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An Efficacy Study of the Biology Version 15 Course

Florida Virtual School

[Report 447, December 2012]



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Executive Summary

Florida Virtual School[®] contracted with the Educational Research Institute of America to analyze the test score data for students enrolled in the Biology I 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 participates in 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 Biology I course is mapped to national standards and designed to meet Common Core and Florida Sunshine State Standards.

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

Inferential statistics were not possible for the subgroups since each group of students took a small number of randomly selected items which were not of equal difficulty. The differences for the average scores across all six modules showed the following:

Basic and Honors Students

- The average pretest score for the basic students was 38% correct, and their average posttest score was 61% correct, resulting in a gain of 23%.
- The average pretest score for the honors students was 46% correct, and their average posttest score was 68% correct, resulting in a gain of 22%.

Male and Female Students

- The average pretest score for the male students was 41% correct, and their average posttest score was 63% correct, resulting in a gain of 22%.
- The average pretest score for the female students was 41% correct, and their average posttest score was 63% correct, resulting in a gain of 22%.

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

- The average pretest score for the lower socio-economic students was 39% correct, and their average posttest score was 57% correct, resulting in a gain of 18%.
- The average pretest score for the higher socio-economic students was 42% correct, and their average posttest score was 65% correct, resulting in a gain of 23%.

White, Minority, and Multi-Ethnic Students

- The average pretest score for the white students was 41% correct, and their average posttest score was 64% correct, resulting in a gain of 23%.
- The average pretest score for the minority students was 42% correct, and their average posttest score was 65% correct, resulting in a gain of 23%.
- The average pretest score for the multi-ethnic students was 40% correct, and their average posttest score was 61% correct, resulting in a gain of 21%.

In summary, the FLVS Biology I course produces significant academic improvement and the improvement is found across all groups (gender, socio-economic status, 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 a student's 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 also 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.

Research Questions

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

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

Course Description

The Biology I version 15 course is designed with a total of seven instructional modules. These modules include instructional lessons and activities to meet a specific set of standards for each module.

More specifically, the Biology I course guides students through the study of living and non-living systems and how they interact with one another. Students explore the world they live in by posing questions and seeking answers through scientific inquiry. Discovery takes place through observation and data collection. The students are introduced to the structure, function, diversity, and evolution of living matter. This course aims to make the content applicable to real-life for students. It encourages curiosity and provides opportunity for students to work on

hands-on lab activities and develop relationships through collaborative learning activities. By providing these opportunities, FLVS engages students in the study of biological science to ultimately broaden their experience of the world around them.

Segment I:

Module 1: Foundations of Biology

Module 2: Life's Origin

Module 3: Cell Reproduction

Module 4: Earth's Diversity

Segment II:

Module 5: Scientific Connections

Module 6: Classification and Diversity

Module 7: Human Systems

Besides engaging students in challenging curriculum, FLVS guides students to reflect on their learning and to evaluate their progress through a variety of assessments. 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 Biology I 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>
3%	23%	36%	25%	13%

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>
46%	54%	73%	27%	33%	67%

Table 3: Ethnicity of Students Comprising the Research Sample

<i>Ethnicity</i>		
<i>White</i>	<i>Minority</i>	<i>Multi-Ethnic</i>
46%	24%	30%

**The total percentage is greater than 100% since some students checked more than one ethnic category.*

Description of the Assessments

For this Biology I study, there are six pretests and seven posttests. There are a total of seven modules. There is no pretest for module 1 because pretests were designed for exemption purposes, and the course design was structured so that lessons in module 1 were not exemptible. Thus, there are six pretest/posttest comparisons across the seven program modules analyzing how basic and honors students performed on the test items. For the pretests, basic and honors students were given the same items. For the posttests, basic and honors students were given the same items, but honors students had additional honors items. Since there were no honors standards covered in module 7, honors students took the same items as the basic students. Therefore, there is no comparison of basic and honors students for module 7.

Each pretest or posttest assessment includes from 11 to 25 groups of banked test items. The total number of test items range from 33 to 75 test items. To limit item exposure and promote academic integrity, each student receives one randomly-selected test item from the bank of items in each group.

For the Biology I pretests, there are 114 pretest groups with three test items for each group. The result is a total of 342 test items across the 114 groups. 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 since all 342 items are included in the assessment bank, but each student takes only 11 to 25 items per test and a total of 114 pretest items throughout the course.

Each posttest includes from 12 to 21 groups of banked test items for a total of 399 test items. Again, to limit exposure and promote academic integrity, each student randomly receives only a total of 133 test items from the bank. 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 since all 399 items are included in the assessment bank, but each student takes only 12 to 21 items per test and a total of 133 posttest items throughout the course.

According to the FLVS course development guidelines, a test blueprint is created for each pre-test and module exam. Each test item is written to measure a particular benchmark at an appropriately specified cognitive complexity level based on an adaptation of Webb's Depth of Knowledge. For traditional multiple choice tests, 10-20% of test items are at the low complexity level with 80-90% at moderate to high complexity levels. "The categories—low complexity, moderate complexity, and high complexity—form an ordered description of the demands an

item may make on a student” (FCAT Handbook, 2005). Tests and test items are reviewed by subject matter experts and editorial staff, and tests are assembled per blueprint requirements.

*Table 4: Items for Pretest
Module Assessments*

	<i>Basic and Honors</i>	
Pretest Modules	Total # of Banked Items	# of Items per Student
Module 1		
Module 2	48	16
Module 3	75	25
Module 4	51	17
Module 5	33	11
Module 6	75	25
Module 7	60	20

*Table 5: Items for Posttest
Module Assessments*

<i>Biology I files</i>	<i>Basic and Honors</i>		<i>Extra Honors Items</i>	
Posttest Modules	Total # of Banked Items	# of Items per Student	Additional Banked Items*	# of Extra Items per Student*
Module 1	60	20	9	3
Module 2	63	21	18	6
Module 3	63	21	6	2
Module 4	57	19	9	3
Module 5	36	12	24	8
Module 6	63	21	6	2
Module 7	57	19	0	0

**The extra Honors Items are not included in the pretest/posttest analyses. However, honors items were included in the posttest item analysis report 449.*

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

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.

Separate analyses were conducted for each of the modules 2 to 7.

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

Module 2

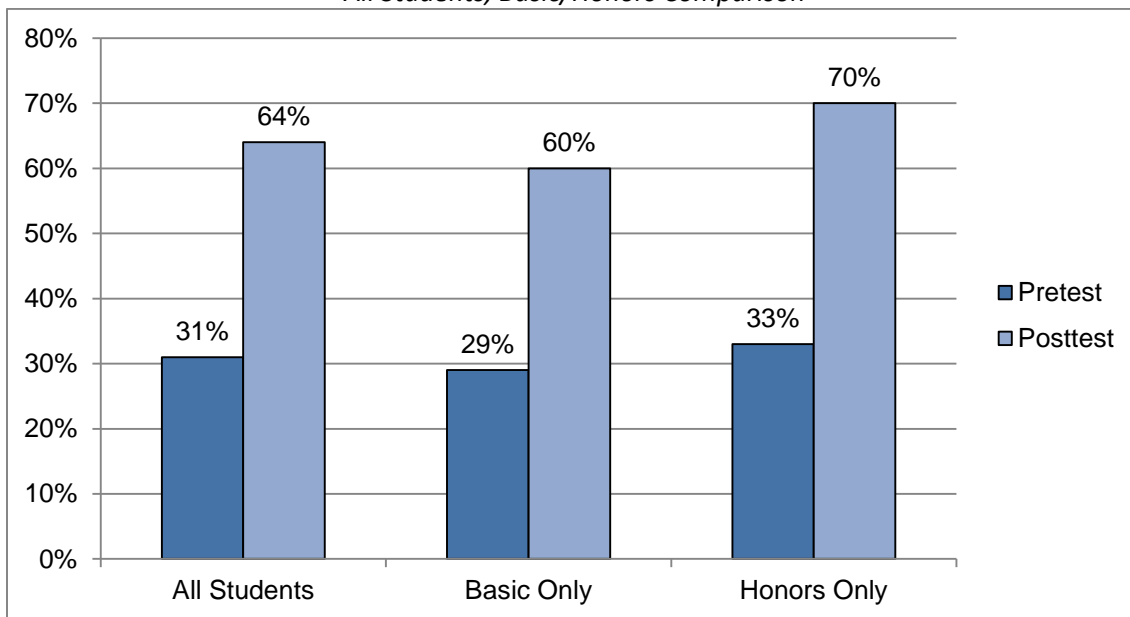
Module 2 is titled “Life’s Origins” and introduces students to cells. It begins with an introduction to biological macromolecules, explores the structures of prokaryotic and eukaryotic cells, compares animal and plant cells, and takes students through the processes of respiration and photosynthesis. Table 6 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$) and the effect sizes were all very large. The honors students scored higher than the basic students. In addition, the non-free/reduced lunch students scored slightly higher than the free/reduced lunch students. Other than those differences, it appears there was little difference between the various demographic groups.

