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An Efficacy Study of the Geometry Version 14 Course

Florida Virtual School

[Report 451, January 2013]



Contents

Executive Summary.....	2
Research Design.....	4
Research Questions	4
Course Description.....	4
Description of the Research Sample.....	5
Description of the Assessments.....	6
Data Analyses and Results	9
Results for Each Module	10
Module 1.....	11
Module 2.....	14
Module 3.....	17
Module 4.....	20
Module 5.....	23
Module 6.....	26
Module 7.....	29
Module 8.....	32
Module 9.....	35
Module 10.....	38
Conclusions	41

Executive Summary

Florida Virtual School[®] contracted with the Educational Research Institute of America to analyze the test score data for students enrolled in the Geometry version 14 course.

Florida Virtual School (FLVS[®]) is an established leader in developing and providing virtual Kindergarten through grade 12 education solutions to students worldwide. A nationally recognized e-Learning model, FLVS, founded in 1997, was the country's first state-wide Internet-based public high school. In 2000, the Florida Legislature established FLVS as an independent educational entity with a gubernatorial appointed board. FLVS is the only public school with funding tied directly to student performance.

Each course has a real-time teacher who guides each student through the coursework, which is broken down into modules. As a student works through the modules of a course, he or she will connect with the teacher to take exams online and receive discussion-based assessments over the phone. Students do the work at their own pace and on their own time, but they interact with their teachers in multiple ways--including Live Lessons, phone calls, chat, texting, and email--throughout the course.

The Geometry course is designed to meet the Florida Next Generation Sunshine State Standards and has been mapped to the Common Core State Standards.

Pretest/posttest comparisons of students' performance were based on 10 module tests which covered the total content for the course. The results showed statistically significant gains from pretesting to posttesting for all 10 modules. The effect size, a measure of how much gain was made, was large.

Inferential statistics were not possible for the subgroups since each group took a small number of randomly selected items which were not equal in difficulty. However, descriptive statistics show consistent differences favoring the honors group for each module. Additionally, the differences for the average scores across all 10 modules showed the following:

Basic and Honors Students

- The average pretest score for the basic students was 40% correct, and their average posttest score was 69% correct, resulting in a gain of 29%.
- The average pretest score for the honors students was 45% correct, and their average posttest score was 78% correct, resulting in a gain of 33%.

Male and Female Students

- The average pretest score for the male students was 43% correct, and their average posttest score was 75% correct, resulting in a gain of 32%.
- The average pretest score for the female students was 42% correct, and their average posttest score was 72% correct, resulting in a gain of 30%.

Lower Socio-Economic Status and Higher Socio-Economic Status Students

- The average pretest score for the lower socio-economic students was 41% correct, and their average posttest score was 68% correct, resulting in a gain of 27%.
- The average pretest score for the higher socio-economic students was 42% correct, and their average posttest score was 75% correct, resulting in a gain of 33%.

White, Minority, and Multi-Ethnic Students

- The average pretest score for the white students was 42% correct, and their average posttest score was 74% correct, resulting in a gain of 32%.
- The average pretest score for the minority students was 42% correct, and their average posttest score was 71% correct, resulting in a gain of 29%.
- The average pretest score for the multi-ethnic students was 42% correct, and their average posttest score was 72% correct, resulting in a gain of 30%.

In sum, the FLVS Geometry course produces significant academic improvement and is fairly similar across all three demographic groups (gender, socio-economic, and ethnicity).

Research Design

Carefully constructed studies are needed to determine the efficacy of online courses. The courses provide an important educational opportunity to students, and participation continues to grow at a rapid pace. In addition, the enrichment of students' educational opportunities through online courses can help to prepare him or her for the demands of post-secondary education and the workplace. FLVS has developed a unique approach to online course instruction in which excellent online curriculum resources are accompanied by significant direct instruction, support and guidance from teachers. Real-world application provides unique student preparation for college and/or careers.

The use of a modular approach to course development includes pretest and posttest assessments that help to guide instruction and provide excellent data to analyze program success. This study used the pretest and posttest module scores of large numbers of students over a several year period to assess student program success.

Research Questions

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

1. Do students enrolled in the **Florida Virtual School Geometry** program increase their knowledge and skills in geometry?
2. Do students enrolled in basic or honors courses achieve similar gains in the **Florida Virtual School Geometry** program?
3. Do students with differing demographic characteristics (gender, socio-economic status, and ethnicity) achieve similar gains when enrolled in the **Florida Virtual School Geometry** program?

Course Description

The Geometry version 14 course is designed with a total of 10 instructional modules. These modules include instructional activities to meet a specific set of standards for each module.

Geometry is everywhere, not just in pyramids. Engineers use geometry to build highways and bridges. Artists use geometry to create perspective in their paintings, and mapmakers help travelers find things using the points located on a geometric grid. Throughout this course, students travel a mathematical highway illuminated by spatial relationships, reasoning, connections, and problem solving.

Segment I:

Module 1: Basics of Geometry

Module 2: Triangle Properties

Module 3: Congruent Triangles

Module 4: Right Triangles and Trigonometry

Module 5: Quadrilaterals

Segment II:

Module 6: Transformations and Similarity

Module 7: Surface Area and Volume

Module 8: Circles

Module 9: Proofs

Module 10: Proofs

Besides engaging students in challenging curriculum, FLVS guides students to reflect on their learning and to evaluate their progress through a variety of assessments. These assessments can be in the form of self-checks, collaboration activities, practice lessons, multiple choice questions, writing assignments, projects, research papers, essays, discussion-based assessments, and student discussions. State and nationally-recognized educational standards and frameworks guide assessment design. Instructors evaluate progress and provide interventions through the variety of assessments built into the course, as well as through contact with the student in other venues.

Description of the Research Sample

The study included students enrolled in the Geometry course between August 23, 2010 and October 30, 2012.

Tables 1 to 3 provide a description of the demographic characteristics of the students included in the analysis.

Table 1: Grade Levels of Students Comprising the Research Sample

<i>Grade Levels</i>				
<i>8</i>	<i>9</i>	<i>10</i>	<i>11</i>	<i>12</i>
<i>5%</i>	<i>17%</i>	<i>32%</i>	<i>29%</i>	<i>17%</i>

Table 2: Gender, Course, and Free Lunch Eligibility for Free/Reduced Lunch Program of Students Comprising the Research Sample

<i>Gender</i>		<i>Course</i>		<i>Eligible for Free Reduced Lunch Program</i>	
<i>Males</i>	<i>Females</i>	<i>Basic</i>	<i>Honors</i>	<i>Yes</i>	<i>No</i>
<i>43%</i>	<i>57%</i>	<i>67%</i>	<i>33%</i>	<i>32%</i>	<i>68%</i>

Table 3: Ethnicity of Students Comprising the Research Sample

<i>Ethnicity</i>		
<i>White</i>	<i>Minority</i>	<i>Multi-Ethnic</i>
<i>58%</i>	<i>16%</i>	<i>26%</i>

Description of the Assessments

For this geometry study, there are 10 pretests and 10 posttests. Each pretest includes from 13 to 27 groups of banked test items for a total of 377 groups. To limit item exposure and promote academic integrity, each student randomly receives only one test item from the bank of items in each group. For Geometry, each pretest group consists of four banked test items for a total of 864 pretest items, but each student only receives a total of 216 pretest items from those banked items spread across the 10 module pretests. Each group of items was also designed to measure the same set of standards at the same cognitive complexity level. This random sampling provides a broad assessment due to the fact that all 864 items are included in the assessment bank, but each student takes only 15 to 27 items per module pretest. Across the 10 module pretests throughout the course, the student takes a total of 216 pretest items.

Each posttest (module test) includes from 13 to 24 groups of banked test items for a total of 161 groups. To limit item exposure and promote academic integrity, each student randomly receives only one test item from the bank of items for each group. For Geometry, each posttest group consists of four banked test items for a total of 644 posttest items, but each student only receives a total of 161 posttest items from those banked items spread across the 10 posttests.

Each group of items was also designed to measure the same set of standards at the same cognitive complexity level. This random sampling provides a broad assessment due to the fact that all 644 items are included in the assessment bank, but each student takes only from 13 to 24 items per posttest and a total of 161 posttest items across the 10 module tests throughout the course.

In addition, extra items were administered to only the honors students and only for the posttests; these items are not included in the pretest/posttest comparisons.

Table 4: Geometry Module Pretests

<i>Basic and Honors</i>		
<i>Pretest Modules</i>	<i>Total # of Banked Items</i>	<i># of Items per Student</i>
<i>Module 1</i>	<i>92</i>	<i>23</i>
<i>Module 2</i>	<i>100</i>	<i>25</i>
<i>Module 3</i>	<i>80</i>	<i>20</i>
<i>Module 4</i>	<i>80</i>	<i>20</i>
<i>Module 5</i>	<i>60</i>	<i>15</i>
<i>Module 6</i>	<i>88</i>	<i>22</i>
<i>Module 7</i>	<i>104</i>	<i>26</i>
<i>Module 8</i>	<i>108</i>	<i>27</i>
<i>Module 9</i>	<i>80</i>	<i>20</i>
<i>Module 10</i>	<i>72</i>	<i>18</i>

Table 5: Geometry Module Posttests

<i>Basic and Honors</i>		
<i>Posttest Modules</i>	<i>Total # of Banked Items</i>	<i># of Items per Student</i>
<i>Module 1</i>	<i>52</i>	<i>13</i>
<i>Module 2</i>	<i>52</i>	<i>13</i>
<i>Module 3</i>	<i>60</i>	<i>15</i>
<i>Module 4</i>	<i>68</i>	<i>17</i>
<i>Module 5</i>	<i>52</i>	<i>13</i>
<i>Module 6</i>	<i>68</i>	<i>17</i>
<i>Module 7</i>	<i>84</i>	<i>21</i>
<i>Module 8</i>	<i>96</i>	<i>24</i>
<i>Module 9</i>	<i>52</i>	<i>13</i>
<i>Module 10</i>	<i>60</i>	<i>15</i>

The pretests and posttests were developed to assess the skills and strategies included in each Geometry module. The assessments focused on the skills, strategies, and knowledge necessary for effective understanding of geometry.

Data Analyses and Results

Data analyses were based on the percent correct score for each student. Since different number of test items were included on the pretests and posttests, it was necessary to use percent correct scores. Only those students who were administered both a pretest and posttest for the module being analyzed are included in the data analysis.

The following analyses were conducted to determine answers to the research questions that were the guiding focus of this study:

1. Pretest/posttest comparisons, using *Paired Comparison t-tests*, were used to analyze growth for each module.
2. Students were divided into two sub-groups based on their enrollment in either the basic or honors section of the Geometry course. Pretest/posttest comparisons were then analyzed using *Paired Comparison t-tests* to determine if both groups' learning gains increased statistically significantly.
3. Students were then divided into demographic groups based on gender, socio-economic status (determined by eligibility for free/reduced lunch programs), and ethnicity (white, minority, or multi-ethnic). Pretest/posttest comparisons were then analyzed using *Paired Comparison t-tests* to determine if there were any increase differences between the various demographic groups.
4. An effect-size analysis was computed for each of the paired *t-tests*. Cohen's *d* statistic was used to determine the effect size. This statistic provides an indication of the strength of the treatment effect regardless of the statistical significance. Cohen's *d* statistic is interpreted as follows:
 - .2 = small effect
 - .5 = medium effect
 - .8 = large effect

Results for Each Module

Each of the three research questions are analyzed for each module:

1. *Do students enrolled in the **Florida Virtual School Geometry** program increase their knowledge and skills in Geometry?*
2. *Do students enrolled in basic or honors courses achieve similar gains in the **Florida Virtual School Geometry** program?*
3. *Do students with differing demographic characteristics (gender, socio-economic status, and ethnicity) achieve similar gains when enrolled in the **Florida Virtual School Geometry** program?*

Module 1

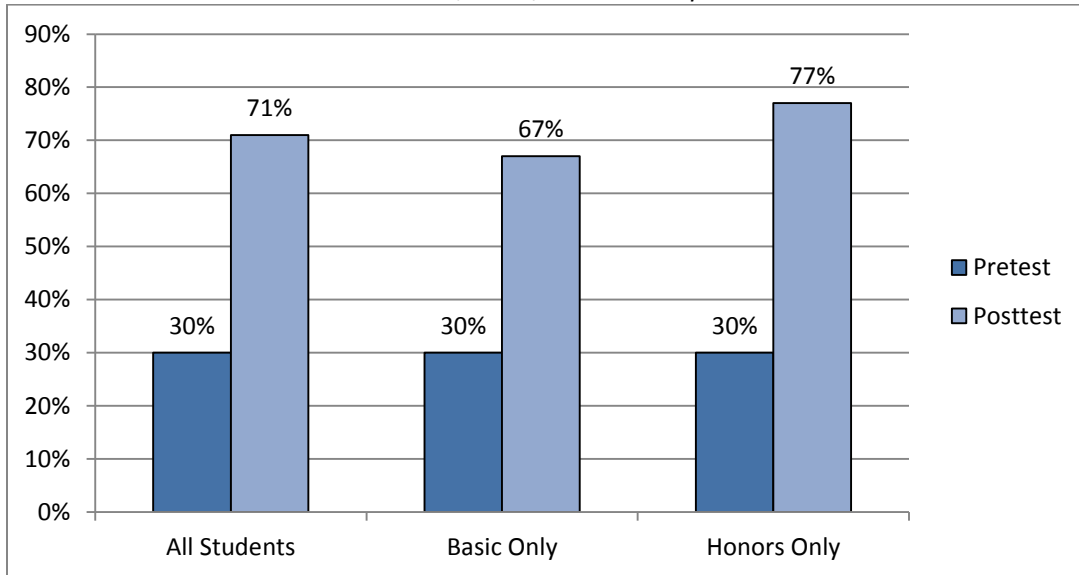
Module 1 is designed to be an introduction to geometry. Students learn basic constructions, definitions, and the overall understanding of how geometry varies from previous math courses. They are also introduced to how algebra can be used in geometry. Table 6 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$), and the effect sizes were all large. The honors students scored higher than the basic students. In addition, the free/reduced lunch students made larger gains than the ineligible for free/reduced lunch students. Other than those differences, there was little difference between the various demographic groups.

