Appendix E

Reports

Review of Enrollment in APS Pre-Kindergarten Programs and Academic Performance during the Middle School Years

Prepared for Arlington Public Schools

In this report, we examine the ongoing performance of a cohort of students who participated in pre-kindergarten programs within the Arlington Public Schools (APS). These programs include Montessori, Virginia Preschool Initiative, Special Education, and Dual Enrolled Special Education. Included in this report is a comparison with students who did not participate in such programs. Performance measures include a variety of assessments conducted between sixth and eighth grade, such as the Degrees of Reading Power (DRP) Program, the Standards of Learning (SOL), and the Stanford Achievement Test Series (Stanford 10). We also include a secondary analysis that describes differences in World Languages course enrollment in middle school.

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Overview

Executive Summary

This report serves as a companion document to a report entitled "Longitudinal Analysis of Performance of Students in APS Prekindergarten Programs" created by Hanover Research for the Arlington Public Schools (APS) in June 2008. In that report we provided an analysis of the impact of participation in APS pre-kindergarten programs on future academic performance during grades K-5. We provided a preliminary investigation of the differences in academic performance between participants and non-participants in APS Pre-K programs. Our analysis also highlighted differences in performance among participants of the various APS Pre-K programs.

In this report, we replicate the analysis of subsequent academic performance described in the 2008 report, focusing on the subsequent performance of the same group of pre-kindergarten students in grades six through eight. Performance measures include the Degrees of Reading Power (DRP) Program, Standards of Learning (SOL), and the Stanford Achievement Test Series (Stanford 10). We also include an examination of enrollment in World Languages during middle school. We describe differences in academic performance in several ways. For example, in the first section, we examine the data based on seven categories:

- ❖ Full Cohort - All Students
- ❖ APS Pre-K Attendees
- ❖ No APS Pre-K
- ❖ Montessori
- ❖ Virginia Preschool Initiative (VPI)
- ❖ Special Education
- ❖ Dual Enrolled Special Education

In addition, we examine the performance of middle schools students according to their economically disadvantaged (ED) status. This analysis is performed in order to isolate the interaction of ED status and APS pre-kindergarten participation on academic performance. For similar reasons we also disaggregate the academic performance of students according to whether they were classified as having Limited English Proficiency (LEP).

In this report we confirm the following trends, first identified in 2008:

- ❖ APS Pre-K students score lower, on a variety of tests, than students who did not attend an APS Pre-K program.
- ❖ APS Montessori students outperform VPI students.
- ❖ ED APS Pre-K students score higher than ED non-participants.
- ❖ LEP APS Pre-K students outperform LEP non-participants.
- ❖ LEP Montessori students score higher than LEP VPI students.

It is important to note that throughout this report we frequently refer to "APS Pre-K participants" and "non-participants." While these "non-participants" did not attend an APS Pre-kindergarten program, they likely attended other programs.

For each category, we calculate sample means and standard deviations for students' scores on a number of assessments.[1] This provides a basis for comparison between groups. We are then able to determine how students who participated in an APS Pre-K program compared to students who did not enroll in an APS Pre-K program on each performance measure. This allows us to answer questions related to specific programs such as: Did individuals who participated in the VPI receive higher scores on their sixth grade DRP than students in the Montessori program?

By examining the data in this manner, we are also able to determine whether the effects of APS Pre-K program participation appear to diminish over time. Comparing student scores on a number of assessments conducted at different points throughout their educational experiences allows us to see if average scores between APS Pre-K program participants and non-participants begin to even out at a certain point.

When calculating average scores, we used all available testing data, including SOL scores marked as "excluded in calculating accreditation ratings." We did this in order to provide the most complete picture of APS Pre-K participant and non-participant academic performance. In our commentary, we focus our discussion on comparisons between groups for which there are at least 10 members in each.

In subsequent sections, we break down the data based on Economically Disadvantaged (ED) and Limited English Proficiency (LEP) status. This enables us to control for some factors that may influence student performance beyond participation or non-participation in an APS Pre-K program.

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[1] Due to the large amount of data, we provide an Excel file accompanying the report which includes all of the sample means and standard deviations for each performance measure included in the raw data. In the body of this report we describe major trends, illustrated with a selection of assessment scores.

Key Findings

Comparison with the 2008 Report

❖ Results from this report continue the trend identified in the 2008 report in which APS Pre-K students scored lower on a variety of assessments than students who did not participate in APS Pre-K programs.

❖ As in the 2008 report, APS Montessori students outperformed VPI students on most assessments.

❖ Aligned with 2008 results, students who were dual enrolled in special education had higher scores than students who were enrolled only in special education.

❖ As was seen in the 2008 report, economically disadvantaged students who participated in APS Pre-K programs tended to score higher on assessment tests than economically disadvantaged students who had not participated in APS Pre-K programs.

❖ Reversing the trend from the 2008 report, ED VPI program participants frequently had higher scores than ED Montessori participants.

❖ LEP students who participated in APS Pre-K programs outperformed LEP non-participants, a trend first observed in the 2008 report.

❖ Montessori LEP students received higher scores than VPI LEP students in both the 2008 and 2011 reports.

Full APS Middle School Cohort

❖ The middle school cohort contained 1,229 middle school students, including 142 who attended an APS Pre-K program. Retention among the original 392 APS Pre-K students was 36.2 percent.

❖ In general, APS Pre-K participants' assessment scores were lower than the scores of APS Pre-K non-participants.

❖ Participants in APS Pre-K programs had lower mean scores than APS Pre-K non-participants on both the fall and the spring DRP tests. The same pattern was evident for students requiring remediation.

❖ APS Pre-K non-participants scored higher than APS Pre-K students in middle school SOL tests, with the exception of three eighth grade tests.

❖ A total of 654 students within the middle school cohort took at least one advanced math class (as evidenced by SOL tests) during grades 6-8. Of these, 576 (88.1 percent) did not attend an APS Pre-K program while 78 (11.9 percent) did.

❖ For each grade, a slightly greater percentage of APS Pre-K participants than APS Pre-K non-participants enrolled in advanced math courses.

❖ A higher percentage of APS Pre-K students began world language instruction in grades six and eight in comparison to grade seven. A greater percentage of APS Pre-K non-participants began taking these courses in grade seven.

❖ APS Pre-K participants and non-participants performed at fairly similar levels on the Stanford 10 tests. The difference between these two groups on each of the tests described was 5 points or less.

Specific APS Pre-kindergarten Programs

Montessori versus VPI

❖ With respect to mean scores, with few exceptions, Montessori students outperformed VPI students on all assessments, including DRP, SOL and Stanford 10 tests, from sixth through eighth grade.

❖ Students in the Montessori and VPI programs had comparable SOL passing rates. For some tests, Montessori students passed at greater rates than VPI, while on other tests, this was reversed.

❖ Forty-four of the 79 APS Montessori students (55.7 percent) took at least one advanced math class during grades six to eight. This compares with 17 of 27 APS VPI students (63.0 percent) who took at least one advanced class. Both groups were most likely to enroll in these classes in eighth grade.