*Table 6: Biology I Instructional Module 2
Comparison of Pretest to Posttest Percent Correct Scores*

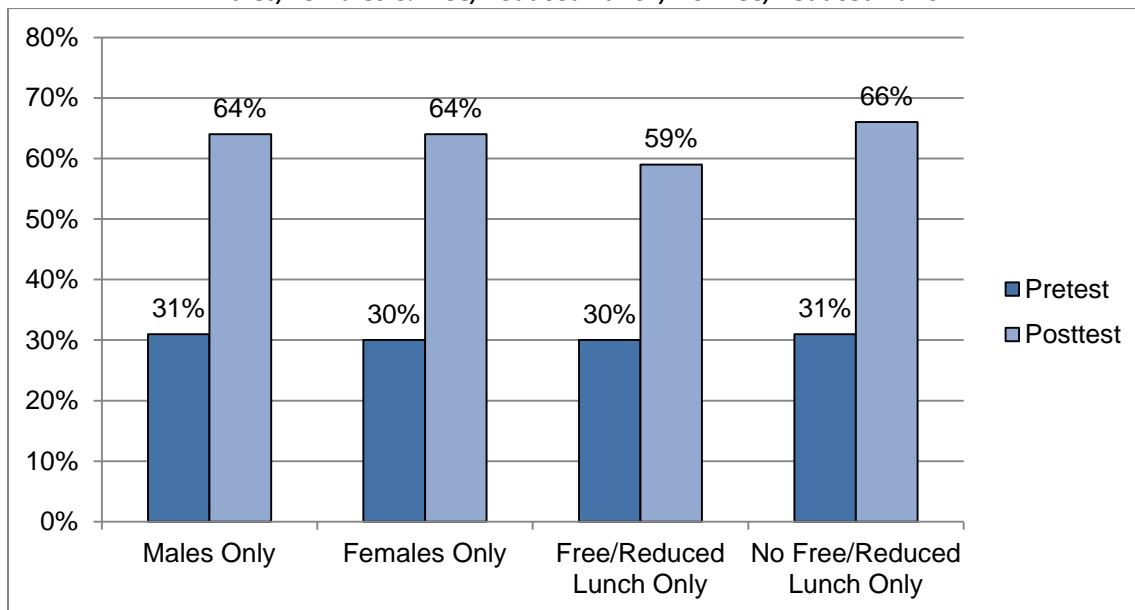
Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
<i>Pretest</i>	944	31%	.15	50.612	$\leq .0001$	1.87
<i>Posttest</i>	944	64%	.17			
<i>Basic Only</i>						
<i>Pretest</i>	591	29%	.15	36.984	$\leq .0001$	1.93
<i>Posttest</i>	591	60%	.17			
<i>Honors Only</i>						
<i>Pretest</i>	353	33%	.15	35.954	$\leq .0001$	2.47
<i>Posttest</i>	353	70%	.15			
<i>Males Only</i>						
<i>Pretest</i>	438	31%	.15	33.018	$\leq .0001$	1.99
<i>Posttest</i>	438	64%	.17			
<i>Females Only</i>						
<i>Pretest</i>	506	30%	.15	38.497	$\leq .0001$	2.12
<i>Posttest</i>	506	64%	.17			
<i>Free/Reduced Lunch Only</i>						
<i>Pretest</i>	293	30%	.14	26.234	$\leq .0001$	1.92
<i>Posttest</i>	293	59%	.16			
<i>No Free/Reduced Lunch Only</i>						
<i>Pretest</i>	651	31%	.15	43.974	$\leq .0001$	2.18
<i>Posttest</i>	651	66%	.17			
<i>Non-Minority Only</i>						
<i>Pretest</i>	463	30%	.14	36.111	$\leq .0001$	2.17
<i>Posttest</i>	463	65%	.18			
<i>Minority Only</i>						
<i>Pretest</i>	157	30%	.15	22.357	$\leq .0001$	2.25
<i>Posttest</i>	157	66%	.17			
<i>Multi-Ethnic</i>						
<i>Pretest</i>	324	32%	.16	27.998	$\leq .0001$	1.88
<i>Posttest</i>	324	62%	.16			

Figures 1, 2, and 3 provide a visual look at the increases. In general, the percentage increases were about 30% to 35% for each comparison group.

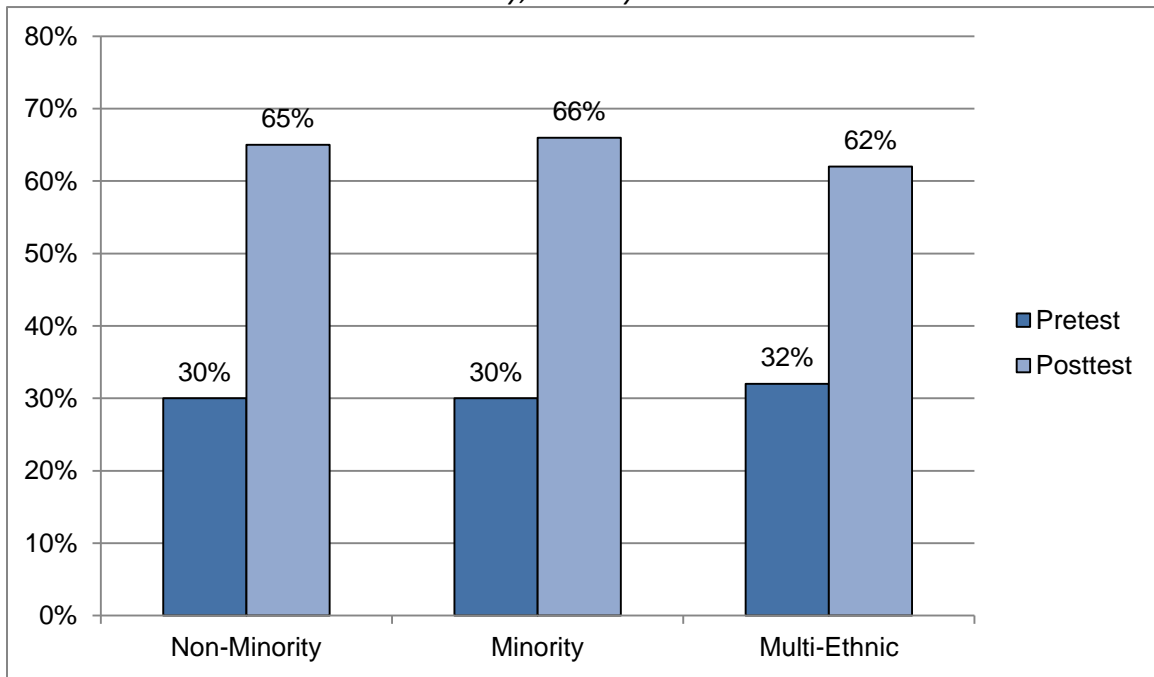
*Figure 1: Biology I Module 2
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



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



*Figure 3: Biology I Module 2
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority & Multi-Ethnic*



