Appendix F

Test Score Data

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Science SOL Results

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Science Standards of Learning Assessments

The Commonwealth of Virginia measures academic achievement through annual Standards of Learning (SOL) tests. Students are expected to take grade-level science assessments in grades 3, 5, and 8 as well as high school end-of-course (EOC) assessments after completing Biology, Chemistry, or Earth Science. Students who wish to earn a standard diploma must earn three science credits, one of which must be verified by the passing of the associated SOL test. Students wishing to earn an advanced diploma must earn four science credits, two of which must be verified.

Sections 1 and 2 present *unadjusted* SOL results for APS for the past five school years, 2008-09 through 2012-13. For purposes of state accountability, the failing scores for certain transfer students, limited English proficient (LEP) students, and students who fail an EOC test the first time are omitted during accreditation calculations. Data that is unadjusted includes these scores.

In order to allow for comparison between APS pass rates and statewide SOL results, section 3 presents *adjusted* SOL results for the past three school years, 2010-11 through 2012-13. In other words, the failing scores for certain transfer students, limited English proficient (LEP) students, and students who fail an EOC test the first time have been omitted. This data comes from the state report cards published on the Virginia Department of Education (VDOE) website.

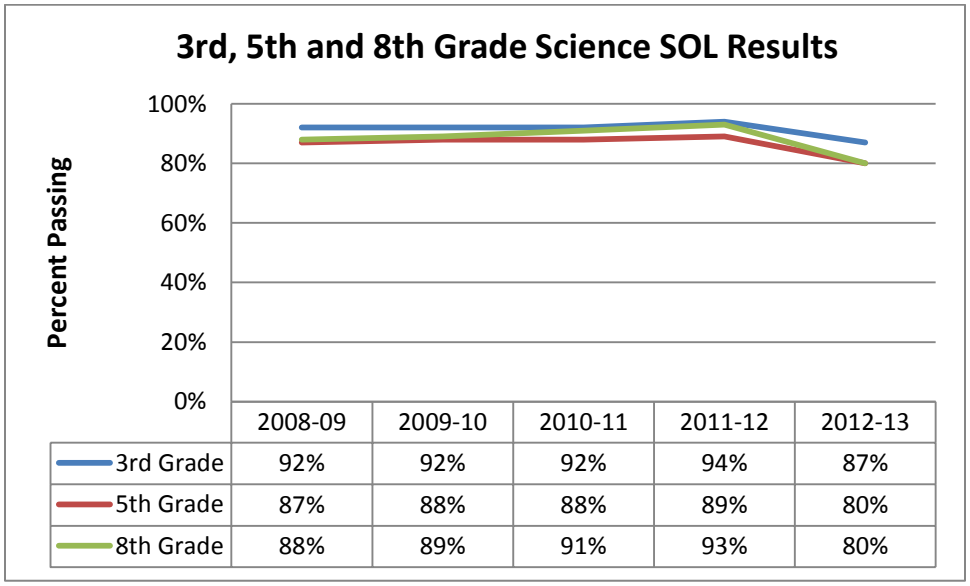
Also, the scores for students with 504 plans have been included with the scores achieved by students classified as disabled in Sections 1 and 2. The scores for students with 504 plans have been included with the scores achieved by students classified as non-disabled in Sections 3, under VDOE accreditation guidelines.

Note on 2012-13 SOL Tests

The Commonwealth of Virginia adopted new Science Standards of Learning in 2010, which were implemented beginning in the 2011-2012 school year. These changes were not substantial in content, with the exception of a new standard in both Kindergarten and Chemistry. The new standards have an increased focus on rigor and higher order thinking skills. These changes were incorporated into the SOL tests in the spring administration of the 2013 SOL test. Another addition to the 2013 test was the inclusion of technology-enhanced items, which had been field-tested the previous year and accounted for approximately 15% of the 2013 test. As a result of these changes, the 2013 results are not comparable to results from previous years. They are included in this report as a baseline for the new assessments.

Section 1: Elementary and Middle School Science SOL Results

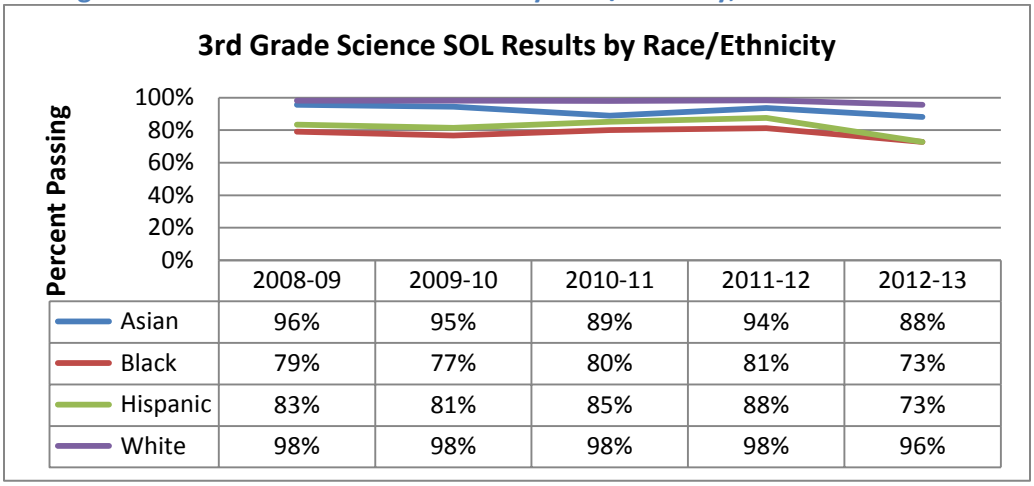
Figure 1: Elementary and Middle School Science SOL Results, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
3rd Grade	92%	92%	92%	94%	87%
5th Grade	87%	88%	88%	89%	80%
8th Grade	88%	89%	91%	93%	80%

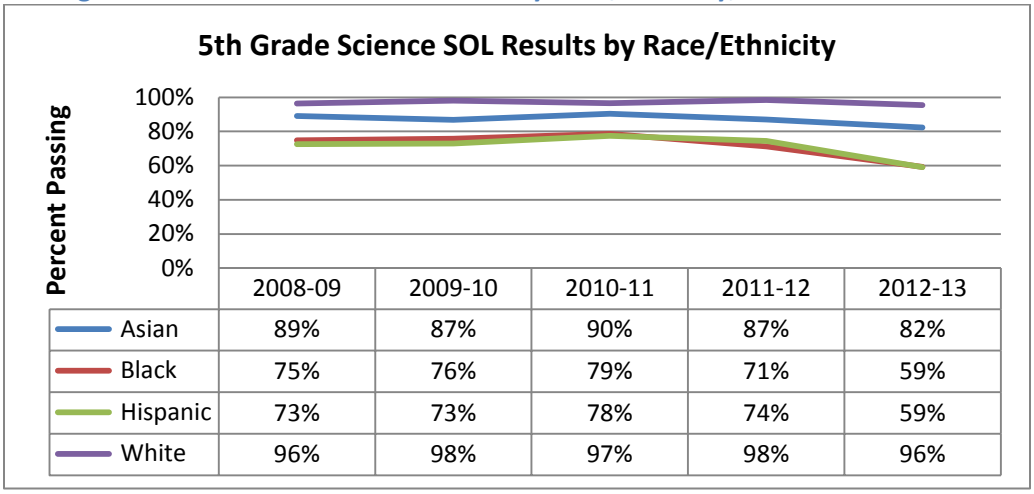
Elementary and Middle School Science SOLs by Race/Ethnicity

Figure 2: Grade 3 Science SOL Results by Race/Ethnicity, 2008-09 to 2012-13



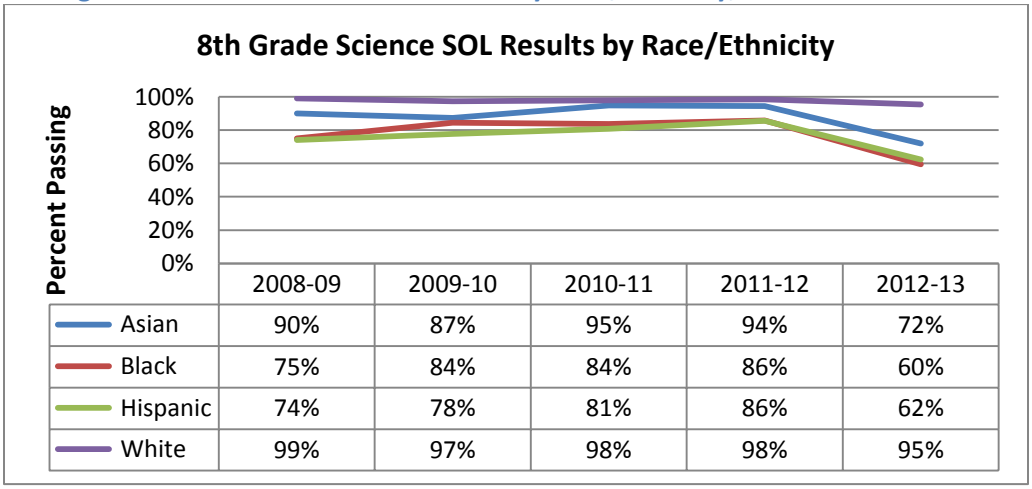
	2008-09	2009-10	2010-11	2011-12	2012-13
Asian	96%	95%	89%	94%	88%
Black	79%	77%	80%	81%	73%
Hispanic	83%	81%	85%	88%	73%
White	98%	98%	98%	98%	96%

Figure 3: Grade 5 Science SOL Results by Race/Ethnicity, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Asian	89%	87%	90%	87%	82%
Black	75%	76%	79%	71%	59%
Hispanic	73%	73%	78%	74%	59%
White	96%	98%	97%	98%	96%

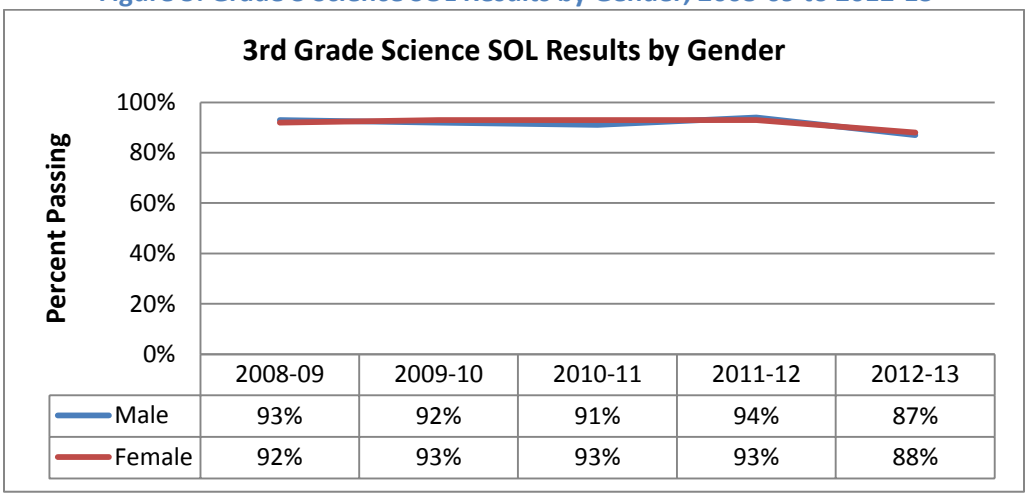
Figure 4: Grade 8 Science SOL Results by Race/Ethnicity, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Asian	90%	87%	95%	94%	72%
Black	75%	84%	84%	86%	60%
Hispanic	74%	78%	81%	86%	62%
White	99%	97%	98%	98%	95%

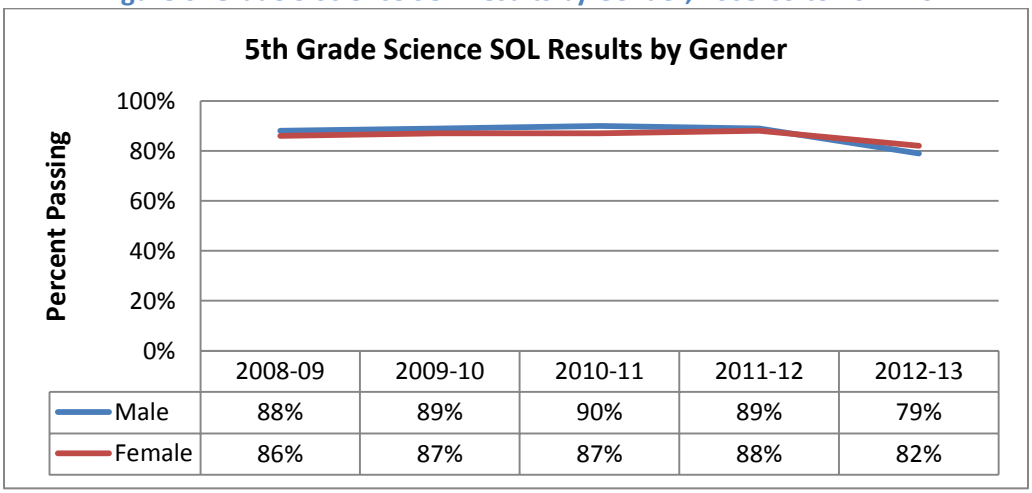
Elementary and Middle School Science SOLs by Gender

Figure 5: Grade 3 Science SOL Results by Gender, 2008-09 to 2012-13



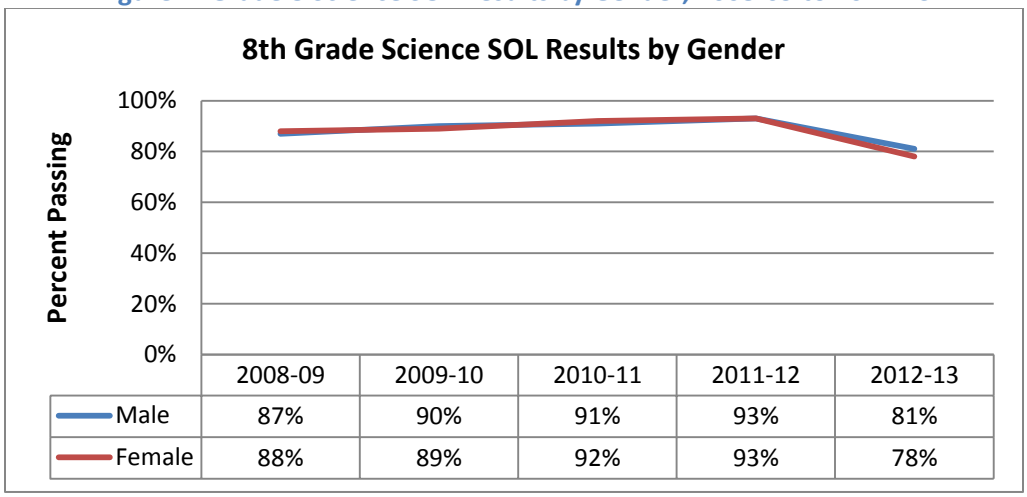
	2008-09	2009-10	2010-11	2011-12	2012-13
Male	93%	92%	91%	94%	87%
Female	92%	93%	93%	93%	88%

Figure 6: Grade 5 Science SOL Results by Gender, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Male	88%	89%	90%	89%	79%
Female	86%	87%	87%	88%	82%

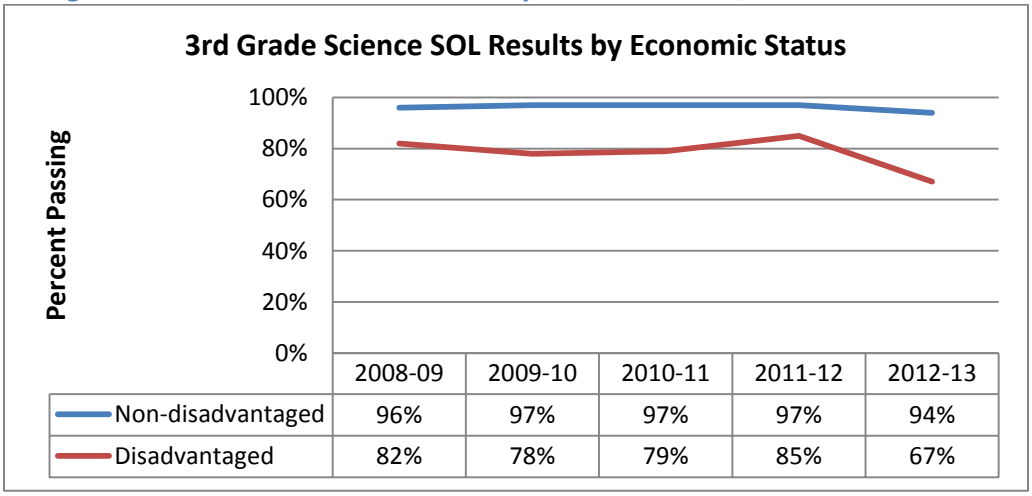
Figure 7: Grade 8 Science SOL Results by Gender, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Male	87%	90%	91%	93%	81%
Female	88%	89%	92%	93%	78%