❖ Approximately 82.9 percent of Montessori APS Pre-K students took at least one world languages course in middle school. This compares with the 77.8 percent of APS VPI students. Students in both groups were most likely to enroll in these courses during seventh grade.

❖ APS Montessori students outperformed APS VPI students in each subject area of the Stanford 10 tests.

Special Education versus Dual Enrolled Special Education

❖ In middle school, dual enrolled students scored higher than special education students on almost all assessments including DRP, SOL and Stanford 10 tests.

❖ Approximately 95 percent of dual enrolled students took at least one world languages course in middle school. This compares with 47.4 percent of special education students.

❖ Dual enrolled students outperformed special education students on each of the four Stanford 10 tests.

Economically Disadvantaged Students

❖ ED students who had participated in APS Pre-K programs outperformed ED APS Pre-K non-participants on many middle school assessments described in this report.

❖ Seventh grade ED students who had enrolled in an APS Pre-K program scored 5 to 32 points higher on average in each SOL test for which there were 10 or more students in each group.

❖ Of the 402 ED APS Pre-K non-participant students, 101 (25.1 percent) enrolled in at least one advanced math course during middle school (as evidenced by SOL tests). Of the 74 ED APS Pre-K students, 31 (41.9 percent) enrolled in at least one advanced math course.

❖ Of the 402 ED APS Pre-K non-participant students, 227 (56.5 percent) enrolled in a world languages course. Of the 74 ED APS Pre-K students, 54 (73 percent) enrolled in a world language course.

❖ ED students who had participated in an APS Pre-K program outscored APS Pre-K non-participants by three to five points in every test described in Figure 3 on page 12.

❖ Economically disadvantaged students in the VPI program outscored Montessori students on almost all DRP, SOL and Stanford 10 tests.

Limited English Proficient Students

❖ Overall, LEP students who participated in an APS Pre-K program outperformed students who did not participate in APS Pre-K on all middle school assessments described in this report.

❖ LEP students who attended an APS Pre-K program scored higher than APS Pre-K non-participants on all seventh and eighth grade tests for which there were 10 or more students in each group. However, sixth grade SOL scores were an exception; non-participant scores were higher.

❖ Of the 61 APS Pre-K students who were also designated as LEP, 29 (47.5 percent) enrolled in at least one advanced math course during middle school (as evidenced by SOL tests). Of the 353 APS Pre-K non-participants, 108 (30.6 percent) enrolled in at least one advanced math course.

❖ Of the 353 LEP non-participant students, 216 (61.2 percent) enrolled in a world languages course. Of the 61 APS Pre-K students, 46 (75.4 percent) enrolled in a world languages course.

❖ LEP students who participated in an APS Pre-K program outscored non-participants in all four Stanford 10 tests.

❖ Montessori LEP students received higher scores than VPI LEP students on almost every middle school assessment in the sample.

Scope and Methods of the Report

The data file provided by Arlington Public Schools included student demographic and academic assessment data gathered between 2000-2001 and 2009-2010. Variables present in the file included: APS program attendance, race, gender, and a variety of other demographic characteristics such as grade level, school, economic disadvantage (ED) status, disability status, and Limited English Proficiency (LEP) status. Also present were various middle school academic performance variables associated with the DRP program, SOLs, and the Stanford 10, and the names and course numbers associated with enrollment in world languages course work. The database included the initial cohort of 392 students who were examined in the 2008 report, as well as students who entered APS after kindergarten (including both those who left before sixth grade and those who were still enrolled in APS in middle school). There were a total of 2,834 students for whom at least one year of data were available in the database. Eleven of these students whose pre-kindergarten program was listed as "retained in kindergarten" were excluded from this analysis at the direction of APS (leaving 2,823 students in the data set).

The table below presents an overview of the retention rates of the initial APS Pre-K cohort and the entire sample into the middle school years. As this table demonstrates, **an average of 36.2 percent of students who attended an APS pre-kindergarten program went on to enroll in an APS middle school. Approximately 44.7 percent of students who did not attend an APS Pre-K program went on to attend at least one APS middle school grade**.

Figure 1: Retention in Middle School Cohort

Program	Entire Sample	Middle School Cohort	Percent Retention
Dual Enrolled Special Education	51	20	39.2%
Montessori	159	76	47.8%
Special Education	92	19	20.7%
VPI	90	27	30.0%
All APS Pre-K Programs	392	142	36.2%
No APS Pre-K	2,431	1,087	44.7%
Total	**2,823**	**1,229**	**43.5%**

**Figure 2: Enrollment in APS Pre-Kindergarten Programs:
Initial Cohort versus Middle School Cohort**
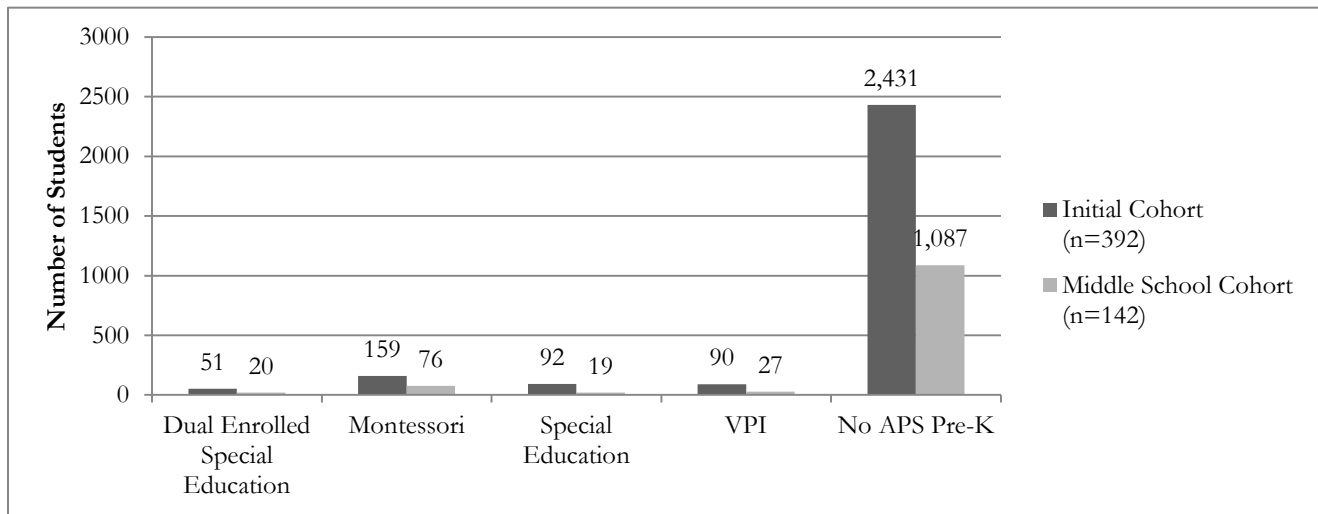
As our focus is on middle school academic performance, we limit our analysis to the cohort of students who were enrolled at APS during sixth, seventh or eighth grade and for whom we have a valid score on at least one performance test. In this report, we refer to this narrower cohort as the "Middle School Cohort."

