

A STUDY OF THE INSTRUCTIONAL EFFECTIVENESS OF
Holt McDougal Physics ©2012

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ABSTRACT

To help secondary school students develop better skills, knowledge, and problem solving in Physics, *Houghton Mifflin Harcourt* has published, ***Holt McDougal Physics 2012***©. Physics is best taught and learned with a strong focus on problem-solving. Students need to learn how to work through the challenges that come with general problem solving and solving mathematical equations in physics. For that reason, Holt McDougal designed an innovative program designed to provide your students with the right balance of concepts and computation.

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.

The physics classes included 9 different teachers who taught in 8 different schools which were located in 7 different states. A 50 item test was designed to assess students' understanding, knowledge, analysis skills and strategies as they are taught in the program. The ***Holt McDougal Physics 2012***© program had not been previously used in the schools by any classes.

The results showed that the ***Holt McDougal Physics 2012***© classes made statistically significant gains over the course of the academic year. The results also showed the program proved equally effective with both higher and lower pretest scoring students.

Overview of the Study

This report describes full academic year study conducted to determine the impact of the *Holt McDougal Physics 2012*© program for high school students. The study took place over an entire school year, from September to June in 2013. For the entire course each teacher used the program as the primary instructional program.

Houghton Mifflin Harcourt contracted with the *Educational Research Institute of America* (ERIA) to conduct an academic year study to determine the program's effectiveness.

Research Questions

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

1. Is *Holt McDougal Physics 2012*© effective in improving the skills, knowledge, and problem solving of high school students in Physics?
2. Is *Holt McDougal Physics* effective in improving skills, knowledge and problem solving in Physics 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 2012/2013 academic year. All of the students in the study were enrolled in grade 11 or 12. A total of 9 different teachers in 8 different schools in 7 states were included in the study. The study took place over a full academic year.

Before the program instruction started, students were administered a comprehensive test designed to cover the content of the *Holt McDougal Physics 2012*© 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.

Project Background

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

Serway and Faughn's Holt McDougal Physics © 2012 is a comprehensive program with a balanced approach to concepts and problem-solving. The newly designed pages provide increased student accessibility and newly integrated advanced topics. Holt McDougal Physics offers a conceptual foundation and appropriately leveled mathematically-based presentation of physics. The text links concepts and problem solving so students get clear conceptual development and plenty of practice working with both fundamental physical concepts and problem-solving skills. New differentiated instruction strategies provide for a wide range of student needs, including Below Level, English Learners, Pre-AP, and Inclusion students. Holt McDougal Physics © 2012 focuses on strengthening problem solving by providing strategies and extra practice with guidance and feedback to ensure success. Technology learning tools have been added to Holt McDougal Physics © 2012. Physics Lab includes comprehensive lab resources with a wide variety of print and digital lab options, including virtual, STEM, and open-ended inquiry labs.*

Timeline and Program Use

The teachers used **Holt McDougal Physics © 2012** text as the primary physics instructional program. Most teachers reported using the program from 3-5 days per week for 40-45 minutes per day. Pretests were administered at the middle of September, 2012 and posttests were administered the middle of June, 2013.

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

State	Location	Grades	ENROLLMENT	% Minority	% Free/Reduced Lunch	%Special Education
PA	Suburban	09-12	591	4%	22%	UNK
OH	Rural	09-12	290	1%	5%	8%
OH	Suburban	09-12	690	3%	0%	8%
RI	Suburban	09-12	1096	11%	21%	UNK
MN	Urban	09-12	1700	21%	15%	UNK
MI	Rural	09-12	961	9%	37%	UNK
MA	Rural	09-12	1067	9%	UNK	UNK
NJ	Suburban	06-12	500	20%	UNK	UNK
AVERAGES			862	10%	17%	8%

Description of the Assessment

The pretest and posttest used in the study were developed to assess standards-based physics topics across the program chapters. Based on these standards, a 50 item multiple-choice assessment test was developed focusing on the skills, strategies, and knowledge necessary for effective understanding of Physics.

Table 2 provides the statistical results for the administration of the pretest and the post-test. The pretest reliabilities were lower than ideal for assessment. However, the pretests were administered prior to any physics instruction. The KR 20 reliabilities for the post-tests indicate the test was reliable for arriving at decisions regarding the achievement of the students to whom the tests were administered.

Table 2
Pretest and Post-Test Test Statistics

Test	Reliability*	SEM**
Pretest	.61	2.87
Post-test	.72	2.86

*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 Physics* 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 lower performers and higher 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

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 354 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 281, and the average standard score on the posttest was 319. The increase was statistically significant ($\leq .0001$). The effect size was large.