Module 3

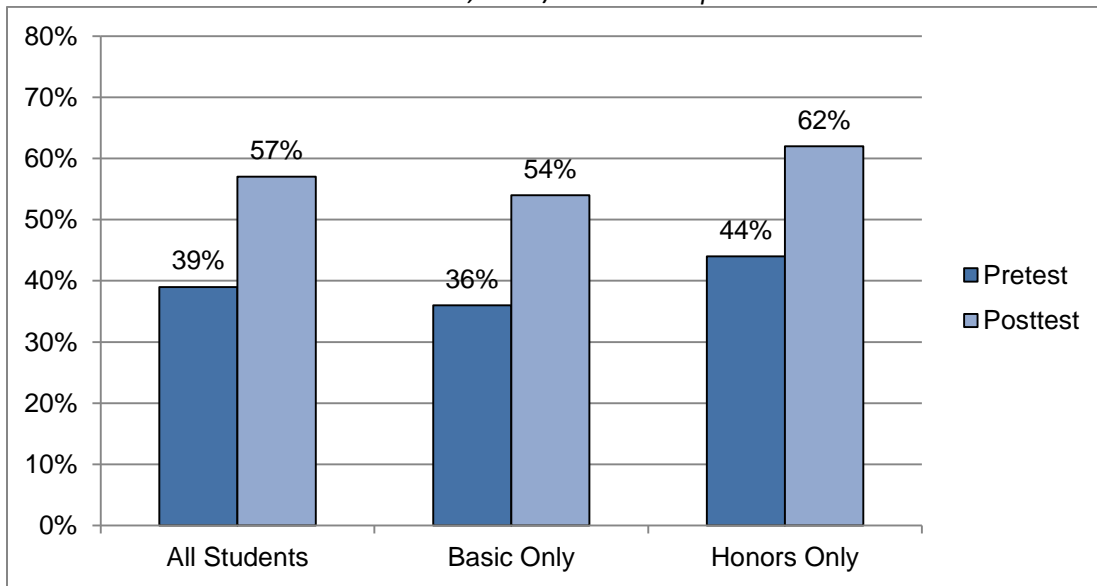
Module 3 is titled “Cell Reproduction” and introduces students to mitosis, meiosis, and genetics. Table 7 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$), and the effect sizes were all large. As expected, the honors students scored higher than the basic students. Other than that difference, it appears there was little difference between the various demographic groups.

*Table 7: Biology I Module 3
Comparison of Pretest to Posttest Percent Correct Scores*

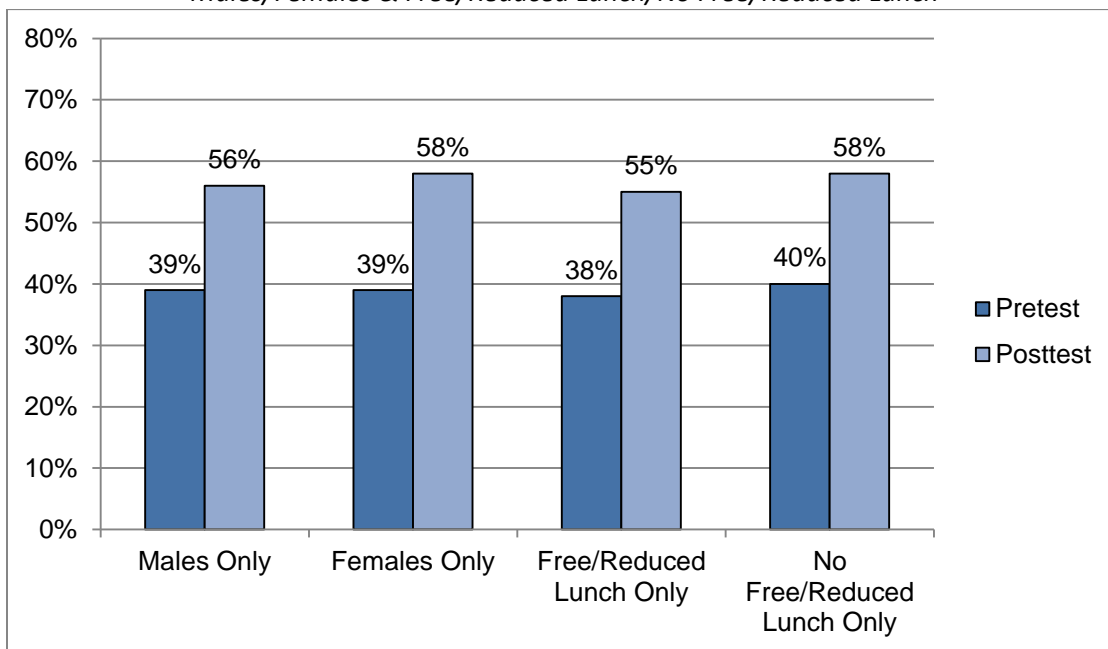
Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
<i>Pretest</i>	845	39%	.16	24.855	$\leq .0001$	1.09
<i>Posttest</i>	845	57%	.17			
<i>Basic Only</i>						
<i>Pretest</i>	507	36%	.16	17.980	$\leq .0001$	1.06
<i>Posttest</i>	507	54%	.18			
<i>Honors Only</i>						
<i>Pretest</i>	338	44%	.16	17.466	$\leq .0001$	1.16
<i>Posttest</i>	338	62%	.15			
<i>Males Only</i>						
<i>Pretest</i>	394	39%	.17	15.591	$\leq .0001$	1.00
<i>Posttest</i>	394	56%	.17			
<i>Females Only</i>						
<i>Pretest</i>	451	39%	.15	19.520	$\leq .0001$	1.19
<i>Posttest</i>	451	58%	.17			
<i>Free/Reduced Lunch Only</i>						
<i>Pretest</i>	259	38%	.15	14.006	$\leq .0001$	1.13
<i>Posttest</i>	259	55%	.17			
<i>No Free/Reduced Lunch Only</i>						
<i>Pretest</i>	586	40%	.16	20.552	$\leq .0001$	1.09
<i>Posttest</i>	586	58%	.17			
<i>Non-Minority Only</i>						
<i>Pretest</i>	425	39%	.16	17.780	$\leq .0001$	1.15
<i>Posttest</i>	425	58%	.17			
<i>Minority Only</i>						
<i>Pretest</i>	139	42%	.16	8.943	$\leq .0001$	0.94
<i>Posttest</i>	139	58%	.18			
<i>Multi-Ethnic</i>						
<i>Pretest</i>	281	39%	.16	15.096	$\leq .0001$	1.03
<i>Posttest</i>	281	56%	.17			

Figures 4, 5, and 6 provide a visual look at the increases. In general, the percentage increases were about 15% to 20% for each comparison group.

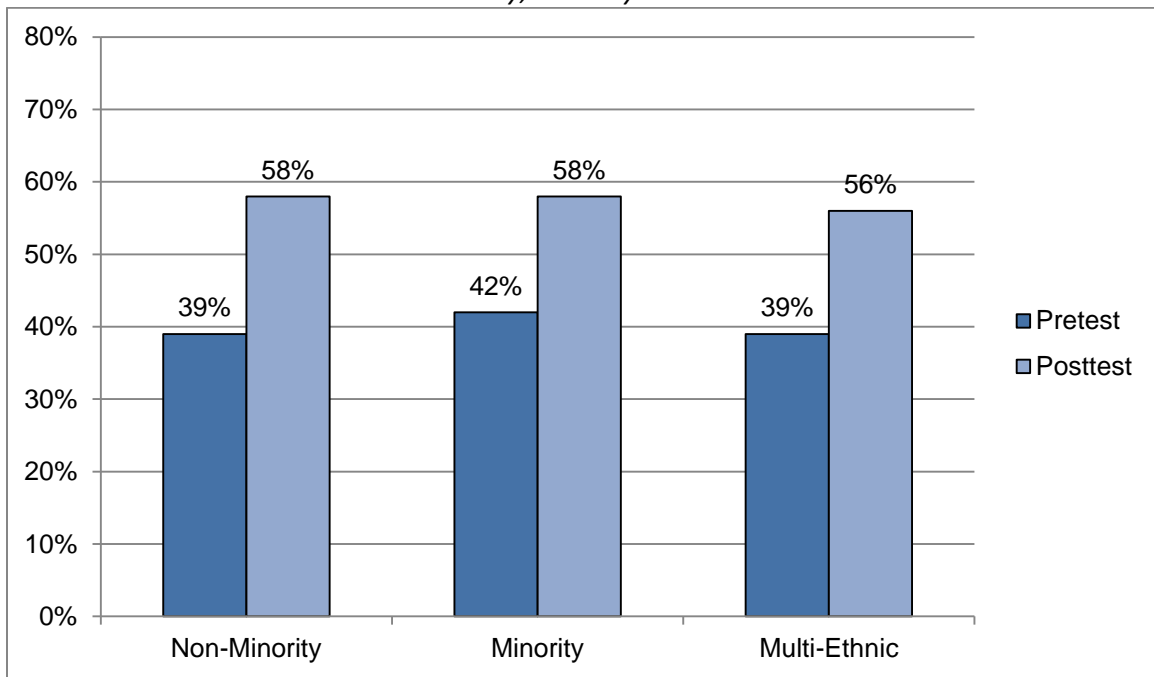
*Figure 4: Biology I Module 3
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