We examine the performance of middle schools students on various tests according to their participation in APS Pre-K programs and their status as economically disadvantaged (ED). This analysis is performed in order to isolate the interaction of ED status and APS pre-kindergarten participation on academic performance. For similar reasons we also disaggregate students' academic performance according to whether they were classified as having Limited English Proficiency (LEP).

Measures of Academic Performance

Student scores were provided for a variety of assessments, including the Degrees of Reading Power (DRP) Program, Standards of Learning (SOL), and the Stanford Achievement Test Series, Tenth Edition (Stanford10).

Degrees of Reading Power (DRP) Program

The DRP by Questar Assessment, Inc., measures how well students understand the meaning of text.[2] The data sample contains DRP data for APS sixth graders for both the fall and the spring. An analysis of raw scores is presented, as is a DRP identification of whether a student was identified for remediation.

Standards of Learning (SOL)

The SOLs are a set of academic standards which are measured through annual SOL tests and assessments.[3] The data sample contains SOL data for APS sixth, seventh and eighth graders in subject areas such as Math, Reading, History, Science, Writing and World Geography. An analysis of both scale scores and an identification of enrollment in advanced math courses are presented in this report.[4,5] We give primary attention to Math and Reading SOLs.

Stanford Achievement Test Series, Tenth Edition (Stanford 10)

The Stanford 10, by Pearson Education, Inc. is a test of content typically taught in schools across the United States. The purpose of this assessment is to compare the performance of students to a representative national sample of students.[6] The data sample contains Stanford 10 data for sixth graders and includes subject areas such as reading, math, language, spelling, science and social science. Normal Curve Equivalent (NCE) Scores for the Stanford 10 are analyzed in this report.[7] While a stratification of all Stanford 10 subtests/scores are included in the Appendix, we

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[2] Degrees of Reading Power (DRP) Program.
http://www.questarai.com/Products/DRPProgram/Pages/default.aspx. (Accessed on 10 June 2011)

[3] Testing & Standards of Learning (SOL). http://www.doe.virginia.gov/testing/index.shtml. (Accessed on 10 June 2011)

[4] There are five possible performance levels: Pass Advanced, Pass Proficient, Fail, Fail Basic, and Fail Below Basic.

[5] "Student performance is graded on a scale of 0-600 with 400 representing the minimum level of acceptable proficiency and 500 representing advanced proficiency." SOL Test Scoring & Performance Reports. http://www.doe.virginia.gov/testing/scoring/index.shtml. (Accessed on 13 June 2011)

[6] Arlington Public Schools. Stanford 10 Achievement Test. http://www.apsva.us/Page/1125 (Accessed on 21 July 2011)

[7] Normal Curve Equivalent scores allow for comparison from one subtest to another. NCE scores of 1, 50 and 99 correspond to percentile ranks of 1, 50 and 99. The NCE is a modification of the standard score or z-score, which measures how many standard deviations above or below the mean a given score is.

focus on Reading Total, Language (Writing), Math Total, Science, and Social Science NCE scores in the main body of this report.

The table below summarizes the assessments that are described in this report.

Figure 3: Assessment by Testing Type, Area, and Grade

Assessment		Grade		
Testing Type	Area	Sixth	Seventh	Eighth
DRP	Fall	X		
	Spring	X		
SOL	Math[8]	X	X	X
	Algebra I	X	X	X
	Algebra II		X	X
	Geometry		X	X
	Reading	X	X	X
	Writing			X
	History		X	
	World Geography			X
Stanford 10	Word Study	X		
	Vocabulary	X		
	Reading Comprehension	X		
	Reading Total[9]	X		
	Math Problem Solving	X		
	Math Procedures	X		
	Math Total[10]	X		
	Prewriting	X		
	Composing	X		
	Editing	X		
	Language[11]	X		
	Spelling	X		
	Science	X		
	Social Science	X		
	Partial[12]	X		
	Total	X		

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[8] Note that starting in middle school, students may take higher Math SOL tests depending on which math class they are enrolled. For example, sixth graders may take either sixth, seventh or eighth grade Math SOLs.

[9] Word Study, Vocabulary and Reading Comprehension are included in the Reading Total Score

[10] Math Problem Solving and Math Procedures are included in the Math Total score.

[11] Pre-writing, Composing and Editing are included in the Language Scores

[12] The Partial Battery score is based on the combined scores for Total Reading, Total Math and Language.

<u>World Languages Coursework</u>

The final area of analysis includes a description of differences in enrollment in world languages in middle school. These languages include Arabic, Chinese, French, Spanish, German, and Latin. We describe whether or not students took a world language during middle school and when this instruction began.

Full APS Cohort

As mentioned above, information regarding 1,229 students in the middle school cohort, 142 of whom attended an APS Pre-K program, was provided by APS for this report. Of the entire middle school cohort, 52.3 percent were reported as male and 47.7 percent as female. In terms of racial and ethnic composition of the group, 49.0 percent were white, 25.3 percent Hispanic, 13.9 percent black, and 11.2 percent Asian.

We begin our analysis by comparing the scores of APS Pre-K participants with students who had not participated in an APS Pre-K program.

Degrees of Reading Power (DRP) Program

In this section we present an analysis of DRP raw scores and remedial designations by attendance at an APS pre-kindergarten program. Recall that the analysis of DRP scores was limited to sixth grade. For sixth grade, the instructional level of the average student is 56 (p=0.75) where p is the P-value or percent of comprehension. As shown in the table below, it is clear that participants of APS Pre-K programs had lower mean scores than non-participants on both the fall and the spring DRP.

The same pattern exists for students requiring remediation. In the fall, 33.1 percent of APS Pre-K participants needed remediation, compared to 28.1 percent of non-participants. The difference was slightly less pronounced in the spring with 24.2 of APS Pre-K participants recommended for remediation while 20.9 percent of non-participants received this recommendation.

Figure 4: Degrees of Reading Power – Mean Scores and Remediation

| Group | Fall | | | | | Spring | | | | |
| | Average DRP (.75) Score | | | Percentage Identified for Remediation | | Average DRP (.75) Score | | | Percentage Identified for Remediation | |
	n	Mean	Standard Deviation	n	%	n	Mean	Standard Deviation	n	%
APS Pre-K	136	61.56	13.67	45	33.1%	128	67.15	14.22	31	24.2%
No APS Pre-K	1,022	64.86	15.87	287	28.1%	969	69.94	15.13	203	20.9%
Middle School Cohort	1,158	64.47	15.66	332	28.6%	1,097	69.61	15.05	234	21.3%