Table 6: Comparison of Pretest to Posttest Percent Correct Scores
Geometry Instructional Module 1

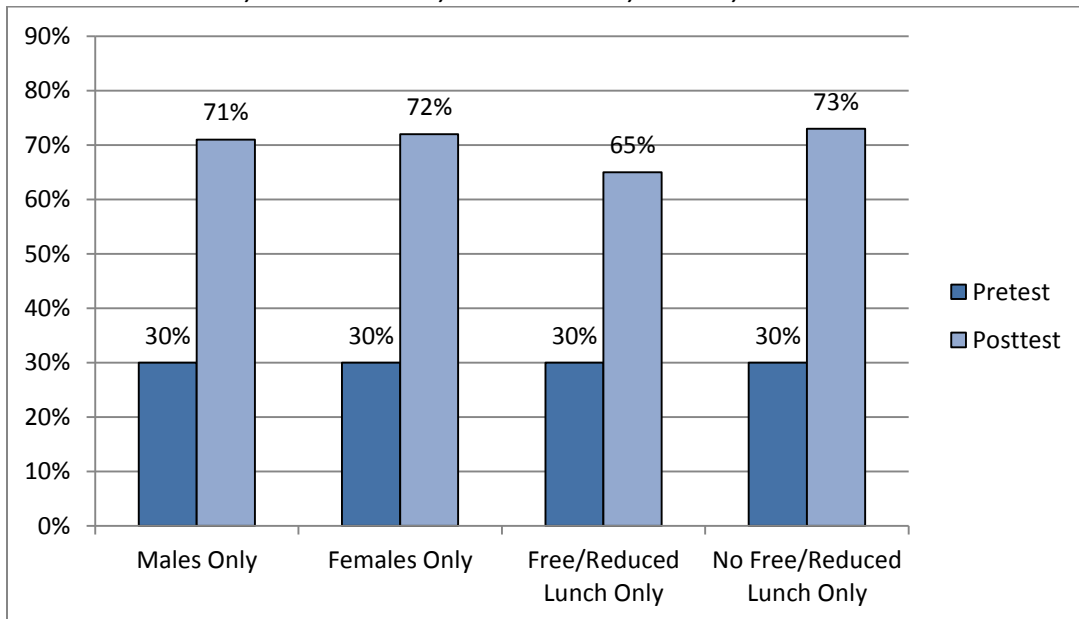
Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
<i>Pretest</i>	3817	30%	.12	116.278	$\leq .0001$	2.68
<i>Posttest</i>	3817	71%	.18			
<i>Basic Only</i>						
<i>Pretest</i>	2322	30%	.12	80.320	$\leq .0001$	2.42
<i>Posttest</i>	2322	67%	.18			
<i>Honors Only</i>						
<i>Pretest</i>	1495	30%	.12	93.285	$\leq .0001$	3.07
<i>Posttest</i>	1495	77%	.16			
<i>Males Only</i>						
<i>Pretest</i>	1723	30%	.12	78.807	$\leq .0001$	2.68
<i>Posttest</i>	1723	71%	.18			
<i>Females Only</i>						
<i>Pretest</i>	2094	30%	.12	85.494	$\leq .0001$	2.68
<i>Posttest</i>	2094	72%	.18			
<i>Free/Reduced Lunch Only</i>						
<i>Pretest</i>	937	30%	.12	48.236	$\leq .0001$	2.20
<i>Posttest</i>	937	65%	.19			
<i>No Free/Reduced Lunch Only</i>						
<i>Pretest</i>	2880	30%	.12	108.146	$\leq .0001$	2.92
<i>Posttest</i>	2880	73%	.17			
<i>Non-Minority Only</i>						
<i>Pretest</i>	1973	30%	.12	90.474	$\leq .0001$	2.85
<i>Posttest</i>	1973	72%	.17			
<i>Minority Only</i>						
<i>Pretest</i>	803	30%	.13	46.146	$\leq .0001$	2.33
<i>Posttest</i>	803	68%	.19			
<i>Multi-Ethnic</i>						
<i>Pretest</i>	1041	30%	.12	59.397	$\leq .0001$	2.61
<i>Posttest</i>	1041	70%	.18			

Figures 1, 2, and 3 provide a visual look at the increases. In general, the percentage increases were about 41% for each comparison group.

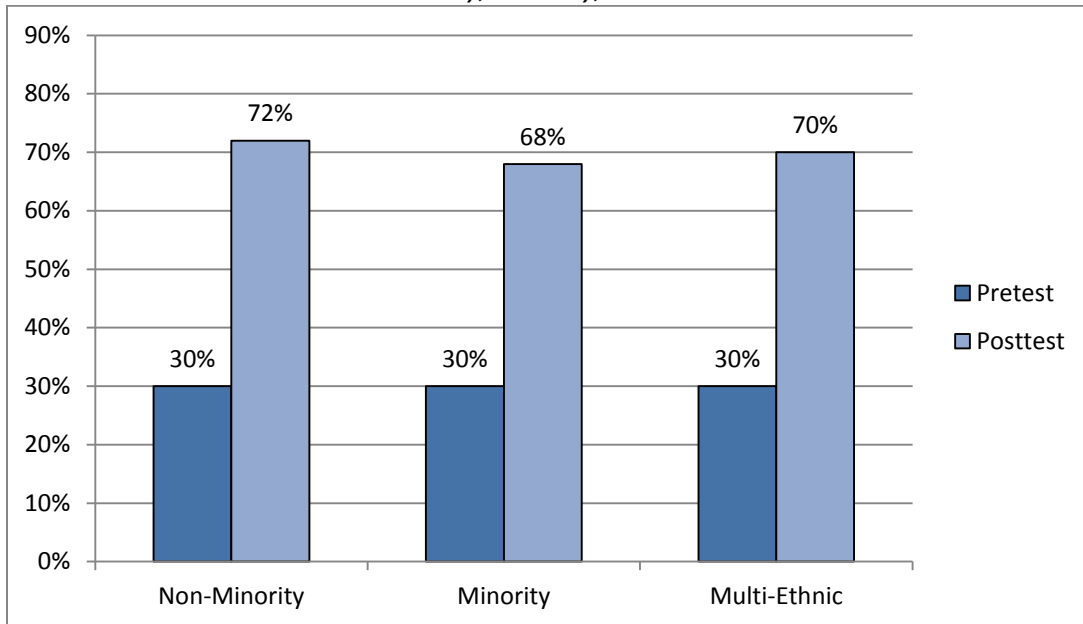
*Figure 1: Geometry Module 1
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



*Figure 2: Geometry Module 1
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*



*Figure 3: Geometry Module 1
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority, & Multi-Ethnic*



Module 2

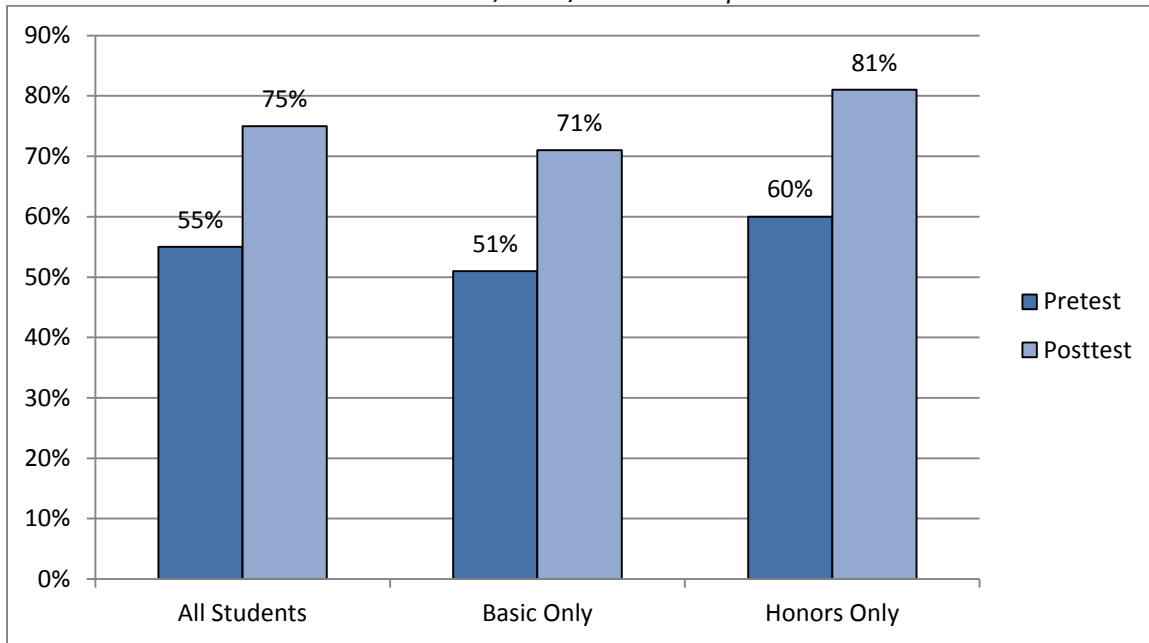
This module introduces students to the first basic 2D figure in geometry – the triangle. Table 7 shows that the increases from pretesting to posttesting were statistically significant ($\leq .0001$), and the effect sizes were large. The honors students scored higher than the basic students, and the ineligible for free/reduced lunch group made greater gains than the free/reduced lunch group. Other than those differences, there was little difference between the various demographic groups.

*Table 7: Comparison of Pretest to Posttest Percent Correct Scores
Geometry Instructional Module 2*

Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
All Students						
Pretest	2737	55%	.20	47.091	$\leq .0001$	1.03
Posttest	2737	75%	.19			
Basic Only						
Pretest	1587	51%	.20	32.786	$\leq .0001$	1.03
Posttest	1587	71%	.19			
Honors Only						
Pretest	1150	60%	.18	34.795	$\leq .0001$	1.17
Posttest	1150	81%	.16			
Males Only						
Pretest	1254	55%	.20	32.557	$\leq .0001$	1.08
Posttest	1254	76%	.19			
Females Only						
Pretest	1483	55%	.19	34.050	$\leq .0001$	1.00
Posttest	1483	74%	.19			
Free/Reduced Lunch Only						
Pretest	662	53%	.19	18.151	$\leq .0001$.85
Posttest	662	70%	.21			
No Free/Reduced Lunch Only						
Pretest	2075	55%	.20	44.226	$\leq .0001$	1.16
Posttest	2075	77%	.18			
Non-Minority Only						
Pretest	1413	55%	.20	39.590	$\leq .0001$	1.08
Posttest	1413	76%	.19			
Minority Only						
Pretest	594	55%	.21	19.350	$\leq .0001$.95
Posttest	594	74%	.19			
Multi-Ethnic						
Pretest	730	54%	.20	24.403	$\leq .0001$.97
Posttest	730	74%	.19			

Figures 4, 5, and 6 provide a visual look at the increases. In general, the percentage increases were about 20% for each comparison group.