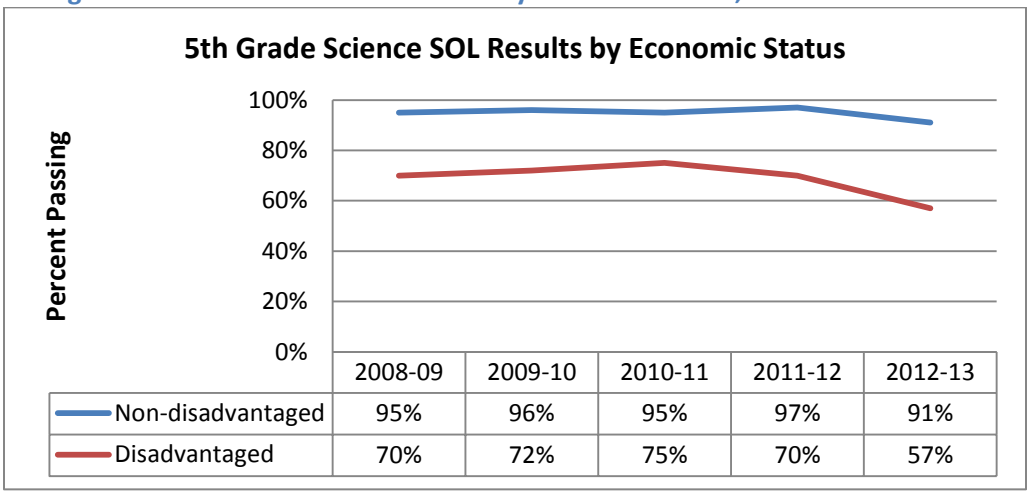
Elementary and Middle School Science SOLs by Economic Status

Figure 8: Grade 3 Science SOL Results by Economic Status, 2008-09 to 2012-13



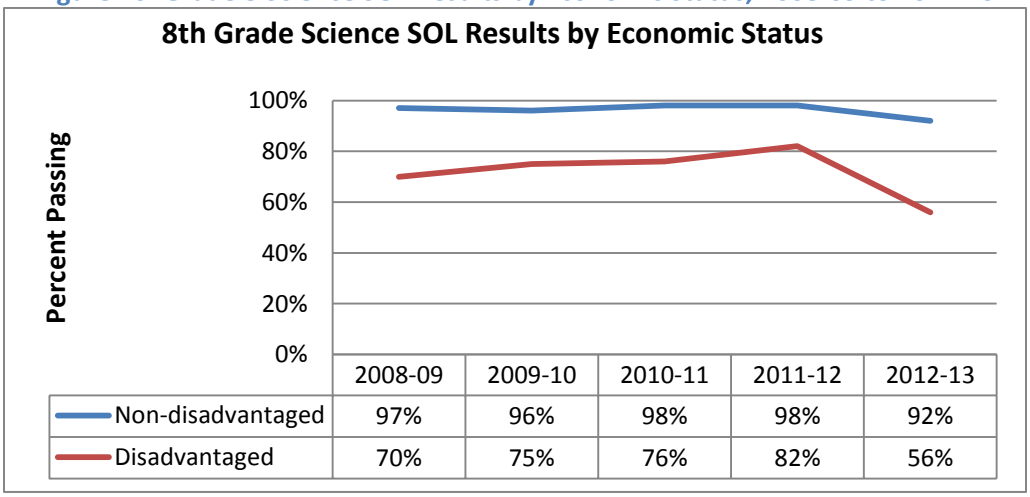
	2008-09	2009-10	2010-11	2011-12	2012-13
Non-disadvantaged	96%	97%	97%	97%	94%
Disadvantaged	82%	78%	79%	85%	67%

Figure 9: Grade 5Science SOL Results by Economic Status, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Non-disadvantaged	95%	96%	95%	97%	91%
Disadvantaged	70%	72%	75%	70%	57%

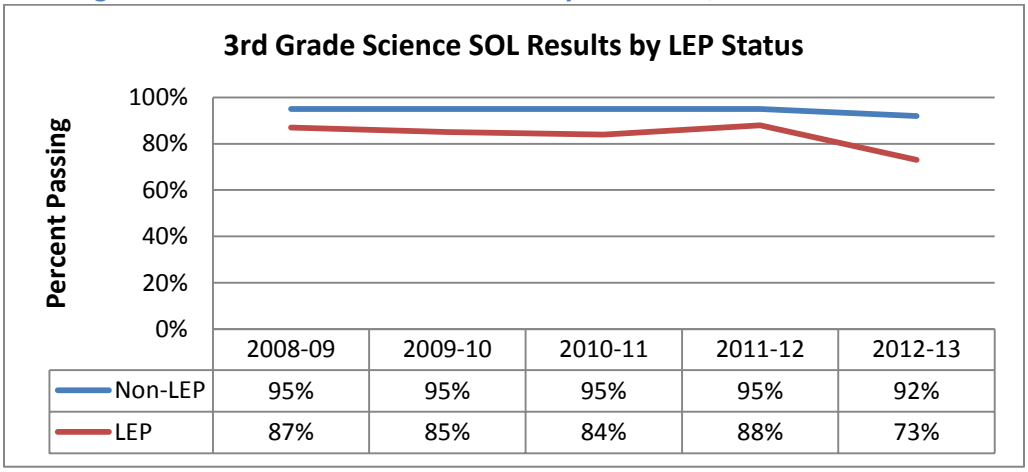
Figure 10: Grade 8 Science SOL Results by Economic Status, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Non-disadvantaged	97%	96%	98%	98%	92%
Disadvantaged	70%	75%	76%	82%	56%

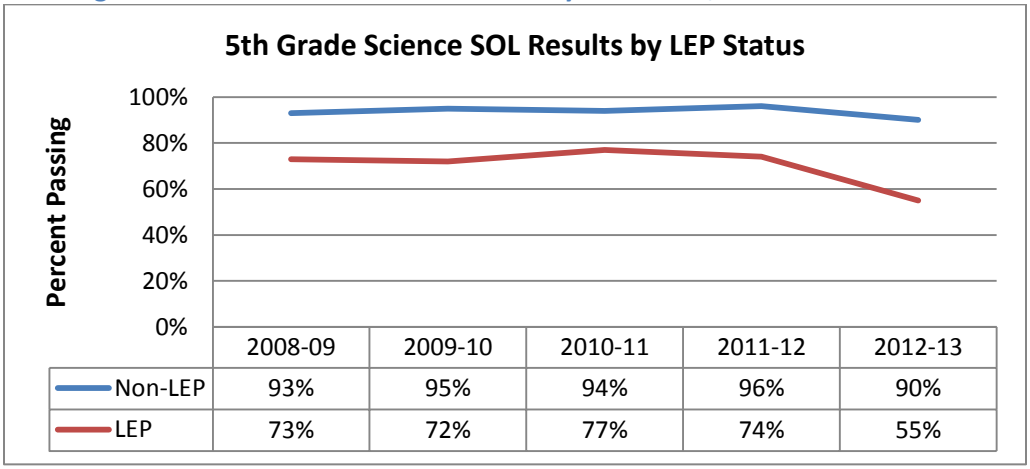
Elementary and Middle School Science SOLs by LEP Status

Figure 11: Grade 3 Science SOL Results by LEP Status, 2008-09 to 2012-13



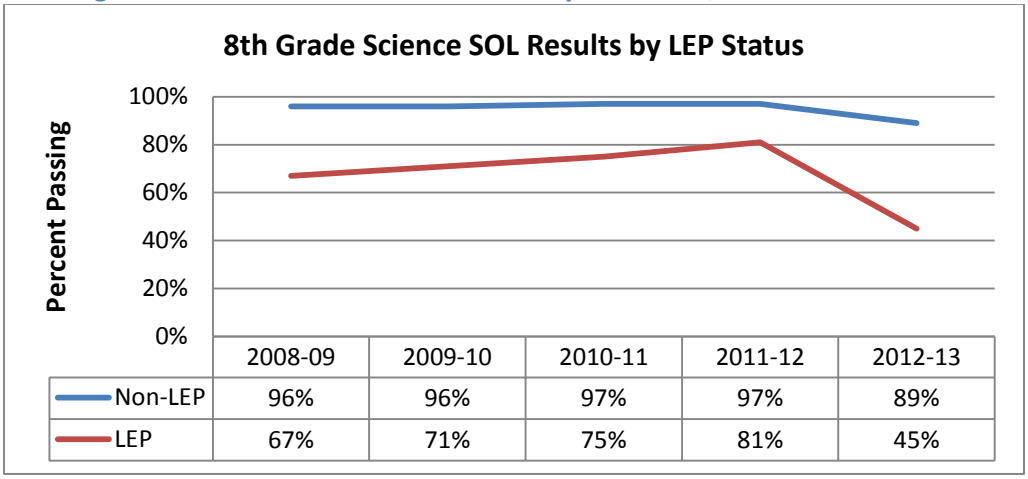
	2008-09	2009-10	2010-11	2011-12	2012-13
Non-LEP	95%	95%	95%	95%	92%
LEP	87%	85%	84%	88%	73%

Figure 12: Grade 5 Science SOL Results by LEP Status, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Non-LEP	93%	95%	94%	96%	90%
LEP	73%	72%	77%	74%	55%

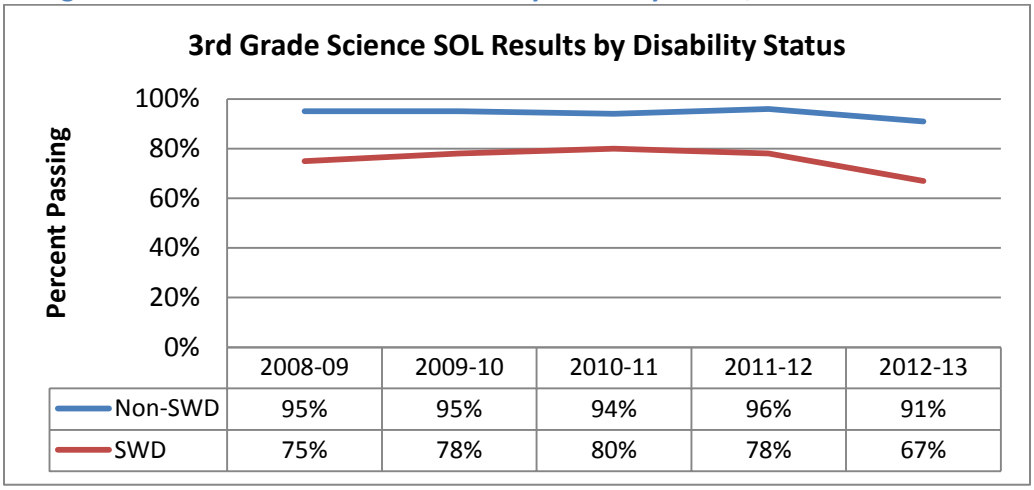
Figure 13: Grade 8 Science SOL Results by LEP Status, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Non-LEP	96%	96%	97%	97%	89%
LEP	67%	71%	75%	81%	45%

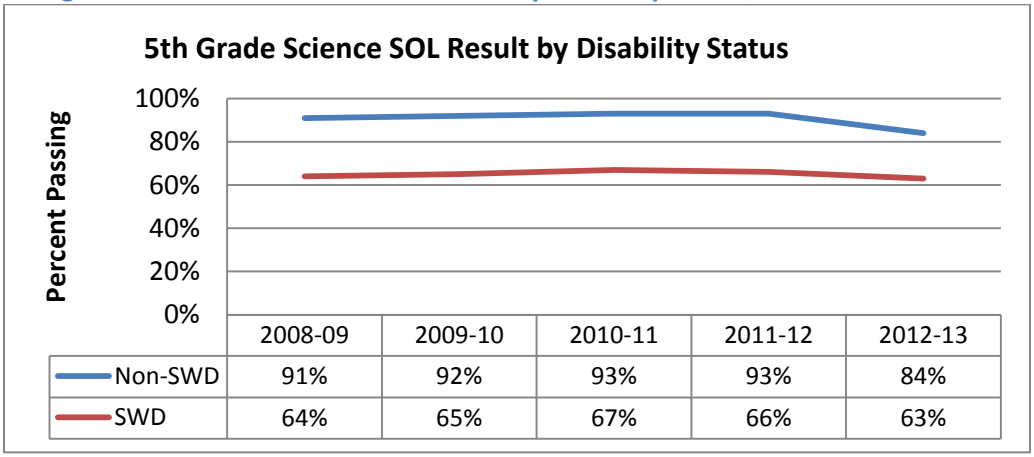
Elementary and Middle School Science SOLs by Disability Status

Figure 14: Grade 3 Science SOL Results by Disability Status, 2008-09 to 2012-13



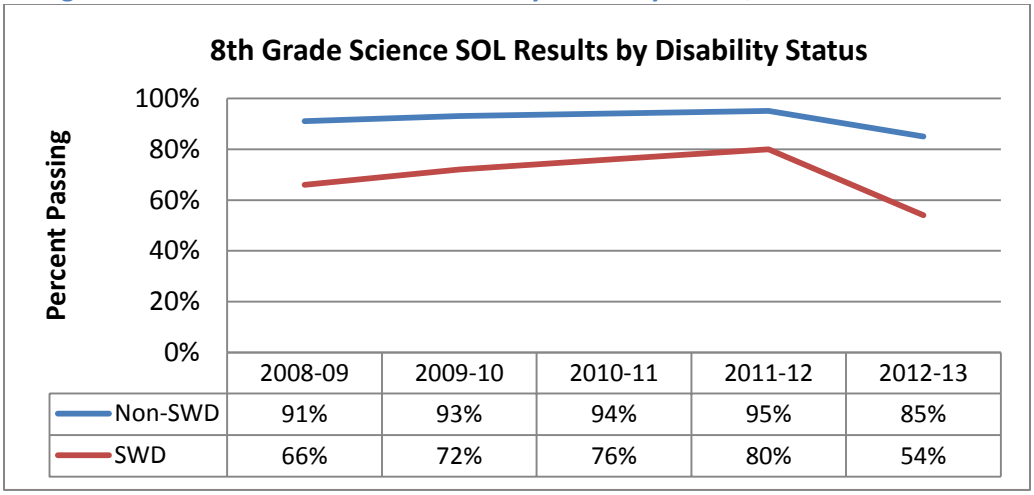
	2008-09	2009-10	2010-11	2011-12	2012-13
Non-SWD	95%	95%	94%	96%	91%
SWD	75%	78%	80%	78%	67%

Figure 15: Grade 5 Science SOL Results by Disability Status, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Non-SWD	91%	92%	93%	93%	84%
SWD	64%	65%	67%	66%	63%

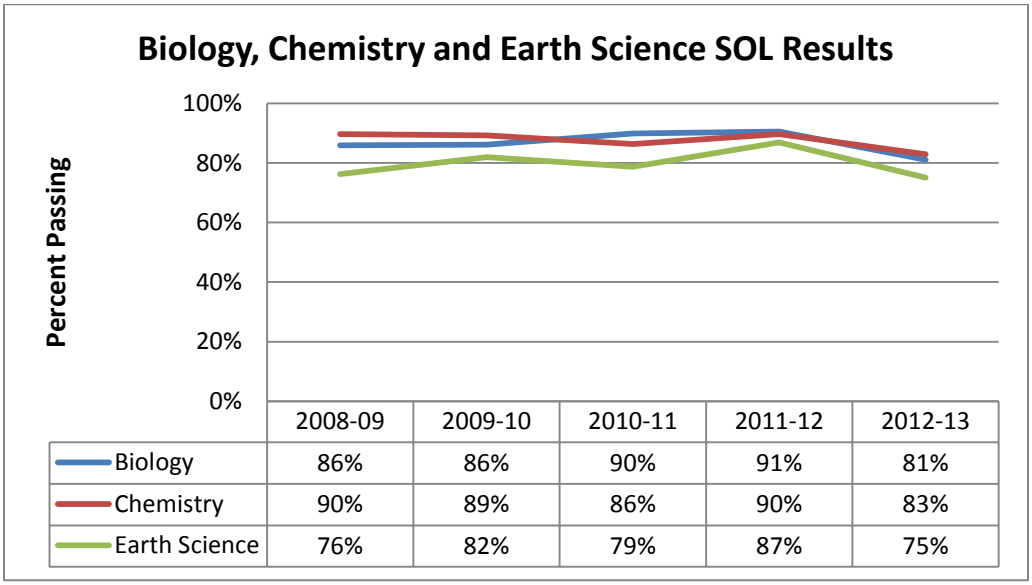
Figure 16: Grade 8 Science SOL Results by Disability Status, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Non-SWD	91%	93%	94%	95%	85%
SWD	66%	72%	76%	80%	54%

Section 2: High School Science SOL Results

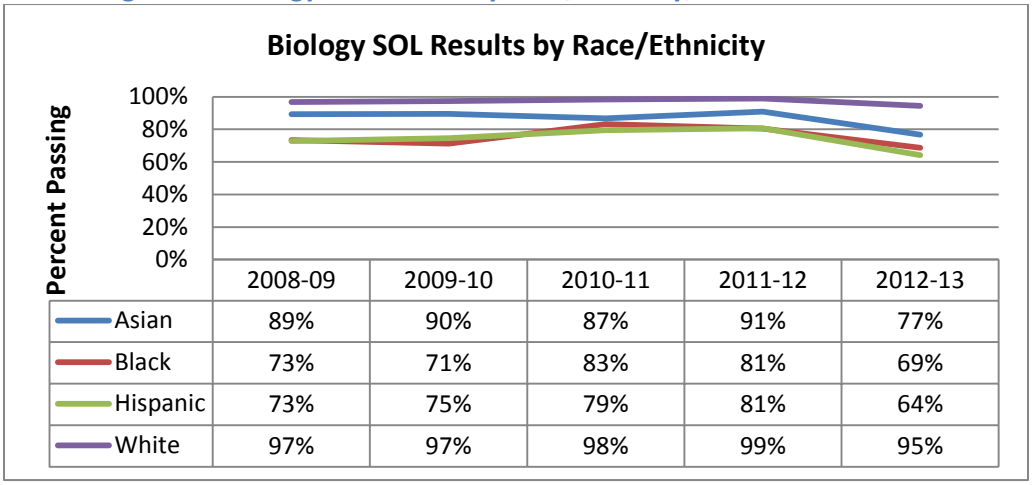
Figure 17: High School Science SOL Results, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Biology	86%	86%	90%	91%	81%
Chemistry	90%	89%	86%	90%	83%
Earth Science	76%	82%	79%	87%	75%

