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A LONGITUDINAL ANALYSIS OF STATE MATHEMATICS SCORES FOR INDIANA SCHOOLS USING *SAXON MATH*

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A LONGITUDINAL ANALYSIS OF STATE MATHEMATICS SCORES FOR INDIANA SCHOOLS USING *SAXON MATH*

This report describes a three year longitudinal study of the instructional effectiveness of *SAXON MATH*, a mathematics program designed for use in kindergarten through grade 12.

Project Background

We live in a mathematical world. Never before has the workplace demanded such complex levels of mathematical thinking and problem solving (National Council of Teachers of Mathematics, 2009). Clearly, those who understand and can do mathematics will have increased opportunities in the workplace. Mathematical competence can open doors that will allow for educational and career advancements. A lack of mathematical competence can close those doors.

Unfortunately, in terms of mathematical skills, the United States is quickly falling behind the rest of the developed world. A recent study comparing the math skills of students in industrialized nations found that U.S. students in grades 4 and 8 consistently performed below most of their peers around the world, a trend that continues into high school (Mullis, Martin, Gonzalez, & Chrostowski, 2004). And although the latest results from the National Assessment of Educational Progress (2007) showed improvements in the math performance of students in grades 4 and 8 nationally, upon closer examination, only fourteen of the fifty states showed improved scores at both grade levels. Seventeen states did not show improvements at either grade level. Further, low-income and minority students in the U.S. perform relatively poorly in math as early as kindergarten and first grade (Denton & West, 2002). By the third grade, the number of American students showing signs of math learning difficulties increases significantly (Ostad, 1998, 1997; Geary, Hoard, Byrd-Craven, & DeSoto, 2004).

To address concerns that many students lack essential skills to be successful in mathematics-related careers, President Bush called for the creation of a National Mathematics Advisory Panel in April, 2006. This panel was charged with fostering "greater knowledge of and improved performance in mathematics among American students" (U.S. Department of Education, 2008).

On March 13, 2008, the National Mathematics Advisory Panel submitted its final report. In the report, the Panel stressed how critical it is that students succeed in algebra, in part because doing so will make them much more likely to succeed in college and be prepared for better career opportunities in the global economy of the 21st century. The Panel also emphasized the importance of children having a strong base in mathematics. Research shows that a strong start can be a major contributor to preventing later difficulties in math learning. Efforts must begin in early childhood, with a particular focus on the foundational skills learned from kindergarten through third grade. Effective early math education can help students to:

- Acquire the foundational knowledge and skills that they will need to be successful with algebra and other advanced math courses (National Association for the Education of Young Children and National Council of Teachers of Mathematics, 2002);
- Avoid retention in the early years by increasing math skills (Magnuson, Myers, Ruhm, & Waldfogel, 2003); and
- Develop positive attitudes toward learning math early on (Ma, 2000).

There has never been a greater need to ensure that the math programs today's young students are using are optimally supporting them in developing the mathematical skills and strategies required for success in high school, in college, and in the workplace. Because of the importance of determining the effectiveness of programs designed to support young children with mathematics instruction, Houghton Mifflin Harcourt contracted with the Educational Research Institute of America (ERIA) to study the effectiveness of the *SAXON MATH* program. This report presents the findings from that study.

Research Questions

The following research questions guided the design of the study:

- Is *SAXON MATH* instructionally effective in improving students' mathematical skills and strategy use over time?
- Do students whose math instruction is supported by *SAXON MATH* show improvements in their mathematical skills and strategy use that are above those shown by students using other math programs?

Design of the Study

A quasi-experimental, pretest/posttest design was used for this study. Indiana schools using the *SAXON MATH* program at grades 3 and/or 5 during the 2004-2005, 2005-2006, and 2006-2007 school years were included in the study. Standard scores from the fall 2004 administration of the math portion of the Indiana Statewide Testing for Educational Progress-Plus (ISTEP+) were used as the pretest and standard scores from the fall 2007 administration of the math portion of the ISTEP+ were used as the posttest.

In order to identify Indiana *SAXON MATH* schools for inclusion in the study, Houghton Mifflin Harcourt provided researchers with a list of Indiana elementary schools that had purchased *SAXON MATH*. Researchers then telephoned the administrators at each of these schools to determine the year each one had started using *SAXON MATH* at grades 3 and 5 and for how long each one had continued to use the program at those same grade levels. Schools were included in the study if it could be verified that they had started using the program at grade 3 and/or grade 5 no later than the 2004-2005 academic year and had continued to do so through the 2006-2007 academic year or longer.

A total of 49 schools in Indiana were verified as having used *SAXON MATH* at grade 3 from the 2004-2005 academic year through the 2006-2007 academic year. A total of 61 Indiana schools were verified as having used *SAXON MATH* at grade 5 for the same three year period. The two lists of schools are similar but not identical. Some of the differences can be explained by the variability of grade levels offered at the schools (e.g. K-5 or K-6). Other differences are due to the fact that some schools did not adopt the program at all grade levels during the same academic year but instead adopted the program at one or two grade levels each year over several years until the program was implemented at all grade levels.

For each school, researchers downloaded the ISTEP+ mathematics data that is available to the public from the Indiana Department of Education (IDOE) Web site. Additional data was secured by contacting personnel in the IDOE Assessment Office. Ultimately, the average standard score in math and the percent of students passing the math portion of the ISTEP+ at grades 3 and 5 at each *SAXON MATH* school during the fall 2004 and fall 2007 administrations of the ISTEP+ were obtained.

The current study also provides comparisons of the performances of grades 3 and 5 students at Indiana *SAXON MATH* schools on the fall 2004 and fall 2007 administrations of the math portion of the ISTEP+ to the performances of all grades 3 and 5 students in the state. The average standard scores on the math portion of the ISTEP+ for all grade 3 and grade 5 Indiana students for the fall 2004 and fall 2007 administrations of the test were determined using data made available by the IDOE. The IDOE provides average scores for public and non-public schools separately. However, the *SAXON MATH* schools include both public and non-public schools. Therefore, the mean scores provided in the current report for all grade 3 and grade 5 students are average scores computed from the total list of public and non-public schools. In addition, it should be pointed out that the mean standard scores for all grade 3 and grade 5 Indiana students for the fall 2004 and fall 2007 administrations does include the *SAXON MATH* grade 3 and grade 5 students.

Instructional Approach under Study

The description of *SAXON MATH* provided by the publisher states the following:

> A well-articulated curriculum challenges students to learn increasingly more sophisticated mathematical ideas as they continue their studies. John Saxon had a similar philosophy in mind when in the early 1980s he developed his theory-based distributed approach to mathematics instruction, practice, and assessment. Utilizing this approach, the *SAXON MATH* K–12 program was created with a comprehensive approach to mathematics. Because smaller pieces of information are easier to teach and easier to learn, the *SAXON MATH* series was developed by breaking down complex concepts into related increments. The instruction, practice, and assessment of those increments were systematically distributed across each grade level. Practice is continual, and assessment is cumulative.
>
> The *SAXON MATH* approach differs from most programs in that it distributes instruction, practice, and assessment instead of massing these elements throughout the lessons and school year. In a massed approach, instruction, practice, and assessment of a skill or concept occur within a short period of time and are clustered within a single chapter or unit. In the *SAXON MATH* program, as students encounter new increments of instruction, they are also continually reviewing previously introduced math concepts. Frequent assessments of newer and older concepts are

encountered throughout the lessons, ensuring that students truly integrate and retain critical math skills.

Description of the Research Sample

A total of 49 schools were verified as having used *SAXON MATH* at grade 3 from the 2004-2005 academic year through the 2006-2007 academic year. The grades enrolled at each school varied considerably across the 49 schools, although 59% of the schools enrolled students in grades K to 5 or K to 6. Table 1 provides a demographic summary of the schools included in the grade 3 group. The average enrollment for the schools was 416. The average percent of students enrolled in free and reduced lunch programs across the schools was 35%. The average percent of minority students was 7%.

Table 1
Means of Demographic Characteristics of Schools Included in the Grade 3 Group

Mean Student Enrollment	*Mean % of Students in Free/Reduced Lunch Programs*	*Mean % of Minority Students*	*Mean % of Special Education Students*	*Mean % of Limited English Proficient Students*
416	35%	7%	16%	2%

A total of 61 schools were verified as having used *SAXON MATH* at grade 5 from the 2004-2005 academic year through the 2006-2007 academic year. As for the grade 3 schools, the grades enrolled at each grade 5 school varied considerably across the 61 schools, although 67% of the schools enrolled students in grades K to 5 or K to 6. Table 2 provides a demographic summary of the schools included in the grade 5 group. The average enrollment for the schools was 365. The average percent of students enrolled in free and reduced lunch programs across the schools was 33%. The average percent of minority students was 9%.

Table 2
Means of Demographic Characteristics of Schools Included in the Grade 5 Group

Mean Student Enrollment	*Mean % of Students in Free/Reduced Lunch Programs*	*Mean % of Minority Students*	*Mean % of Special Education Students*	*Mean % of Limited English Proficient Students*
365	33%	9%	15%	3%

(See Appendix A for demographic information for each grade 3 school and Appendix B for each grade 5 school included in the study.)

Description of the ISTEP+

The following explanation of the ISTEP+ was taken from the Indiana Department of Education Web site (Indiana Department of Education, 2009):

> *The Indiana Statewide Testing for Educational Progress-Plus (ISTEP+) measures what students know and are able to do at each grade level. Based on Indiana's Academic Standards, ISTEP+ provides a learning check-up to make sure students are on track and signal whether they need extra help.*

At grades 3 and 5, Indiana's Academic Standards for Mathematics are organized into six overarching topics: Number Sense, Computation, Algebra and Functions, Geometry, Measurement, and Problem Solving. At grade 5 there is an additional topic: Data Analysis and Probability. Table 3 provides sample grade 3 and grade 5 Indiana Academic Standards for Mathematics for each of the topics (Indiana Department of Education, 2008). (A complete set of Indiana's Academic Standards for Mathematics in grade 3 can be found in Appendix C, and grade 5 can be found in Appendix D.)