*Figure 4: Geometry Module 2
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



*Figure 5: Geometry Module 2
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*

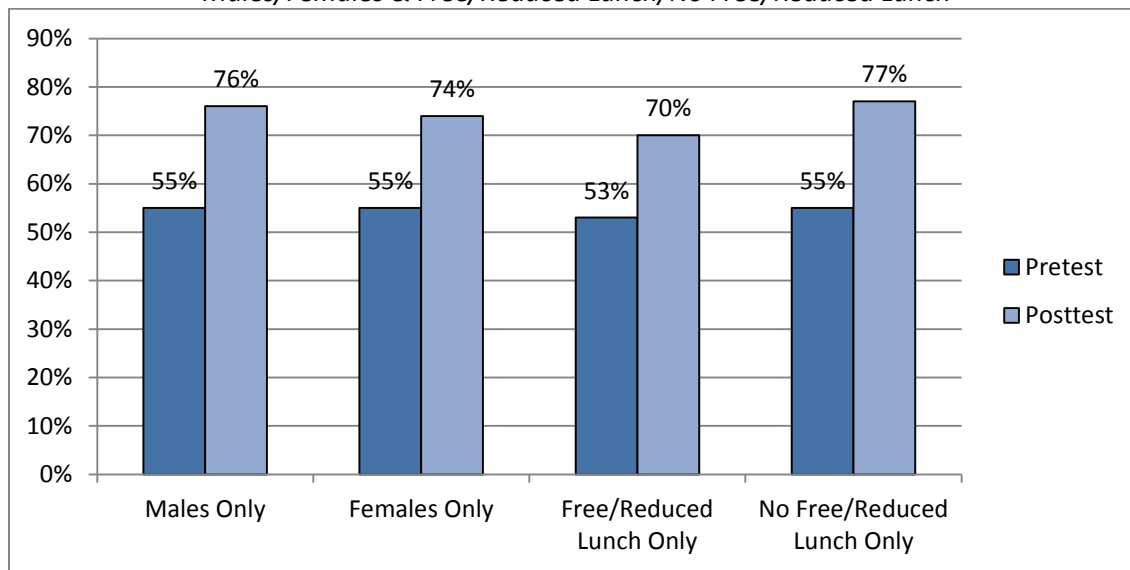
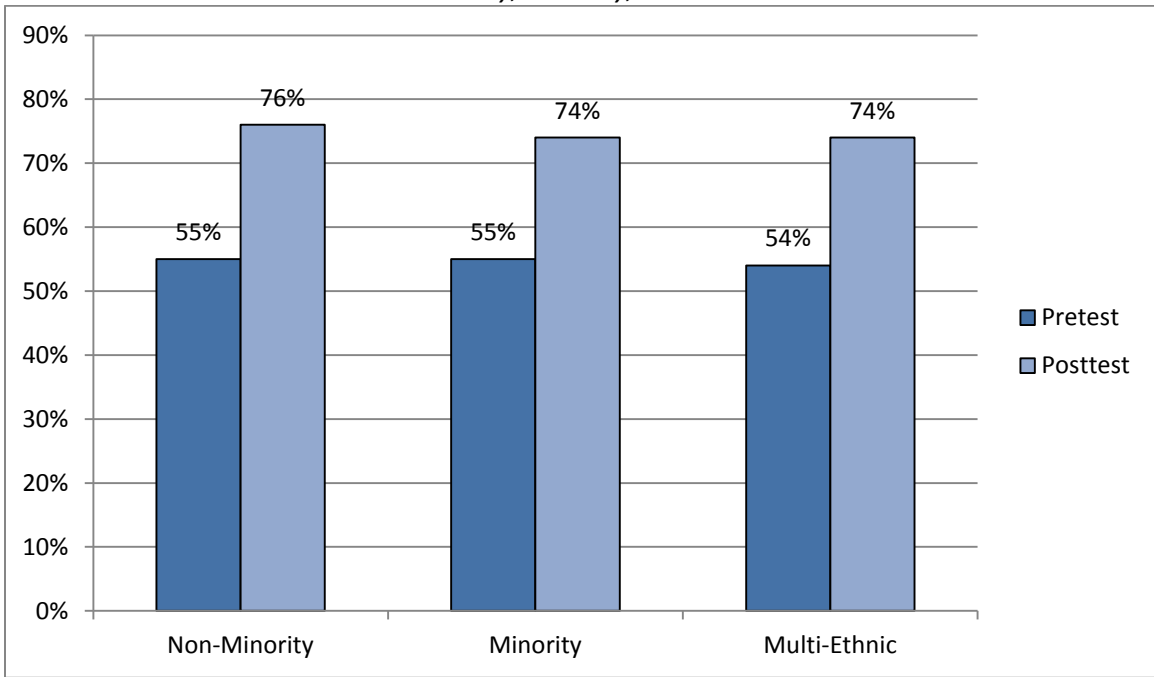


Figure 6: Geometry Module 2
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority, & Multi-Ethnic



Module 3

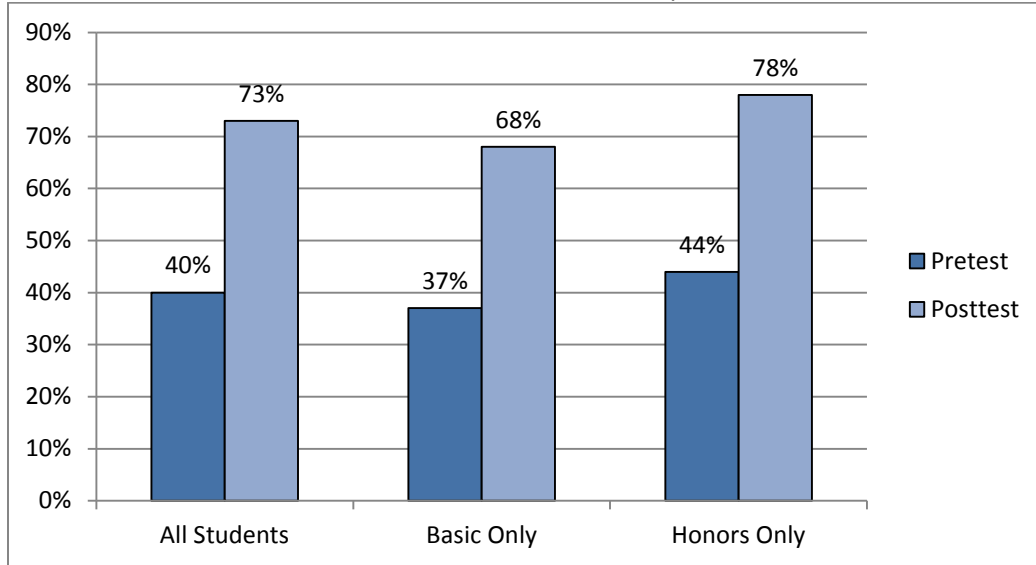
Module 3 covers the relationships between two triangles: triangle inequalities, congruency, and similarity. Table 8 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$), and the effect sizes were all large. The honors students scored higher than the basic students, and the ineligible for free/reduced lunch group made larger gains than the free/reduced lunch group. Other than those differences, it appears there was little difference between the various demographic groups.

*Table 8: Comparison of Pretest to Posttest Percent Correct Scores
Geometry Instructional Module 3*

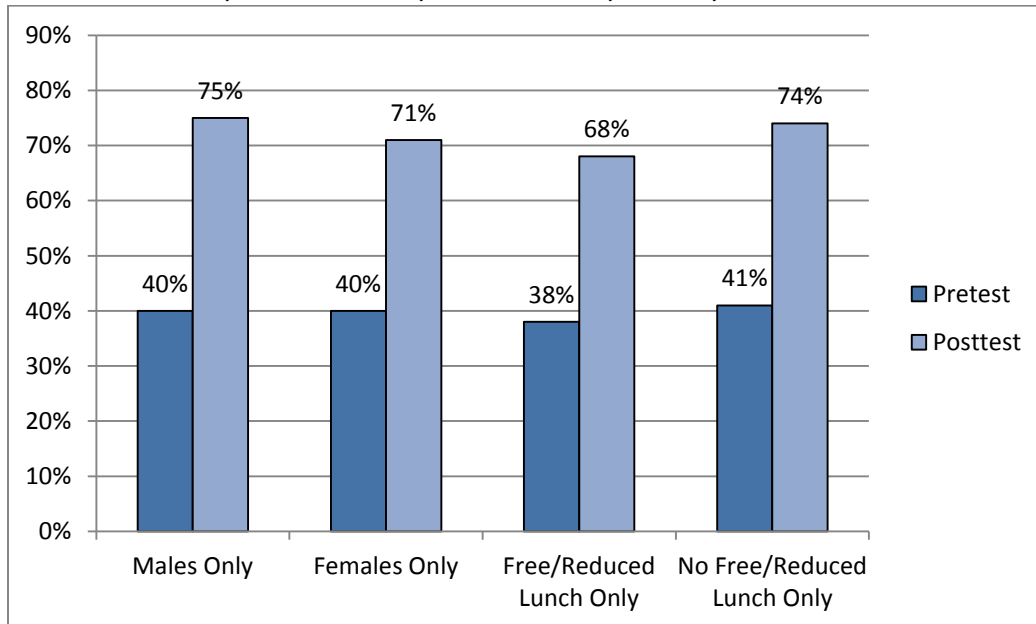
Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
Pretest	2217	40%	.17	73.958	$\leq .0001$	1.83
Posttest	2217	73%	.19			
<i>Basic Only</i>						
Pretest	1170	37%	.17	49.044	$\leq .0001$	1.67
Posttest	1170	68%	.20			
<i>Honors Only</i>						
Pretest	1047	44%	.17	56.775	$\leq .0001$	2.00
Posttest	1047	78%	.17			
<i>Males Only</i>						
Pretest	1029	40%	.18	52.041	$\leq .0001$	1.89
Posttest	1029	75%	.19			
<i>Females Only</i>						
Pretest	1188	40%	.17	52.798	$\leq .0001$	1.72
Posttest	1188	71%	.19			
<i>Free/Reduced Lunch Only</i>						
Pretest	520	38%	.17	34.293	$\leq .0001$	1.62
Posttest	520	68%	.20			
<i>No Free/Reduced Lunch Only</i>						
Pretest	1697	41%	.17	65.796	$\leq .0001$	1.83
Posttest	1697	74%	.19			
<i>Non-Minority Only</i>						
Pretest	1124	40%	.17	53.820	$\leq .0001$	1.89
Posttest	1124	74%	.19			
<i>Minority Only</i>						
Pretest	489	40%	.18	34.303	$\leq .0001$	1.73
Posttest	489	73%	.20			
<i>Multi-Ethnic</i>						
Pretest	604	39%	.17	37.441	$\leq .0001$	1.72
Posttest	604	71%	.20			

Figures 7, 8, and 9 provide a visual look at the increases. In general, the percentage increases were about 33% for each comparison group.

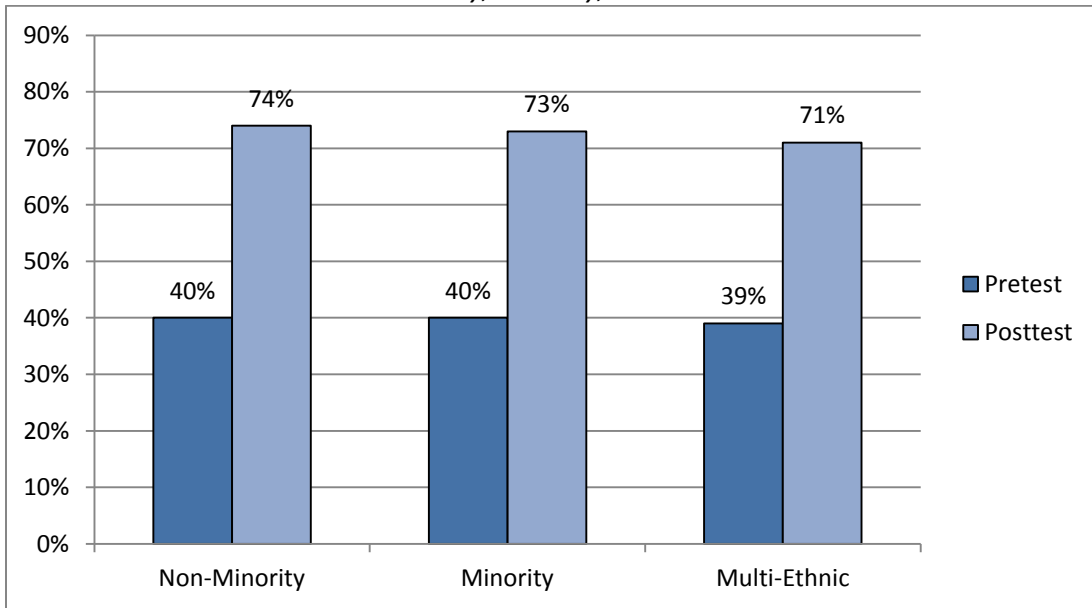
*Figure 7: Geometry Module 3
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



*Figure 8: Geometry Module 3
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*



*Figure 9: Geometry Module 3
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority, & Multi-Ethnic*



Module 4

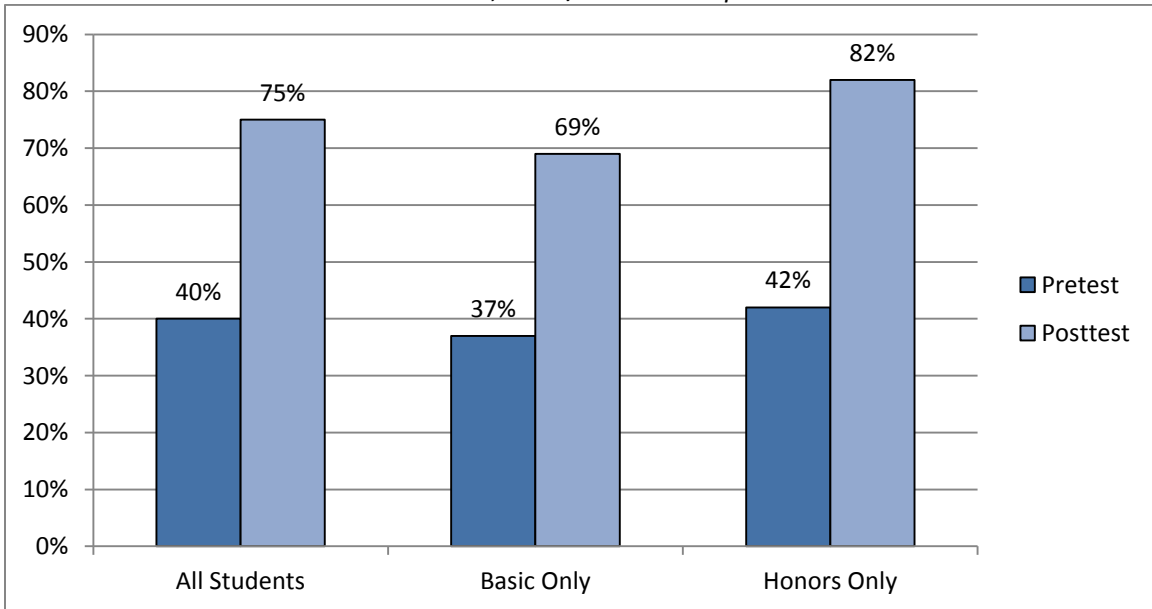
Module 4 focuses solely on right triangles, including the Pythagorean Theorem, trigonometric ratios, and special right triangles. Table 9 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$), and the effect sizes were all large. The honors students scored higher than the basic students, and the ineligible for free/reduced lunch group made larger gains than the free/reduced lunch group. Other than those differences the descriptive data shows little difference between the various demographic groups.