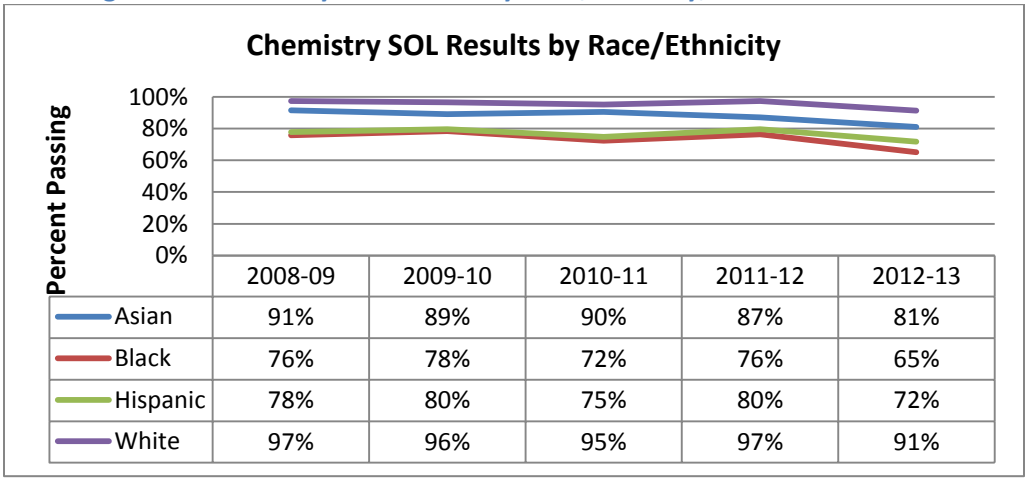
High School Science SOLs by Test and Race/Ethnicity

Figure 18: Biology SOL Results by Race/Ethnicity, 2008-09 to 2012-13



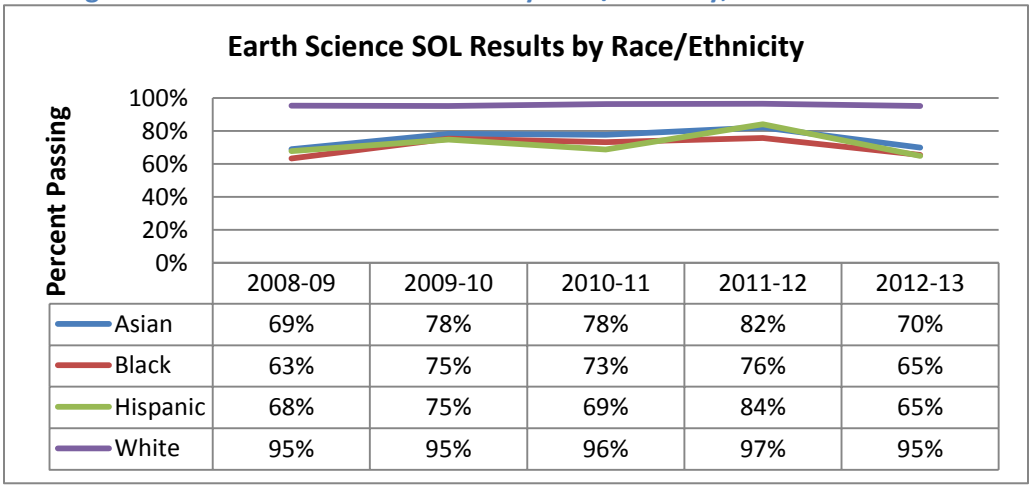
	2008-09	2009-10	2010-11	2011-12	2012-13
Asian	89%	90%	87%	91%	77%
Black	73%	71%	83%	81%	69%
Hispanic	73%	75%	79%	81%	64%
White	97%	97%	98%	99%	95%

Figure 19: Chemistry SOL Results by Race/Ethnicity, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Asian	91%	89%	90%	87%	81%
Black	76%	78%	72%	76%	65%
Hispanic	78%	80%	75%	80%	72%
White	97%	96%	95%	97%	91%

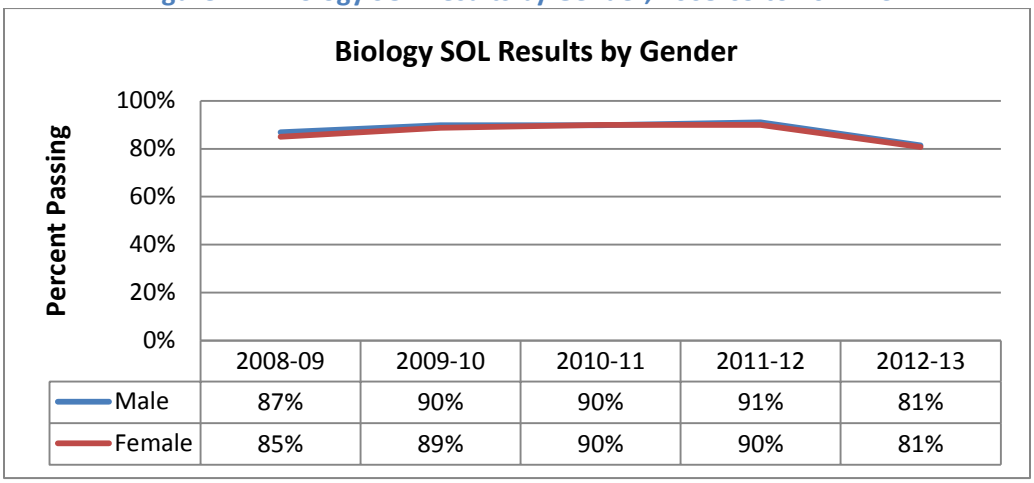
Figure 20: Earth Science SOL Results by Race/Ethnicity, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Asian	69%	78%	78%	82%	70%
Black	63%	75%	73%	76%	65%
Hispanic	68%	75%	69%	84%	65%
White	95%	95%	96%	97%	95%

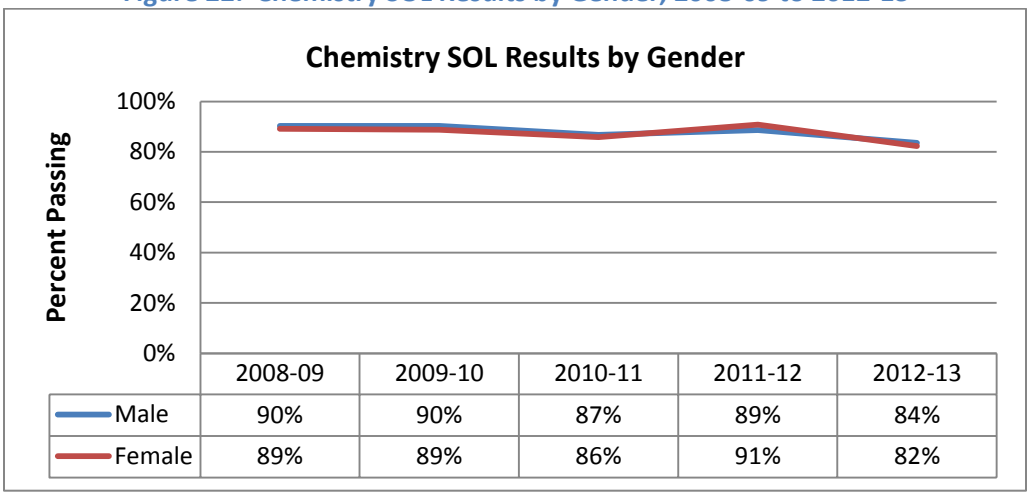
High School Science SOLs by Gender

Figure 21: Biology SOL Results by Gender, 2008-09 to 2012-13



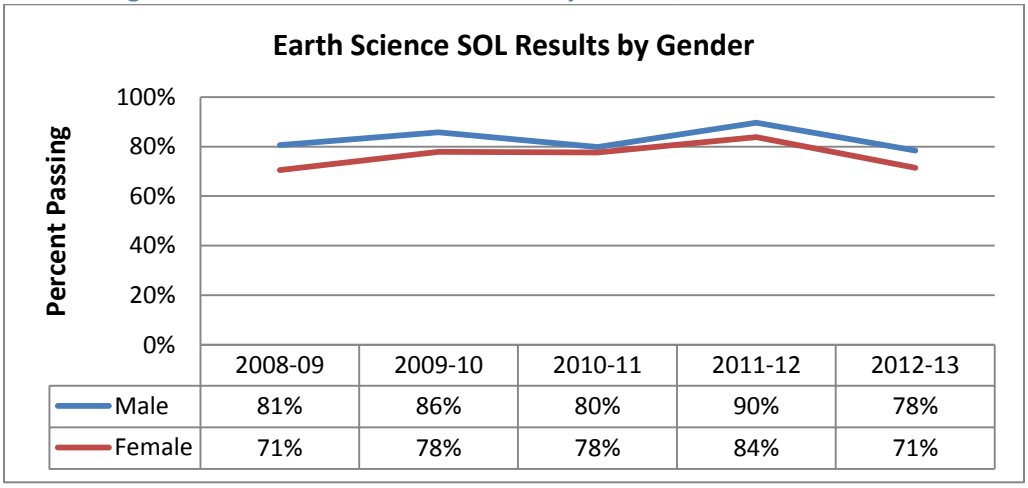
	2008-09	2009-10	2010-11	2011-12	2012-13
Male	87%	90%	90%	91%	81%
Female	85%	89%	90%	90%	81%

Figure 22: Chemistry SOL Results by Gender, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Male	90%	90%	87%	89%	84%
Female	89%	89%	86%	91%	82%

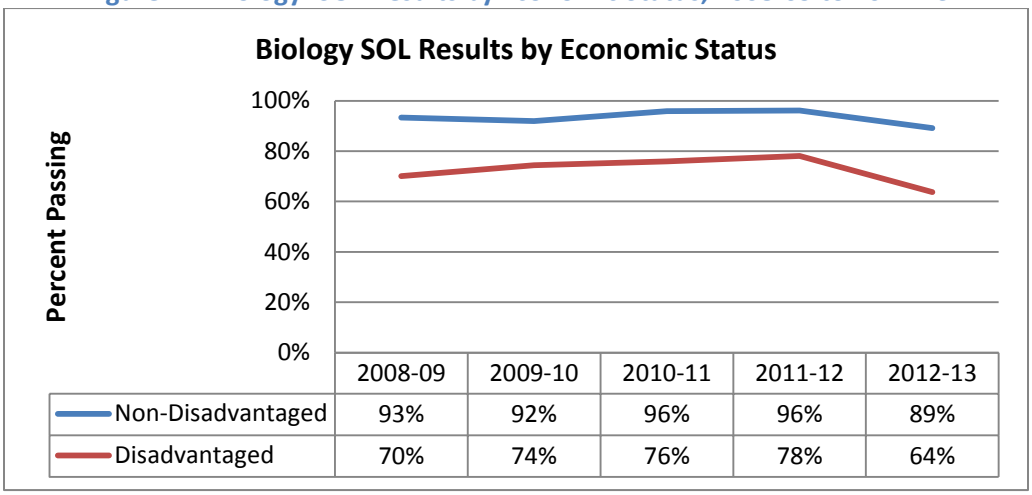
Figure 23: Earth Science SOL Results by Gender, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Male	81%	86%	80%	90%	78%
Female	71%	78%	78%	84%	71%

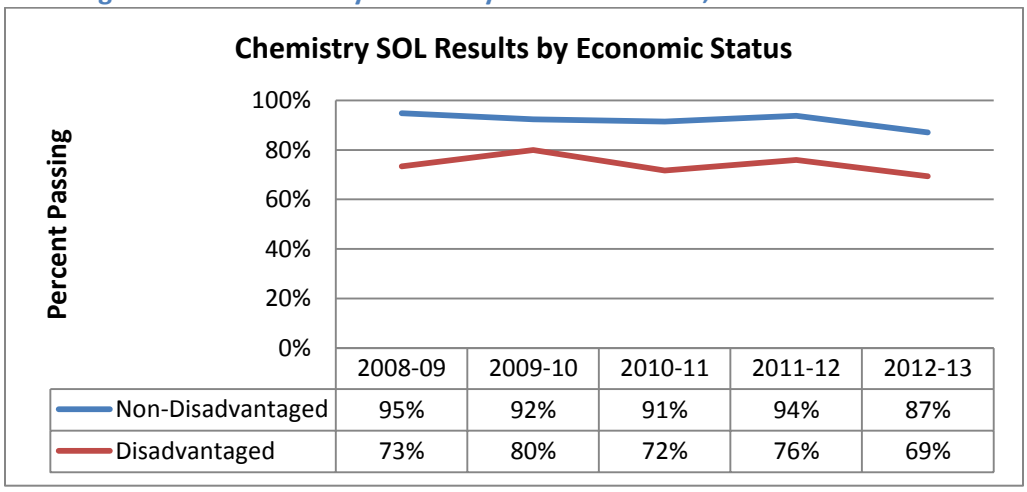
High School Science SOLs by Economic Status

Figure 24: Biology -SOL Results by Economic Status, 2008-09 to 2012-13



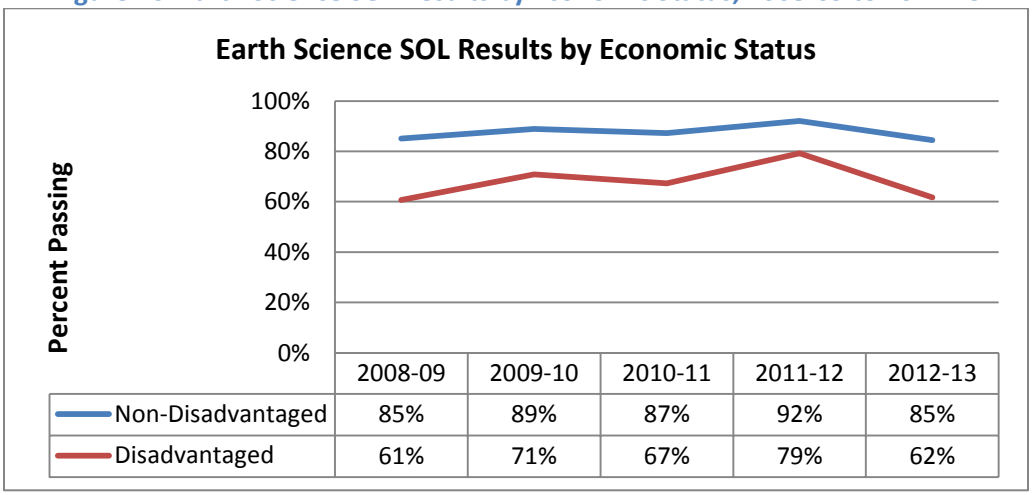
	2008-09	2009-10	2010-11	2011-12	2012-13
Non-Disadvantaged	93%	92%	96%	96%	89%
Disadvantaged	70%	74%	76%	78%	64%

Figure 25: 7th Chemistry Results by Economic Status, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Non-Disadvantaged	95%	92%	91%	94%	87%
Disadvantaged	73%	80%	72%	76%	69%

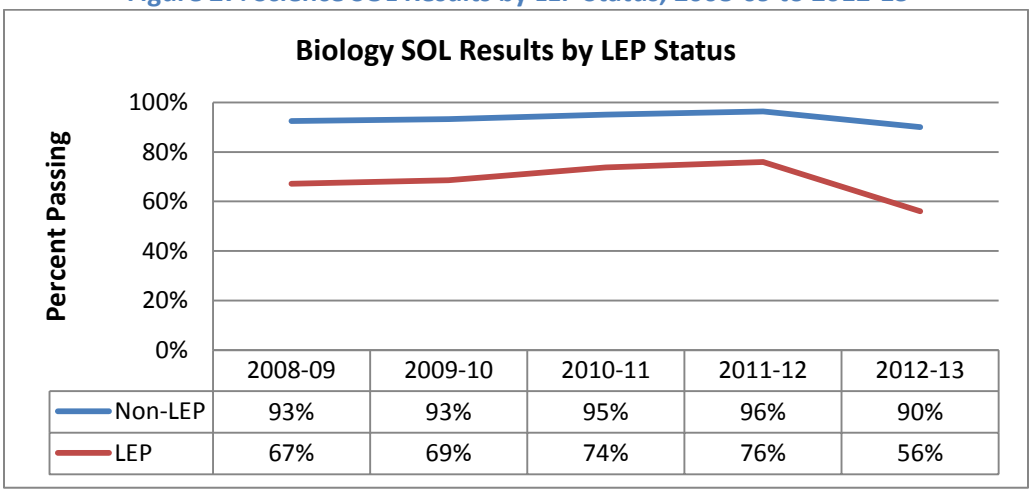
Figure 26: Earth Science SOL Results by Economic Status, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Non-Disadvantaged	85%	89%	87%	92%	85%
Disadvantaged	61%	71%	67%	79%	62%