Figure 5: Mean DRP Scores by APS Pre-Kindergarten Program Attendance
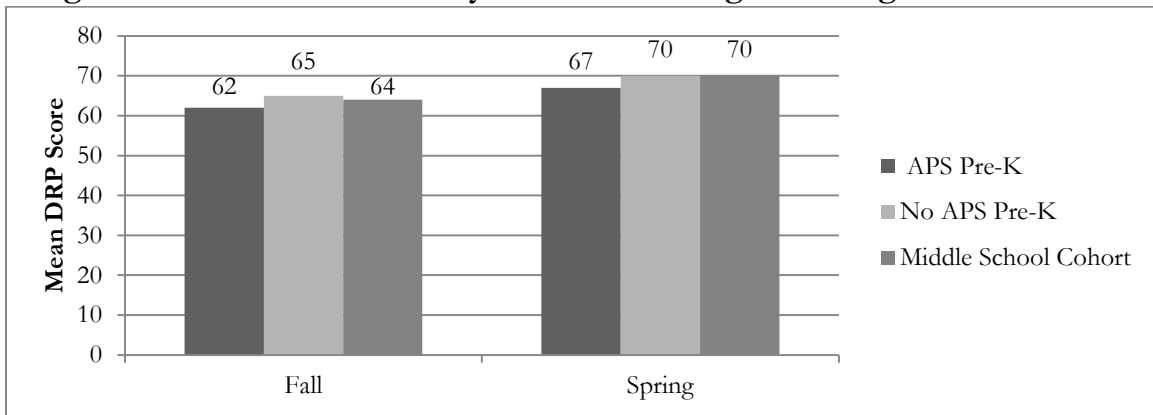
Figure 6: Percent of Students Identified for Remediation
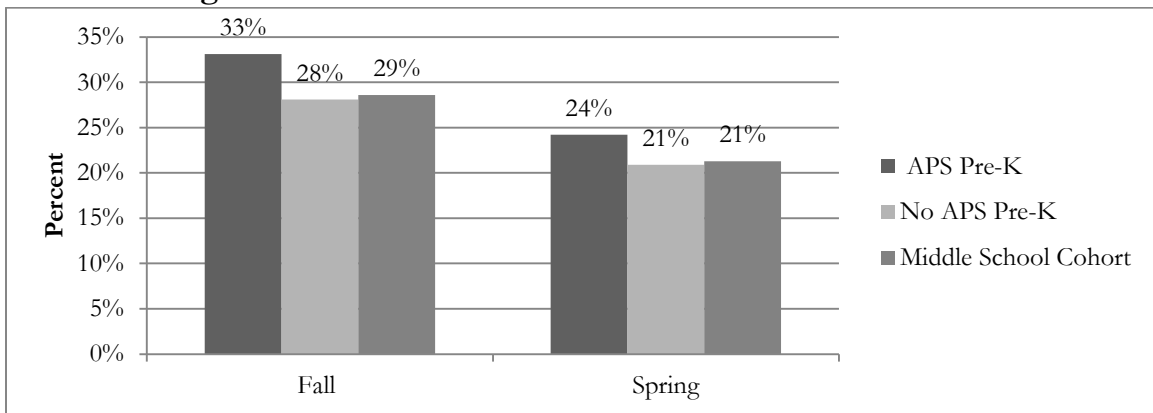
Standards of Learning (SOL)

Mean Scale Scores

Looking at SOL test results, this trend continues to hold, as APS Pre-K participants tended to perform at lower levels than non-participants. The tables and figures on the following page provide average scores for SOL tests in grades six through eight. **For all SOL test results (except for three eighth grade tests), APS Pre-K participants were outscored by non-participants.**

In sixth grade, the difference between APS Pre-K and non-participants ranged from 13 points in Reading to 69 points in Eighth Grade Math. The three students who took Algebra I in sixth grade were non-participants.

Figure 7: Sixth Grade Standards of Learning – Mean Scores

Group	6th Grade Math		7th Grade Math		8th Grade Math		Reading		Algebra I	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
APS Pre-K	76	384	54	496	6	509	136	477		
No APS Pre-K	625	403	328	525	59	578	977	490	3	572
Middle School Cohort	**701**	**401**	**382**	**521**	**65**	**572**	**1113**	**489**	**3**	**572**

Figure 8: Difference in Sixth Grade Standards of Learning Mean Scores (APS Pre-K – No APS Pre-K)
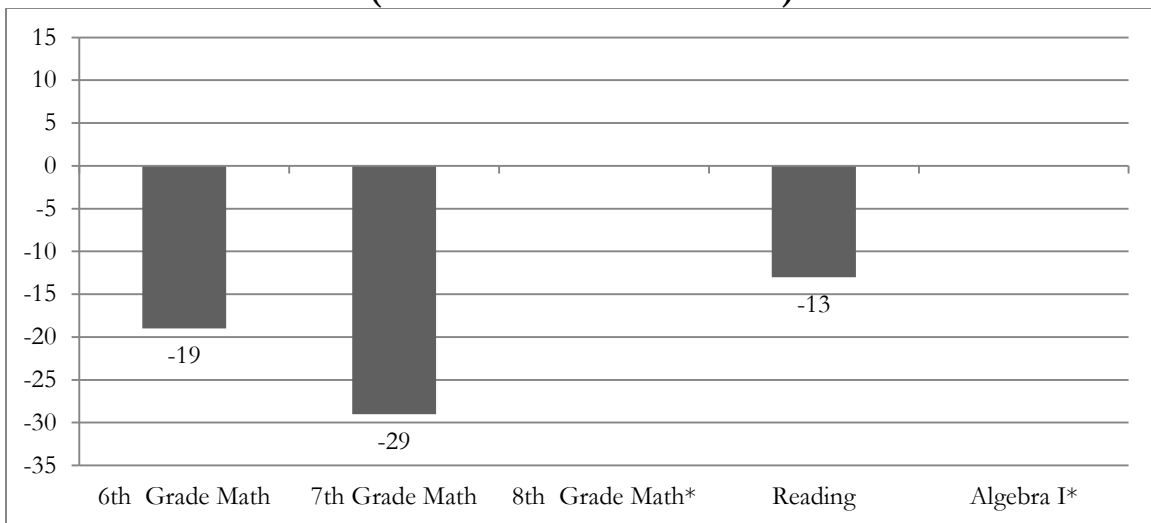
* This difference is not shown due to insufficient data.

Turning to seventh grade SOL test results, we once again see that non-participants outscored APS Pre-K participants in every test. The difference ranged from two points in Reading to 19 points in Eighth Grade Math.

