

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

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# A LONGITUDINAL ANALYSIS OF STATE MATHEMATICS SCORES FOR OKLAHOMA 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

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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 21<sup>st</sup> 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

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The following research question guided the design of the study:

Is *SAXON MATH* instructionally effective in improving students' mathematical skills and strategy use over time?

## Design of the Study

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A quasi-experimental, pretest/posttest design was used for this study. Oklahoma schools using the *SAXON MATH* program at grades 3 and/or 5 during the 2005-2006, 2006-2007, and 2007-2008 school years were included in the study. Achievement data from the spring 2005 and the spring 2008 administrations of the math portion of the Oklahoma Core Curriculum Tests (OCCT) were used as the pretest and posttest respectively.

In order to identify Oklahoma *SAXON MATH* schools for inclusion in the study, Houghton Mifflin Harcourt provided researchers with a list of Oklahoma 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 had continued to use the program at those same grade levels. This information was not readily available from all school administrators due to changes in administration and/or lack of records. Also, some schools were unwilling to provide the requested data. Schools were included in the study if it could be verified, based on these phone calls, that they had started using the program at grade 3 and/or grade 5 no later than the 2005-2006 academic year and had continued to do so through the 2007-2008 academic year or longer.

A total of 17 schools in Oklahoma were verified as having used *SAXON MATH* at grade 3 from the 2005-2006 academic year through the 2007-2008 academic year. Likewise, a total of 17 Oklahoma schools were verified as having used *SAXON MATH* at grade 5 for the same three year period. Only seven of the schools are the same across the grade 3 and grade 5 lists of schools. To a large extent, differences in the grade 3 and grade 5 school

lists can be explained by the variability in grade levels offered at the schools (e.g. K-2, K-12). 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 verified school, researchers downloaded the OCCT mathematics data that was available to the public from the Oklahoma State Department of Education (OSDOE) Web site. For each administration of the OCCT, the OSDOE Web site provides the percentage of students at each school achieving at each of four performance levels on the math portion of the OCCT:

1. Advanced
2. Satisfactory
3. Limited Knowledge
4. Unsatisfactory

No raw scores or standard scores were available. Researchers contacted the OSDOE and were told by representatives there that no additional school level or district level scores were available beyond the information provided on the OSDOE Web site.

## **Instructional Approach under Study**

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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**

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A total of 27 schools in Oklahoma were verified as having used *SAXON MATH* at grade 3 and/or grade 5 from the 2005-2006 academic year through the 2007-2008 academic year. Seventeen schools were verified as having used the program at grade 3 and 17 at grade 5. (Only seven of the 17 schools in each grade level list are the same across lists.) The grades offered at each school varied considerably across the 27 schools, with several schools offering only two or three grade levels and several other schools enrolling students in kindergarten through grade 12. Table 1 provides a demographic summary of the schools included in the study. Schools identified as “Elementary” schools in the table are those that enroll students in grades or grade spans between kindergarten and grade 6. Schools identified in the table as “Combined” are schools that enroll students in grades K through 12. The average enrollment for the schools was 312. The average percent of students enrolled in free and reduced lunch programs across the schools was 63%. The average percent of minority students was 41%.

**Table 1**  
**Demographic Characteristics of Oklahoma SAXON MATH**  
**Schools Included in the Study**

<i>Locale</i>	<i>Type</i>	<i>Student Enrollment</i>	<i>% Free/Reduced Lunch</i>	<i>% Minority</i>	<i>% Special Education Services</i>	<i>% Limited English Proficient</i>
Small Town	Elementary	97	66%	52%	12%	46%
Small Town	Elementary	105	51%	49%	11%	41%
Small Town	Elementary	125	48%	22%	12%	2%
Small Town	Elementary	130	49%	46%	11%	40%
Rural	Elementary	134	87%	67%	12%	2%
Small Town	Elementary	137	52%	28%	14%	4%
Rural	Combined	145	45%	29%	14%	37%
Rural	Combined	149	72%	40%	29%	0%
Small Town	Combined	162	80%	37%	11%	5%
Small Town	Elementary	175	87%	71%	11%	39%
Rural	Elementary	207	46%	20%	10%	11%
Rural	Elementary	262	74%	23%	16%	5%
Small Town	Combined	267	91%	28%	21%	1%
Rural	Elementary	274	75%	51%	13%	15%
Rural	Elementary	285	73%	60%	18%	0%
Small Town	Elementary	298	53%	42%	11%	2%
Rural	Elementary	322	54%	24%	20%	0%
Small Town	Elementary	404	50%	44%	10%	2%
Rural	Elementary	431	54%	23%	13%	0%
Small Town	Elementary	442	73%	73%	10%	37%
Urban Fringe City	Elementary	451	32%	44%	12%	0%
Small Town	Elementary	470	67%	57%	10%	36%
Small Town	Elementary	525	51%	41%	11%	2%
Rural	Elementary	570	54%	15%	16%	5%
Rural	Elementary	575	70%	77%	12%	17%
Rural	Elementary	591	80%	29%	17%	8%
Small Town	Elementary	680	54%	23%	15%	3%
<b><i>Average</i></b>		<b><i>312</i></b>	<b><i>63%</i></b>	<b><i>41%</i></b>	<b><i>14%</i></b>	<b><i>13%</i></b>

### **Description of the Oklahoma Core Curriculum Tests (OCCT)**

The following explanation of the OCCT was taken from the Oklahoma State Department of Education Web site (Oklahoma State Department of Education, 2009):

Oklahoma public schools administer Oklahoma Core Curriculum Tests (OCCT) in grades 3 through 8, and after completion of specific high school courses. All state tests are aligned to the Oklahoma Priority Academic Student Skills (PASS). Reading and Math tests are administered in grades 3-8; Science, Social Studies, and Writing are given in grade 5; Geography is given in grade 7; and Science,

U.S. History, and Writing are given in grade 8. English II, ACE English III, ACE Algebra I, ACE Algebra II, ACE Geometry, Biology I, and U.S. History are given as End-of-Instruction (EOI) tests in high school.

Tables 2 and 3 below provide Test Blueprints for the grade 3 and grade 5 OCCT math tests respectively (International Center for Leadership in Education, 2006). Each Test Blueprint reflects the degree to which each PASS standard and objective is represented on the test.

**Table 2**  
**Oklahoma School Testing (OCCT) Program Test Blueprint**  
**Grade 3 Math**

<b>PASS Standards &amp; Objectives</b>	<b>Ideal Number of Items for Alignment to PASS*</b>	<b>Ideal Percentage of Items**</b>
<b>Patterns and Algebraic Reasoning</b>	<b>8</b>	<b>18%</b>
Algebra patterns (1.1)	4	
Algebra patterns (1.2)	4	
<b>Number Sense</b>	<b>7</b>	<b>16%</b>
Place Value (2.1)	3-4	
Whole Numbers and Fractions (2.2)	3-4	
<b>Number Operations and Computation</b>	<b>12</b>	<b>27%</b>
Estimation (3.1)	4	
Multiplication (3.2)	4	
Money Problems (3.3)	4	
<b>Geometry and Measurement</b>	<b>12</b>	<b>27%</b>
Spatial Reasoning (4.1)	4	
Measurement (4.2)	4	
Time and Temperature (4.4)	4	
<b>Data Analysis and Probability</b>	<b>6</b>	<b>13%</b>
Data Analysis (5.1)	2-4	
Probability (5.2)	2-4	
<b>Total</b>	<b>45</b>	<b>100%</b>

\* A minimum of 4 items is required to report results for an objective, and a minimum of 6 items is required to report a standard. While the actual numbers of items on the test may not match the blueprint exactly, each future test will move toward closer alignment with the ideal blueprint.

\*\* Percents are approximations and may result in a sum other than 100 due to rounding.



**Table 3**  
**Oklahoma School Testing (OCCT) Program Test Blueprint**  
**Grade 5 Math**

PASS Standards & Objectives	Ideal Number of Items for Alignment to PASS*	Ideal Percentage of Items**
<b>Patterns and Algebraic Reasoning</b>	<b>8</b>	<b>18%</b>
Algebra patterns (1.1)	4	
Algebra patterns (1.2)	4	
<b>Number Sense</b>	<b>8</b>	<b>18%</b>
Fractions/Decimals/Percents (2.1)	4	
Number Theory (2.2)	4	
<b>Number Operations and Computation</b>	<b>8</b>	<b>18%</b>
Estimation (3.1)	4	
Whole Numbers/Decimals/Fractions	4	
<b>Geometry and Measurement</b>	<b>12</b>	<b>27%</b>
Geometric Figure Properties (4.1)	4	
Perimeter/Area (4.2)	4	
Convert Measurements (4.5)	4	
<b>Data Analysis and Probability</b>	<b>9</b>	<b>20%</b>
Data Analysis (5.1)	5	
Probability (5.2)	4	
<b>Total</b>	<b>45</b>	<b>100%</b>

\* A minimum of 4 items is required to report results for an objective, and a minimum of 6 items is required to report a standard. While the actual numbers of items on the test may not match the blueprint exactly, each future test will move toward closer alignment with the ideal blueprint.