Table 3
Samples from Indiana's Academic Standards for Mathematics in Grades 3 and 5

Number Sense	
Grade 3 Sample	3.1.1 Count, read, and write whole numbers up to 1,000.
Grade 5 Sample	5.1.1 Convert between numbers in words and numbers in figures, for numbers up to millions and decimals to thousandths.
Computation	
Grade 3 Sample	3.2.1 Add and subtract whole numbers up to 1,000 with or without regrouping, using relevant properties of the number system.
Grade 5 Sample	5.2.1 Solve problems involving multiplication and division of any whole numbers.
Algebra and Functions	
Grade 3 Sample	3.3.1 Represent relationships of quantities in the form of a numeric expression or equation.
Grade 5 Sample	5.3.1 Use a variable to represent an unknown number.
Geometry	
Grade 3 Sample	3.4.1 Identify quadrilaterals as four-sided shapes.
Grade 5 Sample	5.4.1 Measure, identify, and draw angles, perpendicular and parallel lines, rectangles, triangles and circles by using appropriate tools (e.g. ruler, compass, protractor, appropriate technology and media tools).
Measurement	
Grade 3 Sample	3.5.1 Measure line segments to the nearest half-inch.
Grade 5 Sample	5.5.1 Understand and apply the formulas for the area of a triangle, parallelogram, and trapezoid.
Problem Solving	
Grade 3 Sample	3.6.1 Analyze problems by identifying relationships, telling relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.
Grade 5 Sample	5.7.1 Analyze problems by identifying relationships, telling relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.
Data Analysis and Probability	
Grade 3 Sample	*No grade 3 standards in this category*
Grade 5 Sample	5.6.1 Explain which types of display are appropriate for various sets of data.

Data Analyses

Two primary analyses were conducted at grade 3 and grade 5:

1. Analyses to determine whether the average standard scores on the math portion of the ISTEP+ increased significantly from the fall 2004 test administration to the fall 2007 test administration for Indiana *SAXON MATH* schools.

A Paired Comparison *t*-test was used to compare average standard scores on the math portion of the ISTEP+ from the fall 2004 test administration (pretest) to the fall 2007 test administration (posttest) for grade 3 and grade 5 students at Indiana *SAXON MATH* schools. In addition, the percentages of Indiana *SAXON MATH* schools reporting pass rates at grades 3 and 5 of less than 70%, from 70% to 89%, and 90% or higher from pretest to posttest were compared. A Paired Comparison *t*-test was also used to compare the grade 3 and grade 5 pretest to posttest gains of higher socio-economic Indiana *SAXON MATH* schools to the gains of the lower socio-economic schools, as well as to compare the grade 3 and grade 5 pretest to posttest gains of *SAXON MATH* schools that had lower average pretest scores to those that had higher average pretest scores.

2. Analyses allowing for comparisons of the fall 2004 and fall 2007 average standard scores on the ISTEP+ math test of *SAXON MATH* schools in Indiana to the Indiana state averages.

For several reasons, it would be inappropriate and misleading to conduct any statistical analyses comparing ISTEP+ math scores for all of the schools in Indiana to those schools using the *SAXON MATH* program. One concern, for example, is that the sample sizes are not comparable. Also, the *SAXON MATH* schools were not randomly assigned to the experimental group. They were a self-selected group in that they chose to adopt the *SAXON MATH* program. Therefore, descriptive statistics are provided as a way to compare grade 3 and grade 5 students at Indiana *SAXON MATH* schools with other grade 3 and grade 5 students throughout the state.

Grade 3

Pretest/Posttest Analyses of SAXON MATH *Schools*

Whole Group Pretest/Posttest Analyses

Researchers at ERIA conducted a Paired Comparison *t*-test to determine if the differences in pretest and posttest scores of grade 3 students in Indiana *SAXON MATH* schools were statistically significant. The .05 level of significance was used as the level at which differences would be considered statistically significant. For the grade 3 analyses, 49 schools were included.

In addition to the Paired Comparison *t*-test, effect-size analyses were computed for each of the comparisons. 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

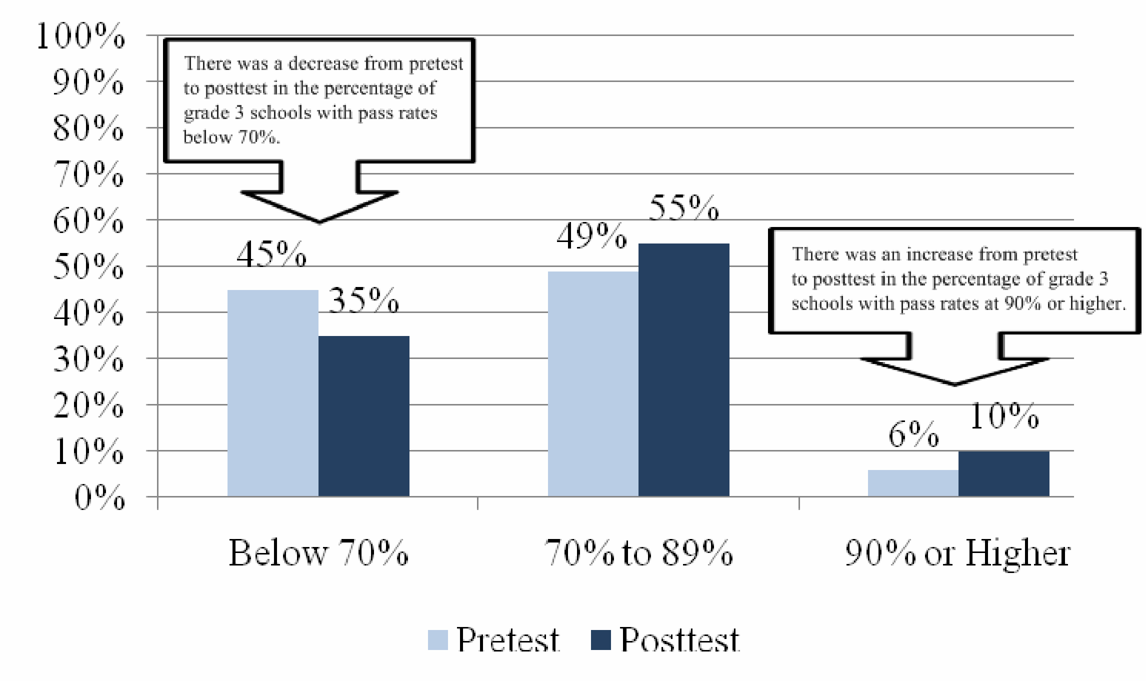
Table 4 presents the results of the *t*-test performed to determine if the difference in pretest and posttest standard scores at grade 3 was statistically significant. The average standard score on the pretest was 420.8, and the posttest the average standard score was 428.8, a difference that was statistically significant at the .0001 level. This level of significance indicates that such a difference would have occurred by chance less than once out of 10,000 repetitions. The effect size was medium.

Table 4
Results Comparing the ISTEP+ Math Standard Scores of Grade 3 Students at Indiana *SAXON MATH* Schools in Fall 2004 (Pretest) and Fall 2007 (Posttest)

Test	***Number of Schools***	***Mean Score***	***SD***	***t*-Test**	***Significance***	***Effect Size***
Pretest	49	420.8	19.8	4.548	<.0001	.51
Posttest	49	428.8	18.1			

Figure 1 shows the percentages of Indiana *SAXON MATH* schools with fewer than 70%, with 70% to 89%, and with 90% or higher of their grade 3 students passing the math portion of the ISTEP+ in fall 2004 (pretest) and in fall 2007 (posttest). The figure shows a decrease in the percentage of schools with pass rates below 70% and increases in the percentage of schools with pass rates from 70% to 89% and 90% or higher.

Figure 1
Percentage of Indiana *SAXON MATH* Schools with Various Ranges of Percentages of Grade 3 Students Passing the ISTEP+ Math in Fall 2004 (Pretest) and in Fall 2007 (Posttest)



Socio-Economic Group Pretest/Posttest Analyses
A Paired Comparison *t*-test was used to compare the pretest and posttest scores of the grade 3 Indiana *SAXON MATH* schools categorized as being of higher and lower socio-economic status (SES). The percentage of students receiving free and reduced lunch was used as the indicator of SES for this comparison. Schools were ranked from highest to lowest according to the percentage of students receiving free and reduced lunch at each school. That list was then divided in half with 25 schools in the lower free/reduced lunch group and 24 schools in the higher free/reduced lunch group. The lower free/reduced lunch schools were considered the higher socio-economic schools, and the higher free/reduced lunch schools were considered the lower socio-economic schools. The .05 level of significance was used as the level at which increases would be considered statistically significant.

Table 5 presents the results of the *t*-test performed to determine if the difference between pretest and posttest standard scores for the lower and higher SES schools at grade 3 was statistically significant. For the higher SES schools, the average standard score on the pretest was 418.9, and the posttest was 426.6. For the lower SES schools, the average standard score on the pretest was 422.7, and the posttest was 431.0. Both differences were statistically significant at the .004 level. This level of significance indicates that such a difference would have occurred by chance less than four out of 1,000 repetitions. The effect size for both groups was small.

Table 5
Results Comparing the ISTEP+ Mathematics Standard Scores of Grade 3 Students at Indiana *SAXON MATH* Schools in Fall 2004 (Pretest) and in Fall 2007 (Posttest) For High and Low SES Schools

Test	***Number of Schools***	***Mean Score***	***SD***	***t*-Test**	***Significance***	***Effect Size***
Higher Socio Economic Schools						
Pretest	25	418.9	17.4	3.146	<.004	.45
Posttest	25	426.6	16.9			
Lower Socio Economic Schools						
Pretest	24	422.7	22.1	3.220	<.004	.40
Posttest	24	431.0	19.5			

Figure 2 shows the percentages of higher SES Indiana *SAXON MATH* schools with fewer than 70%, with 70% to 89%, and with 90% or higher of their grade 3 students passing the math portion of the ISTEP+ in fall 2004 (pretest) and in fall 2007 (posttest). The figure shows a modest increase in the percentage of schools with pass rates from 90% or higher.