Table 9: Comparison of Pretest to Posttest Percent Correct Scores
Geometry Instructional Module 4

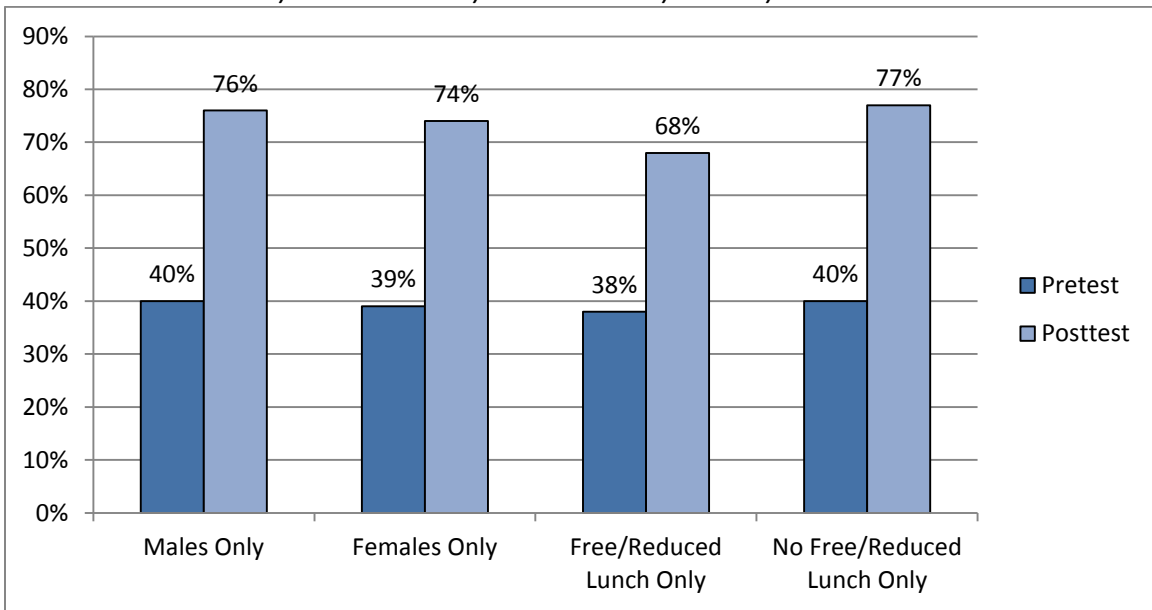
Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
<i>Pretest</i>	1673	40%	.21	56.842	$\leq .0001$	1.67
<i>Posttest</i>	1673	75%	.21			
<i>Basic Only</i>						
<i>Pretest</i>	949	37%	.21	37.355	$\leq .0001$	1.49
<i>Posttest</i>	949	69%	.22			
<i>Honors Only</i>						
<i>Pretest</i>	724	42%	.21	45.631	$\leq .0001$	2.09
<i>Posttest</i>	724	82%	.17			
<i>Males Only</i>						
<i>Pretest</i>	782	40%	.22	38.034	$\leq .0001$	1.64
<i>Posttest</i>	782	76%	.22			
<i>Females Only</i>						
<i>Pretest</i>	891	39%	.20	42.295	$\leq .0001$	1.71
<i>Posttest</i>	891	74%	.21			
<i>Free/Reduced Lunch Only</i>						
<i>Pretest</i>	370	38%	.20	24.731	$\leq .0001$	1.43
<i>Posttest</i>	370	68%	.22			
<i>No Free/Reduced Lunch Only</i>						
<i>Pretest</i>	1303	40%	.21	51.541	$\leq .0001$	1.76
<i>Posttest</i>	1303	77%	.21			
<i>Non-Minority Only</i>						
<i>Pretest</i>	864	39%	.20	45.191	$\leq .0001$	1.85
<i>Posttest</i>	864	77%	.21			
<i>Minority Only</i>						
<i>Pretest</i>	378	41%	.21	24.320	$\leq .0001$	1.39
<i>Posttest</i>	378	71%	.22			
<i>Multi-Ethnic</i>						
<i>Pretest</i>	431	39%	.23	26.283	$\leq .0001$	1.56
<i>Posttest</i>	431	74%	.22			

Figures 10, 11, and 12 provide a visual look at the increases. In general, the percentage increases were about 35% for each comparison group.

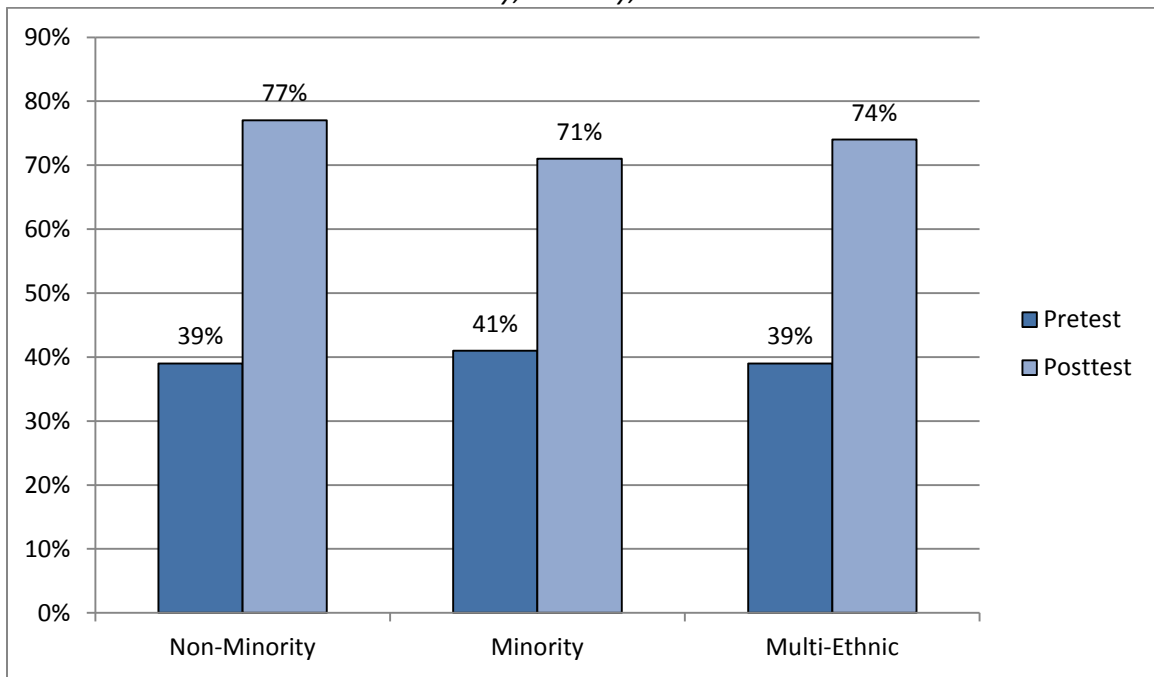
*Figure 10: Geometry Module 4
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



*Figure 11: Geometry Module 4
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*



*Figure 12: Geometry Module 4
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority, & Multi-Ethnic*



Module 5

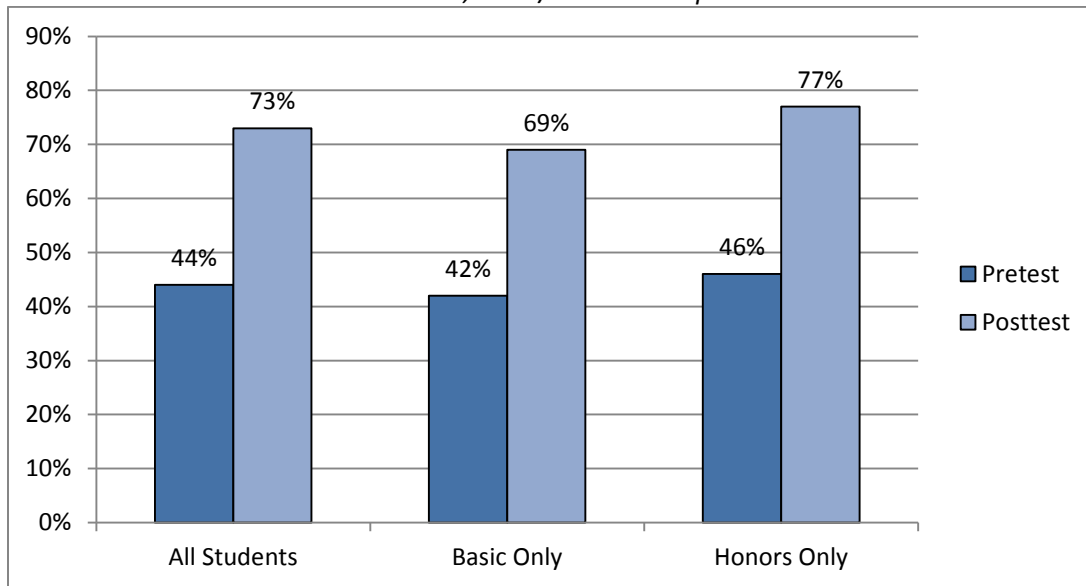
This module covers the second 2D figure – the quadrilateral. Table 10 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$), and the effect sizes were all large. The honors students scored higher than the basic students, and there was little difference between the various demographic groups.

Table 10: Comparison of Pretest to Posttest Percent Correct Scores
Geometry Instructional Module 5

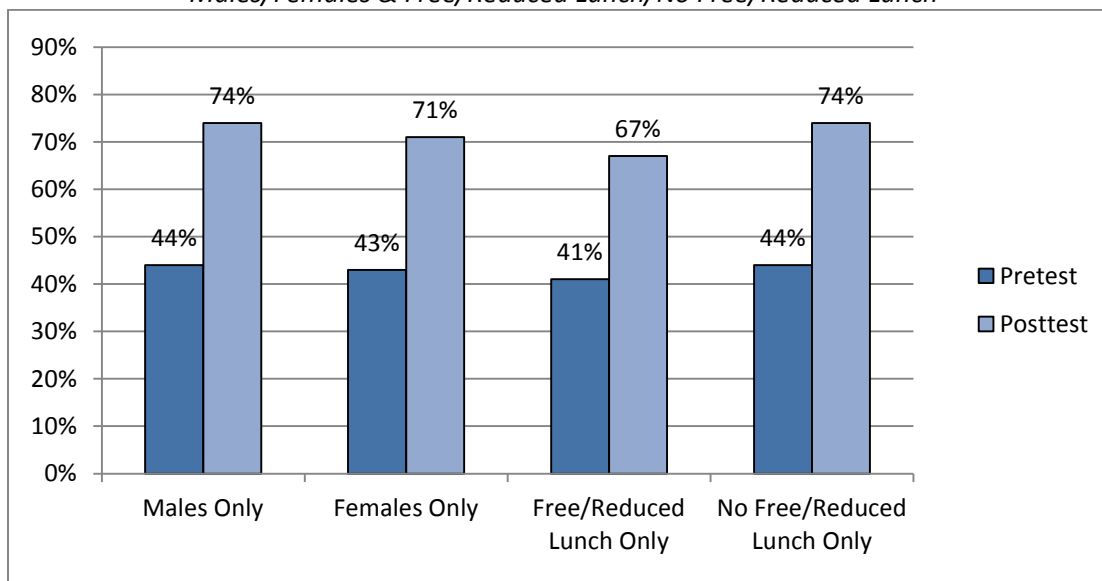
Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
<i>Pretest</i>	1363	44%	.22	41.357	$\leq .0001$	1.38
<i>Posttest</i>	1363	73%	.20			
<i>Basic Only</i>						
<i>Pretest</i>	731	42%	.23	27.242	$\leq .0001$	1.23
<i>Posttest</i>	731	69%	.21			
<i>Honors Only</i>						
<i>Pretest</i>	632	46%	.21	32.078	$\leq .0001$	1.48
<i>Posttest</i>	632	77%	.17			
<i>Males Only</i>						
<i>Pretest</i>	644	44%	.23	28.473	$\leq .0001$	1.42
<i>Posttest</i>	644	74%	.19			
<i>Females Only</i>						
<i>Pretest</i>	719	43%	.22	30.003	$\leq .0001$	1.33
<i>Posttest</i>	719	71%	.20			
<i>Free/Reduced Lunch Only</i>						
<i>Pretest</i>	296	41%	.21	17.040	$\leq .0001$	1.27
<i>Posttest</i>	296	67%	.20			
<i>No Free/Reduced Lunch Only</i>						
<i>Pretest</i>	1067	44%	.23	37.870	$\leq .0001$	1.39
<i>Posttest</i>	1067	74%	.19			
<i>Non-Minority Only</i>						
<i>Pretest</i>	695	43%	.22	32.565	$\leq .0001$	1.50
<i>Posttest</i>	695	73%	.19			
<i>Minority Only</i>						
<i>Pretest</i>	296	45%	.23	16.939	$\leq .0001$	1.18
<i>Posttest</i>	296	71%	.21			
<i>Multi-Ethnic</i>						
<i>Pretest</i>	372	43%	.23	20.124	$\leq .0001$	1.37
<i>Posttest</i>	372	72%	.19			

Figures 13, 14, and 15 provide a visual look at the increases. In general, the percentage increases were about 29% for each comparison group.