Figure 9: Seventh Grade Standards of Learning – Mean Scores

Group	History		Reading		7th Grade Math		8th Grade Math		Algebra I		Algebra II		Geometry	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
APS Pre-K	129	487	129	494	64	415	50	538	11	529			1	544
No APS Pre-K	956	494	957	496	531	423	307	557	115	539	1	600	2	562
Middle School Cohort	1085	493	1086	496	595	422	357	554	126	538	1	600	3	556

Figure 10: Difference in Seventh Grade Standards of Learning Mean Scores (APS Pre-K – No APS Pre-K)
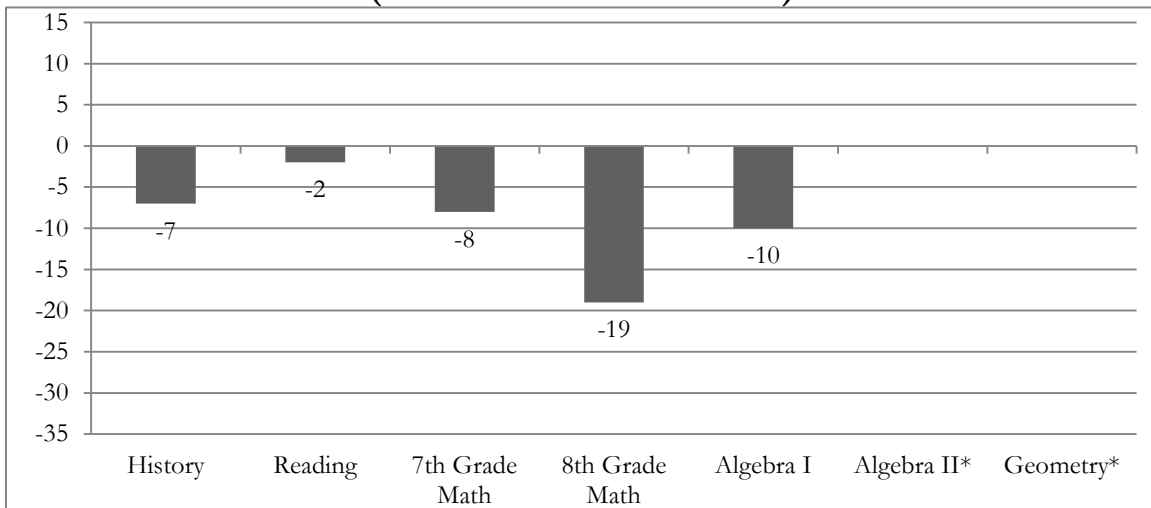
* This difference is not shown due to insufficient data.

The picture changes somewhat in eighth grade; while APS Pre-K participants lagged behind non-participants in Reading, Science, Writing, and World Geography, they scored higher in 8th Grade Math, Algebra I and Geometry.

Figure 11: Eighth Grade Standards of Learning – Mean Scores

Group	Reading		Science		Writing		8th Grade Math		Algebra I		Algebra II		Geometry		World Geography	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
APS Pre-K	128	487	128	490	128	446	54	451	62	509	1	581	11	553	127	470
No APS Pre-K	934	496	937	498	936	449	402	448	417	505	2	538	109	544	932	485
Middle School Cohort	1062	495	1065	497	1064	448	456	449	479	505	3	552	120	545	1059	483

Figure 12: Difference in Eighth Grade Standards of Learning Mean Scores (APS Pre-K – No APS Pre-K)
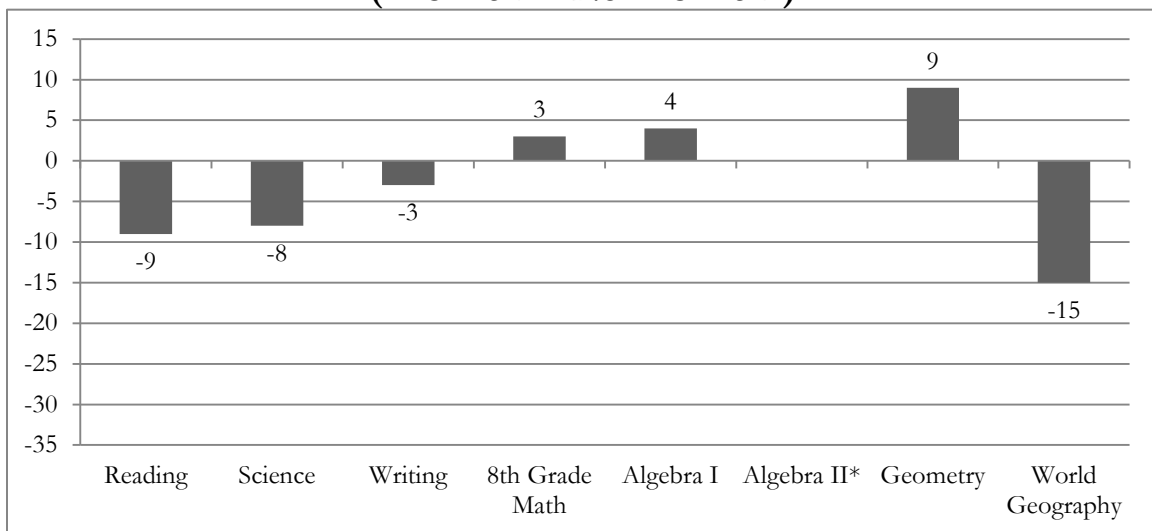
* This difference is not shown due to insufficient data.

<u>Which Students Take Advanced Courses and SOL Tests</u>

A total of 654 students within the middle school cohort took at least one advanced math class (as evidenced by SOL tests) during grades six through eight. Of these, **576 (88.1 percent) did not attend an APS Pre-K while 78 (11.9 percent) did.**

When we consider when students enrolled in advanced math courses, we see that APS Pre-K participants and non-participants were most likely to enroll later in middle school; the percentage of students who enrolled in sixth grade was lower than the percentage who enrolled in seventh grade, which in turn was lower than the percentage who enrolled in eighth grade. For each grade, a slightly greater percentage of APS Pre-K participants than non-participants enrolled in advanced math courses. This difference ranged from 6 percent in sixth grade to 4 percent in eighth grade.

Figure 13: Advanced Math Course Enrollment[13]

Group	6th Grade		7th Grade		8th Grade	
	n	%	n	%	n	%
APS Pre-K (n=142)	60	42.3%	62	43.7%	74	52.1%
No APS Pre-K (n=1,087)	390	35.9%	425	39.1%	528	48.6%
Middle School Cohort (n=1,220)	**450**	**36.6%**	**487**	**39.6%**	**602**	**49.0%**

Figure 14: Difference in Percent Enrollment in Advanced Math Courses (APS Pre-K – No APS Pre-K)

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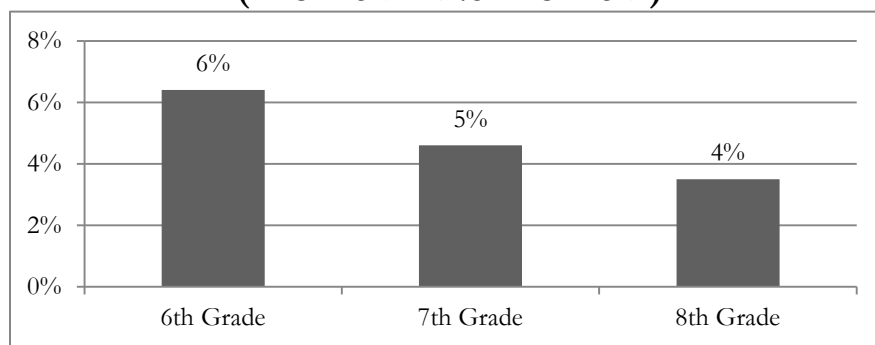
[13] Because this table shows the percentage of all students in each group who were enrolled in an advanced math class during each of the three middle school years, the total percentage does not add to 100%.