\*\* Percents are approximations and may result in a sum other than 100 due to rounding.

## Data Analyses

Neither raw scores nor standard scores for the spring 2005 and spring 2008 administrations of the OCCT were available for the analyses. Instead, the OSDOE Web site provides the percentage of students at each school achieving at each of four performance levels:

1. Advanced
2. Satisfactory
3. Limited Knowledge
4. Unsatisfactory

The analysis of this data required researchers to develop a metric that would result in a single performance score for each school. The metric that was developed assigns a graduated weight to each of the four performance levels, and is similar to how grade point averages are computed. The Advanced, Satisfactory, Limited Knowledge, and Unsatisfactory levels were assigned weights of four, three, two, and one respectively. Thus, the percentage of students at a given school scoring at the Advanced level was multiplied by 4, the percentage of students scoring at the Satisfactory level was multiplied by 3, and so on. Those four products were then added together resulting in what will be called in this report, a “performance score.”

Table 4 provides an example of how performance scores were calculated using the data for two schools.

**Table 4**  
**Calculation of Performance Scores for two Sample Schools**

Performance Levels	% of Students Achieving at Each Level	Performance Level Weight	Products
<i>Sample School 1</i>			
Advanced	20%	× 4 =	80
Satisfactory	65%	× 3 =	195
Limited Knowledge	10%	× 2 =	20
Unsatisfactory	5%	× 1 =	5
<b>PERFORMANCE SCORE (Sum of the Products):</b>			<b>300</b>
<i>Sample School 2</i>			
Advanced	5%	× 4 =	20
Satisfactory	45%	× 3 =	135
Limited Knowledge	45%	× 2 =	90
Unsatisfactory	5%	× 1 =	5
<b>PERFORMANCE SCORES (Sum of the Products):</b>			<b>250</b>

The two sets of school data shown in the table above indicate that a difference of 50 between the performance scores is based on fairly large differences between the schools in the percentages of students at each of the performance levels.

Performance scores were computed for each school at grades 3 and 5 for the spring 2005 and spring 2008 administrations of the math portion of the OCCT. These scores were

used to determine whether student performance on the math portion of the OCCT increased significantly from the spring 2005 test administration (pretest) to the spring 2008 test administration (posttest) for grade 3 and grade 5 students at Oklahoma *SAXON MATH* schools. The following analyses were conducted:

- A Paired Comparison *t*-test was conducted to determine whether the pretest to posttest gains of the total group of grade 3 and grade 5 students at Oklahoma *SAXON MATH* schools were statistically significant.
- A Paired Comparison *t*-test was conducted to determine whether the pretest to posttest gains of economically disadvantaged grade 3 and grade 5 students at Oklahoma *SAXON MATH* schools were statistically significant.
- A Paired Comparison *t*-test was conducted to determine whether the pretest to posttest gains of economically disadvantaged grade 3 and grade 5 students at Oklahoma *SAXON MATH* schools where the economically disadvantaged students scored lower on the pretest and at schools where the economically disadvantaged students scored higher on the pretest were statistically significant.
- A Paired Comparison *t*-test was conducted to determine whether the pretest to posttest gains of grade 3 and grade 5 students at lower scoring pretest and higher scoring pretest Oklahoma *SAXON MATH* schools (as determined by the average pretest scores of the total group of grade 3 and grade 5 students at each school) were statistically significant.

## **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 whether the pretest to posttest gains of the total group of grade 3 students at Oklahoma *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, 17 schools were included.

In addition to the Paired Comparison *t*-test, an effect-size analysis was computed. 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 5 presents the results of the *t*-test performed to determine if the pretest to posttest performance score gains for grade 3 students at Oklahoma *SAXON MATH* schools were statistically significant. The average performance score was 273.1 on the pretest and 296.7 on the posttest, a difference that was statistically significant at the .005 level. This level of significance indicates that such a difference would have occurred by chance less than five times out of 1,000 repetitions. The effect size was large.

**Table 5**  
**Results Comparing the Average OCCT Math Performance Scores of Grade 3 Students at Oklahoma *SAXON MATH* Schools in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**

<i>Test</i>	<i>Number of Schools</i>	<i>Mean Performance Score</i>	<i>SD</i>	<i>t-Test</i>	<i>Significance</i>	<i>Effect Size</i>
Pretest	17	273.1	14.7	3.270	<.005	1.00
Posttest	17	296.7	26.7			

Figure 1 shows the number of Oklahoma *SAXON MATH* schools with average grade 3 performance scores below 270, between 270 to 285, and above 285 on the math portion of the OCCT in spring 2005 (pretest) and spring 2008 (posttest). The figure shows decreases in the number of schools with average performance scores below 270 and between 270 to 285 and a large increase in the number of schools with average performance scores above 285.

**Figure 1**  
**Number of Grade 3 Oklahoma *SAXON MATH* Schools with Various Ranges of Average Performance Scores on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**

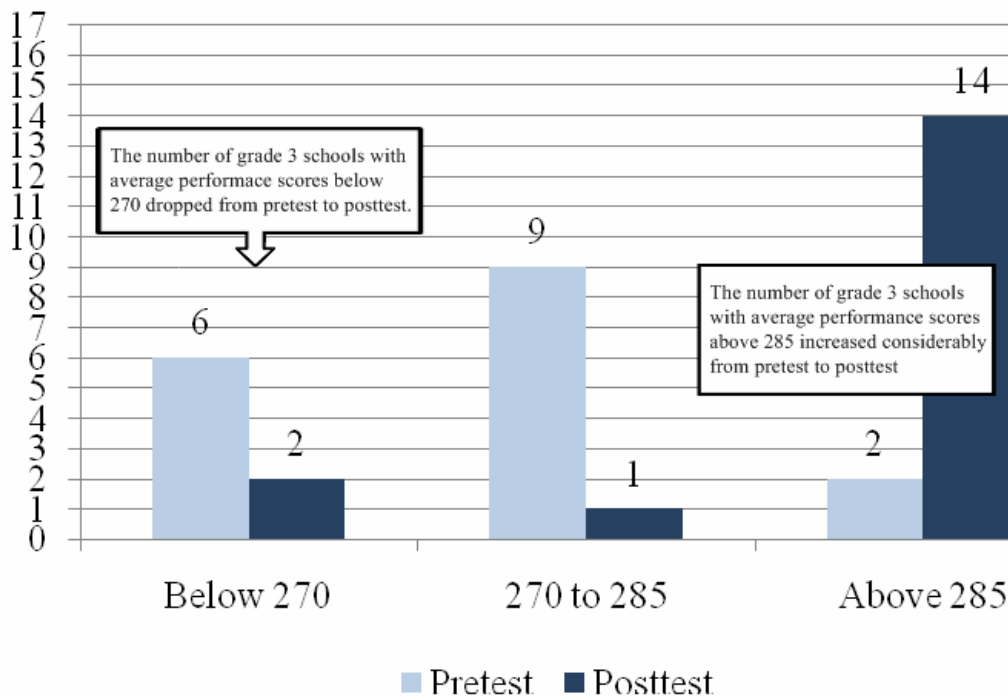
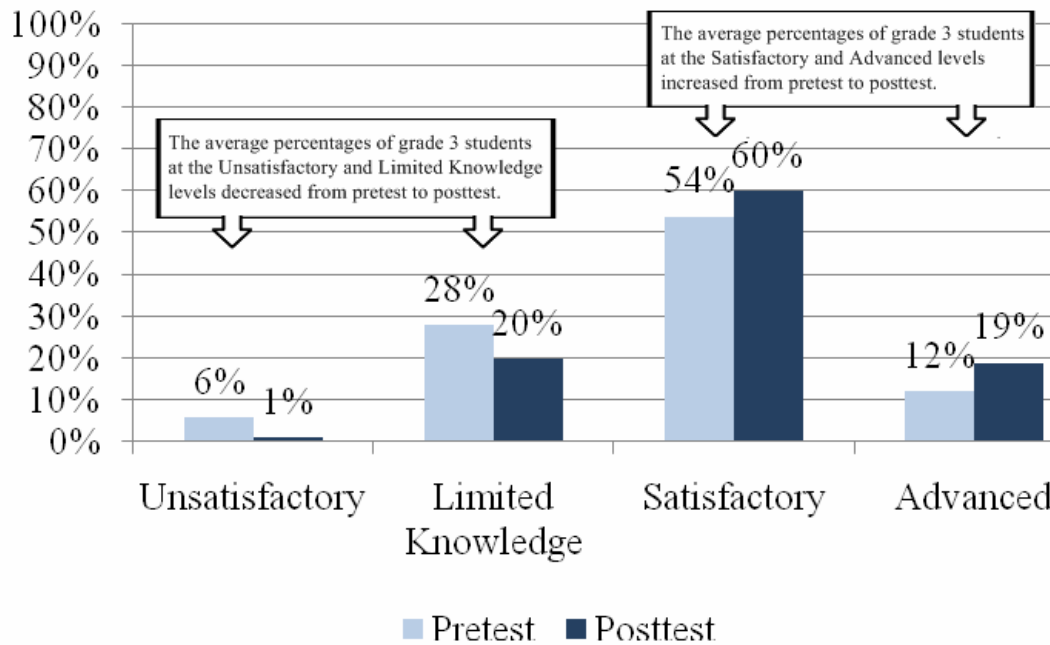