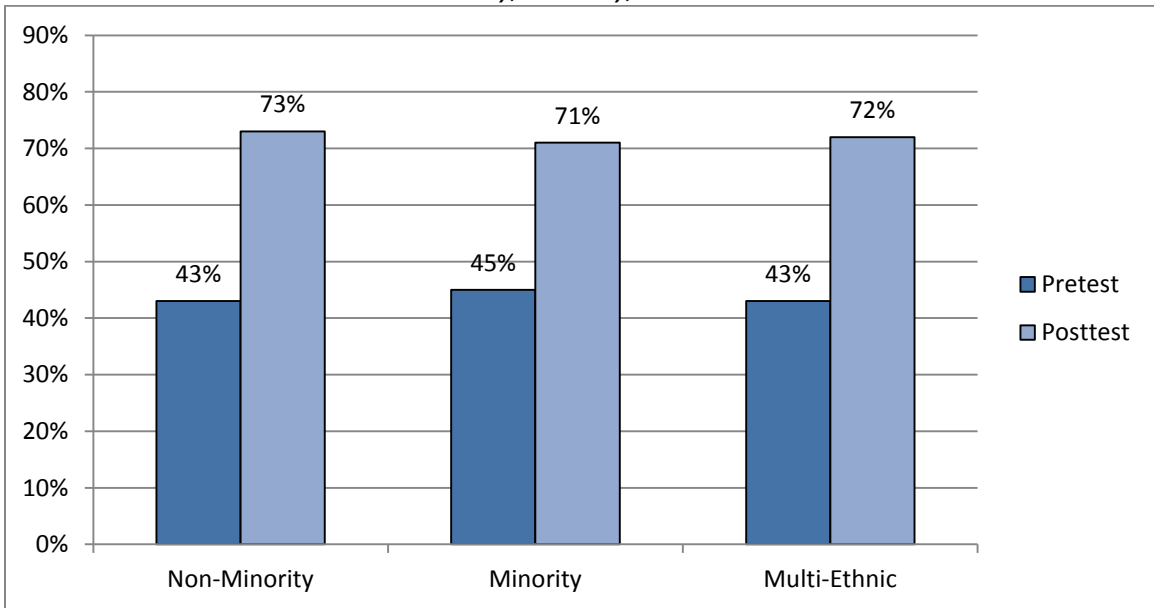
*Figure 13: Geometry Module 5
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



*Figure 14: Geometry Module 5
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*



*Figure 15: Geometry Module 5
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority, & Multi-Ethnic*



Module 6

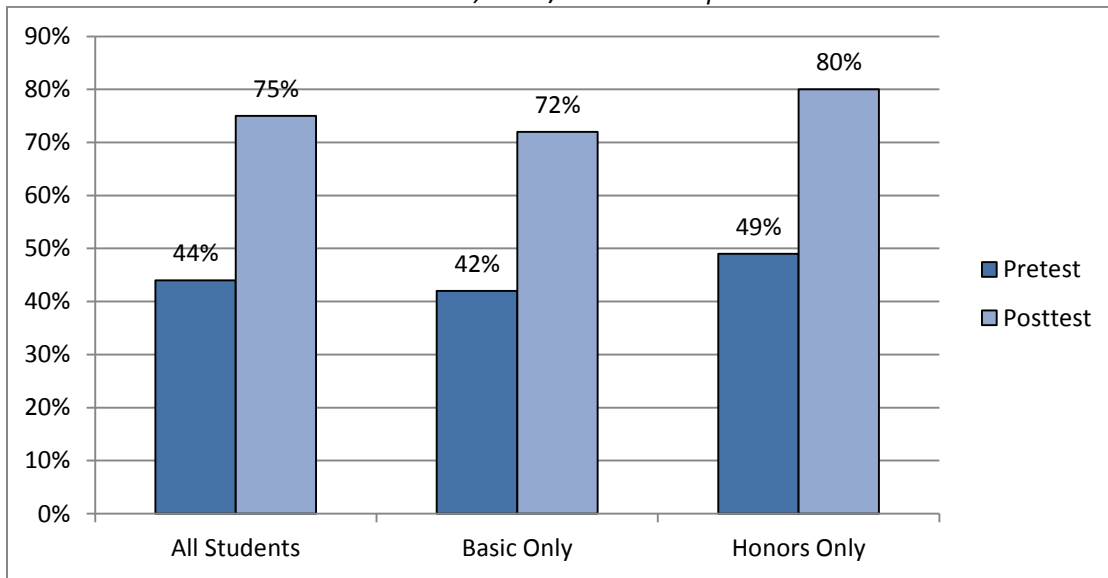
This module covers the effects of transformations on figures, the basics of polygons, and the application of transformations and translations to figures on and off the coordinate plane, including tessellations. Table 11 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$), and the effect sizes were all large. The honors students scored higher than the basic students, and it appears there was little difference between the various demographic groups.

Table 11: Comparison of Pretest to Posttest Percent Correct Scores
Geometry Instructional Module 6

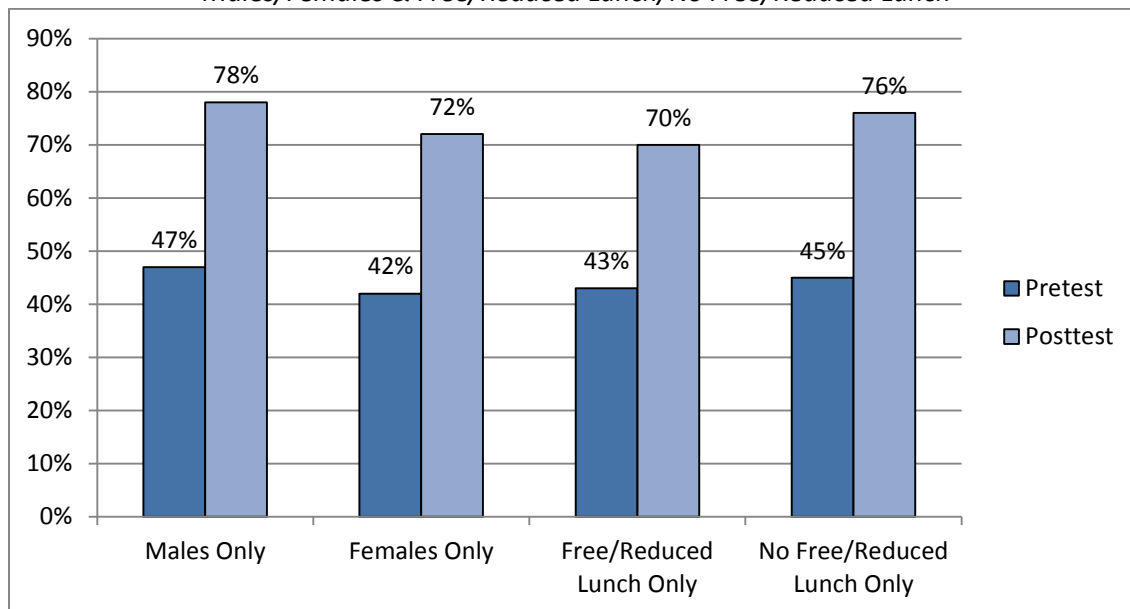
Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
<i>Pretest</i>	2239	44%	.19	67.406	$\leq .0001$	1.72
<i>Posttest</i>	2239	75%	.17			
<i>Basic Only</i>						
<i>Pretest</i>	1401	42%	.19	50.800	$\leq .0001$	1.66
<i>Posttest</i>	1401	72%	.17			
<i>Honors Only</i>						
<i>Pretest</i>	838	49%	.19	45.092	$\leq .0001$	1.81
<i>Posttest</i>	838	80%	.15			
<i>Males Only</i>						
<i>Pretest</i>	1034	47%	.20	44.885	$\leq .0001$	1.66
<i>Posttest</i>	1034	78%	.16			
<i>Females Only</i>						
<i>Pretest</i>	1205	42%	.19	50.416	$\leq .0001$	1.55
<i>Posttest</i>	1205	72%	.17			
<i>Free/Reduced Lunch Only</i>						
<i>Pretest</i>	523	43%	.18	31.607	$\leq .0001$	1.54
<i>Posttest</i>	523	70%	.17			
<i>No Free/Reduced Lunch Only</i>						
<i>Pretest</i>	1716	45%	.20	59.706	$\leq .0001$	1.67
<i>Posttest</i>	1716	76%	.17			
<i>Non-Minority Only</i>						
<i>Pretest</i>	1230	45%	.20	51.672	$\leq .0001$	1.67
<i>Posttest</i>	1230	76%	.17			
<i>Minority Only</i>						
<i>Pretest</i>	383	43%	.19	25.827	$\leq .0001$	1.51
<i>Posttest</i>	383	71%	.18			
<i>Multi-Ethnic</i>						
<i>Pretest</i>	626	45%	.19	35.020	$\leq .0001$	1.61
<i>Posttest</i>	626	74%	.17			

Figures 16, 17, and 18 provide a visual look the increases. In general, the percentage increases were about 30% for each comparison group.

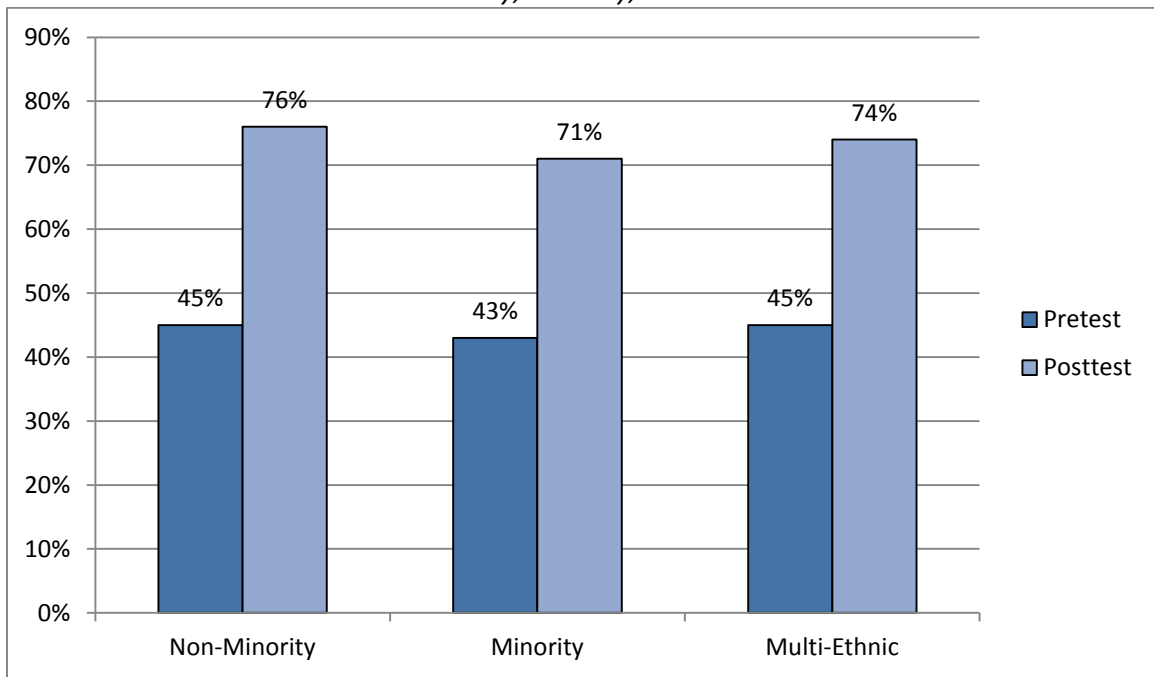
*Figure 16: Geometry Module 6
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



*Figure 17: Geometry Module 6
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*



*Figure 18: Geometry Module 6
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority, & Multi-Ethnic*



Module 7

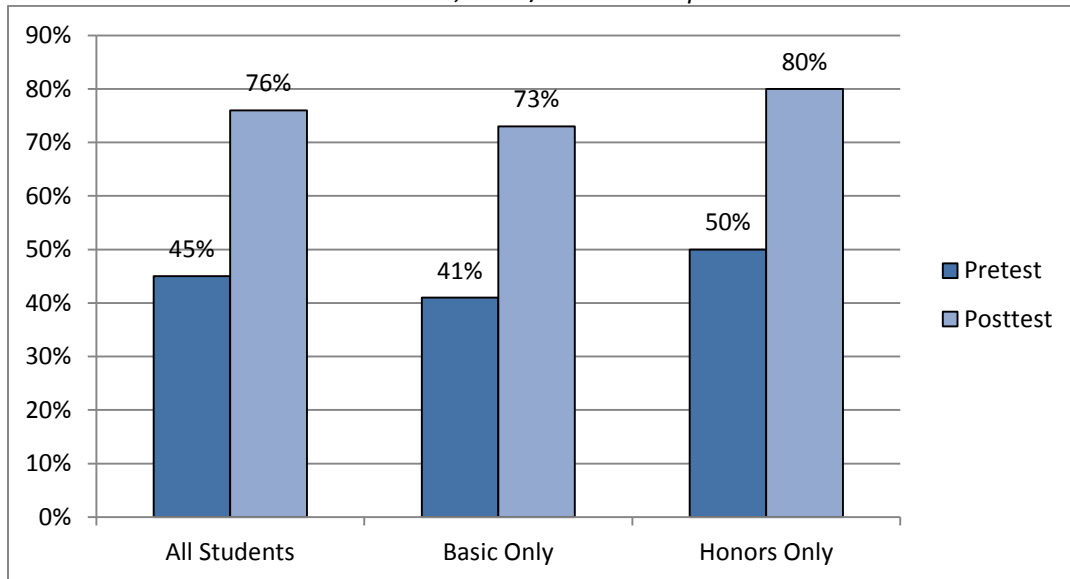
Module 7 begins with the area and perimeter of 2D figures and then works into volume and surface area of 3D figures in non-circle based figures. Table 12 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$), and the effect sizes were all large. The honors students scored higher than the basic students. The ineligible for free/reduced lunch group made larger gains than the free/reduced lunch group, and it appears there was little difference between the various demographic groups.