World Languages Coursework

A total of 924 (75.2 percent) students within the middle school cohort enrolled in a world language course during middle school. Of these, 135 (14.6 percent) started in sixth grade, 693 (75.0 percent) in seventh grade and 96 (10.4 percent) in eighth. As the table below indicates, in general, both APS Pre-K participants and non-participants followed the general trend experienced by the entire cohort. However, it is interesting to note a higher percentage of APS Pre-K students began taking world languages in middle school in grades six and eight in comparison to grade seven when a greater percentage of non-participants began such courses.

Figure 15: Initial World Language Course Enrollment by Grade and APS Pre-K Enrollment[14]

Group	6th Grade		7th Grade		8th Grade	
	n	%	n	%	n	%
APS Pre-K (n=142)	26	18.3%	74	52.1%	12	8.5%
No APS Pre-K (n=1,087)	109	10.0%	619	56.9%	84	7.7%
Middle School Cohort (n=1,220)	**135**	**11.0%**	**693**	**56.4%**	**96**	**7.8%**

Figure 16: Difference in Percent Enrollment in World Language Courses (APS Pre-K – No APS Pre-K)

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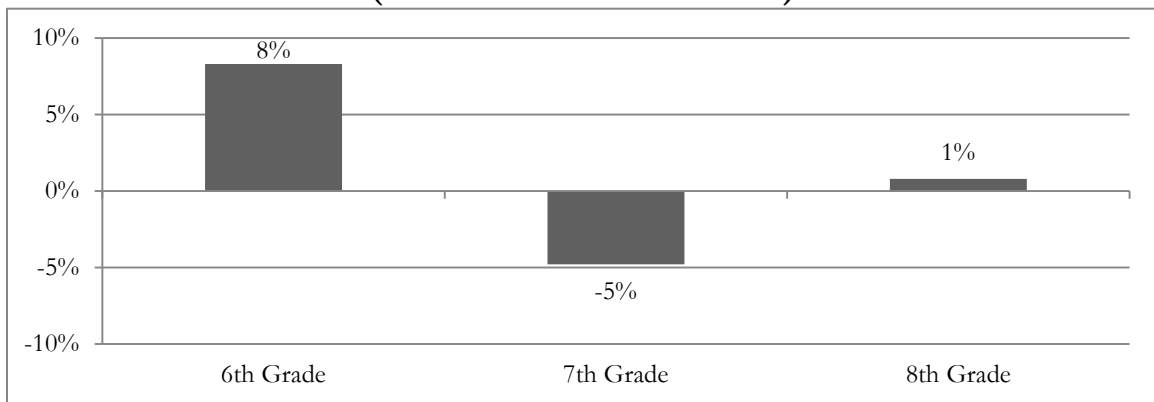
[14] Because not all students in each group took a world language course at some point during middle school, these percentages do not add to 100%.

Stanford Achievement Test Series, Tenth Edition (Stanford 10)

If we focus on a selection of Stanford 10 tests, it appears that APS Pre-K participants and non-participants performed at fairly similar levels. The difference between these two groups on each of the tests described in the table below is five points or less.

Figure 17: Stanford 10 – Mean Scores

Group	Reading Total		Math Total		Science		Social Studies	
	n	Mean	n	Mean	n	Mean	n	Mean
APS Pre-K	135	59	134	66	134	61	134	62
No APS Pre-K	992	64	991	68	995	66	992	66
Middle School Cohort	1127	63	1125	68	1129	65	1126	65

Figure 18: Difference in Stanford 10 Mean Scores
(APS Pre-K – No APS Pre-K)
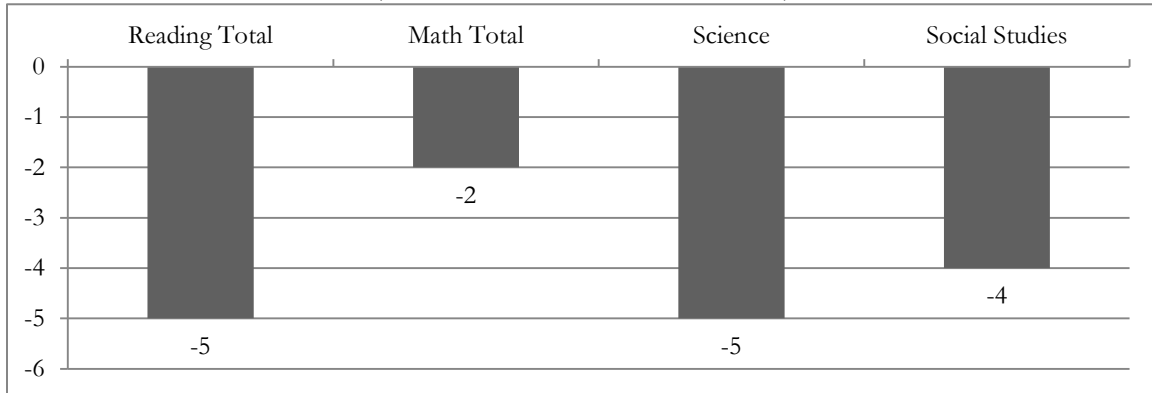
Specific APS Pre-Kindergarten Programs

In this section, we compare specific APS Pre-K programs in order to determine whether they display a difference in terms of future academic performance. As an organizational issue, our main comparisons include Montessori versus VPI programs and Special Education versus Dual Enrolled Special Education programs. An appendix provides tables comparing all of these groups together.

Montessori and VPI

There were 76 Montessori students included in the APS middle school cohort. Of these students, approximately half were designated as economically disadvantaged (ED) when they entered the program. Further, 38.2 percent were designated Limited English Proficient (LEP) when they entered APS. As for racial/ethnic composition, 38.2 percent of the Montessori participants were white, 31.6 percent Hispanic, 22.4 percent black, and 7.9 percent Asian. This group has more females than males, with 53.9 percent female representation

By comparison, 27 of the middle school students participated in VPI. As would be expected due to the eligibility requirements of the program, a much larger percentage of these students (81.5 percent) were designated as economically disadvantaged when they entered APS. Approximately 81.5 percent were Limited English Proficient when they entered APS. Approximately 59.3 percent of the VPI group was listed as Hispanic, 18.5 percent white, 11.1 percent black, and 11.1 percent Asian. This group also has more females than males, with 59.3 percent female representation.

In terms of mean scores, with very few exceptions, **Montessori students outperformed VPI students on all assessments, including DRP, SOL and Stanford 10 tests, from sixth through eighth grade.**

Degrees of Reading Power (DRP) Program

For example, the table below presents Fall and Spring DRP results for Montessori and VPI students. Note that the average (.75) scores for Montessori students are higher. While the percentage of Montessori students who were identified for remediation was lower than the corresponding percentage of VPI students in the fall, this was reversed on the spring test.