Figure 2 shows the average percentage of grade 3 students at Oklahoma *SAXON MATH* schools scoring at the Advanced, Satisfactory, Limited Knowledge, and Unsatisfactory levels at the time of the pretest and the posttest. The average percentages of students at the Unsatisfactory and the Limited Knowledge levels decreased from pretest to posttest, and the average percentages of students at the Satisfactory and the Advanced levels increased from pretest to posttest.

**Figure 2**  
**Average Percentage of Grade 3 Students at Oklahoma *SAXON MATH* Schools Scoring at each of Four Levels on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**



***Pretest/Posttest Analyses of Economically Disadvantaged Students***

A Paired Comparison *t*-test was conducted to determine whether the pretest to posttest gains of economically disadvantaged grade 3 students at Oklahoma *SAXON MATH* schools were statistically significant. According to the OSDOE Web site, Oklahoma students receiving free or reduced lunch are considered to be economically disadvantaged. For each school, the OSDOE Web site indicates the percentage of economically disadvantaged students scoring at each of the four performance levels.

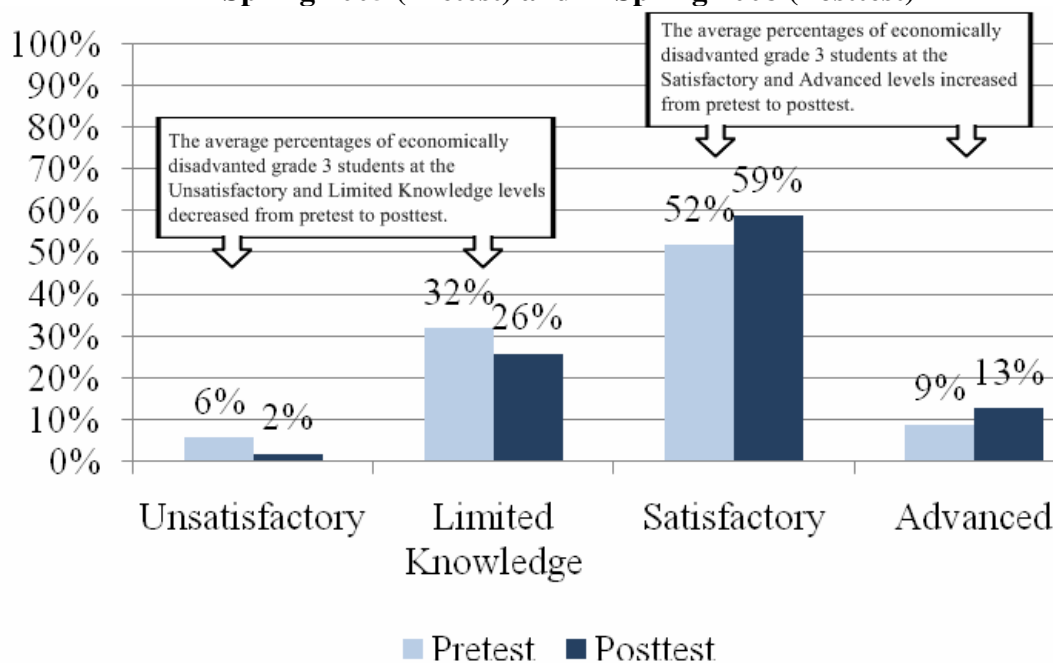
Table 6 presents the results of the *t*-test performed to determine if the pretest to posttest performance score gains of economically disadvantaged grade 3 students at Oklahoma *SAXON MATH* schools were statistically significant. The average performance score on the pretest was 263.4 and on the posttest was 283.2, a difference that was statistically significant at the .02 level. This level of significance indicates that such a difference would have occurred by chance less than two times out of 100 repetitions. The effect size was large.

**Table 6**  
**Results Comparing the Average OCCT Mathematics Performance Scores of Grade 3 Economically Disadvantaged Students at *SAXON MATH* Schools in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**

<i>Test</i>	<i>Number of Schools</i>	<i>Average Performance Score</i>	<i>SD</i>	<i>t-Test</i>	<i>Significance</i>	<i>Effect Size</i>
Pretest	17	263.4	21.4	2.414	<.02	.93
Posttest	17	283.2	20.9			

Figure 3 shows the average percentage of grade 3 economically disadvantaged students at Oklahoma *SAXON MATH* schools scoring at the Advanced, Satisfactory, Limited Knowledge, and Unsatisfactory levels at the time of the pretest and the posttest. The average percentages of students at the Unsatisfactory and Limited Knowledge levels decreased from pretest to posttest, and the average percentages of students at the Satisfactory and Advanced levels increased.

**Figure 3**  
**Average Percentage of Grade 3 Economically Disadvantaged Students at Oklahoma *SAXON MATH* Schools Scoring at each of Four Levels on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**



The grade 3 Oklahoma *SAXON MATH* schools were divided into two approximately equal groups based on the pretest scores of the grade 3 economically disadvantaged students at each school. Nine schools were in the lower pretest group and 8 schools were in the higher pretest group. Paired Comparison *t*-tests were conducted to determine if grade 3 economically disadvantaged students in both groups made significant pretest to posttest gains. Table 7 presents the results of those *t*-tests. The average performance score on the pretest for the grade 3 economically disadvantaged students at schools in the lower scoring group was 248.6, and the average score on the posttest for the grade 3 economically disadvantaged students at the same schools was 290.9, a difference that was statistically significant at the .04 level. This level of significance indicates that such a difference would have occurred by chance less than four times out of 100 repetitions. The effect size was large.

The average performance score on the pretest for the grade 3 economically disadvantaged student at schools in the higher scoring group was 280.2, and the average score on the posttest for the grade 3 economically disadvantaged students at the same schools was 275.8. These average scores decreased from pretest to posttest in a way that was not statistically significant.

**Table 7**  
**Results Comparing the OCCT Average Performance Scores of Grade 3 Economically Disadvantaged Students at Oklahoma *SAXON MATH* Schools in Fall 2005 (Pretest) and in Fall 2008 (Posttest) for Lower and Higher Scoring Pretest Groups Based on Pretest Scores of Economically Disadvantaged Students**

<i>Test</i>	<i>Number of Schools</i>	<i>Mean Performance Score</i>	<i>SD</i>	<i>t-test</i>	<i>Significance</i>	<i>Effect Size</i>
<i>Lower Pretest Group (Based on Pretest Scores of Economically Disadvantaged Students)</i>						
Pretest	9	248.6	14.9	4.645	<.04	2.7
Posttest	9	290.9	15.3			
<i>Higher Pretest Group (Based on Pretest Scores of Economically Disadvantaged Students)</i>						
Pretest	8	280.2	13.8	.594	Non-Significant	--
Posttest	8	275.8	24.7			

Figure 4 shows the average percentage of grade 3 economically disadvantaged students at lower scoring Oklahoma *SAXON MATH* schools (based on pretest scores of grade 3 economically disadvantaged students) scoring at the Advanced, Satisfactory, Limited Knowledge, and Unsatisfactory levels at the time of the pretest and the posttest. The average percentages of students at the Unsatisfactory and Limited Knowledge levels decreased from pretest to posttest, and the average percentages of students at the Satisfactory and Advanced levels increased.