Table 12: Comparison of Pretest to Posttest Percent Correct Scores
Geometry Instructional Module 7

Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
<i>Pretest</i>	1540	45%	.22	52.049	$\leq .0001$	1.54
<i>Posttest</i>	1540	76%	.18			
<i>Basic Only</i>						
<i>Pretest</i>	929	41%	.21	39.148	$\leq .0001$	1.60
<i>Posttest</i>	929	73%	.19			
<i>Honors Only</i>						
<i>Pretest</i>	611	50%	.21	34.700	$\leq .0001$	1.61
<i>Posttest</i>	611	80%	.16			
<i>Males Only</i>						
<i>Pretest</i>	699	47%	.23	34.877	$\leq .0001$	1.53
<i>Posttest</i>	699	78%	.17			
<i>Females Only</i>						
<i>Pretest</i>	841	43%	.20	38.645	$\leq .0001$	1.54
<i>Posttest</i>	841	73%	.19			
<i>Free/Reduced Lunch Only</i>						
<i>Pretest</i>	351	44%	.21	22.872	$\leq .0001$	1.43
<i>Posttest</i>	351	72%	.18			
<i>No Free/Reduced Lunch Only</i>						
<i>Pretest</i>	1189	45%	.22	46.901	$\leq .0001$	1.59
<i>Posttest</i>	1189	77%	.18			
<i>Non-Minority Only</i>						
<i>Pretest</i>	875	46%	.22	39.211	$\leq .0001$	1.49
<i>Posttest</i>	875	76%	.18			
<i>Minority Only</i>						
<i>Pretest</i>	248	41%	.22	20.751	$\leq .0001$	1.52
<i>Posttest</i>	248	73%	.20			
<i>Multi-Ethnic</i>						
<i>Pretest</i>	417	46%	.21	27.232	$\leq .0001$	1.57
<i>Posttest</i>	417	76%	.17			

Figures 19, 20, and 21 provide a visual look at the increases. In general, the percentage increases were about 31% for each comparison group.

*Figure 19: Geometry Module 7
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



*Figure 20: Geometry Module 7
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*

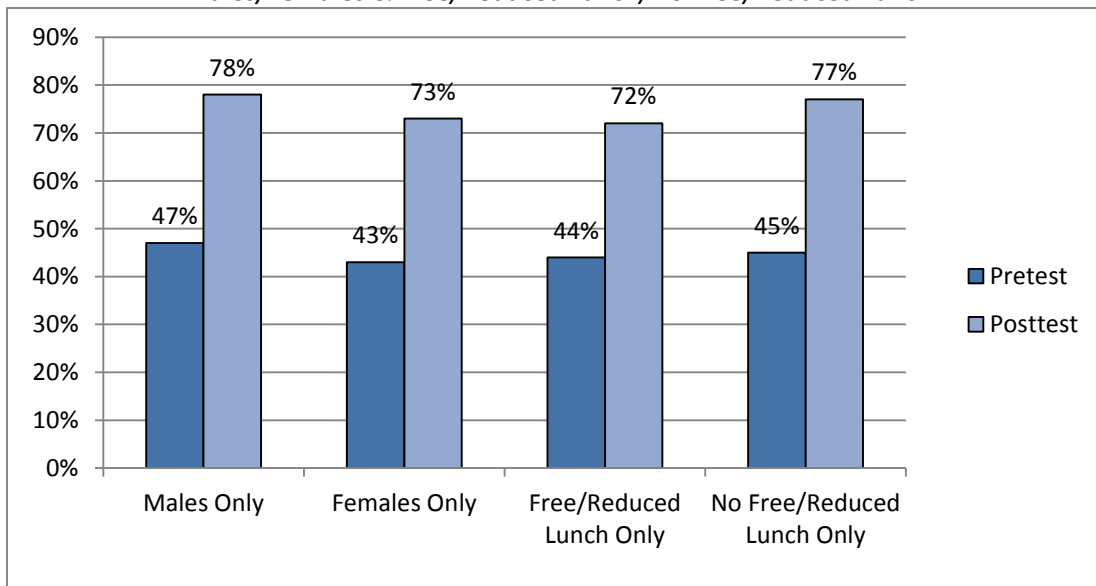
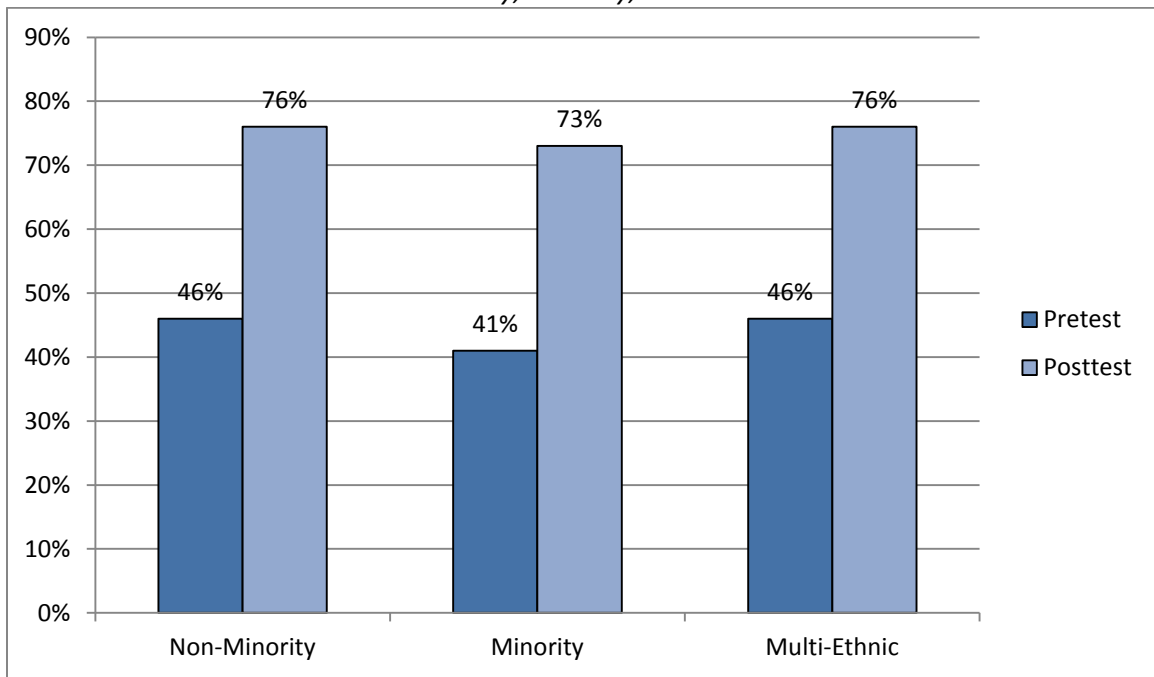


Figure 21: Geometry Module 7
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority, & Multi-Ethnic



Module 8

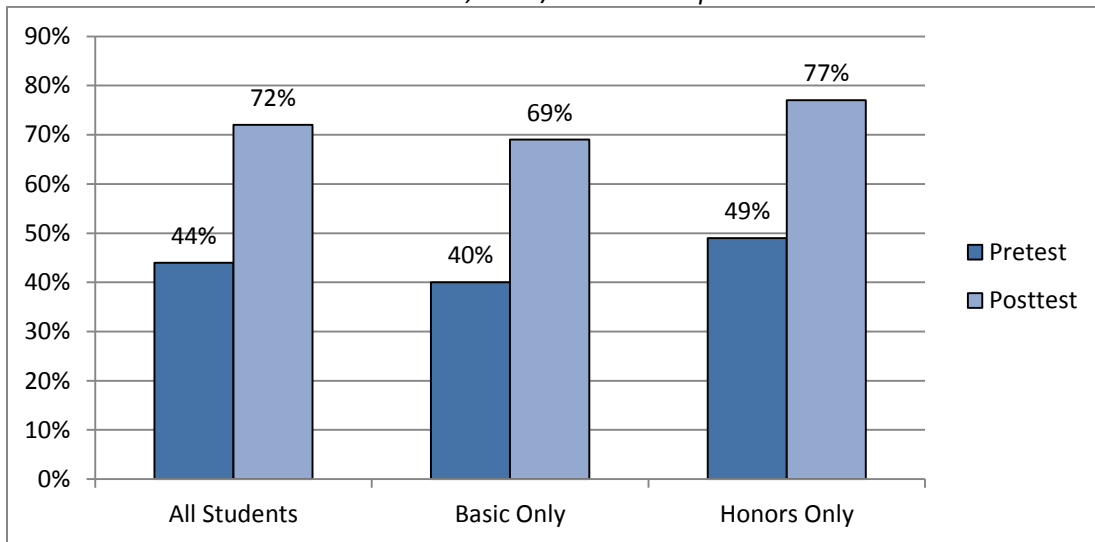
The module focuses entirely on circles: the parts of a circle, the equation, and the 3D figures with circular bases and how they compare to polyhedra. Table 13 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$), and the effect sizes were all large. The honors students scored higher than the basic students, and the ineligible for free/reduced lunch group made larger gains than the free/reduced lunch group. Other than those differences there was little difference between the various demographic groups.

Table 13: Comparison of Pretest to Posttest Percent Correct Scores
Geometry Instructional Module 8

Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
<i>Pretest</i>	1212	44%	.22	39.792	$\leq .0001$	1.42
<i>Posttest</i>	1212	72%	.18			
<i>Basic Only</i>						
<i>Pretest</i>	745	40%	.22	30.434	$\leq .0001$	1.44
<i>Posttest</i>	745	69%	.18			
<i>Honors Only</i>						
<i>Pretest</i>	467	49%	.22	25.767	$\leq .0001$	1.46
<i>Posttest</i>	467	77%	.16			
<i>Males Only</i>						
<i>Pretest</i>	563	45%	.24	26.951	$\leq .0001$	1.39
<i>Posttest</i>	563	74%	.17			
<i>Females Only</i>						
<i>Pretest</i>	649	43%	.20	29.371	$\leq .0001$	1.42
<i>Posttest</i>	649	70%	.18			
<i>Free/Reduced Lunch Only</i>						
<i>Pretest</i>	279	45%	.21	15.694	$\leq .0001$	1.15
<i>Posttest</i>	279	67%	.17			
<i>No Free/Reduced Lunch Only</i>						
<i>Pretest</i>	933	43%	.22	37.129	$\leq .0001$	1.54
<i>Posttest</i>	933	74%	.18			
<i>Non-Minority Only</i>						
<i>Pretest</i>	681	44%	.22	30.324	$\leq .0001$	1.44
<i>Posttest</i>	681	73%	.18			
<i>Minority Only</i>						
<i>Pretest</i>	204	43%	.23	14.561	$\leq .0001$	1.31
<i>Posttest</i>	204	70%	.18			
<i>Multi-Ethnic</i>						
<i>Pretest</i>	327	43%	.21	21.465	$\leq .0001$	1.55
<i>Posttest</i>	327	72%	.16			

Figures 22, 23, and 24 provide a visual look at the increases. In general, the percentage increases were about 28% for each comparison group.