*Figure 5: Biology I Module 3
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*



*Figure 6: Biology I Module 3
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority & Multi-Ethnic*



Module 4

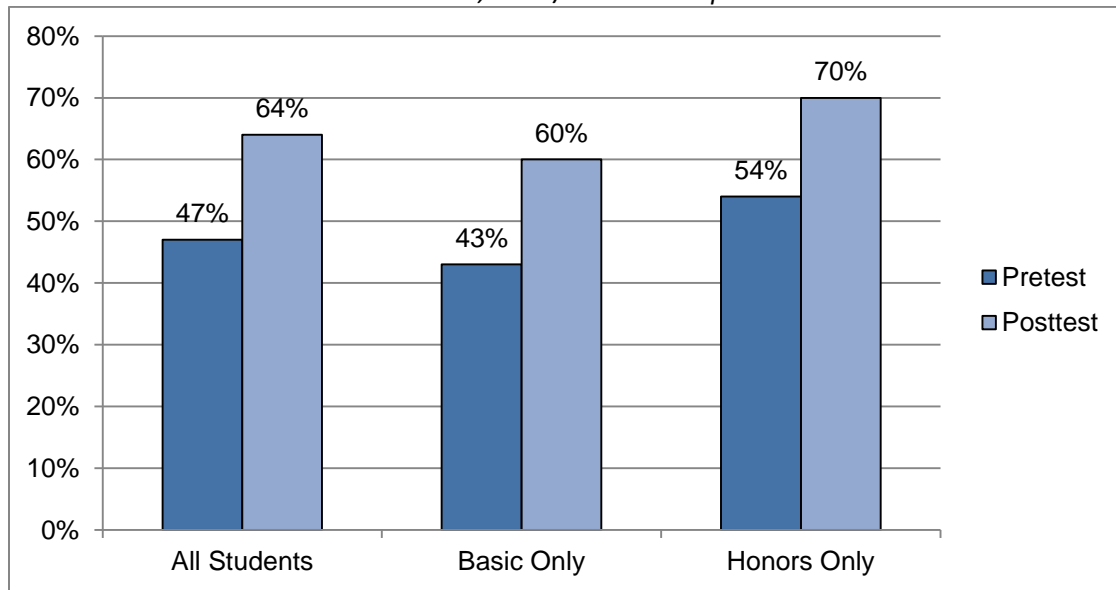
Module 4 is titled “Earth’s Diversity.” This module covers ecology topics such as the biosphere, ecosystems, climate, impacts on the ecosystem, and cycles. Table 8 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$), and the effect sizes were all large. The honors students scored higher than the basic students. In addition, the no-free reduced lunch students scored higher than the free/reduced lunch students. Other than those differences, it appears there was little difference between the various demographic groups.

*Table 8: Biology I Instructional Module 4
Comparison of Pretest to Posttest Percent Correct Scores*

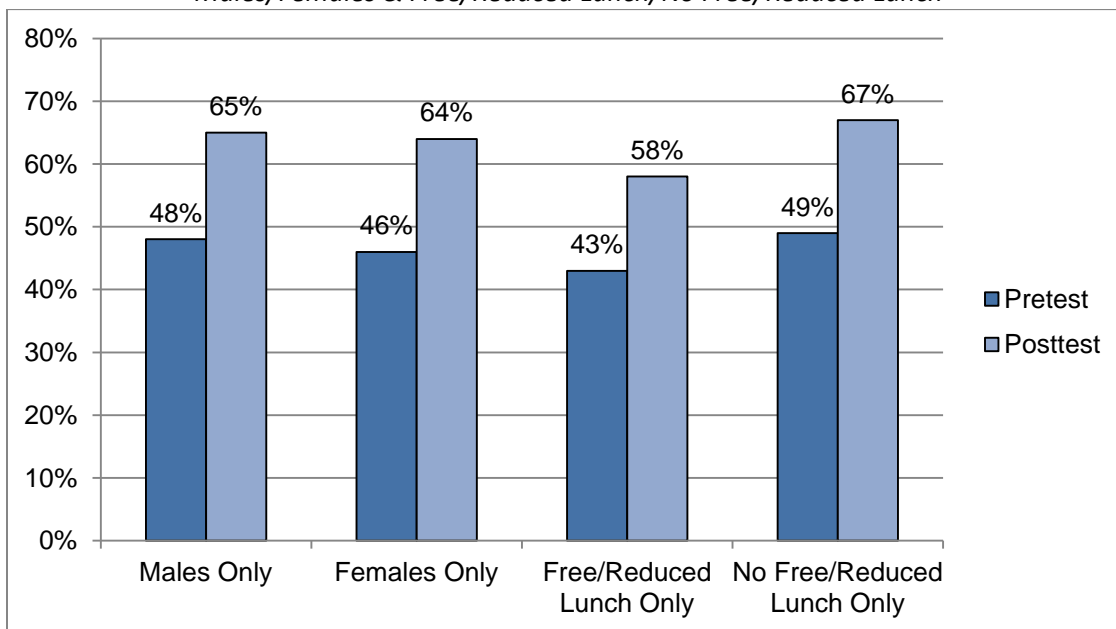
Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
<i>Pretest</i>	810	47%	.20	21.983	$\leq .0001$	.94
<i>Posttest</i>	810	64%	.16			
<i>Basic Only</i>						
<i>Pretest</i>	486	43%	.20	17.345	$\leq .0001$	.94
<i>Posttest</i>	486	60%	.16			
<i>Honors Only</i>						
<i>Pretest</i>	324	54%	.20	13.506	$\leq .0001$	.93
<i>Posttest</i>	324	70%	.14			
<i>Males Only</i>						
<i>Pretest</i>	377	48%	.21	14.629	$\leq .0001$	.91
<i>Posttest</i>	377	65%	.16			
<i>Females Only</i>						
<i>Pretest</i>	433	46%	.20	16.402	$\leq .0001$	.99
<i>Posttest</i>	433	64%	.16			
<i>Free/Reduced Lunch Only</i>						
<i>Pretest</i>	241	43%	.19	11.160	$\leq .0001$	.85
<i>Posttest</i>	241	58%	.16			
<i>No Free/Reduced Lunch Only</i>						
<i>Pretest</i>	569	49%	.21	18.995	$\leq .0001$	.99
<i>Posttest</i>	569	67%	.15			
<i>Non-Minority Only</i>						
<i>Pretest</i>	410	48%	.20	15.818	$\leq .0001$	.94
<i>Posttest</i>	410	65%	.16			
<i>Minority Only</i>						
<i>Pretest</i>	133	50%	.21	8.489	$\leq .0001$	.99
<i>Posttest</i>	133	66%	.15			
<i>Multi-Ethnic</i>						
<i>Pretest</i>	267	45%	.20	12.716	$\leq .0001$	.93
<i>Posttest</i>	267	61%	.16			

Figures 7, 8, and 9 provide a visual look at the increases. In general, the percentage increases were about 15% to 20% for each comparison group.