Figure 2
Percentage of Higher SES Indiana *SAXON MATH* Schools with Various Ranges of Percentages of Grade 3 Students Passing the ISTEP+ Math in Fall 2004 (Pretest) and in Fall 2007 (Posttest)

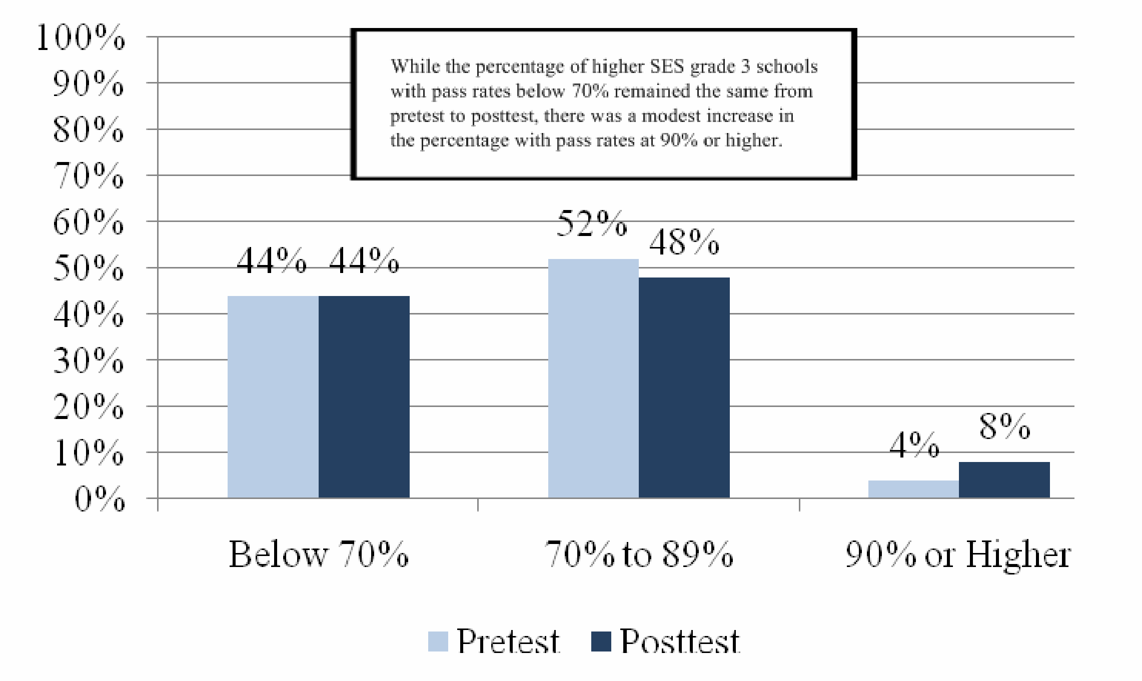
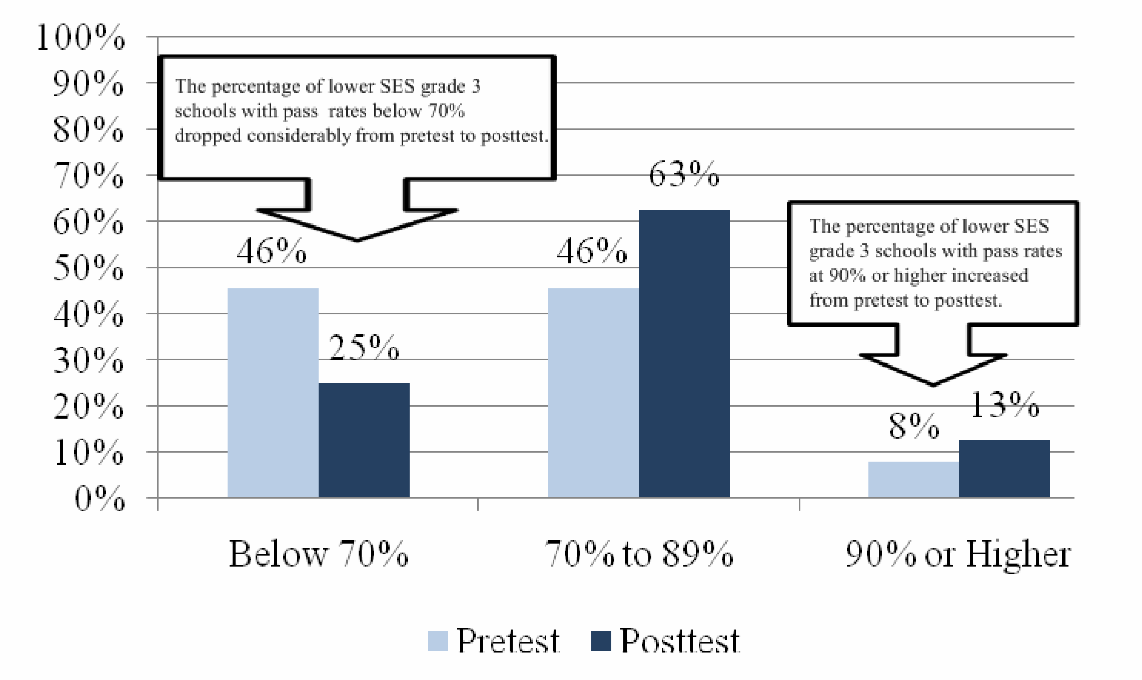


Figure 3 shows the percentages of lower SES Indiana *SAXON MATH* schools with fewer than 70%, with 70% to 89%, and with 90% or higher of their grade 3 students passing the math portion of the ISTEP+ in fall 2004 (pretest) and in fall 2007 (posttest). The results are very different for the lower SES schools than for the higher SES schools. For the lower SES schools, the percentage of schools with pass rates below 70% dropped considerably from pretest to posttest while the percentage of schools with pass rates from 70% to 89% and 90% and higher increased.

Figure 3
Percentage of Lower SES Indiana *SAXON MATH* Schools with Various Ranges of Percentages of Grade 3 Students Passing the ISTEP+ Math in Fall 2004 (Pretest) and in Fall 2007 (Posttest)



Pretest Score Group Pretest/Posttest Analyses

The grade 3 schools were divided into two approximately equal groups based on their pretest scores. The lower pretest group included 25 schools and the higher pretest group included 24 schools. Paired Comparison *t*-tests were conducted to determine if both groups made significant pretest to posttest gains.

Table 6 presents the results of the *t*-test performed to determine if the difference between pretest and posttest standard scores for lower and higher pretest scoring schools at grade 3 was statistically significant. The average standard score for the lower scoring group increased from 406.0 to 419.6. The difference for the lower scoring pretest group was statistically significant at the .0001 level, indicating a change that would have occurred by chance less than once out of 10,000 repetitions. The effect size was large.

The average standard score for the higher scoring group increased from 436.1 to 438.4. The difference for the higher scoring pretest group was not statistically significant. The lack of statistical significance was most likely due to the fact that these schools were already high-achieving math schools at the time of the pretest and simply maintained their average scores, with slight increases, three years later at the time of the posttest.

Table 6
Results Comparing the ISTEP+ Math Standard Scores of Grade 3 Students at Indiana *SAXON MATH* Schools in Fall 2004 (Pretest) and in Fall 2007 (Posttest) For Lower and Higher Scoring Pretest Groups

Test	***Number of Students***	***Mean Score***	***SD***	**t*-test***	***Significance***	***Effect Size***
Lower Scoring Pretest Schools						
Pretest	25	406.0	10.0	5.121	<.0001	1.17
Posttest	25	419.6	12.9			
Higher Scoring Pretest Schools						
Pretest	24	436.1	15.0	1.346	Non-Significant	.13
Posttest	24	438.4	18.0			

Figure 4 shows the percentages of Indiana *SAXON MATH* schools in the lower scoring pretest group with fewer than 70%, with 70% to 89%, and with 90% or higher of their grade 3 students passing the math portion of the ISTEP+ in fall 2004 (pretest) and in fall 2007 (posttest). The figure shows a large decrease in the percentage of schools with pass rates below 70% and a large increase in the passes rates from 70% to 89%. The percent of schools with pass rates above 90% went from 0 to 4%.

Figure 4
Percentage of Indiana *SAXON MATH* Schools in the Lower Scoring Pretest Group with Various Ranges of Percentages of Grade 3 Students Passing the ISTEP+ Math in Fall 2004 (Pretest) and in Fall 2007 (Posttest)