*Figure 22: Geometry Module 8
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



*Figure 23: Geometry Module 8
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*

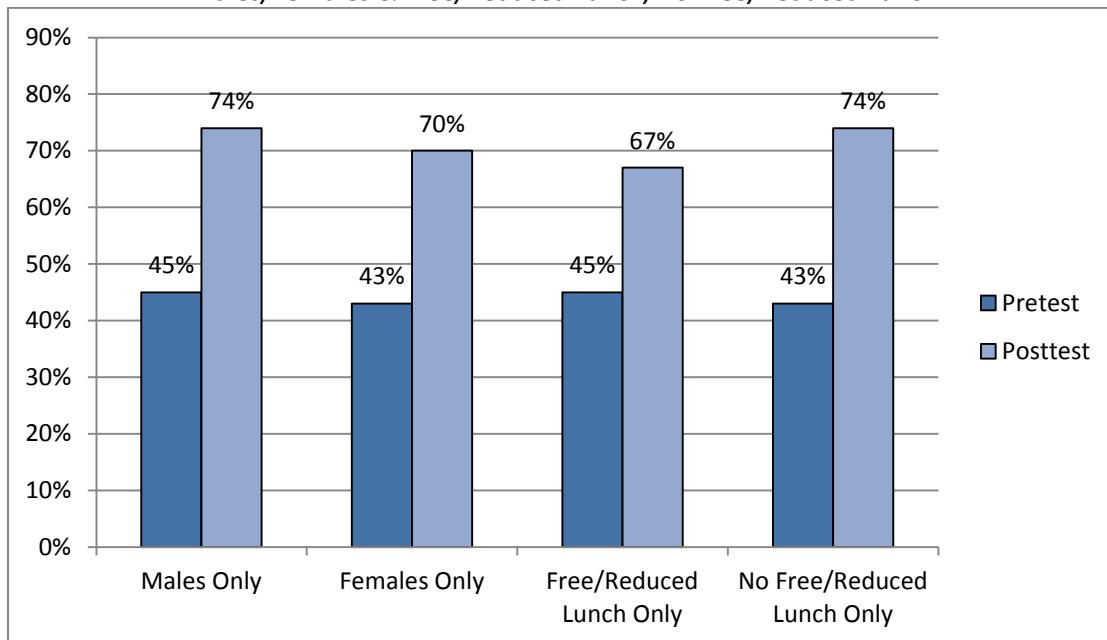
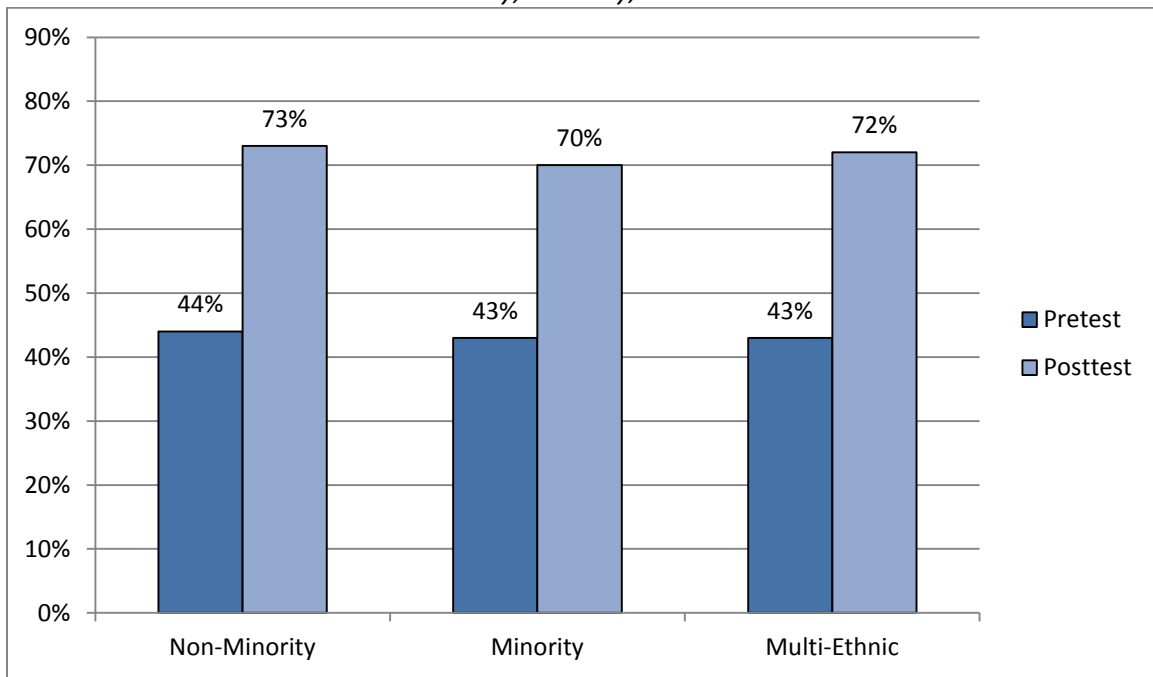


Figure 24: Geometry Module 8
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority, & Multi-Ethnic



Module 9

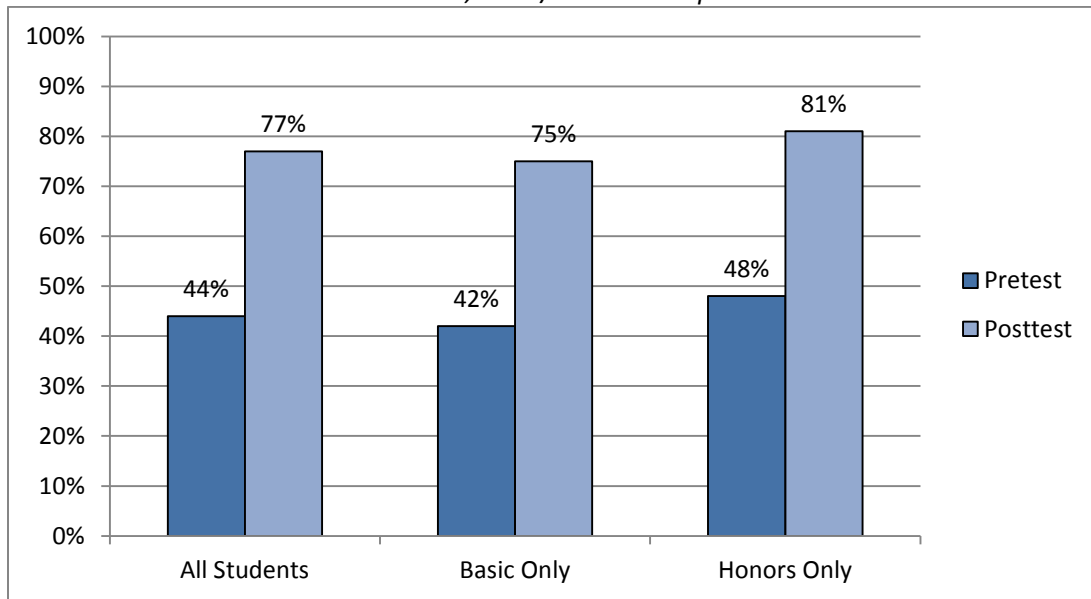
This module focuses on the reasoning aspect of proofs and the logical thinking involved. In addition, this module covers algebraic properties and the geometric aspect of proofs: parallel line proofs. Table 14 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$), and the effect sizes were all large. The honors students scored higher than the basic students, and the ineligible for free/reduced lunch group made larger gains than the free/reduced lunch group. There was little difference between the other various demographic groups.

*Table 14: Comparison of Pretest to Posttest Percent Correct Scores
Geometry Instructional Module 9*

Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
<i>Pretest</i>	1026	44%	.24	37.889	$\leq .0001$	1.59
<i>Posttest</i>	1026	77%	.17			
<i>Basic Only</i>						
<i>Pretest</i>	648	42%	.24	29.885	$\leq .0001$	1.59
<i>Posttest</i>	648	75%	.17			
<i>Honors Only</i>						
<i>Pretest</i>	378	48%	.24	23.268	$\leq .0001$	1.62
<i>Posttest</i>	378	81%	.16			
<i>Males Only</i>						
<i>Pretest</i>	454	44%	.25	27.096	$\leq .0001$	1.62
<i>Posttest</i>	454	78%	.16			
<i>Females Only</i>						
<i>Pretest</i>	572	44%	.23	26.730	$\leq .0001$	1.55
<i>Posttest</i>	572	76%	.18			
<i>Free/Reduced Lunch Only</i>						
<i>Pretest</i>	249	43%	.23	16.529	$\leq .0001$	1.36
<i>Posttest</i>	249	71%	.18			
<i>Ineligible for free/reduced Lunch Only</i>						
<i>Pretest</i>	777	45%	.24	34.354	$\leq .0001$	1.63
<i>Posttest</i>	777	79%	.17			
<i>Non-Minority Only</i>						
<i>Pretest</i>	587	45%	.24	28.911	$\leq .0001$	1.59
<i>Posttest</i>	587	78%	.17			
<i>Minority Only</i>						
<i>Pretest</i>	172	43%	.24	16.065	$\leq .0001$	1.54
<i>Posttest</i>	172	75%	.17			
<i>Multi-Ethnic</i>						
<i>Pretest</i>	267	44%	.23	18.497	$\leq .0001$	1.58
<i>Posttest</i>	267	76%	.18			

Figures 25, 26, and 27 provide a visual look at the increases. In general, the percentage increases were about 32% for each comparison group.

*Figure 25: Geometry Module 9
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



*Figure 26: Geometry Module 9
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*

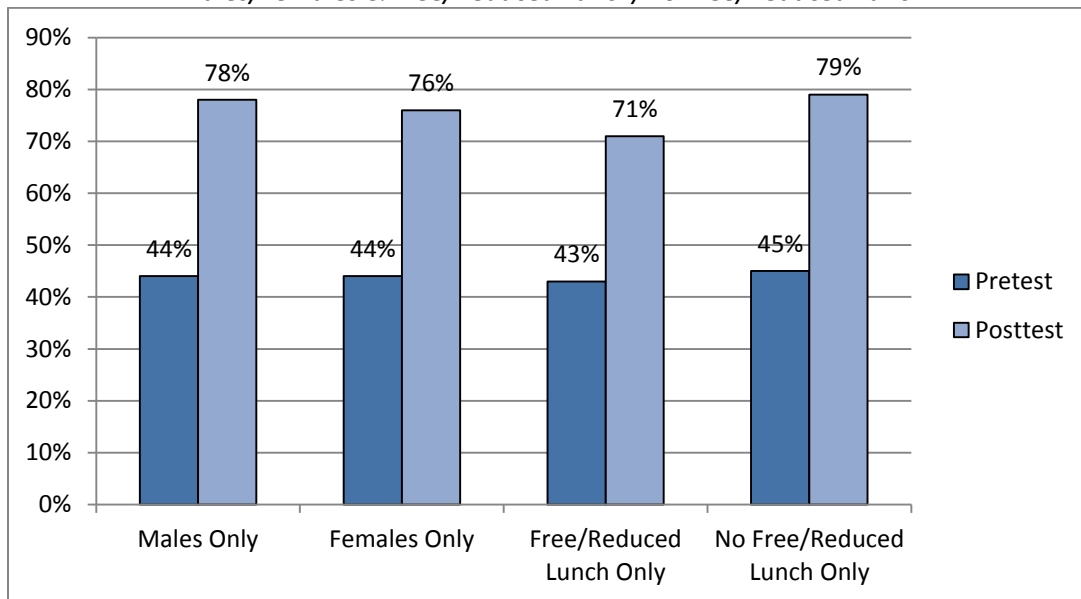
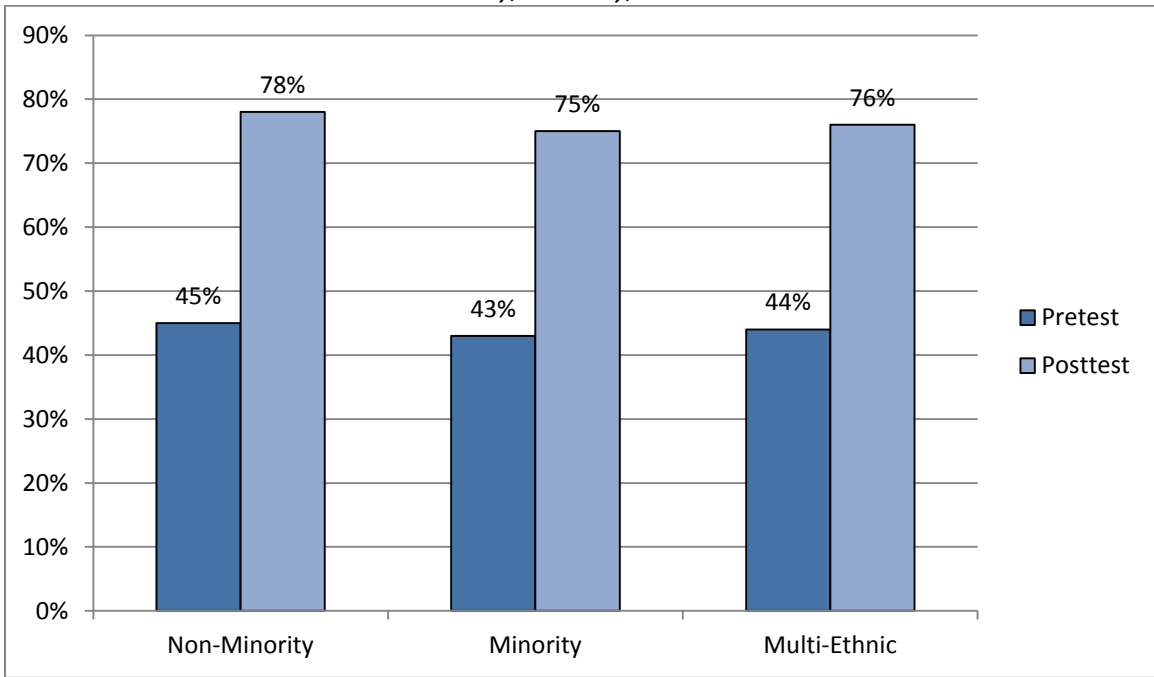