**Figure 4**  
**Average Percentage of Grade 3 Economically Disadvantaged Students at Lower Scoring Oklahoma *SAXON MATH* Schools (Based on Pretest Scores of Grade 3 Economically Disadvantaged Students) Scoring at each of Four Levels on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**

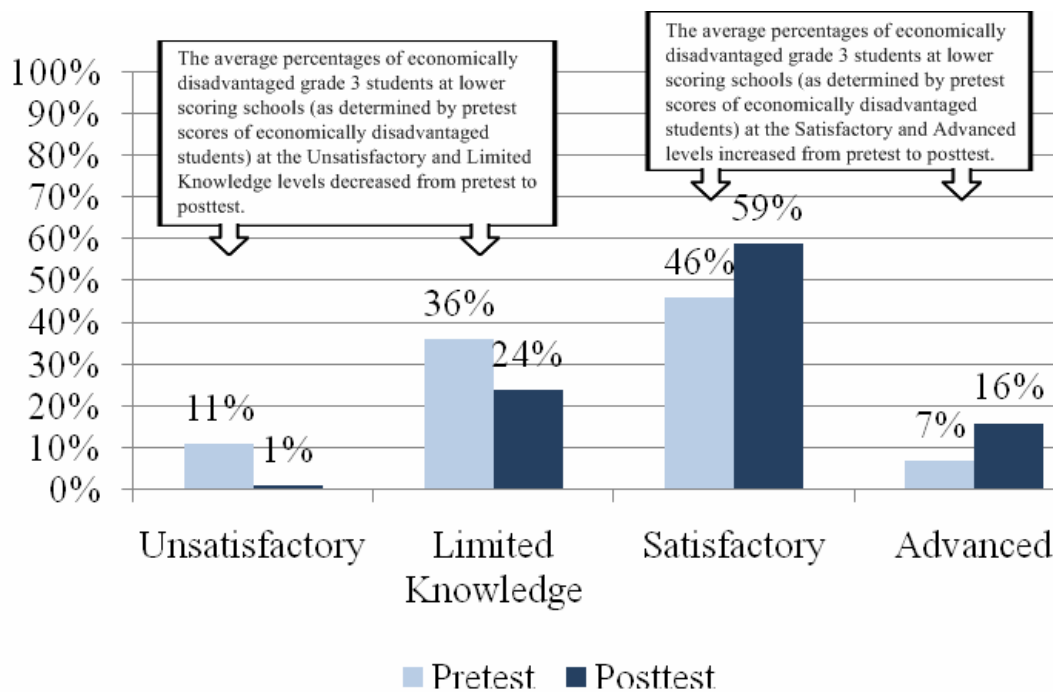
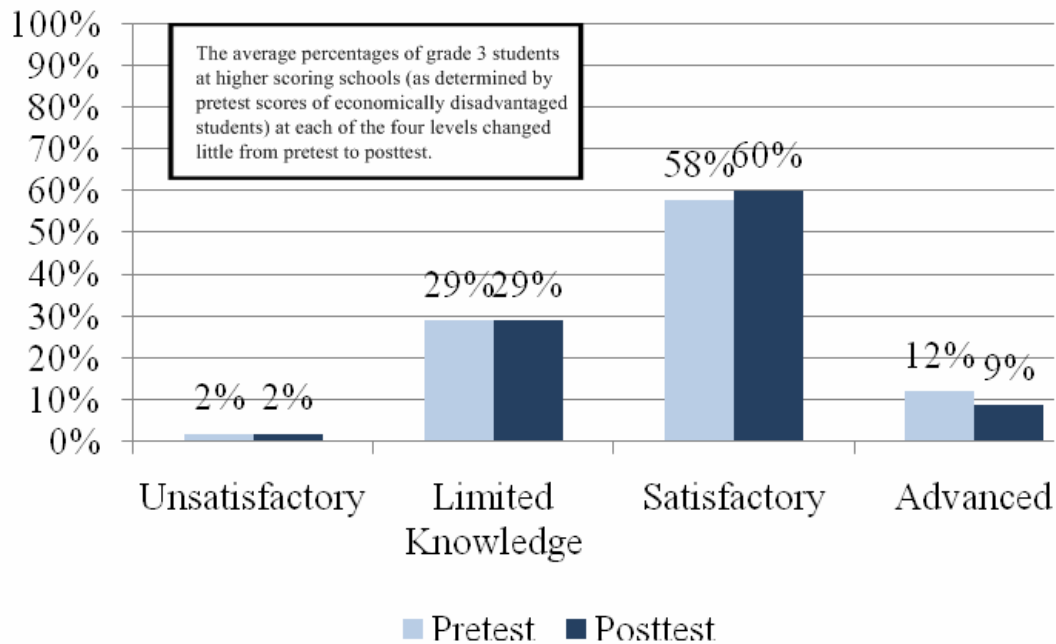




Figure 5 shows the average percentages of grade 3 economically disadvantaged students at higher scoring Oklahoma *SAXON MATH* schools (based on pretest scores of grade 3 economically disadvantaged students) scoring at the Advanced, Satisfactory, Limited Knowledge, and Unsatisfactory levels at the time of the pretest and the posttest. For this group there was little change from pretest to posttest.

**Figure 5**  
**Average Percentage of Grade 3 Economically Disadvantaged Students at Higher Scoring Oklahoma *SAXON MATH* Schools (Based on Pretest Scores of Grade 3 Economically Disadvantaged Students) Scoring at each of Four Levels on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**



### ***Pretest Score Group Pretest/Posttest Analyses***

The grade 3 schools were divided into two approximately equal groups based on the average pretest score of the total group of grade 3 students at each school. The lower pretest group included 9 schools and the higher pretest group included 8 schools. Paired Comparison *t*-tests were conducted to determine if both groups made significant pretest to posttest gains.

Table 8 presents the results of the *t*-test performed to determine if the pretest to posttest gains of grade 3 students at Oklahoma *SAXON MATH* schools in both the lower and higher scoring pretest groups was statistically significant. The average standard score for the lower scoring group increased from 262.4 to 293.6. The difference for the lower scoring pretest group was statistically significant at the .04 level, indicating a change that would have occurred by chance less than four times out of 100 repetitions. The effect size was large.

The average performance score for the higher scoring group increased from 285.1 to 300.2. The difference for the higher scoring pretest group was statistically significant at the .01 level, indicating a change that would have occurred by chance less than once out of 100 repetitions. The effect size was large.

**Table 8**  
**Results Comparing the OCCT Math Standard Scores of Grade 3 Students at Oklahoma *SAXON MATH* Schools in Spring 2005 (Pretest) and in Spring 2008 (Posttest) For Lower and Higher Scoring Pretest Groups**

<i>Test</i>	<i>Number of Schools</i>	<i>Mean Performance Score</i>	<i>SD</i>	<i>t-test</i>	<i>Significance</i>	<i>Effect Size</i>
<i>Lower Scoring Pretest Schools</i>						
Pretest	9	262.4	10.2	2.412	<.04	1.21
Posttest	9	293.6	34.6			
<i>Higher Scoring Pretest Schools</i>						
Pretest	8	285.1	6.8	1.346	<.01	1.27
Posttest	8	300.2	15.2			

Figure 6 shows the average percentage of grade 3 students at lower pretest scoring Oklahoma *SAXON MATH* schools scoring at the Advanced, Satisfactory, Limited Knowledge, and Unsatisfactory levels at the time of the pretest and the posttest. The average percentages of students at the Unsatisfactory and Limited Knowledge levels decreased from pretest to posttest, and the average percentages of students at the Satisfactory and Advanced levels increased.