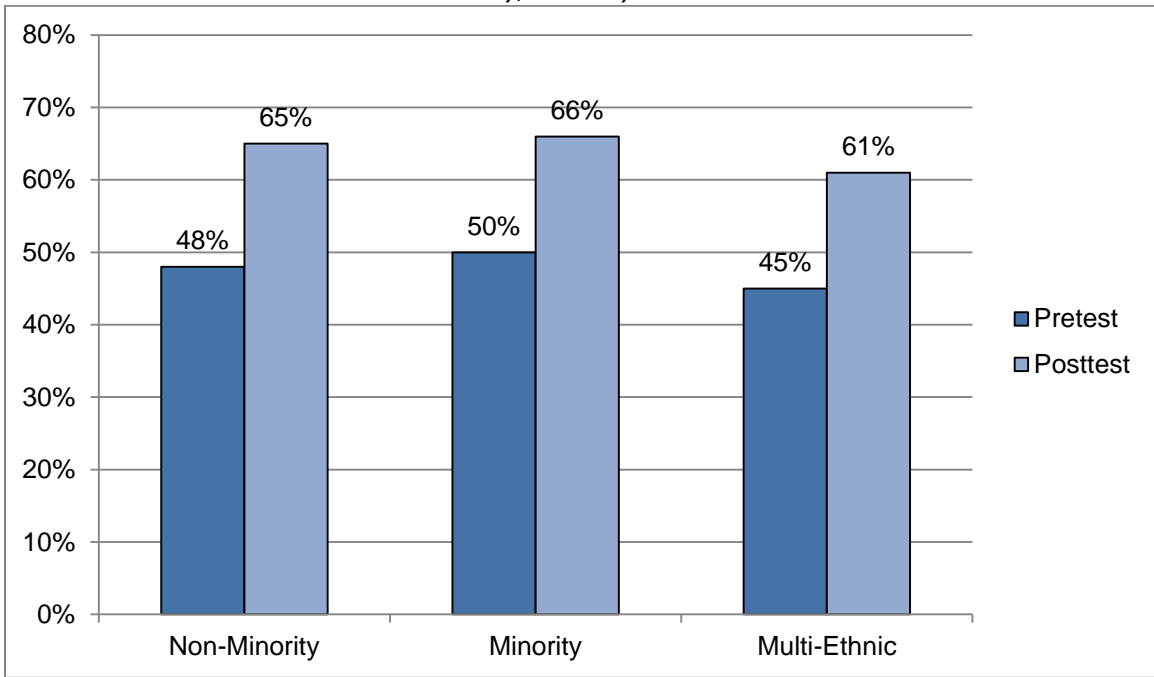
*Figure 7: Biology I Module 4
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



*Figure 8: Biology I Module 4
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*



*Figure 9: Biology I Module 4
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority & Multi-Ethnic*



Module 5

Module 5 is titled “Scientific Connections” and covers standards related to evolution. Table 9 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$) and the effect sizes were all large with the exception of the multi-ethnic group which had a medium effect size. The honors students scored higher than the basic students. In addition, the no-free reduced lunch students scored higher than the free/reduced lunch students. Other than those differences, it appears there was little difference between the various demographic groups.

*Table 9
Comparison of Pretest to Posttest Percent Correct Scores
Biology I Instructional Module 5*

Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
<i>Pretest</i>	1168	52%	.22	24.474	$\leq .0001$	.90
<i>Posttest</i>	1168	70%	.18			
<i>Basic Only</i>						
<i>Pretest</i>	740	48%	.21	19.955	$\leq .0001$	.92
<i>Posttest</i>	740	66%	.18			
<i>Honors Only</i>						
<i>Pretest</i>	428	60%	.21	14.222	$\leq .0001$	.82
<i>Posttest</i>	428	75%	.15			
<i>Males Only</i>						
<i>Pretest</i>	513	53%	.23	15.963	$\leq .0001$	.89
<i>Posttest</i>	513	71%	.17			
<i>Females Only</i>						
<i>Pretest</i>	655	52%	.22	18.570	$\leq .0001$	.85
<i>Posttest</i>	655	69%	.18			
<i>Free/Reduced Lunch Only</i>						
<i>Pretest</i>	314	49%	.21	11.448	$\leq .0001$	.80
<i>Posttest</i>	314	65%	.19			
<i>No Free/Reduced Lunch Only</i>						
<i>Pretest</i>	854	53%	.22	21.704	$\leq .0001$	.92
<i>Posttest</i>	854	71%	.17			
<i>Non-Minority Only</i>						
<i>Pretest</i>	649	53%	.22	18.955	$\leq .0001$	.85
<i>Posttest</i>	649	70%	.18			
<i>Minority Only</i>						
<i>Pretest</i>	208	54%	.23	10.004	$\leq .0001$	.86
<i>Posttest</i>	208	71%	.16			
<i>Multi-Ethnic</i>						
<i>Pretest</i>	311	51%	.23	11.891	$\leq .0001$	.79
<i>Posttest</i>	311	67%	.17			

Figures 10, 11, and 12 provide a visual look at the increases. In general, the percentage increases were about 15% to 20% for each comparison group.

*Figure 10: Biology I Module 5
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*

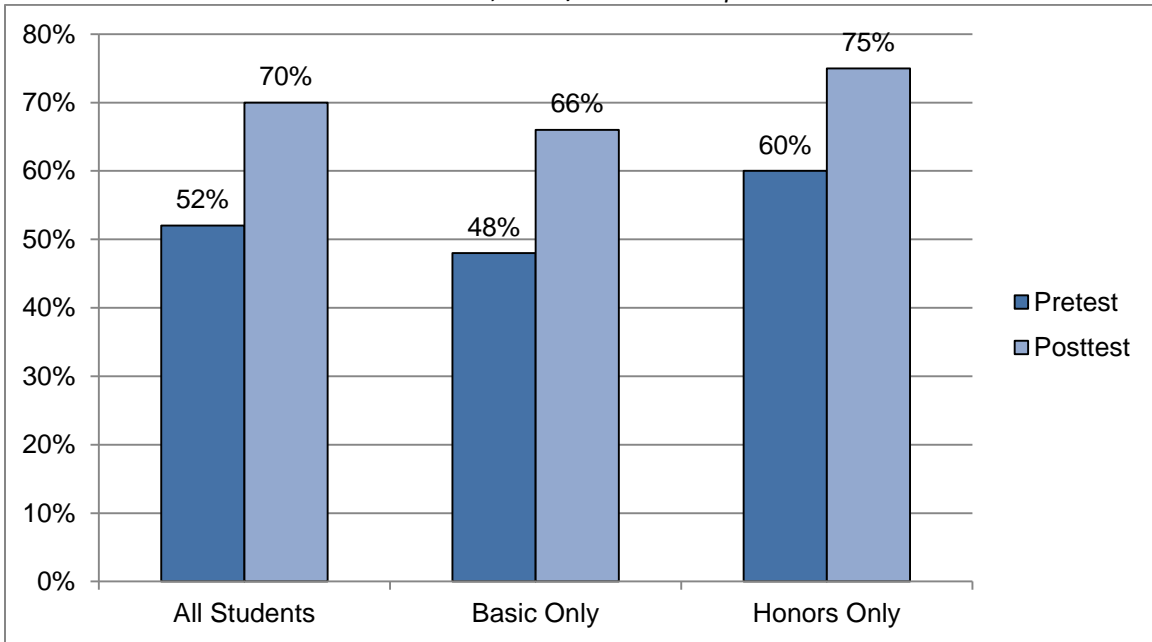


Figure 11: Biology I Module 5
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch