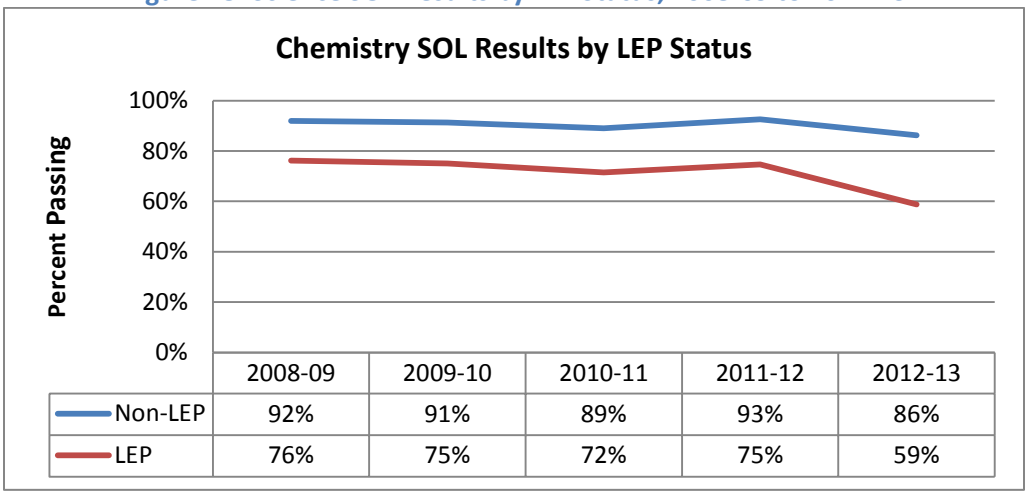
High School Science SOLs by LEP Status

Figure 27: Science SOL Results by LEP Status, 2008-09 to 2012-13



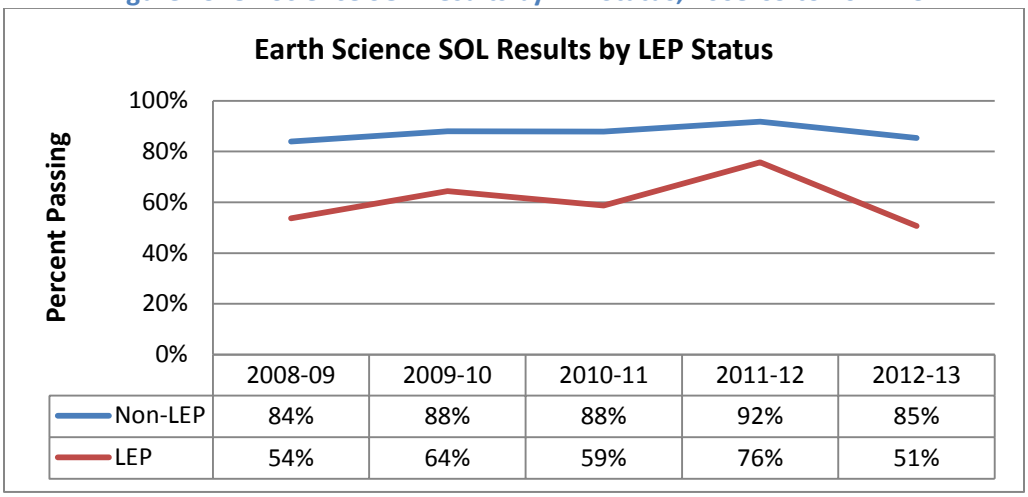
	2008-09	2009-10	2010-11	2011-12	2012-13
Non-LEP	93%	93%	95%	96%	90%
LEP	67%	69%	74%	76%	56%

Figure 28: Science SOL Results by LEP Status, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Non-LEP	92%	91%	89%	93%	86%
LEP	76%	75%	72%	75%	59%

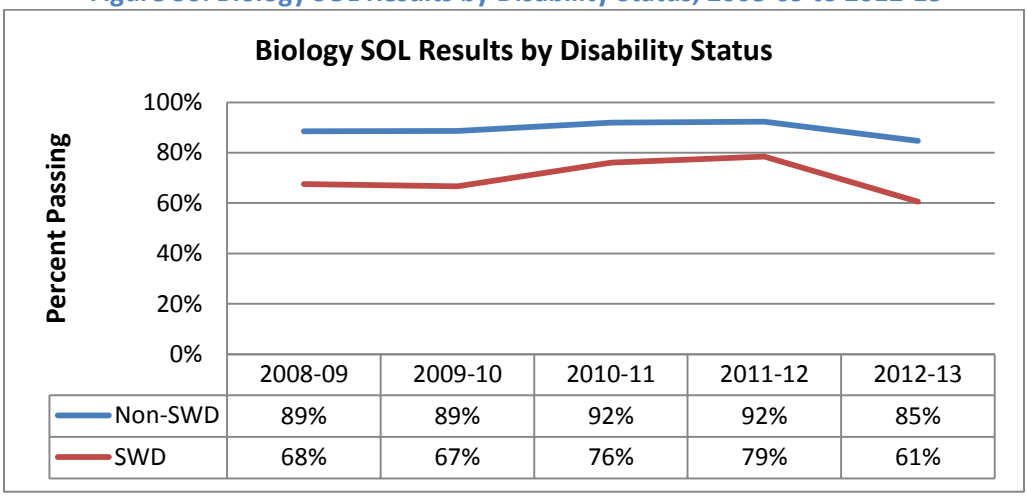
Figure 29: 8th Science SOL Results by LEP Status, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Non-LEP	84%	88%	88%	92%	85%
LEP	54%	64%	59%	76%	51%

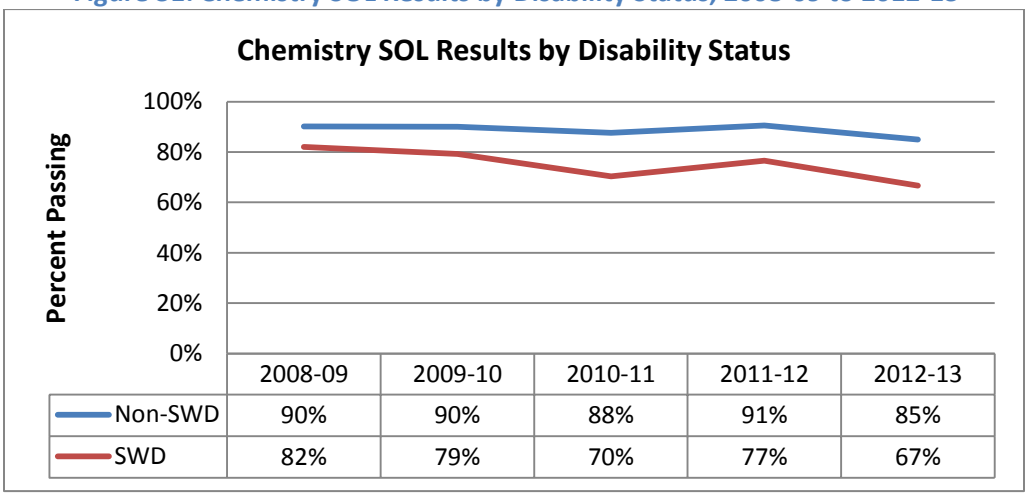
High School Science SOLs by Disability Status

Figure 30: Biology SOL Results by Disability Status, 2008-09 to 2012-13



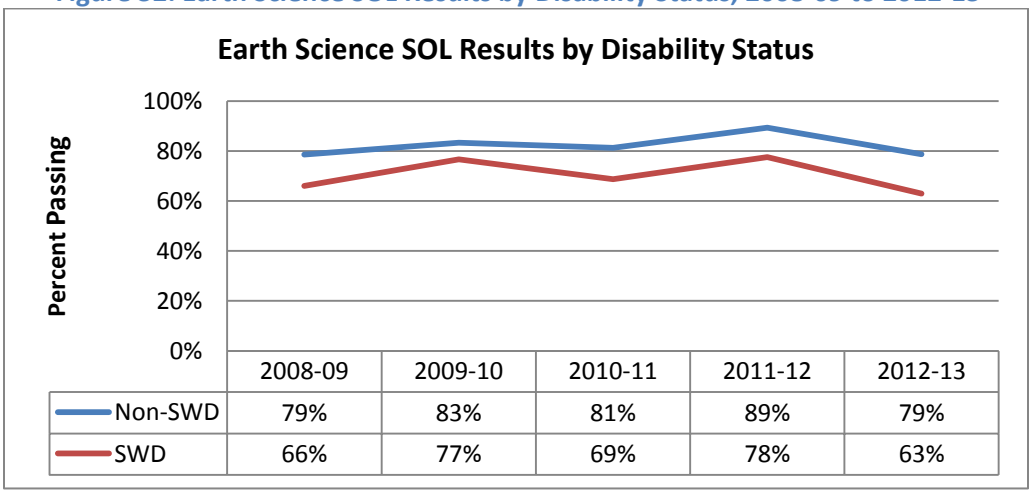
	2008-09	2009-10	2010-11	2011-12	2012-13
Non-SWD	89%	89%	92%	92%	85%
SWD	68%	67%	76%	79%	61%

Figure 31: Chemistry SOL Results by Disability Status, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Non-SWD	90%	90%	88%	91%	85%
SWD	82%	79%	70%	77%	67%

Figure 32: Earth Science SOL Results by Disability Status, 2008-09 to 2012-13



	2008-09	2009-10	2010-11	2011-12	2012-13
Non-SWD	79%	83%	81%	89%	79%
SWD	66%	77%	69%	78%	63%

Section 3: Adjusted Statewide Science SOL Results

Adjusted Elementary and Middle School Science SOL Results

Figure 33: Grade 3 Science SOL Results in APS and Virginia, 2010-11 to 2012-13

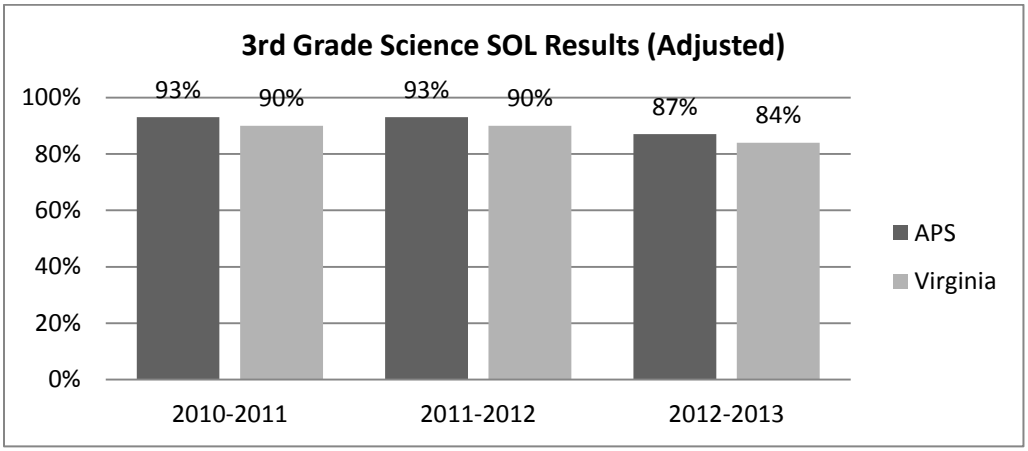


Figure 34: Grade 5 Science SOL Results in APS and Virginia, 2010-11 to 2012-13

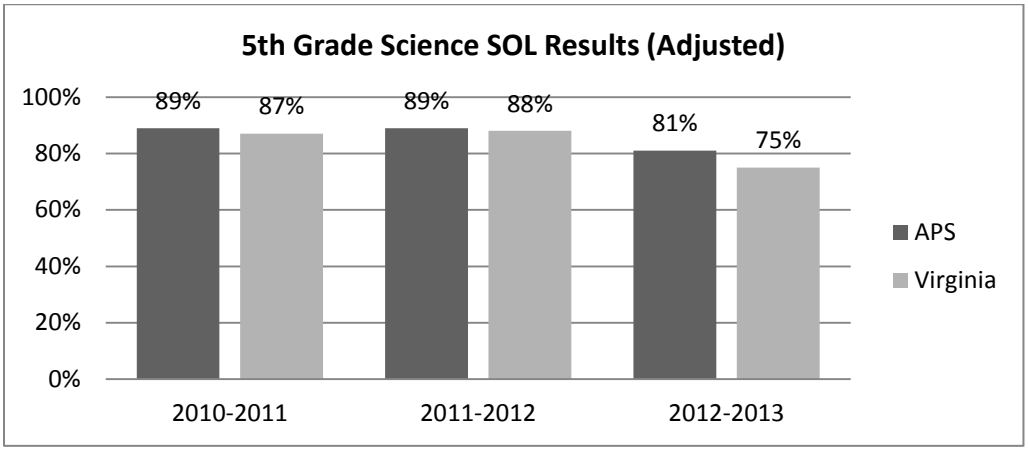
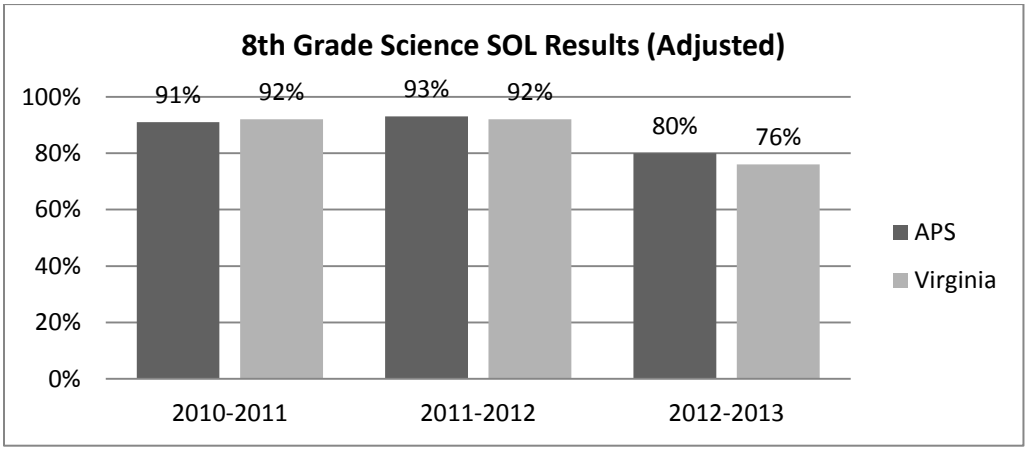


Figure 35: Grade 8 Science SOL Results in APS and Virginia, 2010-11 to 2012-13



Adjusted High School Science SOL Results

Figure 36: Biology SOL Results in APS and Virginia, 2010-11 to 2012-13

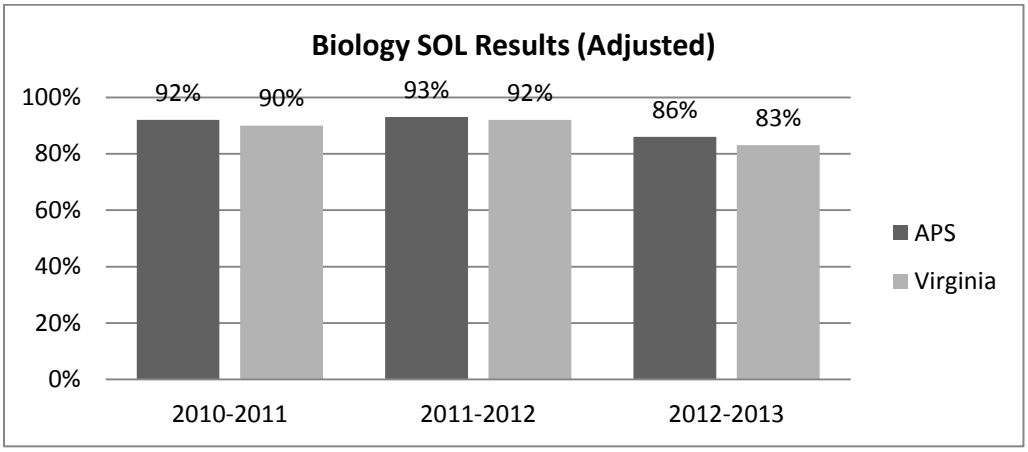


Figure 37: Chemistry SOL Results in APS and Virginia, 2010-11 to 2012-13

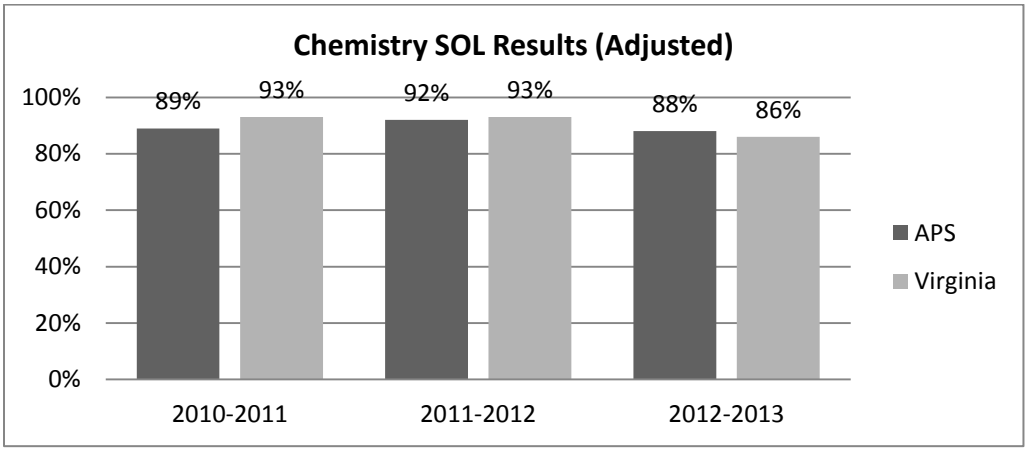
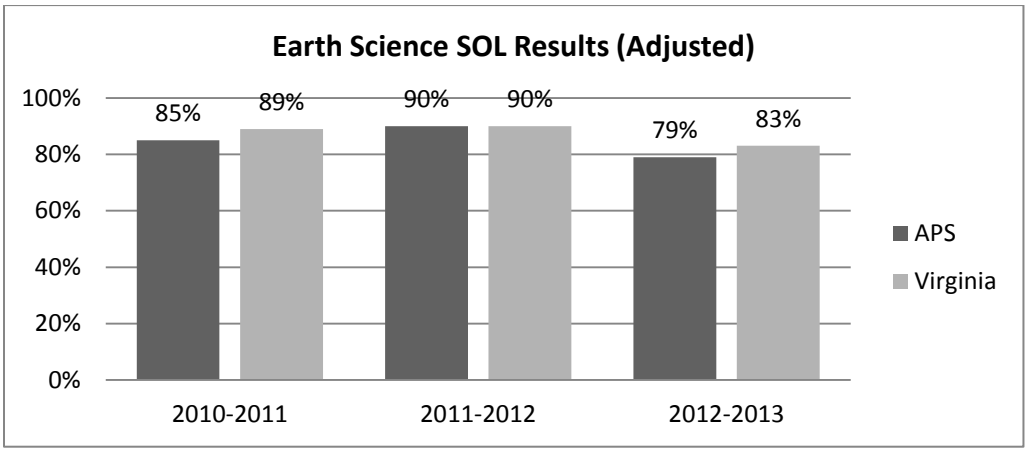