**Figure 6**  
**Average Percentage of Grade 3 Students at Lower Pretest Scoring Oklahoma *SAXON MATH* Schools Scoring at each of Four Levels on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**

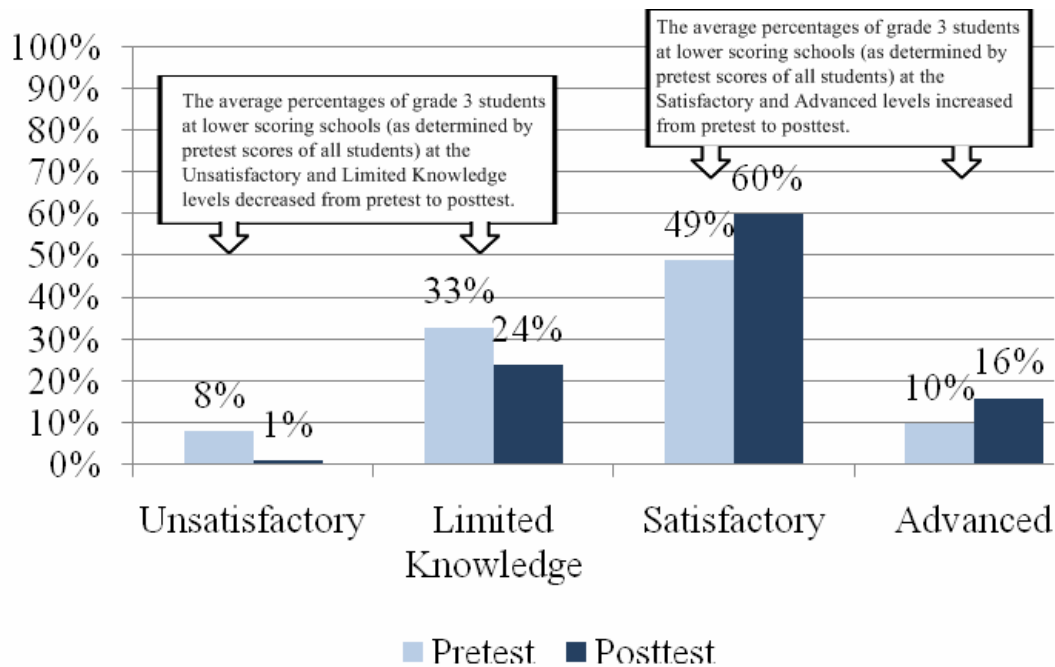
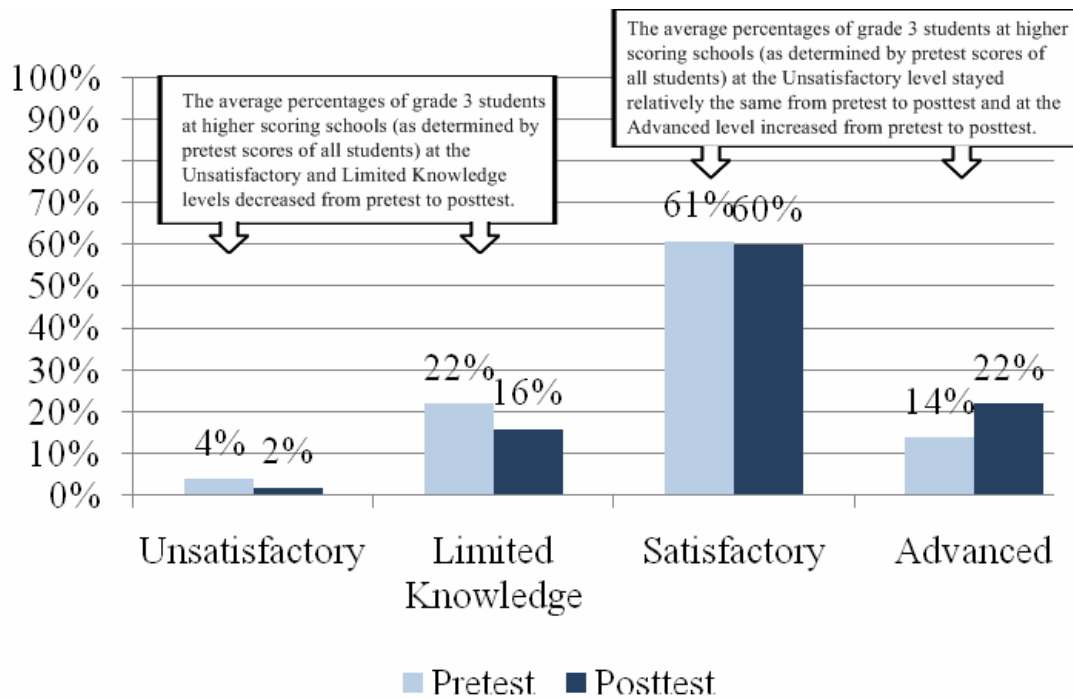


Figure 7 shows the average percentages of grade 3 students at higher pretest scoring Oklahoma *SAXON MATH* schools scoring at the Advanced, Satisfactory, Limited Knowledge, and Unsatisfactory levels at the time of the pretest and the posttest. The largest performance level change from pretest to posttest was the 8% increase in the percentage of students scoring at the Advanced level.

**Figure 7**  
**Average Percentage of Grade 3 Students at Higher Pretest Scoring Oklahoma *SAXON MATH* Schools Scoring at each of Four Levels on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**



## 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 whether the pretest to posttest gains of the total group of grade 5 students at Oklahoma *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, 17 schools were included.

In addition to the Paired Comparison *t*-test, an effect-size analysis was computed. 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 9 presents the results of the *t*-test performed to determine if the pretest to posttest performance score gains for grade 5 students at Oklahoma *SAXON MATH* schools were statistically significant. The average performance score was 281.4 on the pretest and was 314.2 on the posttest, 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 large.

**Table 9**  
**Results Comparing the Average OCCT Math Performance Scores of Grade 5 Students at Oklahoma *SAXON MATH* Schools in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**

<i>Test</i>	<i>Number of Schools</i>	<i>Mean Performance Score</i>	<i>SD</i>	<i>t-Test</i>	<i>Significance</i>	<i>Effect Size</i>
Pretest	17	281.4	15.6	11.597	<.0001	2.07
Posttest	17	314.2	16.0			

Figure 8 shows the number of Oklahoma *SAXON MATH* schools with average grade 5 performance scores below 270, between 270 to 285, and above 285 on the math portion of the OCCT in spring 2005 (pretest) and spring 2008 (posttest). In spring 2005, only six schools had average performance scores above 285. By spring 2008, the average performance scores of all 17 grade 5 *SAXON MATH* schools were above 285.

**Figure 8**  
**Number of Grade 5 Oklahoma *SAXON MATH* Schools with Various Ranges of Average Performance Scores on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**

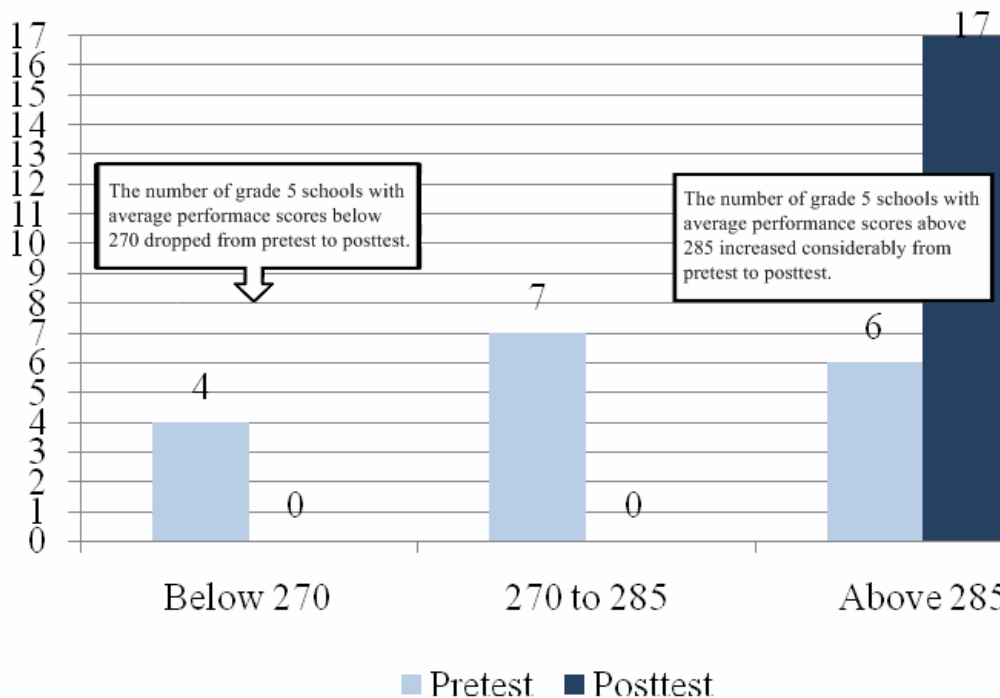
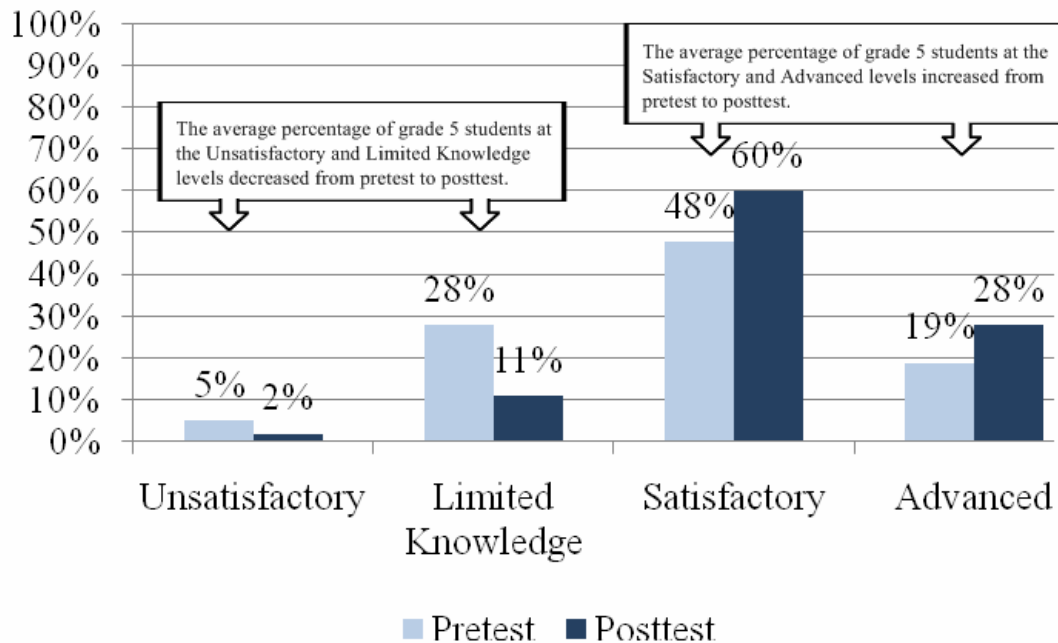