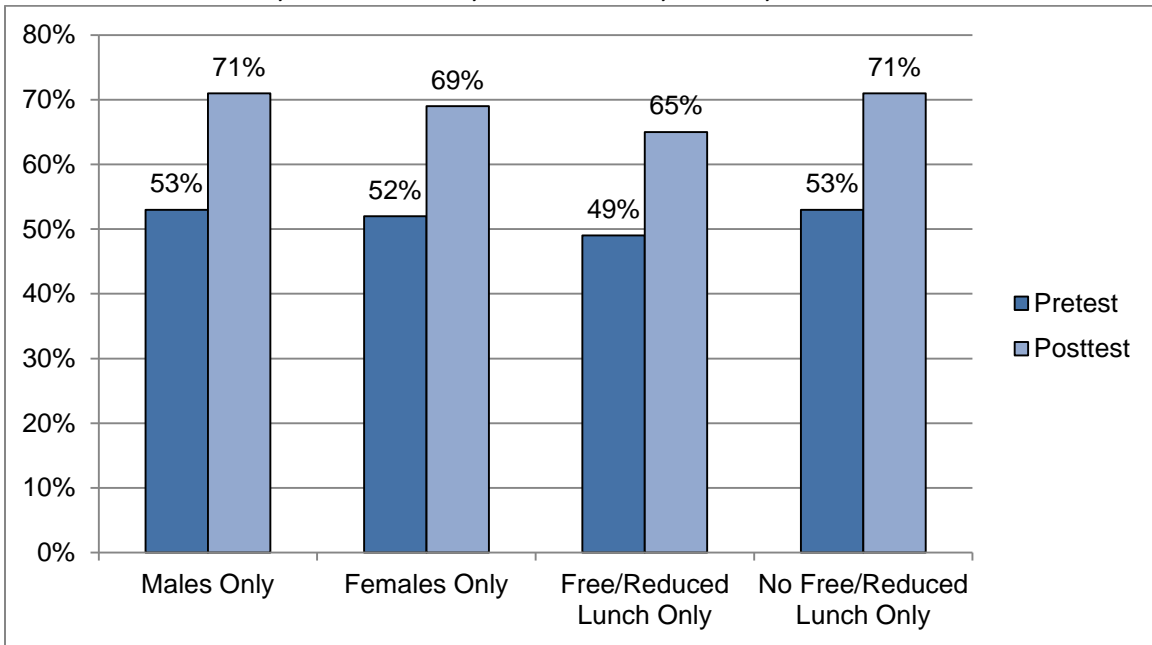
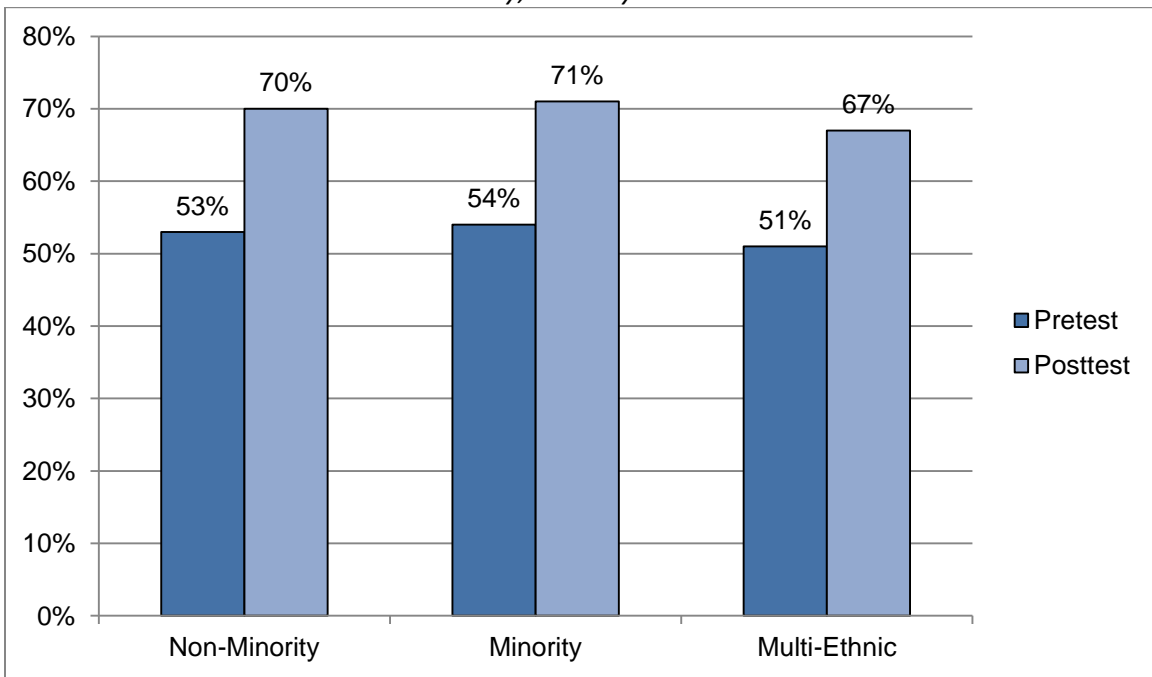


Figure 12: Biology I Module 5
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority & Multi-Ethnic



Module 6

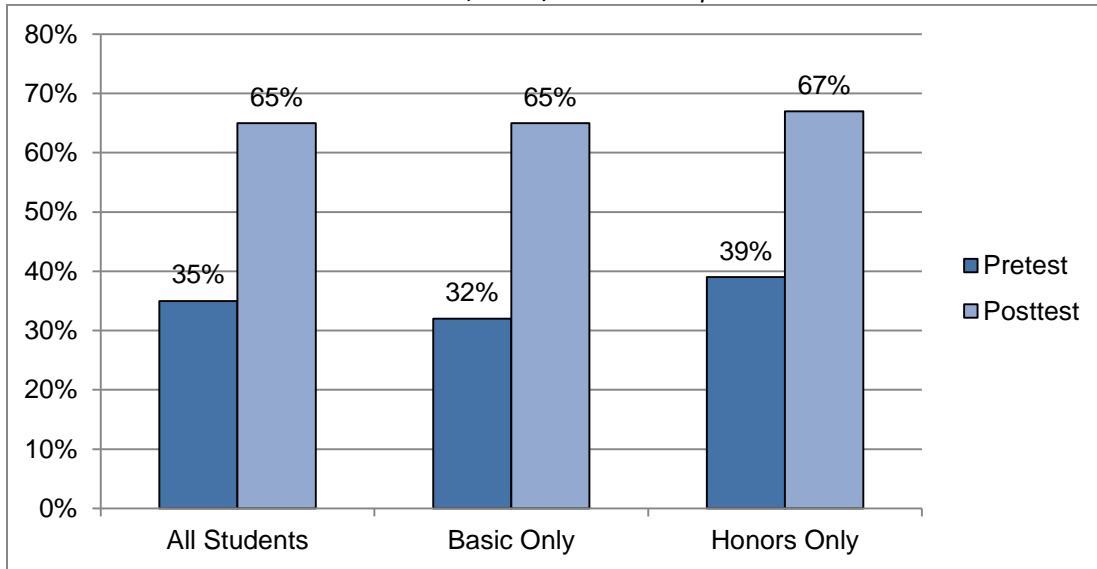
Module 6 is titled “Classification and Diversity.” The students will explore organisms by kingdom, learning about the basic characteristics of each group. Table 10 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$) and the effect sizes were all very large. The honors students scored higher than the basic students. In addition, the non-free/reduced lunch students scored higher than the free/reduced lunch students. Other than those differences, it appears there was little difference between the various demographic groups.

*Table 10: Biology I Instructional Module 6
Comparison of Pretest to Posttest Percent Correct Scores*

Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
<i>All Students</i>						
<i>Pretest</i>	929	35%	.15	47.396	$\leq .0001$	1.93
<i>Posttest</i>	929	65%	.16			
<i>Basic Only</i>						
<i>Pretest</i>	586	32%	.14	40.010	$\leq .0001$	2.12
<i>Posttest</i>	586	65%	.17			
<i>Honors Only</i>						
<i>Pretest</i>	343	39%	.17	26.269	$\leq .0001$	1.80
<i>Posttest</i>	343	67%	.14			
<i>Males Only</i>						
<i>Pretest</i>	410	35%	.16	31.181	$\leq .0001$	1.88
<i>Posttest</i>	410	66%	.16			
<i>Females Only</i>						
<i>Pretest</i>	519	34%	.15	35.692	$\leq .0001$	1.38
<i>Posttest</i>	519	65%	.16			
<i>Free/Reduced Lunch Only</i>						
<i>Pretest</i>	242	32%	.15	21.062	$\leq .0001$	1.81
<i>Posttest</i>	242	61%	.17			
<i>No Free/Reduced Lunch Only</i>						
<i>Pretest</i>	687	35%	.16	42.923	$\leq .0001$	2.00
<i>Posttest</i>	687	67%	.16			
<i>Non-Minority Only</i>						
<i>Pretest</i>	527	35%	.15	35.694	$\leq .0001$	2.32
<i>Posttest</i>	527	65%	.16			
<i>Minority Only</i>						
<i>Pretest</i>	162	35%	.16	20.924	$\leq .0001$	1.93
<i>Posttest</i>	162	67%	.16			
<i>Multi-Ethnic</i>						
<i>Pretest</i>	240	34%	.16	23.266	$\leq .0001$	1.87
<i>Posttest</i>	240	66%	.17			

Figures 13, 14, and 15 provide a visual look at the increases. In general, the percentage increases were about 30% to 35% for each comparison group.