Figure 38: Earth Science SOL Results in APS and Virginia, 2010-11 to 2012-13



Adjusted Elementary and Middle School Science SOL Results by Demographic Variables

Table 1: Grade 3 Science SOL Results in APS and Virginia by Demographic Variables, 2010-11 to 2012-13

Student Subgroup	Location	2010-2011	2011-2012	2012-2013
All Students	APS	93%	93%	87%
	Virginia	90%	90%	84%
Female	APS	94%	93%	88%
	Virginia	90%	90%	83%
Male	APS	92%	94%	86%
	Virginia	89%	89%	84%
Black	APS	82%	80%	73%
	Virginia	80%	80%	69%
Hispanic	APS	86%	87%	72%
	Virginia	86%	87%	79%
White	APS	98%	98%	95%
	Virginia	94%	94%	89%
Asian	APS	89%	94%	87%
	Virginia	95%	96%	94%
SWD	APS	82%	75%	62%
	Virginia	73%	72%	60%
Disadvantaged	APS	80%	85%	67%
	Virginia	82%	82%	72%
LEP	APS	85%	88%	72%
	Virginia	84%	86%	78%

Table 2: Grade 5 Science SOL Results in APS and Virginia by Demographic Variables, 2010-11 to 2012-13

Student Subgroup	Location	2010-2011	2011-2012	2012-2013
All Students	APS	89%	89%	81%
	Virginia	87%	88%	75%
Female	APS	87%	88%	82%
	Virginia	86%	88%	75%
Male	APS	90%	89%	79%
	Virginia	88%	88%	76%
Black	APS	79%	72%	61%
	Virginia	77%	79%	60%
Hispanic	APS	78%	75%	59%
	Virginia	78%	79%	63%
White	APS	97%	98%	96%
	Virginia	92%	93%	84%
Asian	APS	91%	86%	81%
	Virginia	92%	93%	86%
SWD	APS	67%	64%	60%
	Virginia	64%	65%	47%
Disadvantaged	APS	76%	70%	57%
	Virginia	77%	79%	61%
LEP	APS	77%	75%	55%
	Virginia	71%	73%	53%

Table 3: Grade 8 Science SOL Results in APS and Virginia by Demographic Variables, 2010-11 to 2012-13

Student Subgroup	Location	2010-2011	2011-2012	2012-2013
All Students	APS	91%	93%	80%
	Virginia	92%	92%	76%
Female	APS	92%	94%	78%
	Virginia	92%	92%	74%
Male	APS	91%	93%	81%
	Virginia	92%	92%	78%
Black	APS	85%	86%	60%
	Virginia	84%	84%	56%
Hispanic	APS	81%	86%	62%
	Virginia	86%	85%	66%
White	APS	97%	98%	95%
	Virginia	96%	96%	85%
Asian	APS	95%	95%	73%
	Virginia	96%	96%	88%
SWD	APS	74%	79%	50%
	Virginia	72%	70%	43%
Disadvantaged	APS	76%	83%	56%
	Virginia	85%	84%	59%
LEP	APS	75%	82%	45%
	Virginia	80%	79%	46%

Adjusted High School Science SOL Results by Demographic Variables

Table 4: Biology SOL Pass Rates in APS and Virginia by Demographic Variables, 2010-11 to 2012-13

Student Subgroup	Location	2010-2011	2011-2012	2012-2013
All Students	APS	92%	93%	86%
	Virginia	90%	92%	83%
Female	APS	92%	93%	86%
	Virginia	91%	92%	83%
Male	APS	91%	93%	86%
	Virginia	90%	91%	82%
Black	APS	85%	86%	74%
	Virginia	81%	84%	68%
Hispanic	APS	83%	85%	73%
	Virginia	84%	86%	73%
White	APS	99%	99%	97%
	Virginia	95%	96%	89%
Asian	APS	90%	95%	86%
	Virginia	95%	96%	91%
SWD	APS	74%	80%	62%
	Virginia	67%	70%	50%
Disadvantaged	APS	81%	84%	72%
	Virginia	81%	84%	68%
LEP	APS	78%	83%	68%
	Virginia	77%	81%	59%

Table 5: Chemistry SOL Pass Rates in APS and Virginia by Demographic Variables, 2010-11 to 2012-13

Student Subgroup	Location	2010-2011	2011-2012	2012-2013
All Students	APS	89%	92%	88%
	Virginia	93%	93%	86%
Female	APS	88%	93%	87%
	Virginia	93%	92%	85%
Male	APS	90%	91%	89%
	Virginia	94%	93%	87%
Black	APS	80%	83%	71%
	Virginia	87%	87%	74%
Hispanic	APS	78%	84%	76%
	Virginia	85%	84%	74%
White	APS	97%	98%	96%
	Virginia	96%	96%	90%
Asian	APS	92%	91%	90%
	Virginia	96%	96%	93%
SWD	APS	77%	79%	68%
	Virginia	77%	75%	61%
Disadvantaged	APS	76%	84%	76%
	Virginia	87%	86%	74%
LEP	APS	76%	83%	68%
	Virginia	81%	80%	65%

Table 6: Earth Science SOL Pass Rates in APS and Virginia by Demographic Variables, 2010-11 to 2012-13

Student Subgroup	Location	2010-2011	2011-2012	2012-2013
All Students	APS	85%	90%	79%
	Virginia	89%	90%	83%
Female	APS	84%	87%	75%
	Virginia	89%	90%	82%
Male	APS	86%	94%	83%
	Virginia	90%	91%	84%
Black	APS	81%	83%	73%
	Virginia	80%	81%	69%
Hispanic	APS	78%	86%	70%
	Virginia	85%	86%	76%
White	APS	97%	98%	96%
	Virginia	94%	95%	90%
Asian	APS	84%	90%	76%
	Virginia	93%	93%	88%
SWD	APS	75%	79%	66%
	Virginia	68%	70%	55%
Disadvantaged	APS	78%	85%	69%
	Virginia	81%	83%	71%
LEP	APS	71%	81%	56%
	Virginia	75%	77%	61%

Effects of Delivery Model and Instructional Hours on Elementary Science Proficiency

Prepared for Arlington Public Schools

May 2014



In this report, Hanover Research investigates how changing the mode of instructional delivery and the number of instructional contact hours may affect student outcomes on third and fifth grade standardized tests in science.

HANOVER RESEARCH

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EXECUTIVE SUMMARY & KEY FINDINGS

INTRODUCTION

In this report, Hanover Research analyzes Arlington Public Schools' (APS) third and fifth grade student performance on the Virginia Standards of Learning (SOL) exam in science.[1] We use a linear regression model to measure the effect of various instructional delivery models and average instructional contact hours on student outcomes. Using data on third and fifth grade students, we examine scale scores, pass/fail status, and proficiency ratings.

KEY FINDINGS

- **Among third graders**, none of the coefficients on the variables of interest are significant using a 95 percent confidence interval. This implies that, in our sample of third grade students, **the effects of both instructional model and average hours of instruction are not statistically different from zero after controlling for other factors**. Notably, we observe significant coefficients on most of our demographic control variables, which suggests that **variation in instructional models and in average hours of instruction cannot explain third grade outcomes as well as variation among students themselves**.
- Across all three models of fifth-grade students, **Average Hours of Instruction is both positive and statistically significant** using a 99 percent confidence interval. This is **strong evidence that fifth-grade students who have additional instruction hours in science can be expected to earn higher scores on the SOL test** and thus to have higher probabilities both of passing and of passing at an advanced level.
- **"Classroom Teacher" seems to be the best instructional model for fifth grade students.** For fifth graders, with scale score as the outcome variable, each instructional model has a lower outcome score compared to classroom teacher (Instructional Model One). These results suggest that other types of instructional delivery may be correlated with worse outcomes on the SOL tests in science. For third graders, no single instructional model appears to be superior (or inferior) than the other models.
- Demographic characteristics are correlated with SOL outcomes: For both grades, students with LEP status, economically disadvantaged students, students with SPED status, and black and Hispanic students have lower SOL science score outcomes than their comparison groups[2].

[1] More information about the SOL exam in science can be found at http://www.doe.virginia.gov/testing/sol/standards_docs/science/

[2] The comparison groups for all cases are usually the students who are not in that group, for example LEP's comparison group is "Non LEP students". One exception to this is the race categories where the students are compared to those students who are categorized as white.

Table I, below, summarizes the main findings of our study.

Table I: Summary of Report Findings

VARIABLE NAME	GRADE 3	GRADE 5
Type of Instructional Model	No relationship	"Classroom Teacher" produces better outcomes than other instructional models.
Average Hours of Instruction	No relationship	An additional hour of instruction is correlated with higher SOL Science outcomes.
Demographics – Gender	Female students have slightly lower SOL outcomes	Female students have lower SOL outcomes in two out of three measures
Demographics – Race	Black and Hispanic students have lower outcomes compared to white students.	Black and Hispanic students have lower outcomes compared to white students.
Special Status – SPED, LEP, Economically Disadvantaged	Associated with lower SOL science outcomes.	Associated with lower SOL science outcomes.

SECTION I: DATA & METHODOLOGY

DATA

Arlington Public Schools provided Hanover Research with data on student SOL scores and additional variables for 3,242 students during the 2012-13 school year, representing a total of twenty-two schools. Each student in the dataset is uniquely identified by his or her SIR number (i.e., there are no duplicates). Of these students, 1,628 are in Grade 3 and 1,613 are in Grade 5. In addition, there was one student in Grade 4, but since we are only interested in the SOL scores of third and fifth graders, we drop this student from the dataset before performing our analysis.

We examine three student outcome measures related to Standards of Learning in science.

- Scale scores on the Standards of Learning test in science
- A binary variable indicating whether a student passed the SOL science test, as opposed to failing the SOL science test (i.e. a score above or below 400)
- A binary variable indicating whether a person passed/advanced the SOL science test as opposed to either passed with only a proficient score or failed to pass (i.e. a score above or below 500)

Figure 1.1 shows how these measures are related, with the pass/fail and proficiency indicators using the scale score as their base.

Figure 1.1: Science SOL Scale Scores, Pass/Fail Indicators, and Proficiency Ratings[3]

	Scale score	Pass/Fail Indicator	Proficiency Rating
SCORE RANGE (LOW)	0 – 399	Fail	Fail
SCORE RANGE (MID)	400 – 499	Pass	Proficient
SCORE RANGE (HIGH)	500 – 600	Pass	Advanced

In our regression model, these three outcome measures serve as our dependent variables, whose values we predict using data on related, explanatory variables.

Figure 1.2 depicts the distribution of the scale scores for third and fifth grade respectively.

[3] Source: http://www.doe.virginia.gov/administrators/superintendents_memos/1998/inf179.html

Figure 1.2: Distribution of Science SOL Scale Scores

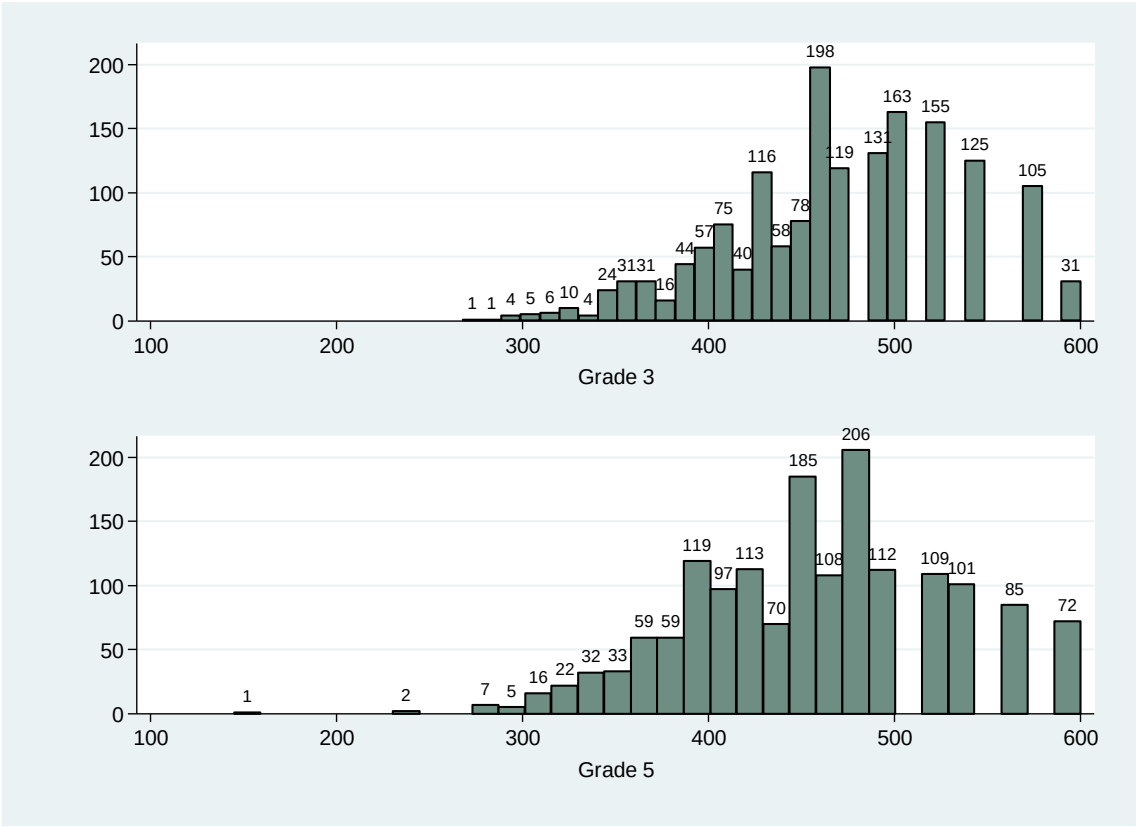

Figure 1.3 describes distribution of race in the student data. We observe that slightly more than half of the students are categorized as white, so they serve as the reference category throughout our analysis.

Figure 1.3: Race Distribution

Description	Frequency	Percentage
Asian	272	8.39%
Black	335	10.34%
Hispanic	792	24.44%
White	1,638	50.54%
Other	204	6.29%
Total	**3,241**	**100%**

Other demographic features of students within the dataset include the following.

- 1,650 (or 50.91 percent of the students) are **female**.
- 534 (or 16.48 percent of the students) have a **SPED** designation.
- 836 (or 25.79 percent of the students) have an **LEP** designation.
- 891 (or 27.49 percent of the students) have an **economically disadvantaged** designation.

Moreover, there are five categories of **instructional delivery models** in the data. Figure 1.4 describes each category and lists the number of students by grade. *Instructional model is one of the predictor variables of primary interest in this study.*

Figure 1.4: Instructional Delivery Models

Instructional Delivery Model	Grade 3		Grade 5	
	FREQ.	PCT.	FREQ.	PCT.
Classroom Teacher[4] (Model One)	867	53.26%	483	29.94%
Classroom Teacher plus enrichment (Model Two)	374	22.97%	202	12.52%
Rotate teachers for science instruction (Model Three)	215	13.21%	468	29.01%
Rotate teachers for science instruction plus enrichment[5] (Model Four)	0	0%	213	13.21%
Science specialist (Model Five)	172	10.57%	247	15.31%
Total	**1628**	**100.00%**	**1613**	**100.00%**

The other predictor variable of primary interest is **average instruction hours in science**. The dataset contains the frequency of teachers indicating a given number of hours in science instruction that a student receives in a particular school and grade. This information was obtained through a teacher survey administered by Arlington Public Schools in May of 2013. Instruction hours were coded into categories as outlined in Figure 1.5.

[4] In our analysis, Classroom Teacher (Instructional Model One) serves as the reference category against which the performance of other instructional models are compared.

[5] We do not have records for any third grade students with instructional delivery model 4 (rotating science teacher plus enrichment).

Figure 1.5: Hours of Science Instruction

Grade 3 Variable Name	Grade 5 Variable Name	Description	Average Time (Hours)
Lessthan1Third	Lessthan1Fifth	Science instruction occurred less than one hour per week	0.5 hours
OneHourThird	OneHourFifth	Science instruction occurred between 1hr-1hr 59 min per week	1.5 hours
TwoHourThird	TwoHourFifth	Science instruction occurred between 2hr-2hr 59 min per week	2.5 hours
ThreeHourThird	ThreeHourFifth	Science instruction occurred between 3hr-3hr 59 min per week	3.5 hours
FourHourThird	FourHourFifth	Science instruction occurred 4 or more hours per week	4 hours

In the table, we include an average time per category, which is estimated as the mid-point of each range. The one exception is the highest category (more than four hours) where we use the minimum of the range (4 hours). Since it is possible for multiple teachers to estimate hours of science instruction for any given student, we use the midpoints of each category and then take a weighted average.