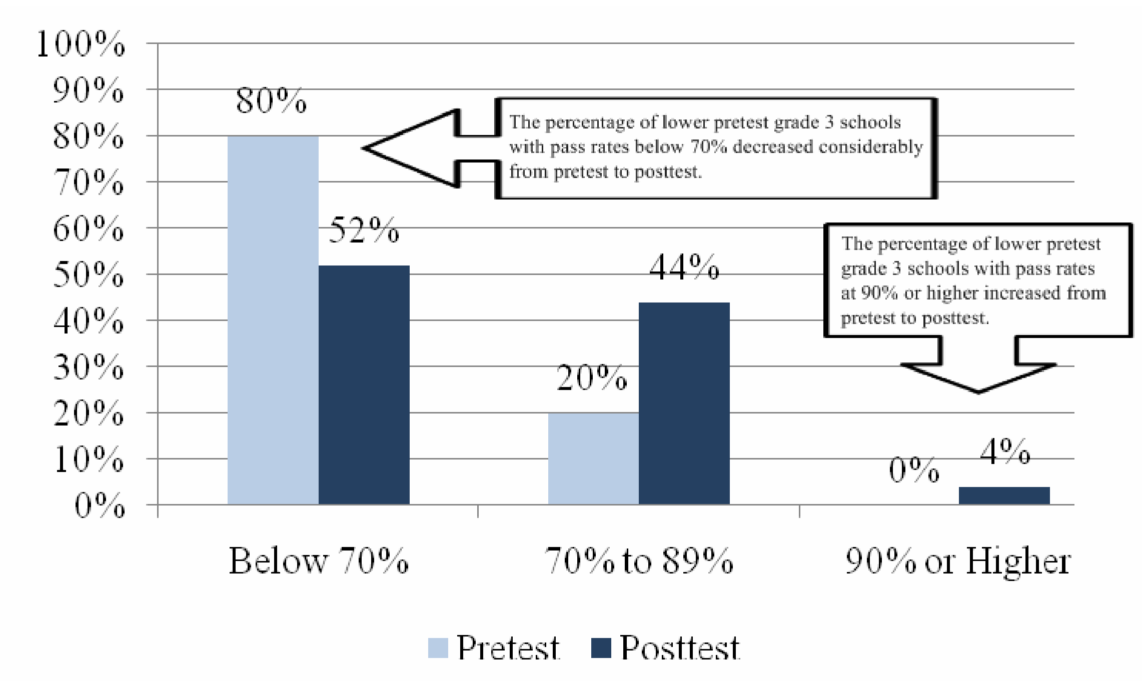
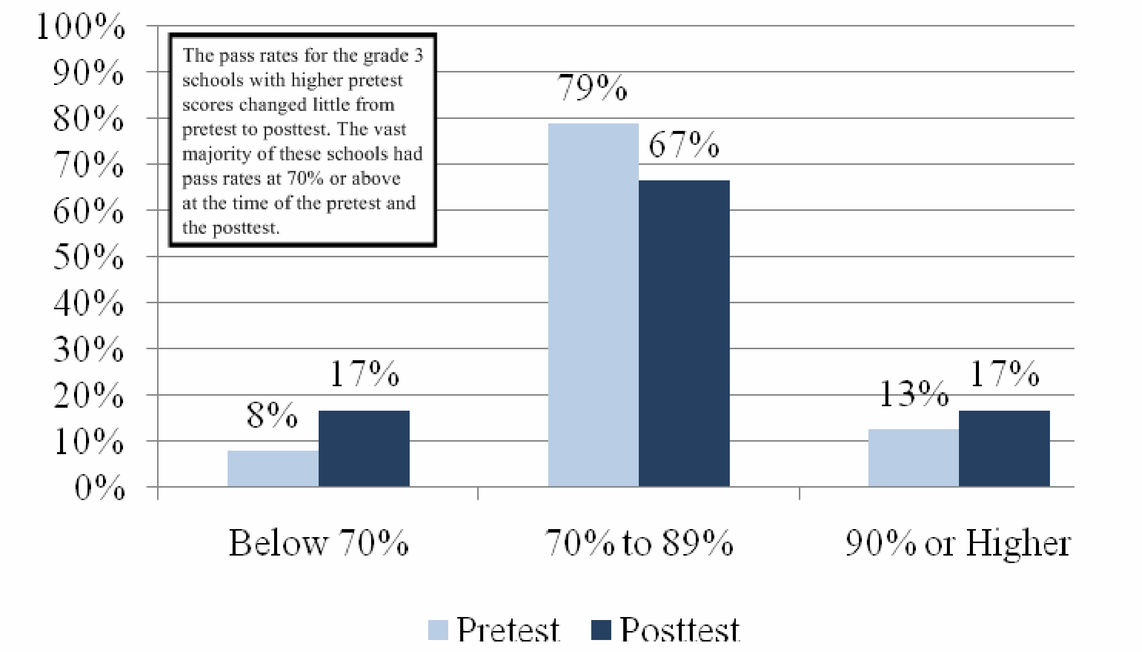


Figure 5 shows the percentages of Indiana *SAXON MATH* schools in the higher scoring pretest group with fewer than 70%, with 70% to 89%, and with 90% or higher of their grade 3 students passing the math portion of the ISTEP+ in fall 2004 (pretest) and in fall 2007 (posttest). These schools were already scoring at high levels at the time of the pretest and, for the most part, maintained high performance levels at the time of the posttest.

Figure 5
Percentage of Indiana *SAXON MATH* Schools in the Higher Scoring Pretest Group with Various Ranges of Percentages of Grade 3 Students Passing the ISTEP+ Math in Fall 2004 (Pretest) and in Fall 2007 (Posttest)



SAXON MATH *Schools Compared to the State*

Table 7 shows that the average standard score on the ISTEP+ in math for all grade 3 Indiana students declined slightly from the fall of 2004 to the fall of 2007, as did the percentage of grade 3 students passing the math portion of the ISTEP+. The grade 3 students at the schools using the *SAXON MATH* program scored a bit below the grade 3 state average in fall 2004. However, their average score exceeded the state average by fall 2007, as did the average percentage of grade 3 *SAXON MATH* students passing the ISTEP+ in math.

Table 7
Comparison of All Indiana Grade 3 Students and Grade 3 *SAXON MATH* Students Average Standard Score on ISTEP+ Math and Percent of Students Passing ISTEP+ Math in Fall 2004 (Pretest) and Fall 2007 (Posttest)

	Indiana Public and Non-Public Grade 3 Schools (N=1,312)		**SAXON MATH *Grade 3 Schools (N=49)***	
	Fall of 2004	Fall of 2007	Fall of 2004	Fall of 2007
Average Grade 3 Standard Score on ISTEP+ Math	423.3	421.3	420.7	428.8
Percent Grade 3 Students Passing ISTEP+ Math	73.0	70.8	71.8	75.1

The comparisons of the *SAXON MATH* schools to the Indiana total set of schools do not provide any definitive comparisons due to a number of important research design issues. Nevertheless, they do provide interesting data when reviewed in comparison to the pretest/posttest statistical analyses for the *SAXON MATH* school results.

Grade 5

Pretest/Posttest Analyses of SAXON MATH *Schools*

Whole Group Pretest/Posttest Analyses

Researchers at ERIA conducted a Paired Comparison *t*-test to determine if the differences in pretest and posttest scores of grade 5 students in Indiana *SAXON MATH* schools were statistically significant. The .05 level of significance was used as the level at which differences would be considered statistically significant. For the grade 5 analyses, 61 schools were included.

In addition to the Paired Comparison *t*-test, effect-size analyses were computed for each of the comparisons. 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

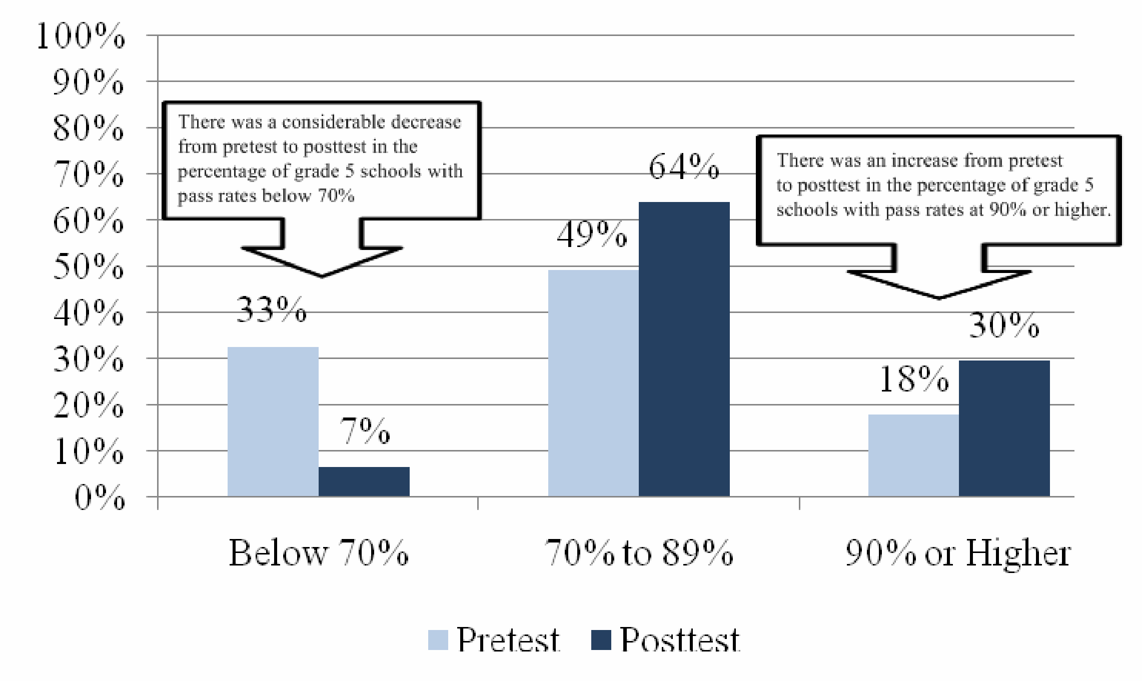
Table 8 presents the results of the *t*-test performed to determine if the difference in pretest and posttest standard scores at grade 5 was statistically significant. The average standard score on the pretest was 466.0, and for the posttest, the average standard score was 478.7, a difference that was statistically significant at the .0001 level. This level of significance indicates that such a difference would have occurred by chance less than once out of 10,000 repetitions. The effect size was medium.

Table 8
Results Comparing the ISTEP+ Math Standard Scores of Grade 5 Students at Indiana *SAXON MATH* Schools in Fall 2004 (Pretest) and Fall 2007 (Posttest)

Test	*Number of Schools*	*Mean Score*	*SD*	*t*-Test	*Significance*	*Effect Size*
Pretest	61	466.0	23.6	4.878	<.0001	.58
Posttest	61	478.7	20.0			

Figure 6 shows the percentages of Indiana *SAXON MATH* schools with fewer than 70%, with 70% to 89%, and with 90% or higher of their grade 5 students passing the math portion of the ISTEP+ in fall 2004 (pretest) and in fall 2007 (posttest). The figure shows a large decrease in the percentage of schools with pass rates below 70% and increases in the percentage of schools with pass rates from 70% to 89% and 90% or higher.

Figure 6
Percentage of Indiana *SAXON MATH* Schools with Various Ranges of Percentages of Grade 5 Students Passing the ISTEP+ Math in Fall 2004 (Pretest) and in Fall 2007 (Posttest)



Socio-Economic Group Pretest/Posttest Analyses

A Paired Comparison *t*-test was used to compare the pretest and posttest scores of the grade 5 Indiana *SAXON MATH* schools categorized as being of higher and lower socio-economic status (SES). The percentage of students receiving free and reduced lunch was used as the indicator of socio-economic status for this comparison. Schools were ranked from highest to lowest according to the percentage of students receiving free and reduced lunch at each school. That list was then divided in half with 30 schools in the lower free/reduced lunch group and 31 schools in the higher free/reduced lunch group. The lower free/reduced lunch schools were considered the higher socio-economic schools and the higher free/reduced lunch schools were considered the lower socio-economic schools. The .05 level of significance was used as the level at which increases would be considered statistically significant.