Figure 9 shows the average percentage of grade 5 students at Oklahoma *SAXON MATH* schools scoring at the Advanced, Satisfactory, Limited Knowledge, and Unsatisfactory levels at the time of the pretest and the posttest. The average percentages of students at the Unsatisfactory and the Limited Knowledge levels decreased from pretest to posttest, and the average percentages of students at the Satisfactory and the Advanced levels increased from pretest to posttest.

**Figure 9**  
**Average Percentage of Grade 5 Students at Oklahoma *SAXON MATH* Schools Scoring at each of Four Levels on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**



***Pretest/Posttest Analyses of Economically Disadvantaged Students***

A Paired Comparison *t*-test was conducted to determine whether the pretest to posttest gains of economically disadvantaged grade 5 students at Oklahoma *SAXON MATH* schools were statistically significant. According to the OSDOE Web site, Oklahoma students receiving free or reduced lunch are considered to be economically disadvantaged. For each school, the OSDOE Web site indicates the percentage of economically disadvantaged students scoring at each of the four performance levels.

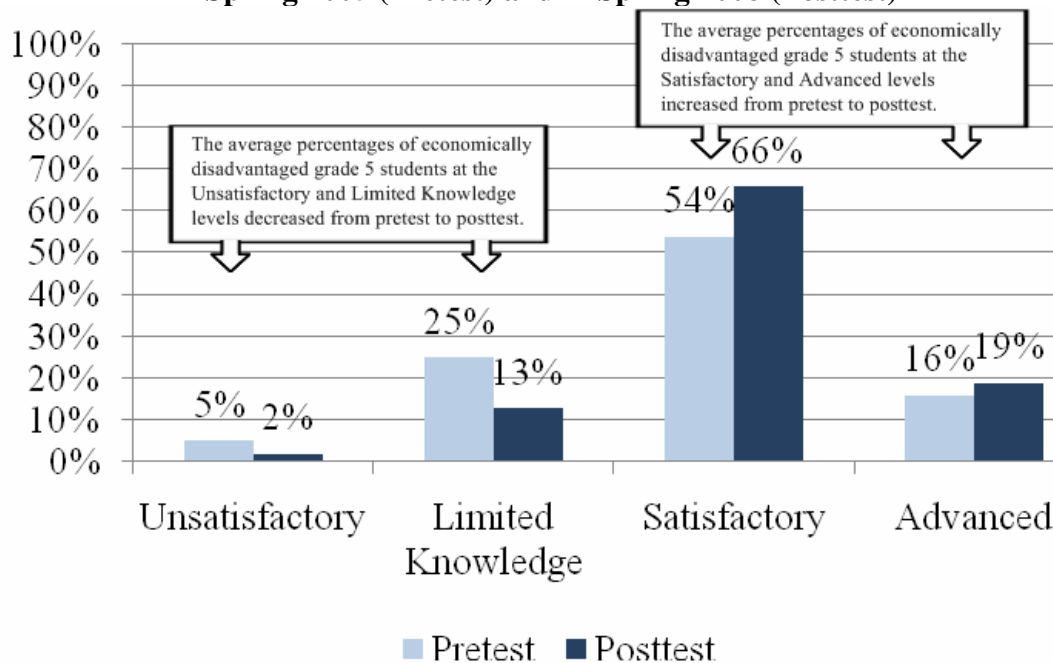
Table 10 presents the results of the *t*-test performed to determine if the pretest to posttest performance score gains of economically disadvantaged grade 5 students at Oklahoma *SAXON MATH* schools were statistically significant. The average performance score on the pretest was 281.1 and on the posttest was 301.4, a difference that was statistically significant at the .003 level. This level of significance indicates that such a difference would have occurred by chance less than three times out of 1,000 repetitions. The effect size was large.

**Table 10**  
**Results Comparing the Average OCCT Mathematics Performance Scores of Grade 5 Economically Disadvantaged Students at *SAXON MATH* Schools in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**

<i>Test</i>	<i>Number of Schools</i>	<i>Average Performance Score</i>	<i>SD</i>	<i>t-Test</i>	<i>Significance</i>	<i>Effect Size</i>
Pretest	17	281.1	25.3	3.525	<.003	.90
Posttest	17	301.4	19.3			

Figure 10 shows the average percentage of grade 5 economically disadvantaged students at Oklahoma *SAXON MATH* schools scoring at the Advanced, Satisfactory, Limited Knowledge, and Unsatisfactory levels at the time of the pretest and the posttest. The average percentages of students at the Unsatisfactory and Limited Knowledge levels decreased from pretest to posttest, and the average percentages of students at the Satisfactory and Advanced levels increased.

**Figure 10**  
**Average Percentage of Grade 5 Economically Disadvantaged Students at Oklahoma *SAXON MATH* Schools Scoring at each of Four Levels on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**



The grade 5 Oklahoma *SAXON MATH* schools were divided into two approximately equal groups based on the pretest scores of the grade 5 economically disadvantaged students at each school. Nine schools were in the lower pretest group and 8 schools were in the higher pretest group. Paired Comparison *t*-tests were conducted to determine if grade 5 economically disadvantaged students in both groups made significant pretest to posttest gains. Table 11 presents the results of those *t*-tests. The average performance score on the pretest for the grade 5 economically disadvantaged students at schools in the lower scoring group was 261.7, and the average score on the posttest for the grade 5 economically disadvantaged students at the same schools was 294.8, a difference that was statistically significant at the .005 level. This level of significance indicates that such a difference would have occurred by chance less than five times out of 1,000 repetitions. The effect size was large.

The average performance score on the pretest for the grade 5 economically disadvantaged student at schools in the higher scoring group was 303.0, and the average score on the posttest for the grade 5 economically disadvantaged students at the same schools was 309.0. These average scores increased from pretest to posttest in a way that was not statistically significant.

**Table 11**  
**Results Comparing the OCCT Average Performance Scores of Grade 5 Economically Disadvantaged Students at Oklahoma *SAXON MATH* Schools in Fall 2005 (Pretest) and in Fall 2008 (Posttest) for Lower and Higher Scoring Pretest Groups Based on Pretest Scores of Economically Disadvantaged Students**

<i>Test</i>	<i>Number of Schools</i>	<i>Mean Performance Score</i>	<i>SD</i>	<i>t-test</i>	<i>Significance</i>	<i>Effect Size</i>
<i>Lower Pretest Group (Based on Pretest Scores of Economically Disadvantaged Students)</i>						
Pretest	9	261.7	17.0	3.883	<.005	1.5
Posttest	9	294.8	20.0			
<i>Higher Pretest Group (Based on Pretest Scores of Economically Disadvantaged Students)</i>						
Pretest	8	303.0	10.3	1.671	Non-Significant	.2
Posttest	8	309.0	16.4			



Figure 11 shows the average percentages of grade 5 economically disadvantaged students at lower scoring Oklahoma *SAXON MATH* schools (based on pretest scores of grade 5 economically disadvantaged students) scoring at the Advanced, Satisfactory, Limited Knowledge, and Unsatisfactory levels at the time of the pretest and the posttest. The average percentages of students at the Unsatisfactory and Limited Knowledge levels decreased from pretest to posttest, and the average percentages of students at the Satisfactory and Advanced levels increased.