Thus, for example, if three teachers estimate one particular student's instruction hours such that *two* of them estimate Lessthan1Third (0 to 1 hour ➔ midpoint of 0.5 hours) and *one* of them estimates OneHourThird (1 to 1 hour 59 minutes ➔ midpoint of 1.5 hours), then the weighted average for this student will be:

$$\frac{(2 \times 0.5) + (1 \times 1.5)}{3} \approx 0.83 \text{ hours} = 50 \text{ minutes}$$

Finally, we also analyze the relationship between science outcomes and the **average survey response** of students, parents, and teachers. The specific responses examined were collected through the bi-annual site-based surveys administered by the district in the spring of 2013. Among other questions (not related to the district's science instruction), the survey asked parents, students, and teachers about their satisfaction with the district's science program (parents and students) or the appropriateness of the amount of time students spend learning science in school (elementary teachers). Figure 1.6 shows the variable names and the specific survey questions. Numeric responses to these questions on a scale of one to four were aggregated for each school and then averaged to provide one common score for each student at a given school.

Figure 1.6: Survey Questions

Variable Name	Specific Question	Range
ParentSBSResponse	"Please rate your level of satisfaction with the education your child is receiving for each of the following subject areas."	(1=very dissatisfied—4=very satisfied)
StudentSBSResponse	"Please rate your level of agreement with the statement, 'I enjoy learning about science'"	(1=strongly disagree—4=strongly agree)
TeacherSBSResponse	"Please rate your level of agreement with the statement, 'Students spend enough time learning about science.'"	(1=strongly disagree—4=strongly agree)

METHODOLOGY

Since each outcome variable is based on the same test, it is likely that the same explanatory variables will be significant predictors of all three outcomes. However this result is not guaranteed. Therefore, we analyze them separately by grade and then compare the results.

We specify the equation for scale scores as a linear regression model with robust standard errors. The binary response variables (passing versus non-passing, passing/advanced versus passing/proficient or non-passing) are specified as linear probability models. As a final robustness check, we re-run our models using alternative specifications and include the results in an Appendix. These alternative models employ school-level fixed effects to control for school-wide differences among students. Since average survey response is also a school-level variable, we must exclude it from our alternative specifications to avoid over-fitting the model.

We use the method of Ordinary Least Squares (OLS) to estimate parameters of the following linear equation. Separately by grade, for each student *(i)*, we run a separate model for each outcome variable, SOL Score, a binary variable for student passing or not, and a binary variable for pass/advanced:

$$(Outcome)_i = \alpha + \beta_1(Classroom\ Teacher\ Plus\ Enrichment)_i + \beta_2(Rotating\ Science\ Teacher)_i + \beta_3(Rotating\ Teacher\ Plus\ Enrichment)_i + \beta_4(Science\ Specialist)_i + \beta_t(Average\ Instruction\ Hours)_i + \delta(Average\ Survey\ Responses)_i + \gamma(Demographics)_i + \varepsilon_i.$$

Here, $\beta_1$through β_4 are coefficients on the dummy variables indicating the instructional delivery model, with Classroom Teacher serving as the reference category. We are primarily interested in these four coefficients, along withβ_t, which is the coefficient on average hours of science instruction. The error term, ε_i, is assumed to be random with mean zero and constant non-zero variance.

INTERPRETING REGRESSION RESULTS

A coefficient estimated by an OLS regression model indicates the amount by which the outcome variable (e.g., SOL scale score) changes in response to a one-unit change in a given predictor variable. A positive coefficient indicates a positive relationship between the two variables. In other words, when a continuous predictor variable increases (or decreases), the outcome variable increases (or decreases). The coefficient estimates the magnitude of the change while holding all other predictor variables constant. In the case of a categorical predictor variable, such as gender, we interpret the coefficient in relation to the designated reference group. For example, a positive coefficient for gender indicates that females earn a higher scale score on average than males.

With linear probability models, we interpret the estimated coefficients differently, based on the binary nature of the outcome variable (e.g., pass/fail status). In contrast to continuous variables, binary variables, by definition, only assume one of two values. In the context of the present analysis, we assign a value of 1 if a student passed (e.g., earned a score of 400 or more) and a value of 0 otherwise. Accordingly, a coefficient in a linear probability model indicates the estimated change in the *probability* that a student will pass following a one-unit change in a given predictor variable (holding all other predictor variables constant). A positive coefficient still indicates a positive relationship—when a continuous predictor variable increases (decreases), the estimated probability increases (decreases). Similarly, we continue to interpret the coefficient of a categorical predictor variable relative to the designated reference group. For instance, a positive coefficient for gender indicates that females are more likely to pass on average than males.

In our analysis of instructional delivery models and instruction hours, positive and significant estimates for any of the coefficients $\beta_1$through β_4 will imply that this particular model of instruction improves the outcome measure significantly more than the reference group's model. A positive and significant coefficient estimate for β_t will imply that the outcome variable increases by the amount of the coefficient estimate, given one additional hour of science instruction. The other independent variables in the final model are used to control for any correlations that might otherwise bias our results. However, each of these coefficients can be interpreted similarly.

SECTION II: RESULTS & INTERPRETATION

GRADE 3

Figure 2.1 displays the estimated coefficients from our regression model for third grade students. The primary variables of interest appear first.

Figure 2.1: Grade 3 Regression Coefficients

Predictor Variables	Outcome Variables (Grade 3)		
	SCALE SCORE	PASS/FAIL[6]	PROFICIENCY RATING[7]
Classroom Teacher Plus Enrichment[8] (Model Two)	2.0254	0.0135	0.0038
Rotating Science Teacher (Model Three)	-4.1626	-0.0025	-0.0471
Science Specialist[9] (Model Five)	-3.5811	-0.0945*	0.0760
Average Hours of Instruction	0.2604	0.0034	-0.0005
Gender (Female)	-6.2568**	0.0013	-0.0376*
Race (Asian)[10]	-10.8198**	0.0187	-0.0981**
Race (Black)	-28.5491***	-0.1107***	-0.2061***
Race (Hispanic)	-22.8163***	-0.0849***	-0.1827***
Race (Other)	-8.0652	-0.0444	-0.1001*
SPED	-43.2983***	-0.2379***	-0.2018***
LEP	-17.1420***	-0.0605*	-0.0968***
Economically Disadvantaged	-38.4002***	-0.1633***	-0.1813***
Average Parent Survey Response	-8.0434	-0.2555***	0.2510***
Average Student Survey Response	3.2274	0.0229	-0.0045
Average Teacher Survey Response	16.1855***	0.1046***	0.0431
Constant	454.8887***	1.3876***	-0.4620
Observations	1,543	1,543	1,543
R-squared	0.3222	0.2214	0.1630
The models were estimated using ordinary least squares with robust standard errors. *** p<0.01, ** p<0.05, * p<0.1			

Contrary to our expectations, none of the coefficients on the variables of interest are significant using a 95 percent confidence interval. This implies that, in our sample of third grade students, the effects of both instructional model and average hours of instruction are not statistically different from zero after controlling for other factors such as demographic characteristics.

[6] This is a linear probability model.
[7] This is a linear probability model.
[8] Classroom Teacher (Instructional Model One) is the reference category.
[9] Rotating Teacher plus Enrichment (Instructional Model Four) is excluded due to lack of observations.
[10] White is the reference category.

Notably, we observe significant coefficients on most of our demographic control variables, which suggests that variation in instructional models and in average hours of instruction cannot explain third grade outcomes as well as variation among students themselves:

- **SPED Status is associated with lower SOL scores.** The estimated coefficients on SPED (indicating special education status) are negative and significant in all three models. In the first model, with scale score as the outcome variable, we expect SPED students to earn roughly 43 fewer points on average than non-SPED students. Moreover, negative coefficients in the second and third models, both with binary outcome variables, imply that SPED students are *less likely* to pass the SOL test than non-SPED students, and they are also *less likely* to pass the SOL test at an advanced level than non-SPED students.
- **Economically Disadvantaged status is associated with lower SOL scores.** If a student is economically disadvantaged, their expected Science SOL score is 38.4 points lower than a non-economically disadvantaged student, and that student is 16.3 percent less likely to pass, and 18.1 percent less likely to pass/advanced. All of these results are statistically significant results.
- **LEP status is associated with lower SOL scores.** If a student is limited English proficient, their expected science SOL score is 17.1 points lower than a non-LEP student, and they are 9.7 percent less likely to pass/advanced—both of which statistically significant results. They are also less likely to pass than a non-LEP student (Model 2), although this relationship is not as strong as it is only significant at the 10% level.
- **Hispanic and black students have lower SOL science outcomes.** Both Hispanic and black students have lower SOL scores, are less likely to pass or pass/advanced compared to white students, and this relationship is statistically significant at the 1 percent level.
- **Teacher response survey.** A one point increase in the average teacher response to the survey question stating the level of agreement with the question "Students spend enough time learning about science" leads to an expected increase of 16.2 points in SOL scale score and a 10.4 percent increase in the probability of passing, both of which are statistically significant results. However, changes in the survey response score do not affect the probability of being pass/advanced.

GRADE 5

Figure 2.2 displays the estimated coefficients from our regression model for fifth grade students. The primary variables of interest appear first and have light green backgrounds.

Figure 2.2: Grade 5 Regression Coefficients

Predictor Variables	Outcome Variables (Grade 5)		
	SCALE SCORE	PASS/FAIL[11]	PROFICIENCY RATING[12]
Classroom Teacher Plus Enrichment[13] (Model Two)	-14.2676***	0.0232	-0.1593***
Rotating Science Teacher (Model Three)	-19.5039***	-0.0262	-0.1485***
Rotating Teacher Plus Enrichment (Model Four)	-3.3794	0.0279	-0.0633*
Science Specialist (Model Five)	-34.0204***	-0.0279	-0.3126***
Average Hours of Instruction	17.6540***	0.0730***	0.0894***
Gender (Female)	-10.3323***	-0.0094	-0.0673***
Race (Asian)[14]	-18.0267***	-0.0290	-0.2184***
Race (Black)	-50.4745***	-0.2344***	-0.2679***
Race (Hispanic)	-34.3509***	-0.1571***	-0.2280***
Race (Other)	6.5819	-0.0310	0.0055
SPED	-32.2728***	-0.1535***	-0.1356***
LEP	-27.8787***	-0.1705***	-0.0764***
Economically Disadvantaged	-26.6890***	-0.1057***	-0.1110***
Average Parent Survey Response	-5.0421	0.0616	-0.1399
Average Student Survey Response	-7.5684	0.0009	-0.0009
Average Teacher Survey Response	8.8019	0.0253	0.1019***
Constant	464.7132***	0.4273	0.4043
Observations	1,357	1,357	1,357
R-squared	0.4084	0.2616	0.2407
The models were estimated using ordinary least squares with robust standard errors. *** p<0.01, ** p<0.05, * p<0.1			

All three of the regression models for fifth graders have a higher R-squared than those for their third grade counterparts, meaning that they can explain more of the differences in outcomes among fifth graders than among third graders. Again, demographic variables are often significant, but many of our primary variables of interest are significant as well.

In particular, across all three models, **Average Hours of Instruction** is both positive and statistically significant using a 99 percent confidence interval. This is strong evidence that fifth-grade students who have additional instruction hours in science can be expected to earn higher scores on the SOL test and thus to have higher probabilities both of passing and of passing at an advanced level.

[11] This is a linear probability model.
[12] This is a linear probability model
[13] Classroom Teacher (Instructional Model 1) is the reference category.
[14] White is the reference category.

Additionally, we see evidence that the instructional model "classroom teacher" is superior to most other instructional models. Observe that compared to the classroom teacher, students in instructional model "Classroom Teacher Plus Enrichment" are expected to score 14.3 points lower in SOL scale score, students in instructional model "Rotating Science Teacher" are expected to score 19.5 points lower, and students in instructional model "Science Specialist" are expected to score 34.0 points lower in SOL scale scores. All of these results are statistically significant at the 1 percent level. These results suggest that, compared to the reference group Classroom Teacher (Instructional Model One), other types of instructional delivery *may be correlated with worse outcomes* on the SOL tests in science.

In addition, demographic variables continue to be significant determinants:

- **SPED Status is associated with lower SOL scores in 5th grade as well**. The estimated coefficients on SPED (indicating special education status) are negative and significant in all three models. In the first model, with scale score as the outcome variable, we expect SPED students to earn roughly 32 fewer points on average than non-SPED students, and are 15.3 percent less likely to pass, and 13.5 percent less likely to pass/advanced, all statistically significant results.
- **Economically Disadvantaged status is associated with lower SOL scores**. If a student is economically disadvantaged, their expected science SOL score is 26.7 points lower than a non-economically disadvantaged student, and is 10.6 percent less likely to pass, and 11.1 percent less likely to pass/advanced, all statistically significant results.
- **LEP status is associated with lower SOL scores.** If a student is limited English proficient, their expected science SOL score is 27.8 points lower than a non-LEP student, and 17.0 percent less likely to pass and 7.6 percent less likely to pass/advanced, all statistically significant results.
- **Hispanic and black students have lower SOL science outcomes.** Similar to the 3rd grade outcomes, in 5th grade both Hispanic and black students have lower SOL scores, are less likely to pass or pass/advanced compared to white students, and this relationship is statistically significant at the 1 percent level.

FUTURE RESEARCH

In future projects, Hanover Research could improve this analysis by including more student-level variables as predictors. For example, in our model, we do not explicitly control for individual unobservable factors, such as student ability or motivation. In order to isolate the effects of a particular program or instructional delivery model, it may help to include such factors, as they are likely to confound the results. One possible proxy for student ability is GPA. We may be interested in segmenting the students in some way, possibly by GPA, and specifying a model to determine if delivery model and instruction hours have different effects on different groups of students.

APPENDIX: ROBUSTNESS CHECKS

GRADE 3

Figure A1: Grade 3 Robustness Check Regression Coefficients

Predictor Variables	Outcome Variables (Grade 3)		
	SCALE SCORE	PASS/FAIL[15]	PROFICIENCY RATING[16]
Classroom Teacher Plus Enrichment[17] (Model Two)	4.6510	0.0260	0.1005
Rotating Science Teacher (Model Three)	-18.6363**	-0.0237	-0.1754**
Science Specialist[18] (Model Five)	8.3889	-0.0538	0.3895***
Average Hours of Instruction	13.4904	0.0175	0.2166***
Gender (Female)	-6.2670**	0.0014	-0.0360
Race (Asian)[19]	-15.1506***	-0.0032	-0.1218***
Race (Black)	-23.4949***	-0.0948***	-0.1747***
Race (Hispanic)	-17.0862***	-0.0649**	-0.1531***
Race (Other)	-4.1992	-0.0348	-0.0740
SPED	-46.2304***	-0.2481***	-0.2136***
LEP	-9.4489**	-0.0396	-0.0543
Economically Disadvantaged	-34.1760***	-0.1485***	-0.1582***
School Fixed Effects?	Yes	Yes	Yes
Constant	457.2037***	0.9468***	-0.2201
Observations	1,543	1,543	1,543
R-squared	0.3887	0.2670	0.1949
The models were estimated using ordinary least squares with robust standard errors. *** p<0.01, ** p<0.05, * p<0.1			

[15] This is a linear probability model.
[16] This is a linear probability model.
[17] Classroom Teacher (Instructional Model One) is the reference category.
[18] Rotating Teacher plus Enrichment (Instructional Model Four) is excluded due to lack of observations.
[19] White is the reference category.

GRADE 5

Figure A2: Grade 5 Robustness Check Regression Coefficients

Predictor Variables	Outcome Variables (Grade 5)		
	SCALE SCORE	PASS/FAIL[20]	PROFICIENCY RATING[21]
Classroom Teacher Plus Enrichment[22] (Model Two)	6.7804	0.0376	-0.0188
Rotating Science Teacher (Model Three)	-15.9496**	-0.0512	-0.0860*
Rotating Teacher Plus Enrichment (Model Four)	-27.0618***	-0.0717	-0.1572**
Science Specialist (Model Five)	-31.8142***	-0.0895	-0.2428***
Average Hours of Instruction	35.7631***	0.0759	0.1873***
Gender (Female)	-10.4676***	-0.0114	-0.0672***
Race (Asian)[23]	-14.7019**	-0.0138	-0.2019***
Race (Black)	-48.3232***	-0.2257***	-0.2524***
Race (Hispanic)	-31.9417***	-0.1469***	-0.2171***
Race (Other)	7.3527	-0.0301	0.0123
SPED	-34.3421***	-0.1643***	-0.1425***
LEP	-28.7312***	-0.1802***	-0.0784***
Economically Disadvantaged	-24.1617***	-0.0960**	-0.0991***
School Fixed Effects?	Yes	Yes	Yes
Constant	346.0***	0.601***	-0.261
Observations	1,357	1,357	1,357
R-squared	0.4336	0.2737	0.2572
The models were estimated using ordinary least squares with robust standard errors. *** p<0.01, ** p<0.05, * p<0.1			

[20] This is a linear probability model.
[21] This is a linear probability model
[22] Classroom Teacher (Instructional Model One) is the reference category.
[23] White is the reference category.