*Figure 13: Biology I Module 6
Pretest and Posttest Percent Correct Scores
All Students, Basic/Honors Comparison*



*Figure 14: Biology I Module 6
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*

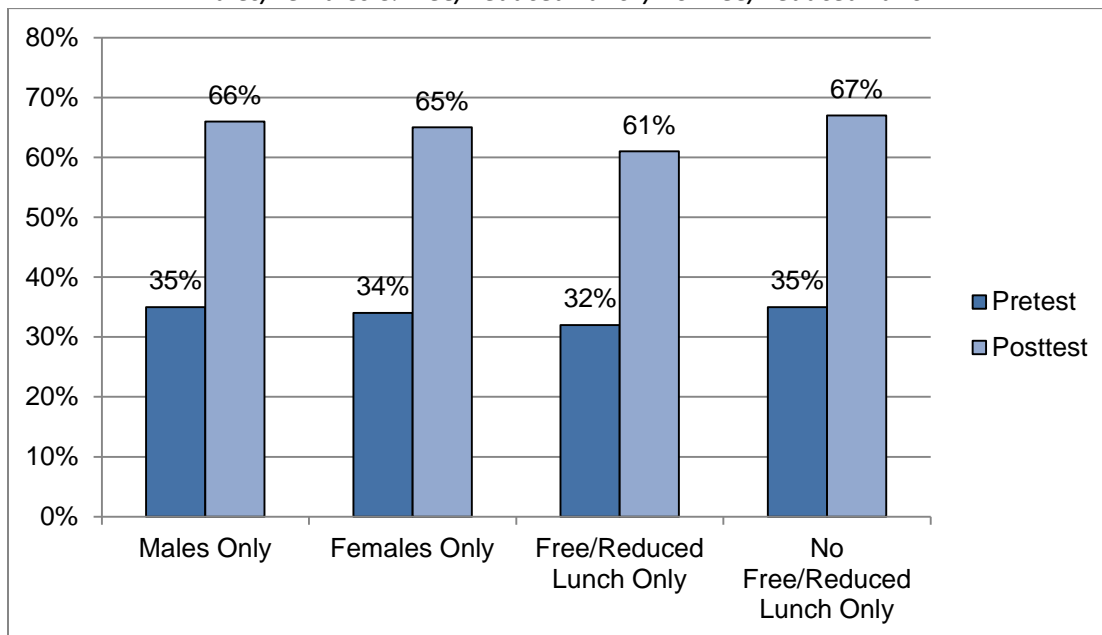
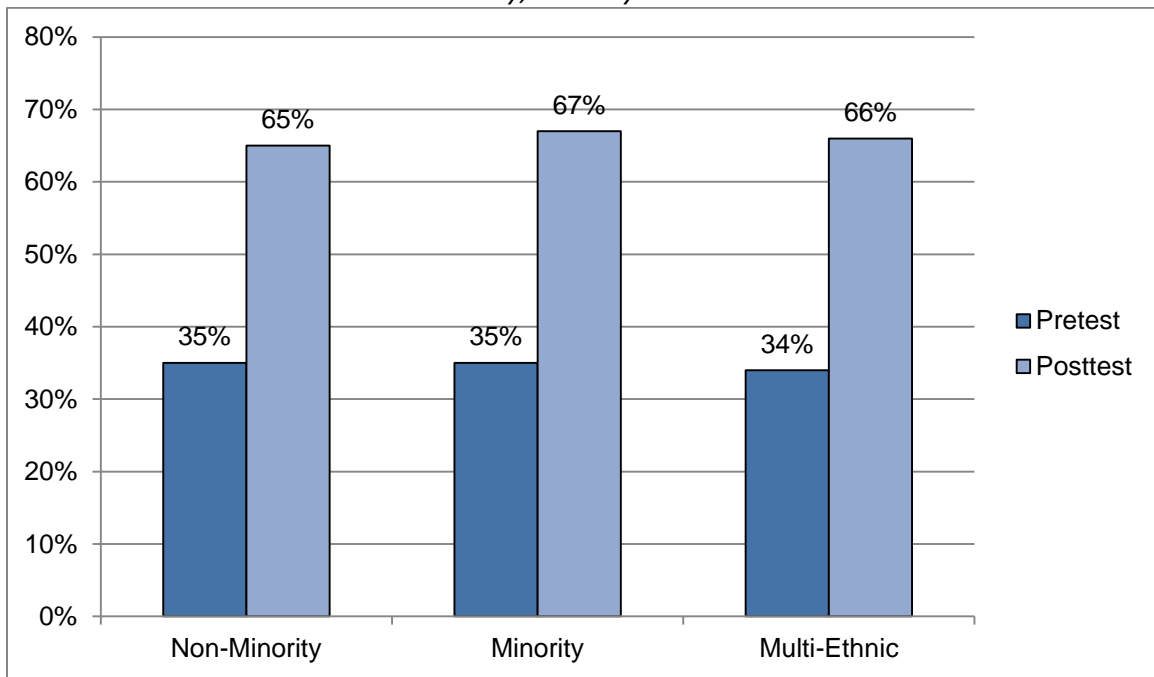


Figure 15: Biology I Module 6
Pretest and Posttest Percent Correct Scores
Non-Minority, Minority & Multi-Ethnic



Module 7

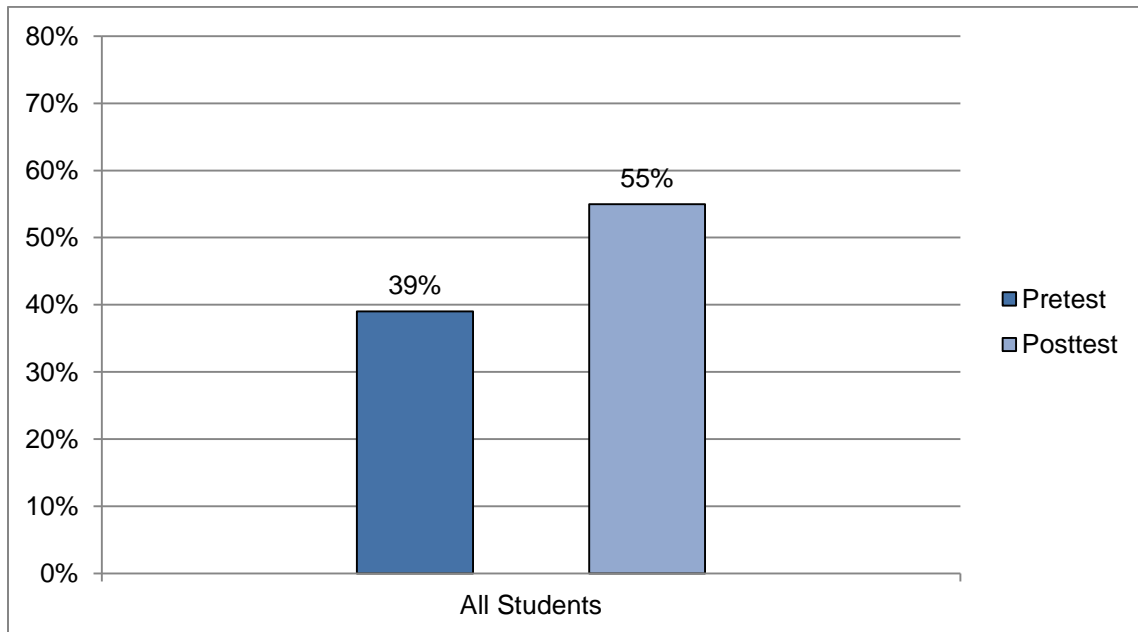
Module 7 is titled “Human Systems.” It covers the major systems in the human body and includes a collaboration option where the students work together to research how a specific disease affects the various systems of the body. Table 11 shows that the increases from pretesting to posttesting were all statistically significant ($\leq .0001$), and the effect sizes were all very large. The no-free reduced lunch students scored higher than the free/reduced lunch students. Other than that difference, it appears there was little difference between the various demographic groups.