Table 9 presents the results of the *t*-test performed to determine if the difference between pretest and posttest standard scores for the lower and higher socio-economic status schools at grade 5 was statistically significant. For the higher SES schools, the average standard score on the pretest was 477.9, and on the posttest was 488.2, a difference that was significant at the .009 level. This level of significance indicates that such a difference would have occurred by chance less than nine out of 1,000 repetitions. For the lower SES schools, the average standard score on the pretest was 465.6, and on the posttest was 468.9, a difference that was statistically significant at the .0001 level. This level of significance indicates that such a difference would have occurred by chance less than once out of 10,000 repetitions. The effect size was medium for the higher SES group and large for the lower SES group.

Table 9
Results Comparing the ISTEP+ Mathematics Standard Scores of Grade 5 Students at Indiana *SAXON MATH* Schools in Fall 2004 (Pretest) and in Fall 2007 (Posttest) For High and Low SES Schools

Test	***Number of Schools***	***Mean Score***	***SD***	***t*-Test**	***Significance***	***Effect Size***
Higher Socio Economic Schools						
Pretest	31	477.9	20.8	2.814	<.009	. 53
Posttest	31	488.2	17.7			
Lower Socio Economic Schools						
Pretest	30	465.6	19.7	4.084	<.0001	.82
Posttest	30	468.9	17.6			

Figure 7 shows the percentages of higher SES Indiana *SAXON MATH* schools with fewer than 70%, with 70% to 89%, and with 90% or higher of their grade 5 students passing the math portion of the ISTEP+ in fall 2004 (pretest) and in fall 2007 (posttest). The figure shows a decrease in the percentage of schools with grade 5 pass rates of below 70% from pretest to posttest and increases in the percentage of schools with pass rates from 70% to 89% and 90% or higher.

Figure 7
Percentage of Higher SES Indiana *SAXON MATH* Schools with Various Ranges of Percentages of Grade 5 Students Passing the ISTEP+ Math in Fall 2004 (Pretest) and in Fall 2007 (Posttest)

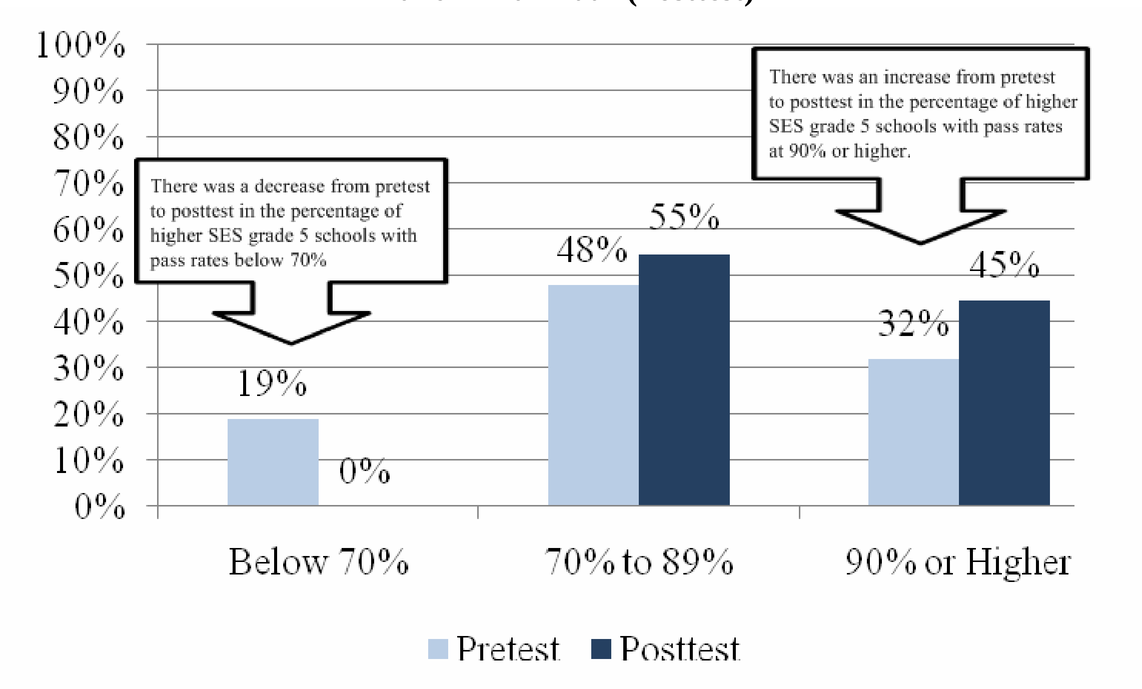
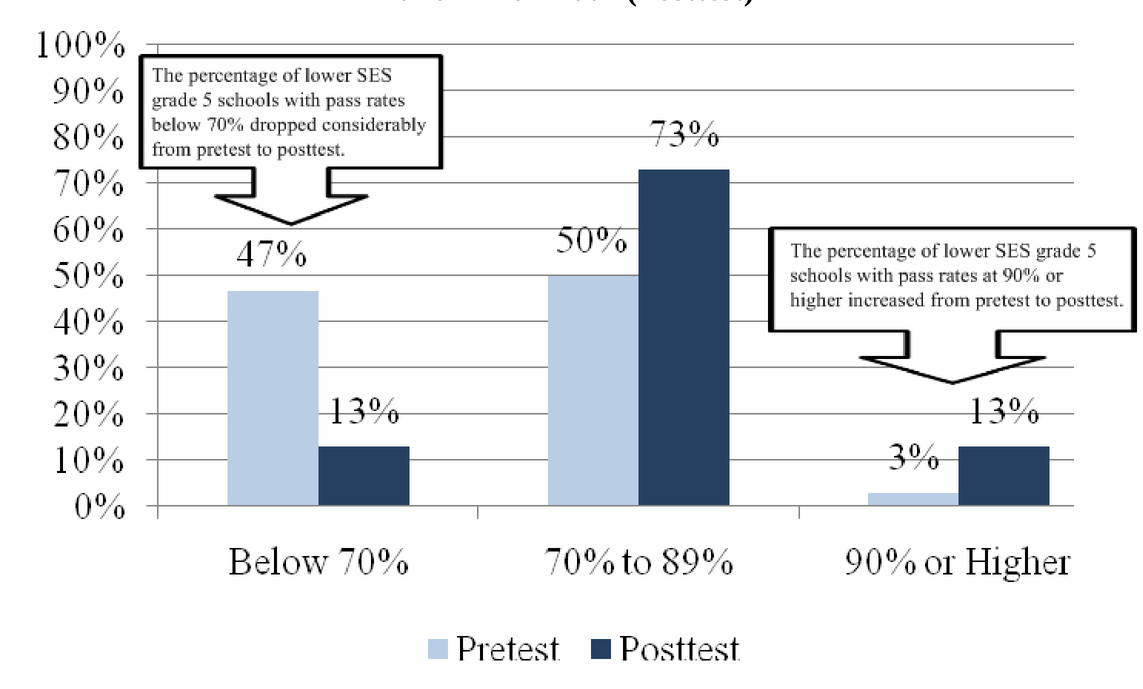


Figure 8 shows the percentages of lower SES Indiana *SAXON MATH* schools with fewer than 70%, with 70% to 89%, and with 90% or higher of their grade 5 students passing the math portion of the ISTEP+ in fall 2004 (pretest) and in fall 2007 (posttest). For the lower SES schools the percentage of schools with pass rates below 70% dropped considerably from pretest to posttest while the percentage of schools with pass rates from 70% to 89% and 90% and higher increased.

Figure 8
Percentage of Lower SES Indiana *SAXON MATH* Schools with Various Ranges of Percentages of Grade 5 Students Passing the ISTEP+ Math in Fall 2004 (Pretest) and in Fall 2007 (Posttest)



Pretest Score Group Pretest/Posttest Analyses

The grade 5 schools were divided into two approximately equal groups based on their pretest scores. The lower pretest group included 31 schools and the higher pretest group included 30 schools. Paired Comparison *t*-tests were conducted to determine if both groups made significant pretest to posttest gains.

Table 10 presents the results of the *t*-test performed to determine if the difference between pretest and posttest standard scores for lower and higher pretest scoring schools at grade 5 was statistically significant. The average standard score for the lower scoring group increased from 448.0 to 470.7. The difference for the lower scoring pretest group was statistically significant at the .0001 level, indicating a change that would have occurred by chance less than once out of 10,000 repetitions. The effect size was large.

The average standard score for the higher scoring group increased from 484.4 to 487.0. The difference for the higher scoring pretest group was not statistically significant. The lack of statistical significance was most likely due to the fact that these schools were already high-achieving math schools at the time of the pretest and simply maintained their average scores, with slight increases, three years later at the time of the posttest.

Table 10
Results Comparing the ISTEP+ Math Standard Scores of Grade 5 Students at Indiana *SAXON MATH* Schools in Fall 2004 (Pretest) and in Fall 2007 (Posttest) For Lower and Higher Scoring Pretest Groups

Test	*Number of Schools*	*Mean Score*	*SD*	*t*-Test	*Significance*	*Effect Size*
Lower Scoring Pretest Schools						
Pretest	31	448.0	15.8	5.680	<.0001	1.2
Posttest	31	470.7	20.7			
Higher Scoring Pretest Schools						
Pretest	30	484.4	14.0	1.170	Non-Significant	.17
Posttest	30	487.0	15.6			

Figure 9 shows the percentages of Indiana *SAXON MATH* schools in the lower scoring pretest group with fewer than 70%, with 70% to 89%, and with 90% or higher of their grade 3 students passing the math portion of the ISTEP+ in fall 2004 (pretest) and in fall 2007 (posttest). The figure shows a large decrease in the percentage of schools with pass rates below 70% and a large increase in the passes rates from 70% to 89%. The percent of schools with pass rates above 90% went from 3 to 13%.