**Figure 11**  
**Average Percentage of Grade 5 Economically Disadvantaged Students at Lower Scoring Oklahoma *SAXON MATH* Schools (Based on Pretest Scores of Grade 5 Economically Disadvantaged Students) Scoring at each of Four Levels on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**

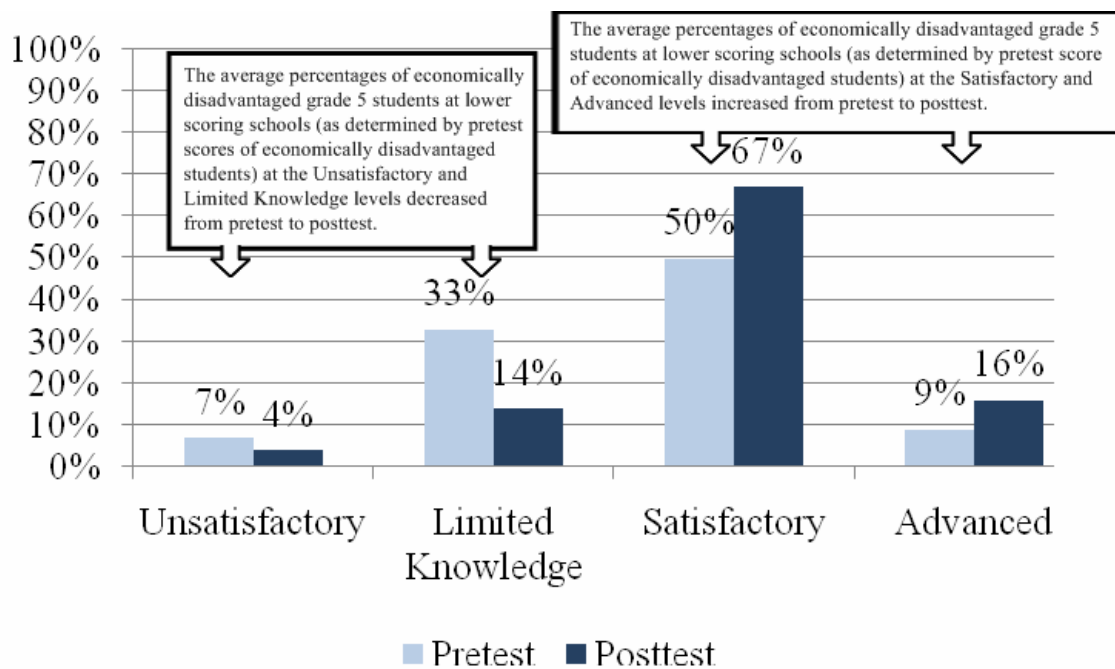
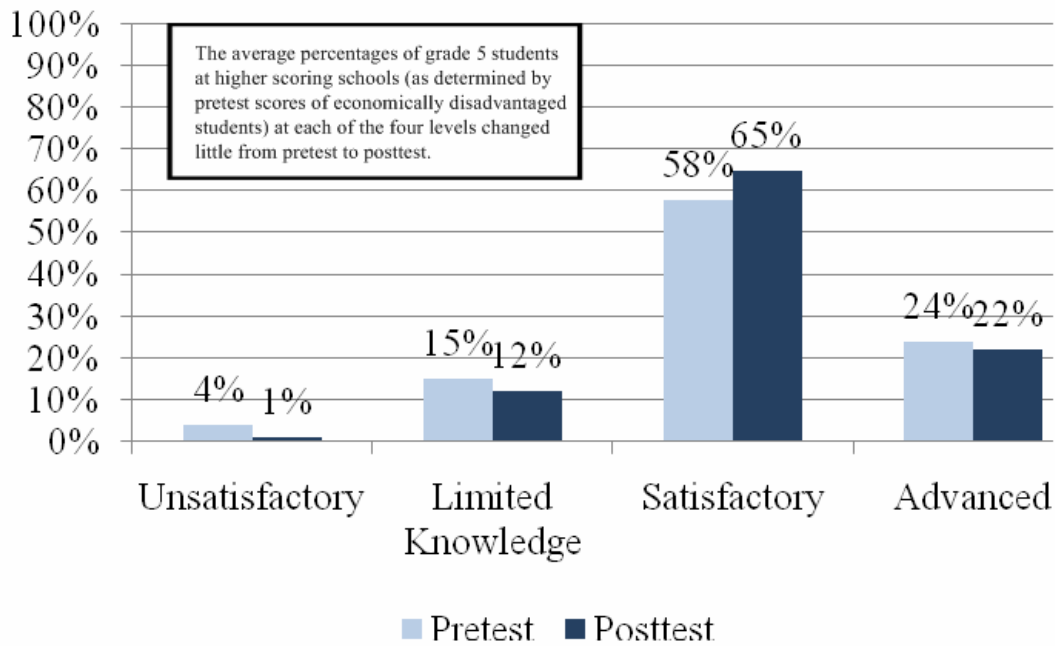


Figure 12 shows the average percentages of grade 5 economically disadvantaged students at higher scoring Oklahoma *SAXON MATH* schools (based on pretest scores of grade 5 economically disadvantaged students) scoring at the Advanced, Satisfactory, Limited Knowledge, and Unsatisfactory levels at the time of the pretest and the posttest. For this group there was little change from pretest to posttest.

**Figure 12**  
**Average Percentage of Grade 5 Economically Disadvantaged Students at Higher Scoring Oklahoma *SAXON MATH* Schools (Based on Pretest Scores of Grade 5 Economically Disadvantaged Students) Scoring at each of Four Levels on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**



### ***Pretest Score Group Pretest/Posttest Analyses***

The grade 5 schools were divided into two approximately equal groups based on the average pretest score of the total group of grade 5 students at each school. The lower pretest group included 9 schools and the higher pretest group included 8 schools. Paired Comparison *t*-tests were conducted to determine if both groups made significant pretest to posttest gains.

Table 12 presents the results of the *t*-test performed to determine if the pretest to posttest gains of grade 5 students at Oklahoma *SAXON MATH* schools in both the lower and higher scoring pretest groups was statistically significant. The average standard score for the lower scoring group increased from 269.9 to 293.6, and the average standard score for the higher scoring group increased from 294.5 to 327.6. Both differences were statistically significant at the .0001 level, indicating changes that would have occurred by chance less than once out of 10,000 repetitions. The effect size was large for both groups.

**Table 12**  
**Results Comparing the OCCT Math Standard Scores of Grade 5 Students at Oklahoma *SAXON MATH* Schools in Spring 2005 (Pretest) and in Spring 2008 (Posttest) For Lower and Higher Scoring Pretest Groups**

<i>Test</i>	<i>Number of Schools</i>	<i>Mean Performance Score</i>	<i>SD</i>	<i>t-test</i>	<i>Significance</i>	<i>Effect Size</i>
<i>Lower Scoring Pretest Schools</i>						
Pretest	9	269.9	8.3	8.117	<.0001	2.05
Posttest	9	293.6	34.6			
<i>Higher Scoring Pretest Schools</i>						
Pretest	8	294.5	10.4	7.766	<.0001	2.03
Posttest	8	327.6	10.0			

Figure 13 shows the average percentages of grade 5 students at lower pretest scoring Oklahoma *SAXON MATH* schools scoring at the Advanced, Satisfactory, Limited Knowledge, and Unsatisfactory levels at the time of the pretest and the posttest. The average percentages of students at the Unsatisfactory and Limited Knowledge levels decreased from pretest to posttest, and the average percentages of students at the Satisfactory and Advanced levels increased.