Table 11: Biology I Instructional Module 7
Comparison of Pretest to Posttest Percent Correct Scores

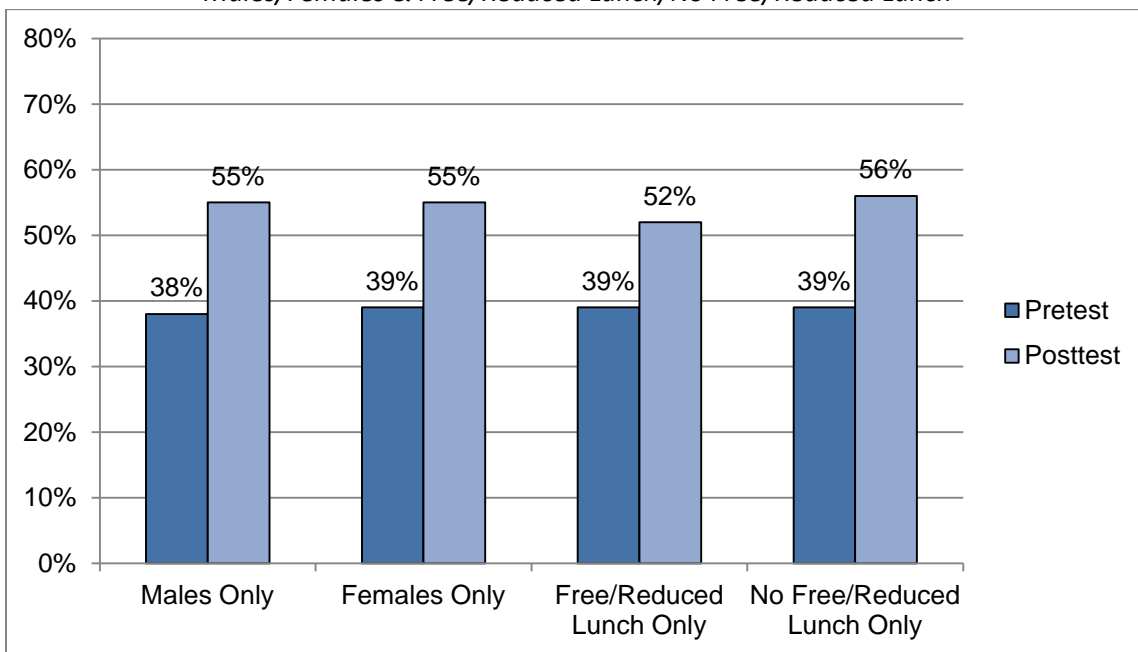
Group	Number	Mean	Standard Deviation	t-Test	Significance	Effect Size
All Students						
Pretest	809	39%	.17	16.545	$\leq .0001$	.77
Posttest	809	55%	.24			
Males Only						
Pretest	365	38%	.18	10.972	$\leq .0001$	.80
Posttest	365	55%	.24			
Females Only						
Pretest	444	39%	.16	12.395	$\leq .0001$	.81
Posttest	444	55%	.23			
Free/Reduced Lunch Only						
Pretest	244	38%	.15	8.275	$\leq .0001$	.77
Posttest	244	52%	.23			
No Free/Reduced Lunch Only						
Pretest	565	39%	.17	14.349	$\leq .0001$	.82
Posttest	565	56%	.24			
Non-Minority Only						
Pretest	443	40%	.17	12.201	$\leq .0001$	.79
Posttest	443	56%	.23			
Minority Only						
Pretest	133	38%	.17	7.241	$\leq .0001$	.89
Posttest	133	56%	.23			
Multi-Ethnic						
Pretest	233	37%	.16	8.507	$\leq .0001$	.74
Posttest	233	53%	.24			

Figures 16, 17, and 18 provide a visual look at the increases. In general the percentage increases were about 15% to 20% for each comparison group.

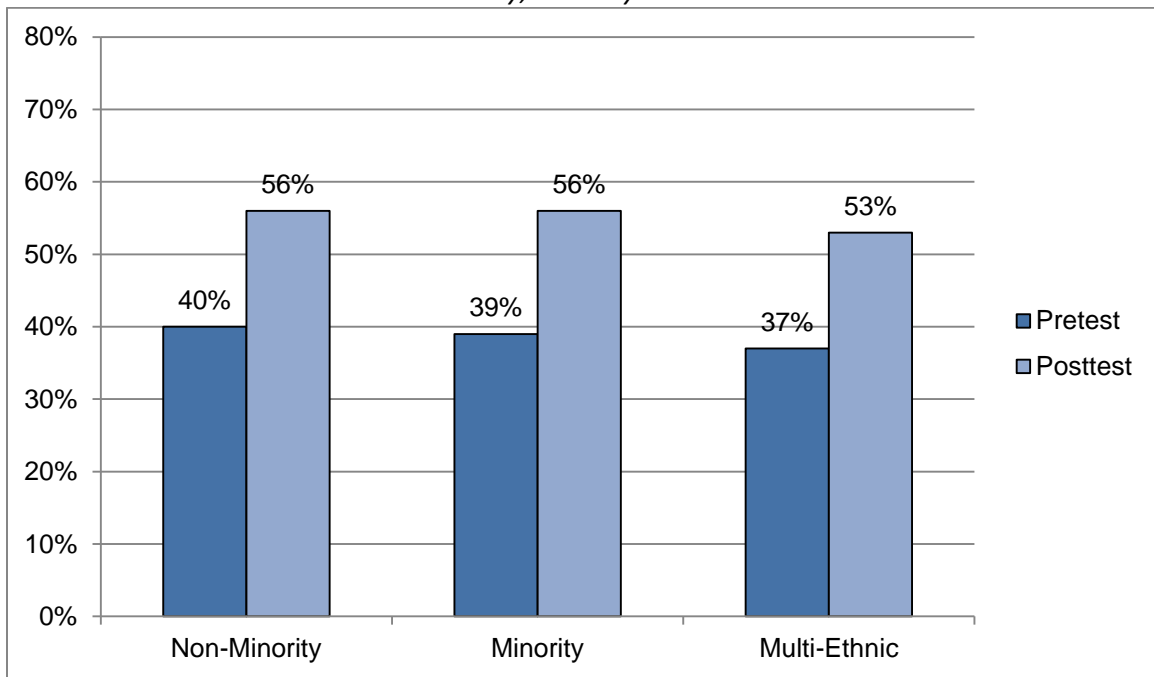
*Figure 16: Biology I Module 7
Pretest and Posttest Percent Correct Scores
All Students*



*Figure 17: Biology I Module 7
Pretest and Posttest Percent Correct Scores
Males/Females & Free/Reduced Lunch/No Free/Reduced Lunch*



*Figure 18: Biology I Module 7
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 Biology I** program increase their knowledge and skills in biology?*

For each of the comparisons across the six 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 medium, large or very large for all of the modules.

The modules and groups that resulted in average effect sizes were module 4 for the multi-ethnic group. For module 7, the total group of students showed an average effect size as did the free/reduced lunch group, the non-minority group, and the multi-ethnic group.

The increases in the percentage of correct responses varied from module to module. These up-and-down differences can be attributed to any of number of different causes. The difficulty of the content of one module may be significantly more difficult than that for another module, and, therefore, the test items for one module may be more difficult than those of another module. It may also be that students were more interested and attentive to the content of one module than to another. When such an up-and-down pattern exists, it is impossible to identify the specific cause, and it is likely that the cause is several factors. Despite the up-and-down results, all of the increases were statistically significant, and the effect sizes were large or very large.

The average percent increase for all students across the nine modules is shown in Table 12.

Table 12: Gain Scores Across Six Modules for All students

Pretest Percent	Posttest Percent	Gain
41%	63%	22%

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

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

Overall, the honors students scored higher than the basic students on the pretests for all modules. The basic and honors students average percent increases across the six modules are shown in Table 13.

Table 13: Gain Scores Across Six Modules for All students

Group	Pretest Percent	Posttest Percent	Gain
Basic	38%	61%	23%
Honors	46%	68%	22%

Although honors students had higher average pretest and average posttest scores than basic students, both groups achieved similar average percentage gains across the six modules.

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

The average percent increase for male and female; higher socio-economic level and lower socio-economic level; and white, minority, and multi-ethnic students across the six modules are shown in Table 14.

Table 14: Gain Scores Across Six Modules for All students

Group	Pretest Percent	Posttest Percent	Gain
Gender Groups			
Male	41%	63%	22%
Female	41%	63%	22%
Socio-Economic Groups			
Lower	39%	57%	18%
Higher	42%	65%	23%
Ethnic Groups			
White	41%	64%	23%
Minority	42%	65%	23%
Multi-Ethnic	40%	61%	21%

The conclusion to question 3 is that there seem to be very minor and non-consistent differences for gender, socio-economic status, and ethnicity. 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 six module pretests and posttests is that all students made statistically significant and large effect size gains from pretesting to posttesting. Honors students scored higher than basic students, but the gains made by each group were similar. The demographic comparisons showed that the program is equally effective regardless of gender, socio-economic status, and ethnicity.