Figure 9
Percentage of Indiana *SAXON MATH* Schools in the Lower Scoring Pretest Group with Various Ranges of Percentages of Grade 5 Students Passing the ISTEP+ Math in Fall 2004 (Pretest) and in Fall 2007 (Posttest)

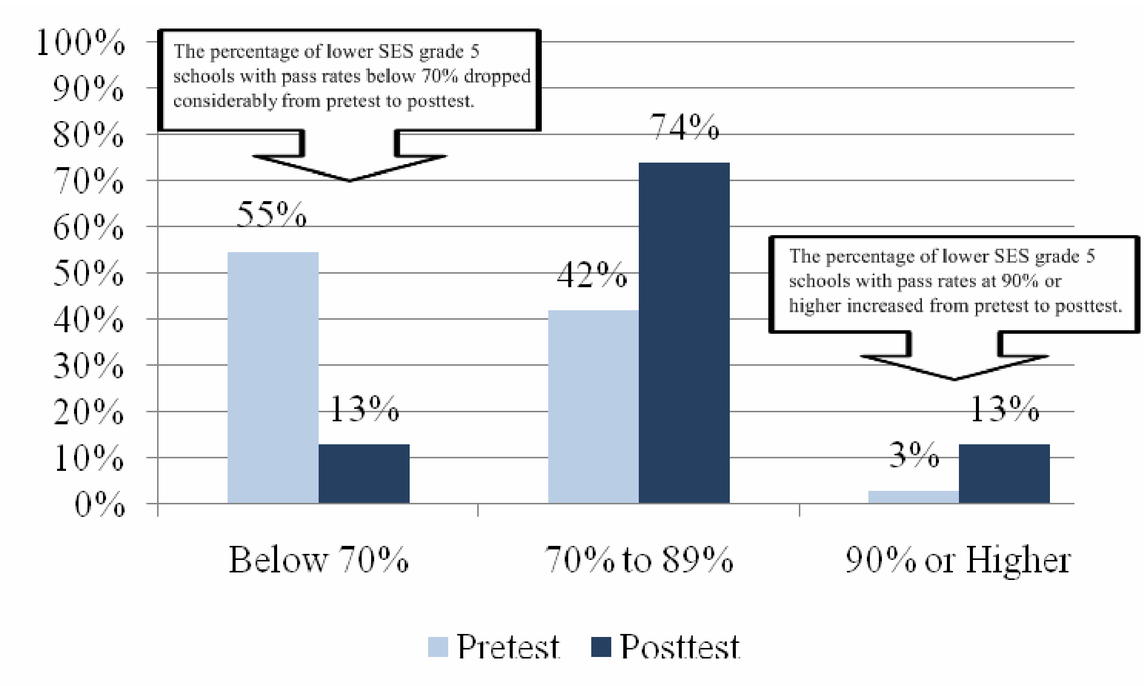
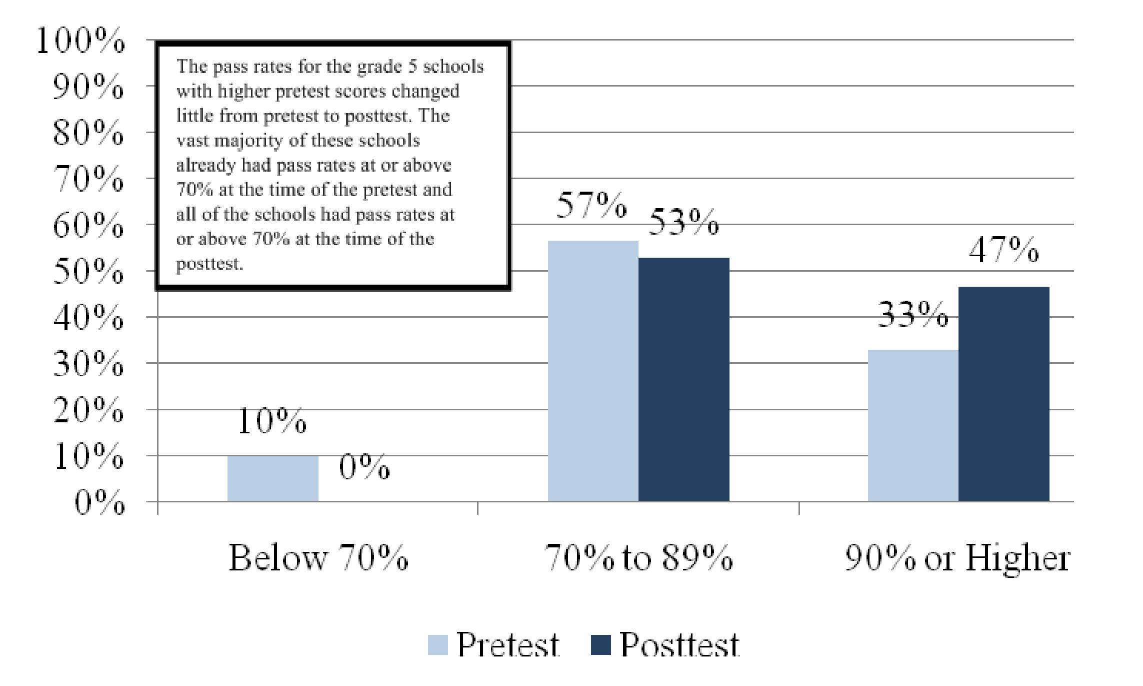


Figure 10 shows the percentages of Indiana *SAXON MATH* schools in the higher scoring pretest group with fewer than 70%, with 70% to 89%, and with 90% or higher of their grade 5 students passing the math portion of the ISTEP+ in fall 2004 (pretest) and in fall 2007 (posttest). These schools were already scoring at high levels at the time of the pretest and, for the most part, maintained high performance levels at the time of the posttest.

Figure 10
Percentage of Indiana *SAXON MATH* Schools in the Higher Scoring Pretest Group with Various Ranges of Percentages of Grade 5 Students Passing the ISTEP+ Math in Fall 2004 (Pretest) and in Fall 2007 (Posttest)



SAXON MATH *Schools Compared to the State*

Table 11 shows that both the pretest and posttest average standard scores of grade 5 students at *SAXON MATH* schools were somewhat higher than the grade 5 state average standard scores. The increases for both groups were about the same from pretest to posttest. Likewise, in both fall 2004 and fall 2007, a greater percentage of grade 5 students at *SAXON MATH* schools passed the math portion of the ISTEP+ than did grade 5 students across the state. At the time of the posttest, 77.8% of grade 5 students in Indiana passed the math portion of the ISTEP+, whereas 84.0% of the grade 5 students at *SAXON MATH* schools passed.

Table 11
Comparison of All Indiana Grade 5 Students and Grade 5 *SAXON MATH* Students Average Standard Score on ISTEP+ Math and Percent of Students Passing ISTEP+ Math in Fall 2004 (Pretest) and Fall 2007 (Posttest)

	Indiana Public and Non-Public Grade 5 Schools (All Schools N=1,277)		**SAXON MATH *Grade 5 Schools (N=61)***	
	Fall 2004	Fall 2007	Fall 2004	Fall 2007
Average Grade 5 Standard Score on ISTEP+ Math	455.6	470.0	466.0	478.7
Percent Grade 5 Students Passing ISTEP+ Math	71.4	77.8	75.9	84.0

The comparisons of the *SAXON MATH* schools to the Indiana total set of schools do not provide any definitive comparisons due to a number of important research design issues. Nevertheless, they do provide interesting data when reviewed in comparison to the pretest/posttest statistical analyses for the *SAXON MATH* school results.

Conclusions

This study sought to determine the effect of the *SAXON MATH* program on students' math skills and strategy use.

When comparing the pretest to posttest gains made by grade 3 and grade 5 students at Indiana *SAXON MATH* schools, gains were statistically significant at both grade levels. In addition, significant gains were made for both the lower and higher SES *SAXON MATH* schools at both grades 3 and 5. Grade 3 and grade 5 students at *SAXON MATH* schools with lower pretest scores made significant gains from pretest to posttest. However, at the *SAXON MATH* schools with higher pretest scores, neither grade level made significant pretest to posttest gains. (This was most likely because their pretest scores were already high.) A summary of the results is provided in Table 12 below. The table indicates whether the gains were significant and provides the effect size of each significant gain.

Table 12
Summary of the Pretest/Posttest Score Analyses Conducted to Determine if Significant Gains were Made on the ISTEP+ Math for Grade 3 and Grade 5 Students at Indiana *SAXON MATH* Schools

	Grade 3		***Grade 5***	
Group	***Gain Statistically Significant?***	***Effect Size***	***Gain Statistically Significant?***	***Effect Size***
All *SAXON MATH* Schools	Yes	Medium	Yes	Medium
Higher SES *SAXON MATH* Schools	Yes	Small	Yes	Medium
Lower SES *SAXON MATH* Schools	Yes	Small	Yes	Large
Higher Pretest Group *SAXON MATH* Schools	No	--	No	--
Lower Pretest Group *SAXON MATH* Schools	Yes	Large	Yes	Large

Table 13 summarizes the increases and decreases from pretest to posttest in the percentages of Indiana *SAXON MATH* schools with fewer than 70%, with 70% to 89%, and with 90% or higher of their grade 3 and grade 5 students passing the math portion of the ISTEP+.

Table 13
Summary of Changes from Pretest to Posttest of Percentages of Grade 3 and Grade 5 *SAXON MATH* Students Passing the Math Portion of the ISTEP+

Student Sample and Grade Level	***Below 70%***	***70% to 89%***	***90% or Higher***
All *SAXON MATH* Schools			
Grade 3	-10%	+6%	+4%
Grade 5	-26%	+15%	+12%
Higher SES *SAXON MATH* Schools			
Grade 3	--	-4%	+4%
Grade 5	-19%	+7%	+13%
Lower SES *SAXON MATH* Schools			
Grade 3	-21%	+17%	+5%
Grade 5	-34%	+23%	+10%
Higher Pretest Group *SAXON MATH* Schools			
Grade 3	+9%	-12%	+4%
Grade 5	-10%	-4%	+14%
Lower Pretest Group *SAXON MATH* Schools			
Grade 3	-28%	+24%	+4%
Grade 5	-42%	+32%	+10%

This study sought to determine if *SAXON MATH* is instructionally effective. Based on the results of this study, instruction based on *SAXON MATH* significantly increases grade 3 and grade 5 students' knowledge and understanding of mathematics over a three year period in Indiana schools using the *SAXON MATH* program.