Figure 19: Degrees of Reading Power – Montessori and VPI Comparison

Group	Fall					Spring				
	Average DRP (.75) Score			Percentage Identified for Remediation		Average DRP (.75) Score			Percentage Identified for Remediation	
	n	Mean	Standard Deviation	n	%	n	Mean	Standard Deviation	n	%
Montessori	74	64.80	12.43	20	27.0%	70	70.03	13.61	14	20.0%
VPI	**26**	**57.50**	**10.80**	**8**	**30.8%**	**23**	**65.78**	**10.08**	**3**	**13.0%**

Figure 20: Mean DRP Scores – Montessori and VPI Comparison
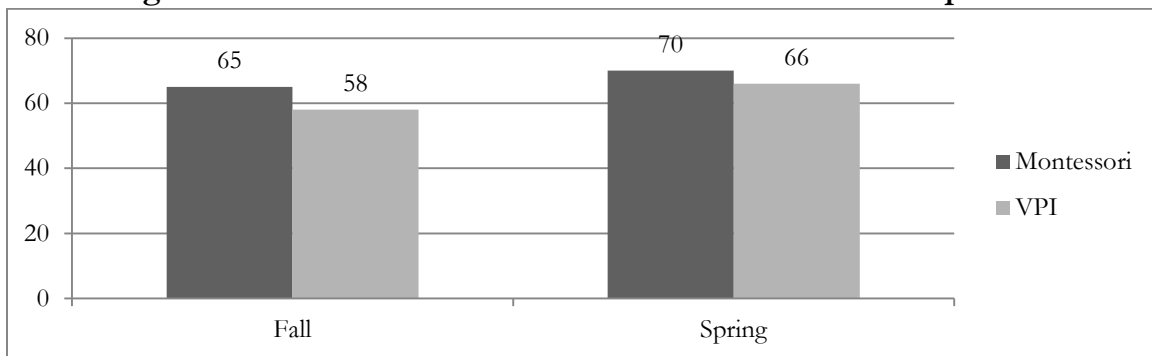
Standard of Learning (SOL)

In terms of SOL scores, there were twelve sets of scores with at least ten corresponding Montessori and 10 VPI students. **Montessori students scored higher than VPI students on nine of these twelve tests**. The three exceptions to this trend are sixth grade math, seventh grade math taken by seventh graders, and eighth grade math taken by seventh graders. The tables below display these disparities in SOL test scores, with the majority of tests displaying a difference of at least 10 points.

<u>Mean Scale Scores</u>

Figure 21: Sixth Grade Standards of Learning – Montessori and VPI Score Comparison

Group	6th Grade Math		7th Grade Math		8th Grade Math		Reading		Algebra I	
	n	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**
Montessori	38	390	30	505	6	509	74	489		
VPI	15	402	9	453			24	471		

Figure 22: Seventh Grade Standards of Learning – Montessori and VPI Score Comparison

	History		Reading		7th Grade Math		8th Grade Math		Algebra I		Algebra II		Geometry	
	n	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**
Montessori	69	496	69	497	31	409	24	524	10	522			3	544
VPI	26	457	26	491	14	438	12	550						

Figure 23: Eighth Grade Standards of Learning – Montessori and VPI Score Comparison

	Reading		Science		Writing		8th Grade Math		Algebra I		Algebra II		Geometry		World Geography	
	n	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**
Montessori	69	491	69	495	70	448	29	453	29	509	1	581	10	555	69	474
VPI	25	487	25	478	26	438	8	447	17	502					25	452

In terms of passing rates, the Montessori and VPI programs appear to be more comparable. In fact, **no clear pattern emerges; for some tests, Montessori students passed at greater rates than VPI, for others this was reversed**. The table below displays SOL passing rates for a selection of sixth, seventh and eighth grade assessments for which both groups had at least 10 students.

Figure 24: Middle School Standards of Learning – Montessori and VPI Comparison

Group	6th Grade		7th Grade				8th Grade			
	Reading		History		Reading		Science		Writing	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Montessori	21	87.5%	22	84.6%	24	92.3%	25	100%	25	96.2%
VPI	64	86.5%	64	92.8%	64	92.8%	65	94.2%	69	98.6%

<u>Which Students Take Advanced Courses and SOL Tests</u>

Next we examine differences in what percentage of Montessori and VPI students take advanced math tests (as evidenced by SOL tests) in each grade level. **Forty-four of the 79 Montessori students (55.7 percent) took at least one advanced math class during grades six through eight. This compares with 17 of 27 VPI students (63.0 percent)** who took at least one advanced class. When we consider when these students took advanced math classes, both groups were most likely to enroll in eighth grade.

**Figure 25: Advanced Math Course Enrollment –
Montessori and VPI Comparison[15]**

Group	6th Grade		7th Grade		8th Grade		Anytime in Middle School	
	n	%	n	%	n	%	n	%
Montessori (n=76)	36	47.4%	35	46.1%	40	52.6%	44	56%
VPI (n=27)	9	33.3%	12	44.4%	17	63.0%	17	63%

<u>Which Students Take a World Language</u>

Of the 76 students in the middle school cohort who attended the Montessori APS Pre-K program, 63 (82.9 percent) took at least one world languages course in middle school. This compares with the 27 VPI students, 21 (77.8 percent) of whom took at least one such course.

The table below provides the frequencies and percentages with which Montessori and VPI participants began enrolling in world languages courses. Note that students in both groups were most likely to enroll in these courses starting in seventh grade.

**Figure 26: Initial World Language Course Enrollment –
Montessori and VPI Comparison[16]**

Group	6th Grade		7th Grade		8th Grade	
	n	%	n	%	n	%
Montessori (n=76)	20	26.3%	36	47.4%	7	9.2%
VPI (n=27)	4	14.8%	16	59.3%	1	3.7%

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[15] Because this table shows the percentage of all students in each group who were enrolled in an advanced math class during each of the three middle school years, the total percentage does not add to 100%.

[16] Because not all students in each group took a world language course at some point during middle school, these percentages do not add to 100%.

Stanford Achievement Test Series, Tenth Edition (Stanford 10)

Looking at the Stanford 10 test results, Montessori students outperformed VPI students in each subject area. This difference ranged from two points in the Math Total score to seven points in Science.

Figure 27: Stanford 10 – Montessori and VPI Comparison

Group	Reading Total		Math Total		Science		Social Studies	
	n	Mean	n	Mean	n	Mean	n	Mean
Montessori	74	62	73	69	73	64	73	65
VPI	25	56	25	67	25	57	25	59

Special Education and Dual Enrolled Special Education

There were 19 students who participated in an APS special education pre-kindergarten program and went on to enroll in at least one middle school grade at APS. As this number is small, caution must be used when interpreting the results in this section. Of these students, 10 (52.6 percent) were designated as economically disadvantaged when they entered APS Pre-K. Further, 8 students (42.1 percent) were designated as Limited English Proficient upon entry to APS.

In terms of racial/ethnic composition, 42.1 percent of special education students were listed as Hispanic, 31.6 percent white, 15.8 percent black, and 10.5 percent Asian. As for gender, the group has a high proportion of males to females, with 73.7 percent male representation.