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	354	281	42.8	13.810	$\leq .0001$	1.15
Posttest	354	319	49.5			

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 354 students was divided into two equal groups of 177. The first group included those students who scored lower on the pretest with a mean of 248 with scores ranging from 158 to 281. The higher scoring group scored an average standard score on the pretest of 313 with scores ranging from 291 to 395.

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.

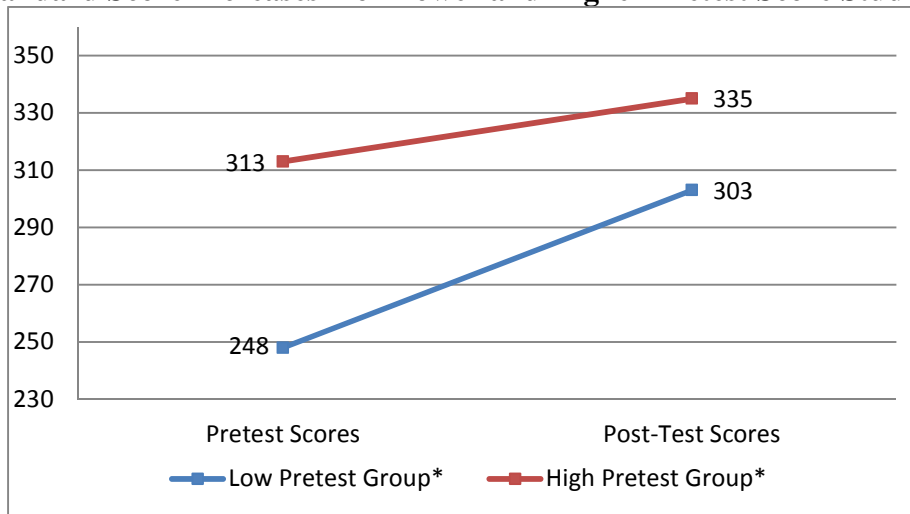
For both the higher and the lower scoring group, the average scores increased. The increase for both groups was statistically significant ($\leq .0001$). The effect size for both the lower and higher scoring pretest groups was large. The data shows that the lower pretest group increased 55 standard score points and the higher pretest scoring group increased 22 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</i>	<i>Test Form</i>	<i>Number of Students</i>	<i>Mean Standard Score</i>	<i>SD</i>	<i>t-test</i>	<i>Significance</i>	<i>Effect Size</i>
Lower Scoring Group							
Total	Pretest	177	248	33.3	15.218	≤.0001	.95
Total	Posttest	177	303	39.0			
Higher Scoring Group							
Total	Pretest	177	313	20.8	5.650	≤.0001	1.30
Total	Posttest	177	335	53.7			

Figure 1 provides a pretest-to-posttest comparison of the standard scores of lower and higher scoring pretest students. The lower scoring pretest group increased their scores more than the higher scoring pretest group resulting in scores that showed a 65 point difference at the beginning of the academic year and only a 32 point difference by the end of the academic year.

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



*Statistically significant

Conclusions

This study sought to determine the effectiveness of *Holt McDougal Physics* © 2012, a high school physics program published by Houghton Mifflin Harcourt. The study was carried out with grade 11 and 12 students in eight schools in seven states. The teachers were 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 Physics 2012*© effective in improving the skills, knowledge, and problem solving of high school students in Physics?
2. Is *Holt McDougal Physics 2012*© effective in improving skills, knowledge and problem solving in Physics of lower performing as well as higher performing high school students?

Question 1: Is Holt McDougal Physics effective in improving the skills and knowledge of high school students in Physics?

A test designed to assess the knowledge, skills, and analytic skills in Physics was developed to assess students at the beginning and end of the school year tryout of the program. Statistical analyses of students' scores showed that the students increased their scores statistically significantly on the assessment. The effect size was large.

Question 2: Is Holt McDougal Physics effective in improving skills and knowledge in Physics of lower performing as well as higher performing high school students?

Statistical analyses of lower pretest scoring students' scores showed that for both the lower and higher pretest scoring students the increases were statistically significant. For the lower and higher pretest scoring students the effect size was large. However, the increase in terms of standard scores was larger for the lower pretest scoring students than it was for the higher pretest scoring group.

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

- ***The Holt McDougal Physics 2012*© textbook program is effective in improving the skills and knowledge of high school students in Physics**
- ***The Holt McDougal Physics 2012*© textbook program is effective in improving skills and knowledge in Physics of lower performing as well as higher performing high school students.**