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Appendices

Appendix A

Demographic Characteristics of Schools Included in the Grade 3 Group

	Locale	Grades	Enroll-ment	% Free/Reduced Lunch	% Minority	% Special Education	% Limited English
1	Rural	K to 6	537	31%	1%	12%	1%
2	Urban Fringe Large City	K to 5	225	62%	4%	29%	1%
3	Urban Fringe Large City	3 to 5	676	28%	3%	7%	0%
4	Urban Fringe Mid-Size City	3 to 5	261	29%	0%	23%	0%
5	Mid-Size Central City	K to 4	558	28%	1%	17%	0%
6	Small Town	K to 4	588	7%	11%	17%	0%
7	Rural	K to 5	364	37%	2%	23%	0%
8	Small Town	K to 5	456	30%	1%	21%	0%
9	Urban Fringe Of Large City	1 to 5	512	27%	5%	14%	1%
10	Rural	K to 4	303	29%	0%	23%	0%
11	Mid-Size Central City	K to 5	326	66%	43%	23%	2%
12	Small Town	K to 6	578	29%	1%	17%	0%
13	Rural	K to 6	532	16%	8%	17%	11%
14	Small Town	K to 6	591	30%	13%	15%	10%
15	Rural	PK to 5	474	38%	5%	18%	1%
16	Rural	K to 5	355	23%	8%	12%	5%
17	Urban Fringe Of Large City	K to 5	681	11%	16%	18%	6%
18	Mid-Size Central City	K to 5	360	87%	34%	14%	1%
19	Urban Fringe Of Large City	K to 5	483	76%	24%	13%	1%
20	Urban Fringe Of Large City	K to 5	219	59%	14%	14%	20%
21	Urban Fringe Of Large City	K to 6	355	14%	14%	14%	5%
22	Urban Fringe Of Large City	K to 6	301	25%	31%	16%	6%
23	Small Town	3 to 5	510	47%	0%	18%	1%
24	Rural	K to 5	162	45%	0%	28%	2%
25	Small Town	K to 3	329	32%	0%	19%	0%
26	Rural	K to 5	201	35%	0%	18%	0%
27	Small Town	K to 6	153	41%	0%	18%	0%
28	Rural	K to 6	595	20%	2%	12%	0%
29	Urban Fringe Of Large City	K to 6	327	35%	2%	12%	0%
30	Urban Fringe Of Large City	K to 6	606	20%	1%	12%	0%
31	Small Town	K to 6	495	34%	1%	22%	0%
32	Mid-Size Central City	K to 5	443	50%	6%	19%	3%
33	Small Town	K to 6	297	59%	9%	20%	2%
34	Mid-Size Central City	K to12	345	52%	8%	17%	1%
35	Small Town	K to 6	198	67%	1%	24%	0%
36	Mid-Size Central City	K to 6	451	14%	1%	17%	1%
37	Rural	3 to 5	500	40%	1%	15%	1%
38	Urban Fringe Of Large City	K to 6	476	26%	1%	13%	0%
39	Rural	K to 8	194	6%	33%	12%	0%
40	Urban Fringe Of Large City	K to 8	435	2%	0%	0%	0%
41	Rural	PK to 6	403	33%	3%	11%	0%
42	Mid-Size Central City	PK to 8	552	45%	10%	10%	6%
43	Small Town	PK to 8	297	28%	2%	13%	2%
44	Rural	K to 8	403	29%	3%	0%	0%
45	Small Town	PK to 8	543	37%	9%	15%	1%
46	Rural	K to 8	297	35%	2%	11%	0%
47	Rural	K to 6	537	31%	1%	12%	1%
48	Small Town	K to 5	225	62%	4%	29%	1%
49	Mid-Size Central City	3 to 5	676	28%	3%	7%	0%
	AVERAGE		**416**	**35%**	**7%**	**16%**	**2%**

Appendix B

Demographic Characteristics of Schools Included in the Grade 5 Group

	Locale	Grades	Enroll-ment	% Free/Reduced Lunch	% Minority	% Special Education	% Limited English
1	Small Town	K to 5	246	41%	2%	16%	0%
2	Urban Fringe Of Large City	K to 5	297	68%	36%	15%	22%
3	Urban Fringe Of Large City	PK to 5	614	24%	1%	27%	0%
4	Mid-Size Central City	K to 6	297	59%	9%	20%	2%
5	Small Town	K to 6	598	40%	6%	16%	1%
6	Urban Fringe Of Large City	K to 5	252	25%	2%	16%	0%
7	Urban Fringe Of Large City	5 to 8	479	30%	0%	16%	0%
8	Rural	K to 5	139	53%	10%	15%	9%
9	Urban Fringe Of Large City	1 to 5	539	22%	4%	15%	1%
10	Mid-Size Central City	K to 6	532	7%	15%	14%	4%
11	Mid-Size Central City	K to 5	174	67%	14%	27%	2%
12	Mid-Size Central City	K to 5	291	65%	4%	20%	2%
13	Urban Fringe Of Large City	5 to 8	421	33%	8%	13%	6%
14	Mid-Size Central City	K to 5	414	86%	13%	18%	0%
15	Urban Fringe Of Large City	K to 5	183	17%	1%	16%	0%
16	Small Town	K to 5	341	11%	1%	21%	0%
17	Rural	K to 6	532	16%	8%	17%	11%
18	Urban Fringe Of Large City	K to 6	441	39%	48%	13%	5%
19	Urban Fringe Of Large City	K to 5	277	35%	6%	14%	4%
20	Urban Fringe Of Mid-Size City	K to 8	472	24%	2%	17%	0%
21	Urban Fringe Of Large City	K to 5	611	8%	8%	20%	7%
22	Small Town	PK to 6	368	60%	3%	21%	0%
23	Small Town	K to 5	283	26%	0%	18%	0%
24	Mid-Size Central City	K to 5	360	87%	34%	14%	1%
25	Mid-Size Central City	K to 5	359	59%	22%	13%	4%
26	Mid-Size Central City	K to 8	360	4%	8%	2%	4%
27	Small Town	PK to 8	362	3%	2%	2%	0%
28	Urban Fringe Of Large City	PK to 8	344	1%	3%	4%	0%
29	Urban Fringe Of Large City	K to 5	675	3%	5%	19%	7%
30	Small Town	K to 6	421	26%	1%	16%	5%
31	Small Town	K to 6	335	18%	6%	5%	3%
32	Rural	K to 5	158	20%	1%	15%	2%
33	Mid-Size Central City	K to 5	243	90%	60%	24%	2%
34	Mid-Size Central City	K to 5	294	67%	34%	18%	2%
35	Rural	K to 5	491	33%	3%	15%	3%
36	Small Town	1 to 5	301	66%	2%	16%	4%
37	Mid-Size Central City	K to 5	342	18%	0%	14%	0%
38	Rural	K to 5	364	37%	2%	23%	0%
39	Small Town	K to 5	326	25%	1%	18%	1%
40	Rural	K to 6	560	25%	1%	17%	0%
41	Urban Fringe Of Large City	PK to 8	491	12%	6%	6%	2%
42	Urban Fringe Of Large City	K to 5	552	30%	6%	22%	2%
43	Small Town	PK to 5	232	8%	1%	2%	0%
44	Urban Fringe Of Large City	PK to 6	242	81%	33%	15%	26%
45	Rural	K to 5	229	49%	0%	21%	1%
46	Rural	K to 5	143	7%	0%	0%	0%
47	Mid-Size Central City	K to 5	464	34%	20%	19%	8%
48	Urban Fringe Of Large City	PK to 8	258	0%	3%	2%	0%
49	Mid-Size Central City	K to 8	260	11%	7%	4%	1%
50	Urban Fringe Of Large City	PK to 8	191	12%	8%	3%	2%
51	Mid-Size Central City	K to 5	822	10%	4%	21%	2%
52	Mid-Size Central City	3 to 8	358	8%	7%	4%	3%
53	Small Town	K to 5	548	36%	9%	9%	4%
54	Small Town	K to 5	324	65%	2%	16%	1%

55	Urban Fringe Of Large City	K to 5	311	51%	50%	16%	23%
56	Urban Fringe Of Large City	K to 5	558	15%	1%	15%	1%
57	Rural	3 to 5	160	30%	1%	20%	0%
58	Small Town	K to 6	279	30%	2%	17%	0%
59	Mid-Size Central City	K to 5	260	35%	11%	26%	2%
60	Urban Fringe Of Mid-Size City	PK to 5	410	76%	0%	18%	0%
61	Rural	K to 8	99	4%	2%	2%	2%
Average			**365**	**33%**	**9%**	**15%**	**3%**

Appendix C

Indiana's Academic Standards for Mathematics – Grade 3

Standard 1 - Number Sense

Students understand the relationships among numbers, quantities, and place value in whole numbers up to 1,000. They understand the relationship among whole numbers, simple fractions, and decimals.*

3.1.1 Count, read, and write whole numbers up to 1,000.

3.1.2 Identify and interpret place value in whole numbers up to 1,000.

3.1.3 Use words, models, and expanded form to represent numbers up to 1,000.

3.1.4 Identify any number up to 1,000 in various combinations of hundreds, tens, and ones.

3.1.5 Compare whole numbers up to 1,000 and arrange them in numerical order.

3.1.6 Round numbers less than 1,000 to the nearest ten and the nearest hundred.

3.1.7 Identify odd and even numbers up to 1,000 and describe their characteristics.

3.1.8 Show equivalent fractions* using equal parts.

3.1.9 Identify and use correct names for numerators and denominators.

3.1.10 Given a pair of fractions, decide which is larger or smaller by using objects or pictures.

3.1.11 Given a set* of objects or a picture, name and write a decimal to represent tenths and hundredths.

3.1.12 Given a decimal for tenths, show it as a fraction using a place-value model.

3.1.13 Interpret data displayed in a circle graph and answer questions about the situation.

3.1.14 Identify whether everyday events are certain, likely, unlikely, or impossible.

3.1.15 Record the possible outcomes for a simple probability experiment.

Standard 2 - Computation

Students solve problems involving addition and subtraction of whole numbers. They model and solve simple problems involving multiplication and division.

3.2.1 Add and subtract whole numbers up to 1,000 with or without regrouping, using relevant properties of the number system.