PROJECT EVALUATION FORM

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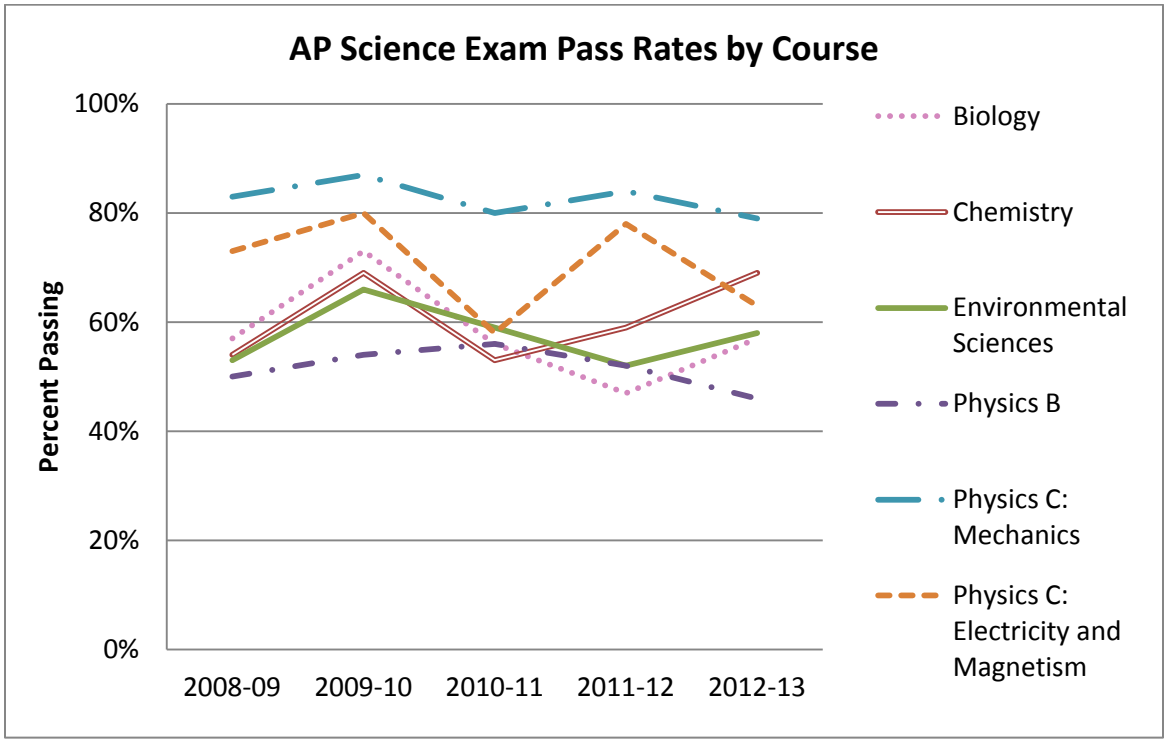
AP Science Results

High school students enrolled in Advanced Placement (AP) Science classes are required to participate in the corresponding AP exam. The College Board offers six courses, and all are available to APS high school students: Biology, Chemistry, Environmental Science, Physics B, Physics C: Electricity and Magnetism, and Physics C: Mechanics.

AP exams are scored on a scale of 1 to 5, with 3 or above considered a passing score. For purposes of this Science Evaluation, five years of AP data were examined.

Figure 1 shows the pass rates for each of the six AP Science exams over a five year period.

Figure 1: AP Science Exam Pass Rates, 2008–09 through 2012–13



The number of students participating in each Science test can be found in the six tables below.

Table 1 shows the number of students tested and the percent passing the AP Biology exam. State and national data is provided for comparison purposes.

Table 1: AP Biology Exam Pass Rates, 2008–09 through 2012–13

Group	2008-09		2009-10		2010-11		2011-12		2012-13	
	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
APS	93	57%	55	73%	84	56%	75	47%	82	57%
Virginia	4,775	48%	4,527	48%	5,145	48%	5,672	48%	6,683	46%
National	150,724	50%	155,553	50%	167,873	49%	179,544	50%	186,233	50%

Table 2 shows the number of students tested and the percent passing the AP Chemistry exam. State and national data is provided for comparison purposes.

Table 2: AP Chemistry Exam Pass Rates, 2008–09 through 2012–13

Group	2008-09		2009-10		2010-11		2011-12		2012-13	
	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
APS	50	54%	51	69%	51	53%	51	59%	89	69%
Virginia	2,850	56%	3,333	55%	3,347	53%	3,834	54%	4,284	54%
National	96,458	55%	100,510	55%	109846	54%	116,608	54%	125,281	55%

Table 3 shows the number of students tested and the percent passing the AP Environmental Science exam. State and national data is provided for comparison purposes.

Table 3: AP Environmental Science Exam Pass Rates, 2008–09 through 2012–13

Group	2008-09		2009-10		2010-11		2011-12		2012-13	
	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
APS	109	53%	96	66%	123	59%	108	52%	130	58%
Virginia	3,372	50%	4,267	44%	4,753	46%	5,189	46%	5,627	50%
National	60,713	54%	72,841	50%	85,697	50%	97,799	49%	107,569	50%

Table 4 shows the number of students tested and the percent passing the AP Physics B exam. State and national data is provided for comparison purposes.

Table 4: AP Physics B Exam Pass Rates, 2008–09 through 2012–13

Group	2008-09		2009-10		2010-11		2011-12		2012-13	
	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
APS	30	50%	41	54%	54	56%	94	52%	74	46%
Virginia	1,208	51%	1,341	53%	1,460	55%	1,984	52%	2,251	51%
National	55,227	59%	59,797	60%	63,654	58%	71,395	60%	75,510	61%

Table 5 shows the number of students tested and the percent passing the AP Physics C: Mechanics exam. State and national data is provided for comparison purposes.

Table 5: AP Physics C: Mechanics Exam Pass Rates, 2008–09 through 2012–13

Group	2008-09		2009-10		2010-11		2011-12		2012-13	
	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
APS	40	83%	69	87%	50	80%	69	84%	81	79%
Virginia	503	63%	470	71%	496	68%	531	68%	648	65%
National	11,712	69%	11,907	71%	13,265	69%	13,793	70%	15,676	72%

Table 6 shows the number of students tested and the percent passing the AP Physics C: Electricity and Magnetism exam. State and national data is provided for comparison purposes.

Table 6: AP Physics C: Electricity and Magnetism Exam Pass Rates, 2008–09 through 2012–13

Group	2008-09		2009-10		2010-11		2011-12		2012-13	
	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
APS	40	73%	56	80%	50	58%	69	78%	81	63%
Virginia	1,215	65%	1,146	63%	1,334	66%	1,507	66%	1,674	71%
National	27,237	73%	28,051	69%	30,594	72%	33,132	72%	35,958	77%

Table 7 shows the pass rates for all AP Science exams disaggregated by race/ethnicity over a five year period.

Table 7: AP Science Exam Pass Rates by Race/Ethnicity, 2008–09 through 2012–13

Group	2008-09		2009-10		2010-11		2011-12		2012-13	
	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
Asian	59	54%	68	69%	68	50%	62	50%	65	57%
Black	32	41%	19	21%	27	22%	35	43%	35	37%
Hispanic	55	36%	42	52%	74	39%	68	38%	77	44%
White	213	69%	233	81%	221	74%	282	70%	334	71%

Figure 2 shows the pass rates for all AP Science exams disaggregated by race/ethnicity over a five year period.

Figure 2: AP Science Exam Pass Rates by Race/Ethnicity, 2008–09 through 2012–13

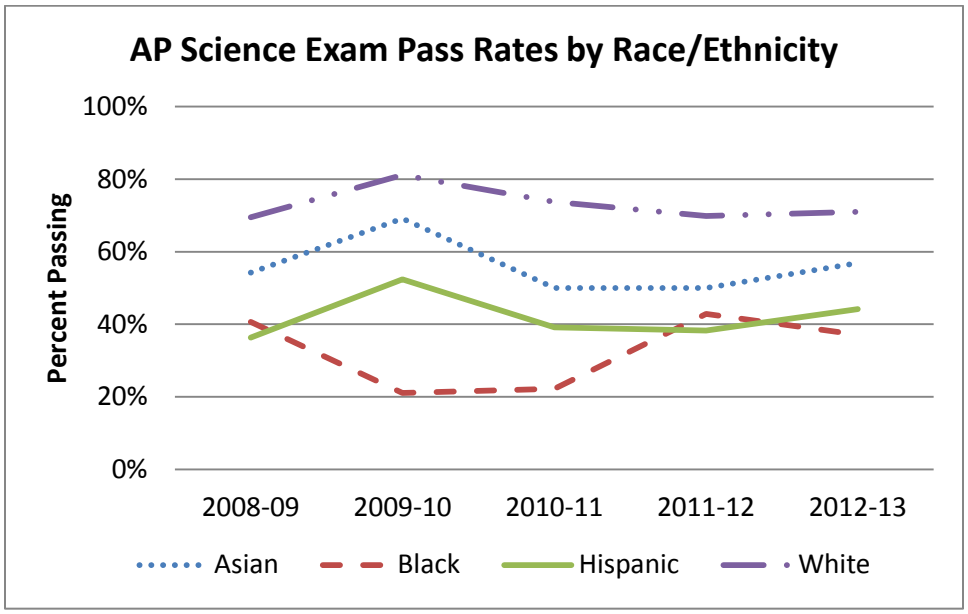


Table 8 shows the pass rates for all AP Science exams disaggregated by four demographics over a five year period.

Table 8: AP Science Exam Pass Rates by Gender, Economic Status, LEP Status, and Disability Status, 2008–09 through 2012–13

Group	2008-09		2009-10		2010-11		2011-12		2012-13	
	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
Females	192	57%	155	63%	202	49%	208	48%	277	55%
Males	170	62%	213	79%	210	70%	258	70%	260	69%
Non-Disadvantaged	295	66%	325	75%	337	65%	399	64%	462	66%
Disadvantaged	67	31%	43	47%	75	35%	67	40%	75	33%
Non-LEP	325	61%	340	74%	375	62%	431	62%	510	63%
LEP	37	43%	28	43%	37	32%	35	40%	27	44%
Non-SWD	357	59%	360	72%	399	59%	439	59%	523	62%
SWD	5	80%	8	88%	13	62%	27	74%	14	50%

Figure 3 shows the pass rates for all AP Science exams disaggregated by gender over a five year period.

Figure 3: AP Science Exam Pass Rates by Gender, 2008–09 through 2012–13

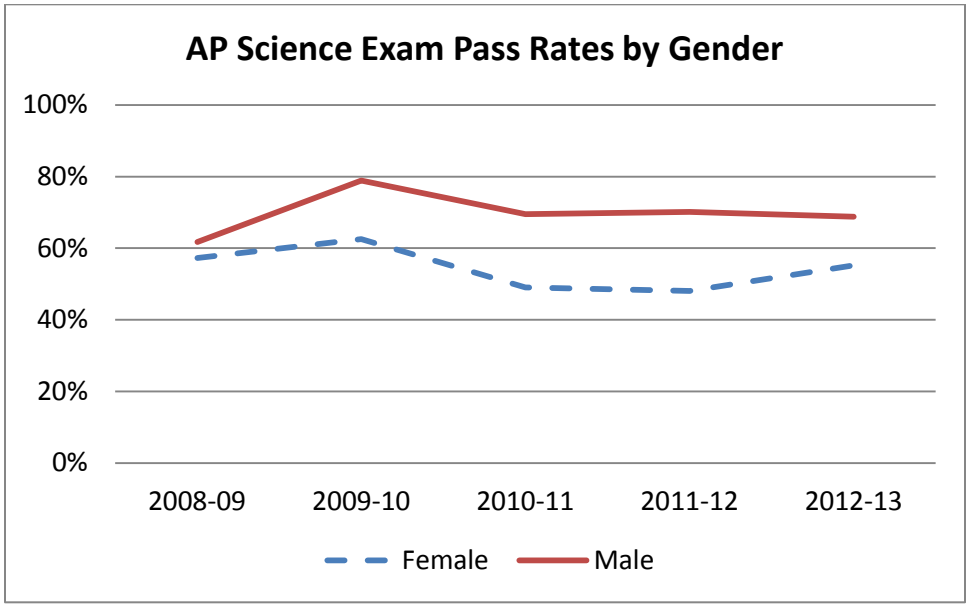


Figure 4 shows the pass rates for all AP Science exams disaggregated by economic status over a five year period.

Figure 4: AP Science Exam Pass Rates by Economic Status, 2008–09 through 2012–13

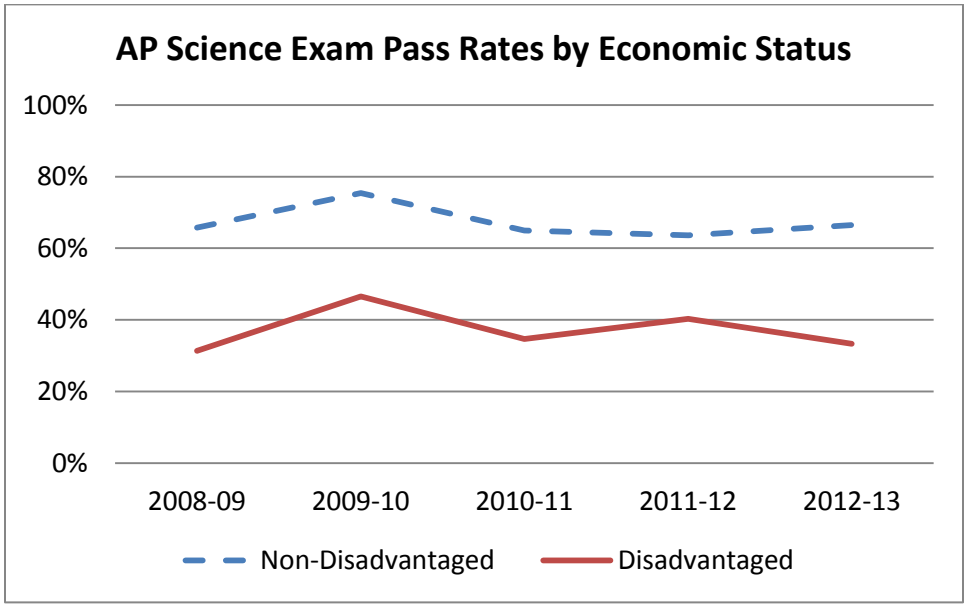


Figure 5 shows the pass rates for all AP Science exams disaggregated by LEP status over a five year period.

Figure 5: AP Science Exam Pass Rates by LEP Status, 2008–09 through 2012–13

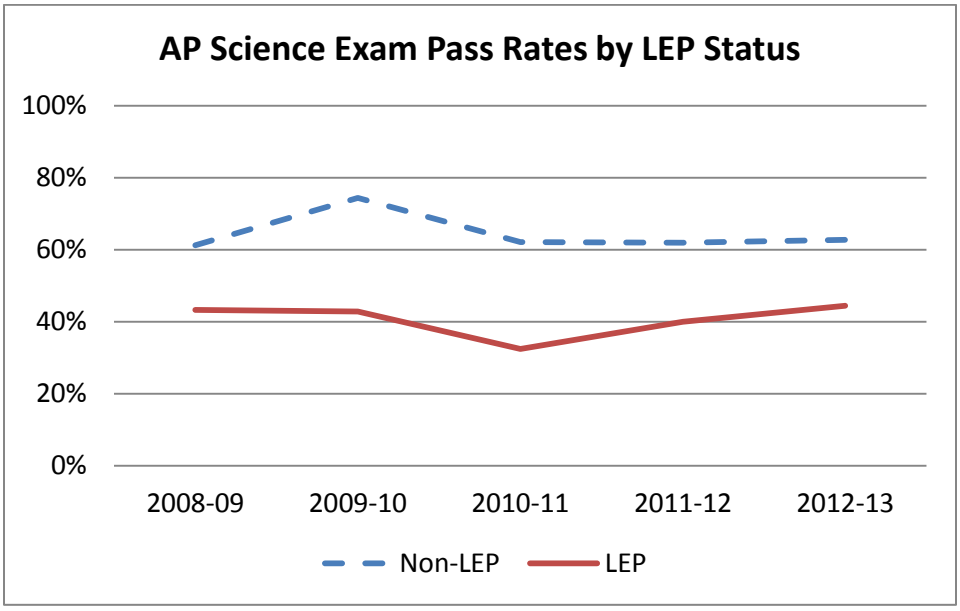
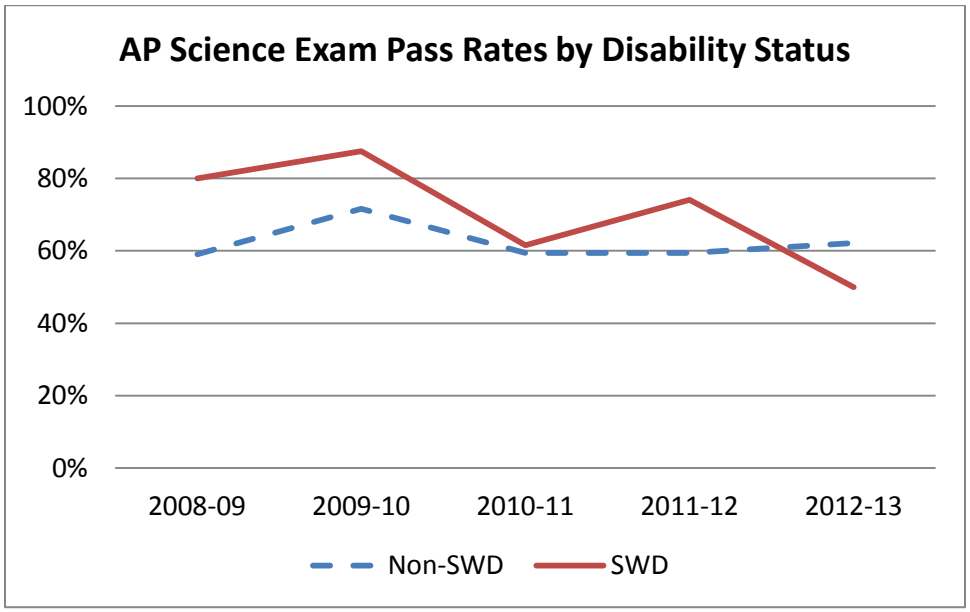


Figure 6 shows the pass rates for all AP Science exams disaggregated by disability status over a five year period.