**Figure 13**  
**Average Percentage of Grade 5 Students at Lower Pretest Scoring Oklahoma *SAXON MATH* Schools Scoring at each of Four Levels on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**

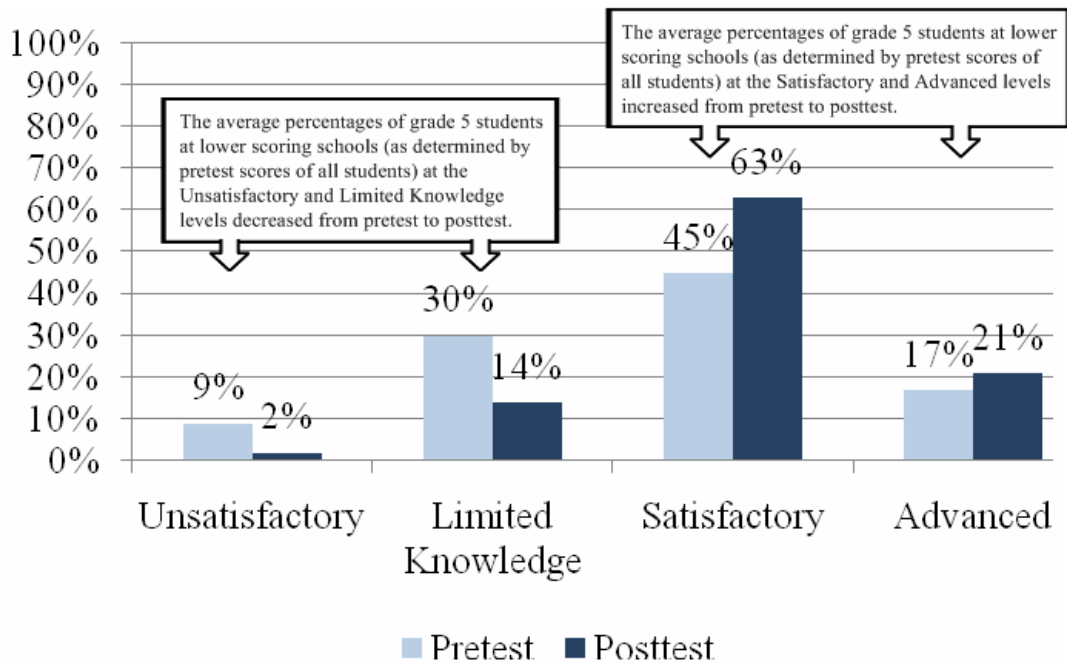
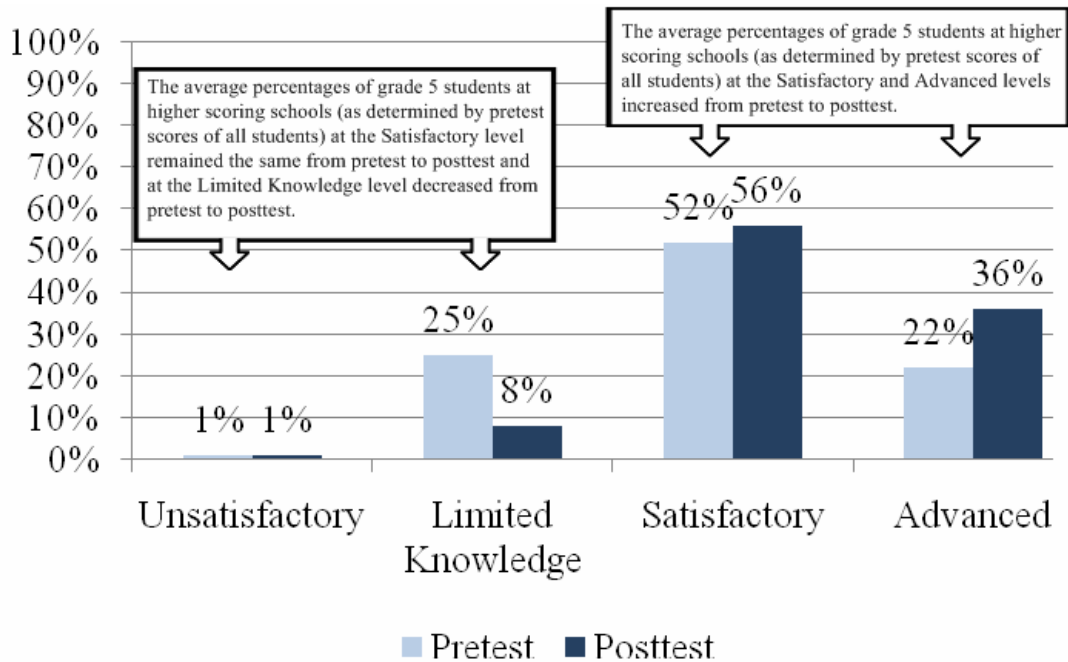


Figure 14 shows the average percentages of grade 5 students at higher pretest scoring Oklahoma *SAXON MATH* schools scoring at the Advanced, Satisfactory, Limited Knowledge, and Unsatisfactory at the time of the pretest and the posttest. The average percentage of students at the Unsatisfactory level remained very low while the average percent of students at the Limited Knowledge level decreased from pretest to posttest. The average percentages of students at the Satisfactory and Advanced levels increased.

**Figure 14**  
**Average Percentage of Grade 5 Students at Higher Pretest Scoring Oklahoma *SAXON MATH* Schools Scoring at each of Four Levels on the OCCT in Math in Spring 2005 (Pretest) and in Spring 2008 (Posttest)**



## 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 Oklahoma *SAXON MATH* schools, gains were statistically significant at both grade levels for the total groups. In addition, significant gains were made at both grade levels for economically disadvantaged students. When Oklahoma *SAXON MATH* schools were divided into lower pretest schools and higher pretest schools based on both the pretest scores of the total group as well as on the pretest scores of the economically disadvantaged students, all of the lower pretest groups at both grade levels made significant pretest to posttest gains. Additionally, the higher pretest groups as determined by the pretest scores of the total group made significant pretest to posttest gains at both grade levels. However, the higher pretest groups as determined by the pretest scores of the economically disadvantaged students did not make significant gains at either grade level. A summary of the results is provided in Table 13 below. The table indicates whether the gains were significant as well as the effect size of each significant gain.

**Table 13**  
**Summary of the Pretest/Posttest Score Analyses Conducted to Determine if Significant Gains were Made on the OCCT Math for Grade 3 and Grade 5 Students at Oklahoma *SAXON MATH* Schools**

<i>Group</i>	<i>Grade 3</i>		<i>Grade 5</i>	
	<i>Gain Statistically Significant?</i>	<i>Effect Size</i>	<i>Gain Statistically Significant?</i>	<i>Effect Size</i>
All <i>SAXON MATH</i> Schools	Yes	Large	Yes	Large
Economically Disadvantaged Students	Yes	Large	Yes	Large
Economically Disadvantaged Students at Lower Pretest <i>SAXON MATH</i> Schools as Determined by Pretest Scores of Economically Disadvantaged Students	Yes	Large	Yes	Large
Economically Disadvantaged Students at Higher Pretest <i>SAXON MATH</i> Schools as Determined by Pretest Scores of Economically Disadvantaged Students	No	--	No	--
Lower Pretest Group <i>SAXON MATH</i> Schools	Yes	Large	Yes	Large
Higher Pretest Group <i>SAXON MATH</i> Schools	Yes	Large	Yes	Large

Table 14 summarizes the increases and decreases from pretest to posttest in the percentages of grade 3 and grade 5 students at Oklahoma *SAXON MATH* schools scoring at each of four performance levels on the math portion of the OCCT.

**Table 14**  
**Summary of Changes from Pretest to Posttest of Percentages of**  
**Grade 3 and Grade 5 *SAXON MATH* Students Passing the**  
**Math Portion of the OCCT**

<b>Student Sample and Grade Level</b>	<i>Unsatisfactory</i>	<i>Limited Knowledge</i>	<i>Satisfactory</i>	<i>Advanced</i>
<b>All <i>SAXON MATH</i> Schools</b>				
Grade 3	-5%	-8%	+6%	+7%
Grade 5	-3%	-17%	+12%	+9%
<b>Economically Disadvantaged Students at <i>SAXON MATH</i> Schools</b>				
Grade 3	-4%	-6%	+7%	+4%
Grade 5	-3%	-12%	+12%	+3%
<b>Economically Disadvantaged Students in Lower Pretest <i>SAXON MATH</i> Schools (As Determined by the Pretest Scores of the Economically Disadvantaged Students)</b>				
Grade 3	-10%	-12%	+13%	+9%
Grade 5	-3%	-19%	+17%	+7%
<b>Economically Disadvantaged Students in Higher Pretest <i>SAXON MATH</i> Schools (As Determined by the Pretest Scores of the Economically Disadvantaged Students)</b>				
Grade 3	0	0	+2%	-3%
Grade 5	-3%	-3%	+7%	-2%
<b>Lower Pretest <i>SAXON MATH</i> Schools</b>				
Grade 3	-7%	-9%	+11%	+6%
Grade 5	-7%	-16%	+18%	+4%
<b>Higher Pretest <i>SAXON MATH</i> Schools</b>				
Grade 3	-2%	-6%	-1%	+8%
Grade 5	0	-17%	+4%	+14%

**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 Oklahoma schools using the *SAXON MATH* program.**

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