3.2.2 Represent the concept of multiplication as repeated addition.

3.2.3 Represent the concept of division as repeated subtraction, equal sharing, and forming equal groups.

3.2.4 Know and use the inverse relationship between multiplication and division facts, such as $6 \times 7 = 42$, $42 \div 7 = 6$, $7 \times 6 = 42$, $42 \infty\div 6 = 7$.

3.2.5 Show mastery of multiplication facts for 2, 5, and 10.

3.2.6 Add and subtract simple fractions with the same denominator.

3.2.7 Use estimation to decide whether answers are reasonable in addition and subtraction problems.

3.2.8 Use mental arithmetic to add or subtract with numbers less than 100.

Standard 3 - Algebra and Functions

Students select appropriate symbols, operations, and properties to represent, describe, simplify, and solve simple number and functional relationships.

3.3.1 Represent relationships of quantities in the form of a numeric expression or equation.

3.3.2 Solve problems involving numeric equations.

3.3.3 Choose appropriate symbols for operations and relations to make a number sentence true.

3.3.4 Understand and use the commutative* and associative* properties of multiplication.

3.3.5 Create, describe, and extend number patterns using multiplication.

3.3.6 Solve simple problems involving a functional relationship between two quantities.

3.3.7 Plot and label whole numbers on a number line up to 10.

Standard 4 - Geometry

Students describe and compare the attributes of plane and solid geometric shapes and use their understanding to show relationships and solve problems.

3.4.1 Identify quadrilaterals* as four-sided shapes.

3.4.2 Identify right angles in shapes and objects and decide whether other angles are greater or less than a right angle.

3.4.3 Identify, describe, and classify: cube, sphere*, prism*, pyramid, cone, and cylinder.

3.4.4 Identify common solid objects that are the parts needed to make a more complex solid object.

3.4.5 Draw a shape that is congruent* to another shape.

3.4.6 Use the terms *point*, *line*, and line *segment* in describing two-dimensional shapes.

3.4.7 Draw line segments and lines.

3.4.8 Identify and draw lines of symmetry in geometric shapes (by hand or using technology).

3.4.9 Sketch the mirror image reflections of shapes.

3.4.10 Recognize geometric shapes and their properties in the environment and specify their locations.

Standard 5
Measurement

Students choose and use appropriate units and measurement tools for length, capacity, weight, temperature, time, and money.

3.5.1 Measure line segments to the nearest half-inch.

3.5.2 Add units of length that may require regrouping of inches to feet or centimeters to meters.

3.5.3 Find the perimeter of a polygon*.

3.5.4 Estimate or find the area of shapes by covering them with squares.

3.5.5 Estimate or find the volumes of objects by counting the number of cubes that would fill them.

3.5.6 Estimate and measure capacity using quarts, gallons, and liters.

3.5.7 Estimate and measure weight using pounds and kilograms.

3.5.8 Compare temperatures in Celsius and Fahrenheit.

3.5.9 Tell time to the nearest minute and find how much time has elapsed.

3.5.10 Find the value of any collection of coins and bills. Write amounts less than a dollar using the ¢ symbol and write larger amounts in decimal notation using the $ symbol.

3.5.11 Use play or real money to decide whether there is enough money to make a purchase.

3.5.12 Carry out simple unit conversions within a measurement system (e.g., centimeters to meters, hours to minutes).

Standard 6 - Problem Solving

Students make decisions about how to approach problems and communicate their ideas.

3.6.1 Analyze problems by identifying relationships, telling relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.

3.6.2 Decide when and how to break a problem into simpler parts.

Students use strategies, skills, and concepts in finding and communicating solutions to problems.

3.6.3 Apply strategies and results from simpler problems to solve more complex problems.

3.6.4 Express solutions clearly and logically by using the appropriate mathematical terms and notation. Support solutions with evidence in both verbal and symbolic work.

3.6.5 Recognize the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.

3.6.6 Know and use strategies for estimating results of whole-number addition and subtraction.

3.6.7 Make precise calculations and check the validity of the results in the context of the problem.

Students determine when a solution is complete and reasonable and move beyond a particular problem by generalizing to other situations.

3.6.8 Decide whether a solution is reasonable in the context of the original situation.

3.6.9 Note the method of finding the solution and show a conceptual understanding of the method by solving similar problems.

Appendix D

Indiana's Academic Standards for Mathematics – Grade 5

Standard 1 - Number Sense

Students compute with whole numbers, decimals, and fractions and understand the relationship among decimals, fractions, and percents. They understand the relative magnitudes of numbers. They understand prime* and composite* numbers.*

5.1.1	Convert between numbers in words and numbers in figures, for numbers up to millions and decimals to thousandths.
5.1.2	Round whole numbers and decimals to any place value.
5.1.3	Arrange in numerical order and compare whole numbers or decimals to two decimal places by using the symbols for less than (<), equals (=), and greater than (>).
5.1.4	Interpret percents as a part of a hundred. Find decimal and percent equivalents for common fractions and explain why they represent the same value.
5.1.5	Explain different interpretations of fractions: as parts of a whole, parts of a set, and division of whole numbers by whole numbers.
5.1.6	Describe and identify prime and composite numbers.
5.1.7	Identify on a number line the relative position of simple positive fractions, positive mixed numbers, and positive decimals.

Standard 2 - Computation

Students solve problems involving multiplication and division of whole numbers and solve problems involving addition, subtraction, and simple multiplication and division of fractions and decimals.

5.2.1	Solve problems involving multiplication and division of any whole numbers.
5.2.2	Add and subtract fractions (including mixed numbers) with different denominators.
5.2.3	Use models to show an understanding of multiplication and division of fractions.
5.2.4	Multiply and divide fractions to solve problems.
5.2.5	Add and subtract decimals and verify the reasonableness of the results.
5.2.6	Use estimation to decide whether answers are reasonable in addition, subtraction, multiplication, and division problems.
5.2.7	Use mental arithmetic to add or subtract simple decimals.

Standard 3 - Algebra and Functions

Students use variables in simple expressions, compute the value of an expression for specific values of the variable, and plot and interpret the results. They use two-dimensional coordinate grids to represent points and graph lines.

5.3.1 Use a variable to represent an unknown number.
5.3.2 Write simple algebraic expressions in one or two variables and evaluate them by substitution.
5.3.3 Use the distributive property* in numerical equations and expressions.
5.3.4 Identify and graph ordered pairs of positive numbers.
5.3.5 Find ordered pairs (positive numbers only) that fit a linear equation, graph the ordered pairs, and draw the line they determine.
5.3.6 Understand that the length of a horizontal line segment on a coordinate plane equals the difference between the x-coordinates and that the length of a vertical line segment on a coordinate plane equals the difference between the y-coordinates.
5.3.7 Use information taken from a graph or equation to answer questions about a problem situation.

Standard 4 - Geometry

Students identify, describe, and classify the properties of plane and solid geometric shapes and the relationships between them.

5.4.1 Measure, identify, and draw angles, perpendicular and parallel lines, rectangles, triangles, and circles by using appropriate tools (e.g., ruler, compass, protractor, appropriate technology, media tools).
5.4.2 Identify, describe, draw, and classify triangles as equilateral*, isosceles*, scalene*, right*, acute*, obtuse*, and equiangular*.
5.4.3 Identify congruent* triangles and justify your decisions by referring to sides and angles.
5.4.4 Identify, describe, draw, and classify polygons*, such as pentagons and hexagons.
5.4.5 Identify and draw the radius and diameter of a circle and understand the relationship between the radius and diameter.
5.4.6 Identify shapes that have reflectional and rotational symmetry*.
5.4.7 Understand that 90°, 180°, 270°, and 360° are associated with quarter, half, three-quarters, and full turns, respectively.
5.4.8 Construct prisms* and pyramids using appropriate materials.
5.4.9 Given a picture of a three-dimensional object, build the object with blocks.

Standard 5 - Measurement

Students understand and compute the areas and volumes of simple objects, as well as measuring weight, temperature, time, and money.

5.5.1 Understand and apply the formulas for the area of a triangle, parallelogram, and trapezoid.

5.5.2 Solve problems involving perimeters and areas of rectangles, triangles, parallelograms,
and trapezoids, using appropriate units.

5.5.3 Use formulas for the areas of rectangles and triangles to find the area of complex shapes
by dividing them into basic shapes.

5.5.4 Find the surface area and volume of rectangular solids using appropriate units.

5.5.5 Understand and use the smaller and larger units for measuring weight (ounce, gram, and ton) and their relationship to pounds and kilograms.

5.5.6 Compare temperatures in Celsius and Fahrenheit, knowing that the freezing point of water
is 0°C and 32°F and that the boiling point is 100°C and 212°F.

5.5.7 Add and subtract with money in decimal notation.

Standard 6 - Data Analysis and Probability

Students collect, display, analyze, compare, and interpret data sets. They use the results of probability experiments to predict future events.

5.6.1 Explain which types of displays are appropriate for various sets of data.

5.6.2 Find the mean*, median*, mode*, and range* of a set of data and describe what each does and does not tell about the data set.

5.6.3 Understand that probability can take any value between 0 and 1, events that are not going to occur have probability 0, events certain to occur have probability 1, and more likely events have a higher probability than less likely events.

5.6.4 Express outcomes of experimental probability situations verbally and numerically (e.g., 3 out of 4, $\frac{3}{4}$).

Standard 7 - Problem Solving

Students make decisions about how to approach problems and communicate their ideas.

5.7.1 Analyze problems by identifying relationships, telling relevant from irrelevant information, sequencing and prioritizing information, and observing patterns.

5.7.2 Decide when and how to break a problem into simpler parts.

Students use strategies, skills, and concepts in finding and communicating solutions to problems.

5.7.3 Apply strategies and results from simpler problems to solve more complex problems.

5.7.4 Express solutions clearly and logically by using the appropriate mathematical terms and notation. Support solutions with evidence in both verbal and symbolic work.

5.7.5 Recognize the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.

5.7.6 Know and apply appropriate methods for estimating results of rational-number computations.

5.7.7 Make precise calculations and check the validity of the results in the context of the problem.

Students determine when a solution is complete and reasonable and move beyond a particular problem by generalizing to other situations.

5.7.8 Decide whether a solution is reasonable in the context of the original situation.

5.7.9 Note the method of finding the solution and show a conceptual understanding of the method by solving similar problems.