Figure 6: AP Science Exam Pass Rates by Disability Status, 2008–09 through 2012–13



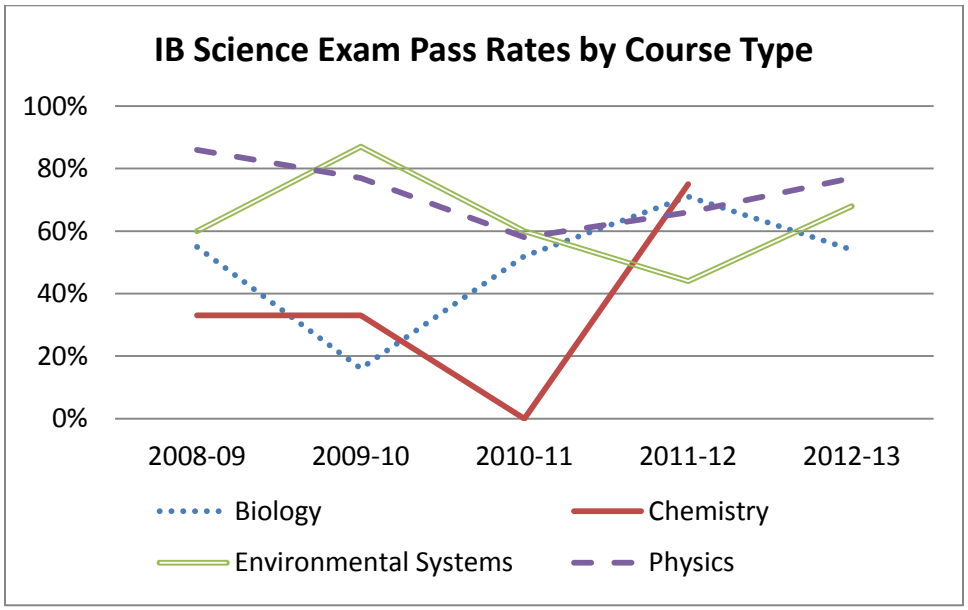
IB Science Results

High school students enrolled in Washington-Lee High School are offered the opportunity to participate in International Baccalaureate (IB) Science classes. Those who enroll in IB Biology, IB Chemistry, IB Environmental Systems, or IB Physics are required to participate in the corresponding IB exam.

IB exams are scored on a scale of 1 to 7; a score of 4 or above is considered passing. For purposes of this Science Evaluation, five years of IB data were examined.

Figure 1 shows the pass rates for each of the four IB Science exams offered in Arlington Public Schools over a five year period.

Figure 1: IB Science Exam Pass Rates, 2008–09 through 2012–13



The number of students participating in each Science test can be found in the tables below.

Table 1 shows the number of students tested and the percent passing the IB Biology exam.

Table 1: IB Biology Exam Pass Rates, 2008–09 through 2012–13

2008-09		2009-10		2010-11		2011-12		2012-13	
# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
20	55%	25	16%	21	52%	24	71%	37	54%

Table 2 shows the number of students tested and the percent passing the IB Chemistry exam.

Table 2: IB Chemistry Exam Pass Rates, 2008–09 through 2012–13

2008-09		2009-10		2010-11		2011-12		2012-13	
# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
12	33%	18	33%	6	0%	12	75%	*	na

*Fewer than 5 tests are not reported.

Table 3 shows the number of students tested and the percent passing the IB Environmental Systems exam.

Table 3: IB Environmental Systems Exam Pass Rates, 2008–09 through 2012–13

2008-09		2009-10		2010-11		2011-12		2012-13	
# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
77	60%	39	87%	92	60%	72	44%	72	68%

Table 4 shows the number of students tested and the percent passing the IB Physics exam.

Table 4: IB Physics Exam Pass Rates, 2008–09 through 2012–13

2008-09		2009-10		2010-11		2011-12		2012-13	
# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
49	86%	77	77%	12	58%	38	66%	43	77%

Table 5 shows the pass rates for all IB Science exams disaggregated by race/ethnicity over a five year period.

Table 5: IB Science Exam Pass Rates by Race/Ethnicity, 2008–09 through 2012–13

Group	2008-09		2009-10		2010-11		2011-12		2012-13	
	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
Asian	22	68%	21	71%	12	50%	12	25%	20	50%
Black	9	33%	12	50%	16	19%	16	25%	12	58%
Hispanic	18	44%	21	48%	19	37%	28	54%	19	68%
White	106	72%	102	70%	78	71%	81	65%	88	72%

Figure 2 shows the pass rates for all IB Science exams disaggregated by race/ethnicity over a five year period.

Figure 2: IB Science Exam Pass Rates by Race/Ethnicity, 2008–09 through 2012–13

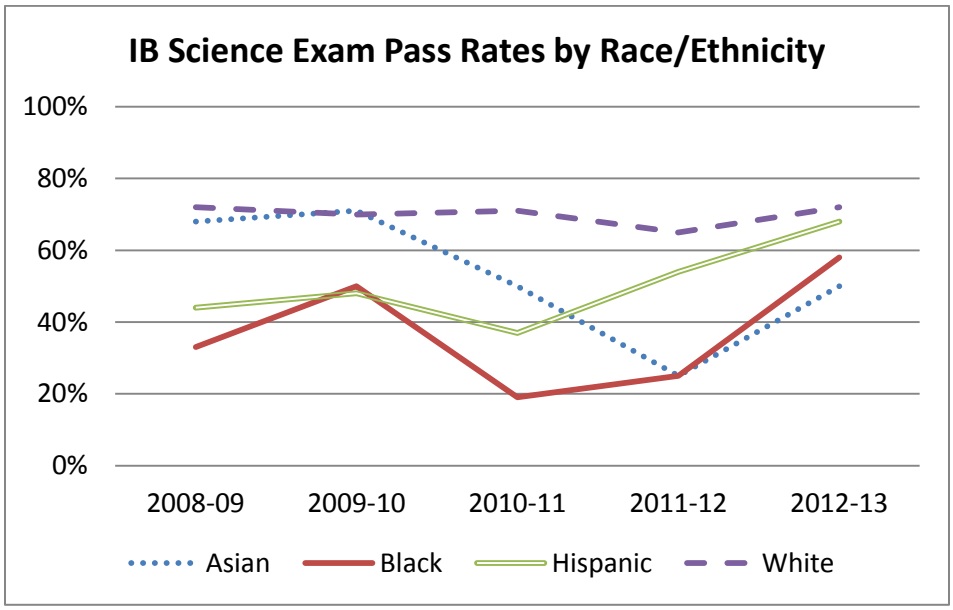


Table 6 shows the pass rates for all IB Science exams disaggregated by four demographics over a five year period.

Table 6: IB Science Exam Pass Rates by Gender, Economic Status, LEP Status, and Disability Status, 2008–09 through 2012–13

Group	2008-09		2009-10		2010-11		2011-12		2012-13	
	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed	# Tested	% Passed
Females	82	61%	75	56%	68	51%	82	61%	86	70%
Males	76	70%	84	73%	63	60%	64	52%	66	64%
Non-Disadvantaged	137	71%	141	67%	113	58%	129	61%	133	68%
Disadvantaged	21	29%	18	50%	18	39%	17	24%	19	58%
Non-LEP	151	66%	154	64%	126	57%	136	61%	148	68%
LEP	7	43%	5	80%	5	20%	10	0%	*	n/a
Non-SWD	158	65%	152	66%	126	57%	138	59%	144	68%
SWD	*	n/a	5	29%	5	20%	8	25%	8	50%

*Fewer than 5 tests are not reported.

Figure 3 shows the pass rates for all IB Science exams disaggregated by gender over a five year period.

Figure 3: IB Science Exam Pass Rates by Gender, 2008–09 through 2012–13

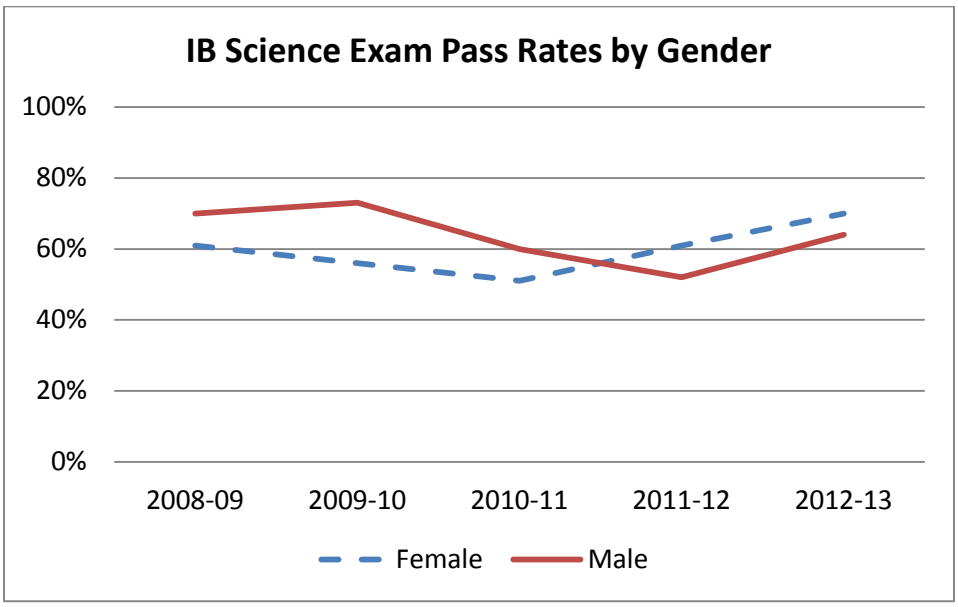


Figure 4 shows the pass rates for all IB Science exams disaggregated by economic status over a five year period.

Figure 4: IB Science Exam Pass Rates by Economic Status, 2008–09 through 2012–13

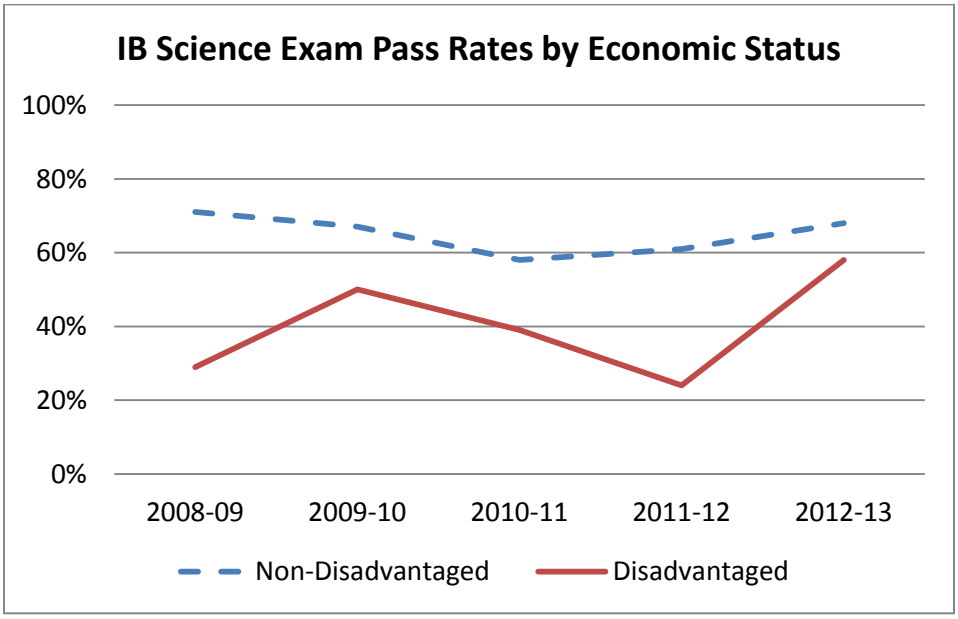


Figure 5 shows the pass rates for all IB Science exams disaggregated by LEP status over a five year period. No data is reported in 2012–13 because less than 5 LEP students participated in IB Science testing that year.

Figure 5: IB Science Exam Pass Rates by LEP Status, 2008–09 through 2012–13

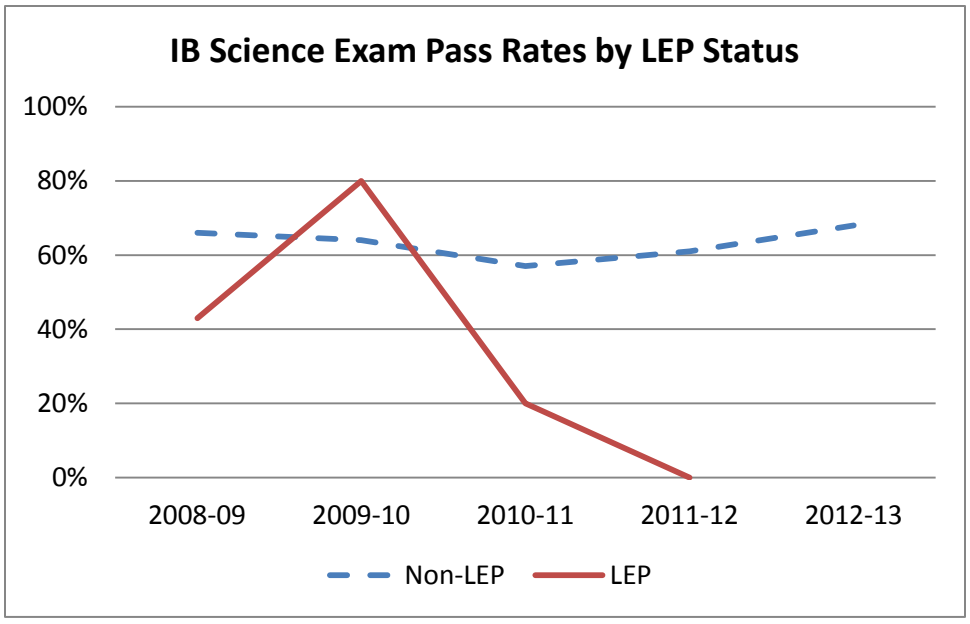
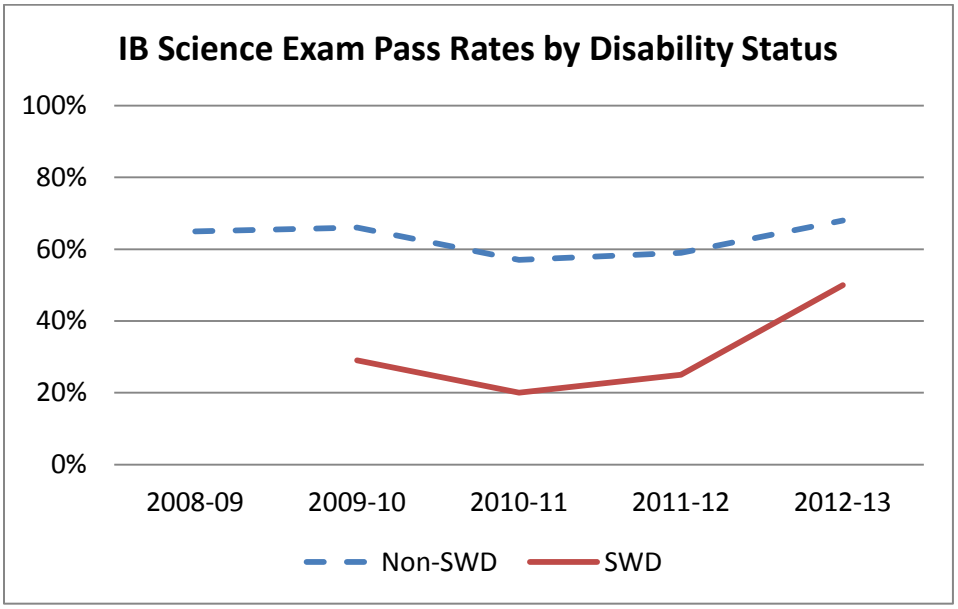


Figure 6 shows the pass rates for all IB Science exams disaggregated by disability status over a five year period. No data is reported in 2008–09 because less than 5 students with disabilities participated in IB Science testing that year.

Figure 6: IB Science Exam Pass Rates by Disability Status, 2008–09 through 2012–13



Adjusted and Unadjusted Standards of Learning Scores

Table 1 outlines the differences between adjusted and unadjusted Standards of Learning (SOL) scores.

Table 1: Differences between Adjusted and Unadjusted SOL Scores

Adjusted SOL Scores	Unadjusted SOL Scores
Purpose Used for high-stakes state and federal[24] accountability purposes to mitigate impact of test scores at schools with high populations of limited English proficient (LEP) students and students who have not attended APS for the entire school year.	Purpose From 2006 to present, used for program evaluation purposes to enable programs to understand the full range of student performance, including for students excluded from official state reports.
Focus • Individual student achievement • School-level performance in content areas	Focus • Program performance and improvement
Includes: Results from alternative assessments (VGLA, VMAST, VAAP, VSEP) Excludes failing scores for: • Students who transferred to APS on or after October 1 • LEP students who have been in the US for fewer than 12 months (Math and Reading only) • Students who retake the test in order to achieve a passing score (i.e., if a student passes on a retake, the prior failing scores are excluded) If a student takes a single test during multiple school years, each year's result is included in the adjusted data for that year.	Excludes: Results from alternative assessments Includes: • SOL scores for all students • Scores from each student's first attempt at a given test If a student takes a single test over multiple school years, only the first attempt from the first year is included. The purpose of this is to ensure that the evaluations are measuring the effects of the program and not of test remediation.
Source • For core subjects, data can be taken from report cards on the VDOE website, which at the division level reflect *federal* adjustments. Data for the three most recent years are available. • For program evaluations such as World Languages, services for English language learners, and services for students with special needs, there is no system currently in place to provide adjusted data.	Source • Calculated by Planning & Evaluation; data for the five most recent years are available.

[24] Note that the division-level adjusted scores available on the VDOE website and included in the Science report reflect *federal* adjustments.

Impact on Scores • There is little difference between adjusted and unadjusted pass rates at the elementary and middle school levels. • At the end-of-course (EOC) level, the adjusted pass rate is typically higher.	Impact on Scores • At the end-of-course (EOC) level, the unadjusted pass rate is typically lower. • Occasionally, the unadjusted pass rate for students with disabilities is higher.