Figure 27: Geometry Module 9
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority, & Multi-Ethnic



Module 10

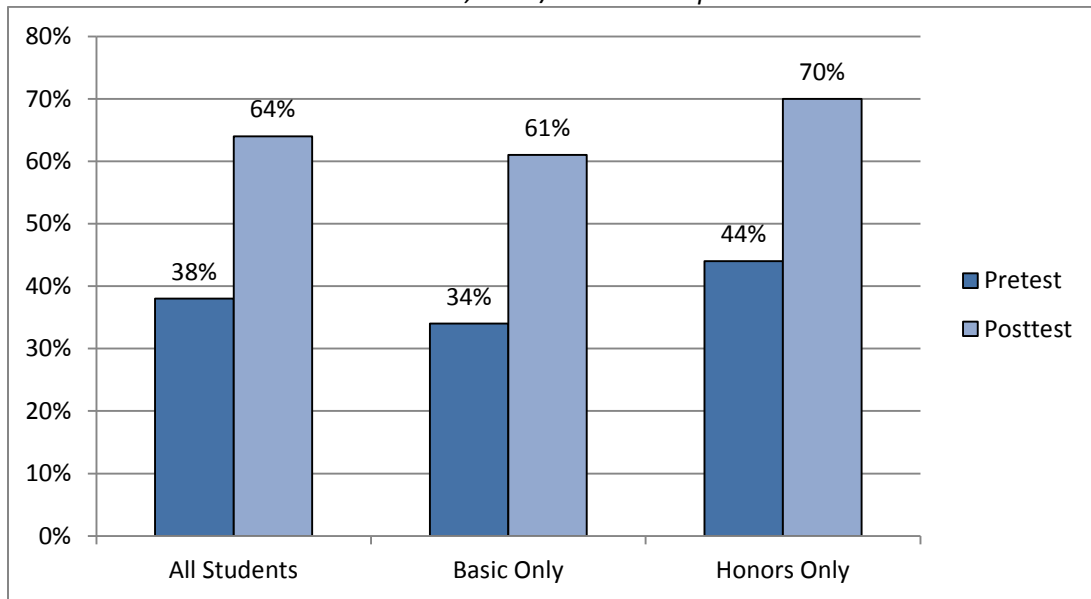
This Module is entirely on formal proofs of all types: from triangles to quadrilateral to circles. Table 15 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$), and the effect sizes were all large. The honors students scored higher than the basic students. Other than that difference, it appears there was little difference between the various demographic groups.

Table 15: Comparison of Pretest to Posttest Percent Correct Scores
Geometry Instructional Module 10

Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
<i>Pretest</i>	827	38%	.22	29.088	$\leq .0001$	1.24
<i>Posttest</i>	827	64%	.20			
<i>Basic Only</i>						
<i>Pretest</i>	519	34%	.21	22.942	$\leq .0001$	1.32
<i>Posttest</i>	519	61%	.20			
<i>Honors Only</i>						
<i>Pretest</i>	308	44%	.23	17.856	$\leq .0001$	1.29
<i>Posttest</i>	308	70%	.17			
<i>Males Only</i>						
<i>Pretest</i>	370	38%	.23	20.043	$\leq .0001$	1.30
<i>Posttest</i>	370	66%	.20			
<i>Females Only</i>						
<i>Pretest</i>	457	37%	.21	21.091	$\leq .0001$	1.27
<i>Posttest</i>	457	63%	.20			
<i>Free/Reduced Lunch Only</i>						
<i>Pretest</i>	205	35%	.21	12.906	$\leq .0001$	1.18
<i>Posttest</i>	205	58%	.18			
<i>No Free/Reduced Lunch Only</i>						
<i>Pretest</i>	622	38%	.23	26.214	$\leq .0001$	1.30
<i>Posttest</i>	622	66%	.20			
<i>Non-Minority Only</i>						
<i>Pretest</i>	479	38%	.23	22.539	$\leq .0001$	1.25
<i>Posttest</i>	479	65%	.20			
<i>Minority Only</i>						
<i>Pretest</i>	130	37%	.23	10.025	$\leq .0001$	1.16
<i>Posttest</i>	130	62%	.20			
<i>Multi-Ethnic</i>						
<i>Pretest</i>	218	36%	.20	15.585	$\leq .0001$	1.38
<i>Posttest</i>	218	63%	.19			

Figures 28, 29, and 30 provide a visual look at the increases. In general, the percentage increases were about 26% for each comparison group.

*Figure 28: Geometry Module 10
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



*Figure 29: Geometry Module 10
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*

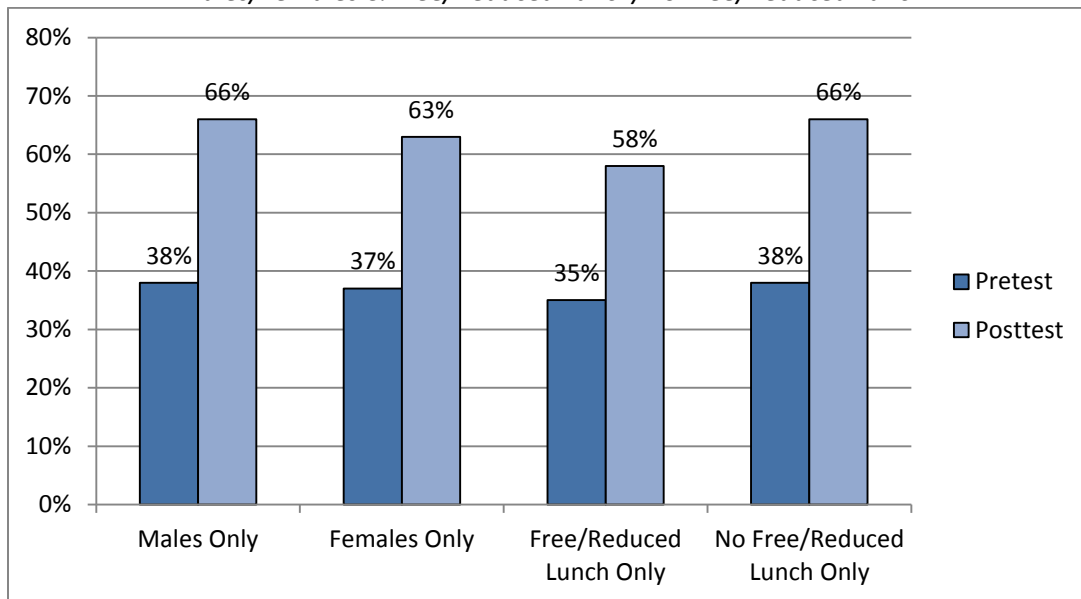
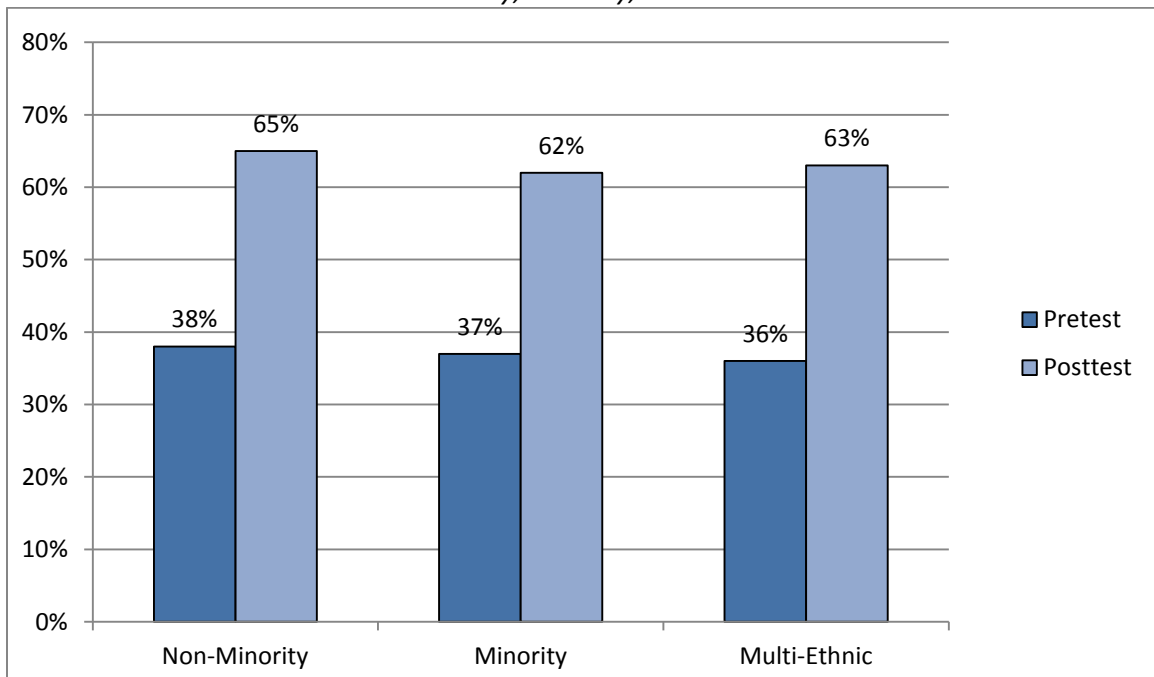


Figure 30: Geometry Module 10
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority, & Multi-Ethnic



Conclusions

The conclusions will review the data analyzed to answer each of the three questions that guided this study.

Question 1: *Do students enrolled in the **Florida Virtual School Geometry** program increase their knowledge and skills in Geometry?*

For each of the comparisons across the 10 modules, the increases were statistically significant ($\leq .0001$), indicating a difference that would occur by chance less than one out of 10,000 repetitions. The effect size, an even more significant estimate of the strength of a change, was large for all of the modules. Perhaps of even greater significance is that the growth from pretesting to posttesting increased across each of the 10 modules. The percent increase across all modules from pretest to posttest was 32%.

The average percent increase for all students across the 10 modules is shown in Table 16.

Table 16: Gain Scores Across 10 Modules for All Students

Pretest Percent	Posttest Percent	Gain
40%	73%	33%

The conclusion to question 1 is that the module pretest/posttest comparisons show significant increases for each of the modules and thus for the total Geometry course.

Question 2: *Do students enrolled in basic or honors courses achieve similar gains in the **Florida Virtual School Geometry** program?*

Overall, the honors students scored higher than the basic students on the pretests and the posttest for all modules. However, the increase scores from pretesting to posttesting showed similar gains for both the basic and honors students. The honors students had slightly greater growth on seven modules while the basic students had slightly greater gains on two of the modules. For one module, there was no difference in growth from pretesting to posttesting for the basic and honors students.

The average percent increase for basic and honors students for each module as well as the average across the 10 modules is shown in Table 17.

Table 17: Gain Scores Across 10 Modules for All Students

Group	Pretest	Posttest Percent	Gain
Module 1: Basic	30%	67%	37%
Module 1: Honors	30%	77%	47%
Module 2: Basic	51%	71%	20%
Module 2: Honors	60%	81%	21%
Module 3: Basic	37%	68%	31%
Module 3: Honors	44%	78%	34%
Module 4: Basic	37%	69%	32%
Module 4: Honors	42%	82%	40%
Module 5: Basic	42%	69%	27%
Module 5: Honors	46%	77%	31%
Module 6: Basic	42%	72%	30%
Module 6: Honors	49%	80%	31%
Module 7: Basic	41%	73%	32%
Module 7: Honors	50%	80%	30%
Module 8: Basic	40%	69%	28%
Module 8: Honors	49%	77%	33%
Module 9: Basic	42%	75%	33%
Module 9: Honors	48%	81%	33%
Module 10: Basic	34%	61%	27%
Module 10: Honors	44%	70%	26%
Average All Modules: Basic	40%	69%	29%
Average All Modules: Honors	45%	78%	33%

The differences between honors and basic students are shown on all of the pretests and posttests. However, the increases from pretesting to posttesting show little difference between the basic and honors students.

Question 3: *Do students with differing demographic characteristics (gender, socio-economic status, and ethnic background) achieve similar gains when enrolled in the **Florida Virtual School Geometry** program?*

Gender differences were almost non-existent in comparing pretest to posttest scores for males and females. When comparing the pretest scores of students who were eligible for free and reduced lunch programs with those who were not eligible for such programs, there were differences in the gains made. The students ineligible for free/reduced lunch programs made slightly larger gains.

The average percent increases for male and female; higher socio-economic level and lower socio-economic level; and white, minority, and multi-ethnic students across the 10 modules are shown in Table 18.

Table 18: Gain Scores Across 10 Modules for All Students

Group	Pretest Percent	Posttest Percent	Gain
Gender Groups			
Male	43%	75%	32%
Female	42%	72%	30%
Socio-Economic Groups			
Lower	41%	68%	27%
Higher	42%	75%	33%
Ethnic Groups			
White	42%	74%	32%
Minority	42%	71%	29%
Multi-Ethnic	42%	72%	30%

The conclusion to question 3 is that there are small and somewhat inconsistent difference for gender, socio-economic status, and ethnic background. Students overall, regardless of demographic differences, made statistically significant and large effect size gains from pretesting to posttesting.

The overall conclusion based on the gain scores on the 10 module pretests and posttests comparison is that all students made statistically significant and large effect size gains from pretesting to posttesting. Honors students tended to score higher than basic students and seemed to make somewhat greater gains. None of the demographic differences seemed to produce large differences in gain scores.