematics: Algebra 1* assessments. The $\leq .05$ 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:

- A paired comparison *t*-test was used to compare the pretest mean standard scores with the posttest mean standard scores for all students.
- The students 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 students who had lower and higher pretest scores.

Descriptive statistics were also used to compare pretest and post-test standard test scores for the total group as well as the higher and lower pretest score groups.

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

Total Group Analysis

Researchers at ERIA conducted a paired comparison *t*-test to determine if the difference from pretest standard scores to posttest standard scores was statistically significant. For this analysis, researchers were able to match the pretest and posttest scores for 156 students. Students who did not take both the pretest and the posttest were not included.

Table 3 shows that the average standard score on the pretest was 285, and the average standard score on the posttest was 315. The increase was statistically significant ($\leq .0001$). The effect size was medium.

Table 3
Paired Comparison *t*-test Results
Pretest/Posttest Comparison of Standards Scores

<i>Test</i>	<i>Number Students</i>	<i>Mean Standard Score</i>	<i>SD</i>	<i>t-test</i>	<i>Significance</i>	<i>Effect Size</i>
Pretest	156	285	39.2	12.374	$\leq .0001$.66
Posttest	156	315	55.0			

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 students were ranked in order on the basis of their pretest standard scores. The group of 156 students was divided into two equal sized groups of 78 students. The first group included those students who scored lower on the pretest with a mean of 253 with scores ranging from 193 to 286. The higher scoring group scored an average standard score on the pretest of 317 with scores ranging from 286 to 385.

Pretest-to-posttest comparisons are shown in Table 4 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.

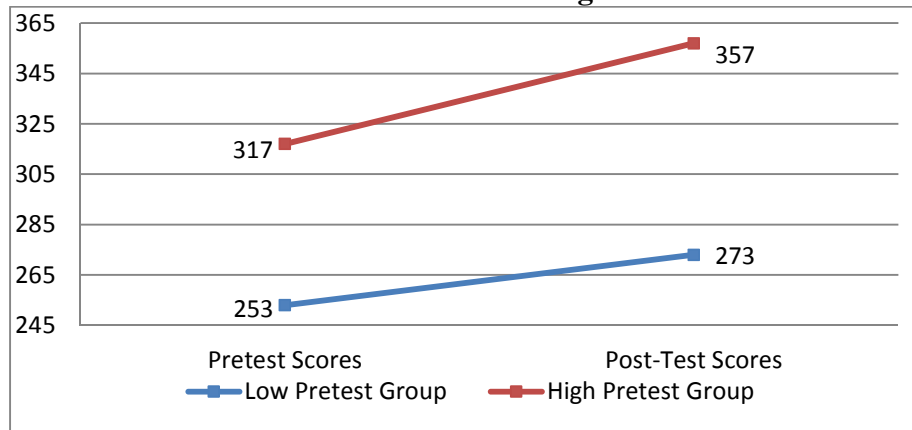
For both the higher and the lower scoring group, the average scores increased statistically significantly, ($\leq .0001$). The effect size for the lower scoring pretest group was medium and for the higher scoring group the effect size was large. In line with those results, the data shows that the lower pretest group increased 20 standard score points and the higher pretest scoring group increased 40 standard score points.

Table 4
Paired Comparison *t*-test Results for Pretest/Posttest Standard Scores
for the High- and Low-Scoring Pretest Groups

<i>Test Form</i>	<i>Number Students</i>	<i>Standard Score</i>	<i>SD</i>	<i>t-test</i>	<i>Significance</i>	<i>Effect Size</i>
Lower Scoring Group						
Pretest	78	253	20.6	5.975	≤.0001	.74
Posttest	78	273	35.1			
Higher Scoring Group						
Pretest	78	317	24.5	12.755	≤.0001	1.34
Posttest	78	357	36.0			

Figure 1 provides a pretest-to-posttest comparison of the standard scores of lower and higher scoring pretest students. The higher scoring pretest group increased their scores more than the lower scoring pretest group; however, both groups made statistically significant growth over the one semester of the study.

Figure 1
Standard Score Increases for Lower and Higher Pretest Score Students



Conclusions

This study sought to determine the effectiveness of *Holt McDougal Exploration in Core Mathematics: Algebra 1* © 2014, a high school program published by Houghton Mifflin Harcourt. The study was carried out with classes at grades 9 and 10. The teacher was using the program for the first time and received no special instruction in using the program.

Two research questions guided the study:

1. Is *Holt McDougal Explorations in Core Math: Algebra 1* effective in improving the algebra skills and knowledge of high school students?
2. Is *Holt McDougal Explorations in Core Math: Algebra 1* effective in improving the algebra skills and knowledge of lower performing as well as higher performing high school students?

Question 1: Is *Holt McDougal Explorations in Core Math: Algebra 1* effective in improving the algebra skills and knowledge of high school students?

A test designed to assess the knowledge, skills, and analytic skills in algebra was developed to assess students at the beginning and end of the second semester of the academic year. Statistical analyses of students' scores showed that the students increased their scores statistically significantly on the assessment. The effect size was medium.

Question 2: Is *Holt McDougal Explorations in Core Math: Algebra 1* effective in improving the algebra skills and knowledge of lower performing as well as higher performing high school students?

Statistical analyses of higher and lower pretest scoring students' scores showed that for both the lower and higher pretest scoring students the increase was statistically significant. For the lowest pretest scoring students the effect size was medium and for the higher pretest scoring students the effect size was large.

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

- ***The Holt McDougal Explorations in Core Mathematics: Algebra 1 textbook program is effective in improving the algebra skills and knowledge of high school students.***
- ***The Holt McDougal Explorations in Core Mathematics: Algebra 1 textbook program is effective in improving the algebra skills and knowledge of lower performing as well as higher performing high school students.***