By comparison, 20 dual enrolled special education middle school students were included in the cohort. As this number is small, caution must be used when interpreting the results in this section. Two of these students (10 percent) were designated as economically disadvantaged when they enrolled in APS, and the same number were Limited English Proficient in 2004-2005. Eighty-five percent of these students were listed as white, and 15 percent were Hispanic. This group also has a higher proportion of males to females, with 70 percent male representation.

Overall, **dual enrolled students scored higher than special education students in all tests for which there were at least 10 corresponding special education and 10 dual enrolled students**. The following table displays a comparison of DRP scores for these two groups.

Degrees of Reading Power (DRP) Program

Figure 28: Degrees of Reading Power – Special Education and Dual Enrolled Comparison

Group	Fall					Spring				
	Average DRP (.75) Score			Percentage Identified for Remediation		Average DRP (.75) Score			Percentage Identified for Remediation	
	n	Mean	Standard Deviation	n	%	n	Mean	Standard Deviation	n	%
Special Education	17	47.65	12.88	13	76.5%	17	52.65	15.51	12	70.6%
Dual Enrolled	19	66.95	13.59	4	21.1%	28	71.39	11.63	2	11.1%

Standard of Learning (SOL)

<u>Mean Scale Scores</u>

When we consider mean scale SOL scores, Reading was the only SOL with sufficient numbers for comparison; on this test dual enrolled students scored 95 points higher than their Special Education counterparts. No students from either of these groups enrolled in 8th Grade Math or Algebra I in sixth grade.

Figure 29: Sixth Grade Standards of Learning – Special Ed and Dual Enrolled Comparison

Group	6th Grade Math		7th Grade Math		8th Grade Math		Reading		Algebra I	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
Special Ed	16	345	2	511			18	406		
Dual Enrolled	7	405	13	504			20	501		

In seventh grade, dual enrolled students outscored special education students in all tests. The differences in History and Reading scores were 60 points or higher.

Figure 30: Seventh Grade Standards of Learning – Special Ed and Dual Enrolled Comparison

Group	History		Reading		7th Grade Math		8th Grade Math		Algebra I		Algebra II		Geometry	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
Special Ed	14	455	14	456	12	397	2	600						
Dual Enrolled	20	516	20	516	7	423	12	545	1	600				

Special education student scores came closest to dual enrolled student scores in Eighth Grade Writing; this difference was only 26 points.

Figure 31: Eighth Grade Standards of Learning – Special Ed and Dual Enrolled Comparison

Group	Reading		Science		Writing		8th Grade Math		Algebra I		Algebra II		Geometry		World Geography	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
Special Ed	15	435	15	455	14	431	12	430	3	512	0		0		15	435
Dual Enrolled	19	511	19	521	18	457	5	498	13	518	0		1	534	18	508

Which Students Take Advanced Courses and SOL Tests

There were three special education students who took an advanced math course during middle school (as evidenced by SOL tests). This compares with 14 dual enrolled students. The table below displays when these students enrolled in an advanced class. Note that the majority of dual enrolled students took advanced math classes in each grade during middle school. By comparison, only 10-16 percent of special education students enrolled in these advanced classes.

Figure 32: Advanced Math Course Enrollment – Special Ed and Dual Enrolled Comparison[17]

Group	6th Grade		7th Grade		8th Grade	
	n	%	n	%	n	%
Special Ed (n=3)	2	10.5%	2	10.5%	3	15.8%
Dual Enrolled (n=14)	13	65.0%	13	65.0%	14	70.0%

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[17] Because this table shows the percentage of all students in each group who were enrolled in an advanced math class during each of the three middle school years, the total percentage does not add to 100%.

Which Students Take a World Language

Of the 20 students in the middle school cohort who dual enrolled in special education during APS Pre-K, 19 (95 percent) enrolled in at least one world language course during middle school. This compares with nine special education students (47.4 percent) who enrolled in such a course. The table below presents the grades during which students in both groups initially enrolled in a world language course.

Figure 33: Initial World Language Course Enrollment –
Special Ed and Dual Enrolled Comparison[18]

Group	6th Grade		7th Grade		8th Grade	
	n	%	n	%	n	%
Special Ed (n=19)			7	36.8%	2	10.5%
Dual Enrolled (n=20)	2	10.0%	15	75.0%	2	10.0%

Stanford Achievement Test Series, Tenth Edition (Stanford 10)

With respect to Stanford 10 tests, dual enrolled students outperformed special education students in each of the four test areas described in the table below. The difference between these two groups ranged from 24 points for Science and Social Studies to 27 points for Reading.

Figure 34: Stanford 10 - Special Ed and Dual Enrolled Comparison

Group	Reading Total		Math Total		Science		Social Studies	
	n	Mean	n	Mean	n	Mean	n	Mean
Special Ed	17	41	17	48	17	45	17	47
Dual Enrolled	19	68	19	73	19	69	19	71

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[18] Because not all students in each group took a world language course at some point during middle school, these percentages do not add to 100%.

Economically Disadvantaged Students

Since economically disadvantaged (ED) status is reviewed each year, we begin by examining students who were designated ED as early as pre-kindergarten (or kindergarten, for students who did not attend an APS Pre-K). A total of 62 students in the middle school cohort were designated as ED while they were enrolled in an APS program during the 2000-01 school year.[19] This first ED status is retained regardless of whether these students are still classified as ED as they progress through school. In addition, we employ the ED status upon initial entry to APS – regardless of grade – in our analysis. Please note that this calculation of ED status does differ from the calculation performed in 2008. In the 2008 report, if a student's ED status changed as they progressed through school, then these students were excluded from the analysis, beginning in the year during which they changed status.

APS Pre-K Participants versus Non-Participants

ED students who had participated in APS Pre-K programs outperformed ED non-participants on many assessments during middle school. For example, the following table provides details on DRP scores. Note that for the fall and spring tests, there is an approximately four point difference between these two groups. There is a large disparity between these two groups with respect to the percentage of each that was identified for remediation. More than 86 percent of ED non-participants were identified for remediation in both tests, while less than 14 percent of ED students who had attended an APS Pre-k were identified as such.

Degrees of Reading Power (DRP) Program

Figure 35: Degrees of Reading Power - Economically Disadvantaged Students

Group	Fall					Spring				
	Average DRP (.75) Score			Percentage Identified for Remediation		Average DRP (.75) Score			Percentage Identified for Remediation	
	n	Mean	Standard Deviation	n	%	n	Mean	Standard Deviation	n	%
ED APS Pre-K	57	57.39	12.81	31	13.2%	63	62.88	13.52	21	12.3%
ED No APS Pre-K	358	53.45	12.52	203	86.8%	340	58.91	12.56	150	87.7%

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[19] For the 2000-01, 2001-02, 2002-03 and 2003-04 school years, data regarding students' ED status was only available if they were designated as ED. A designation of not ED was omitted for these years. For all subsequent years, both designations were present in the database.

Standard of Learning (SOL)

Mean Scale Scores

With respect to sixth grade SOLs, ED APS Pre-K students and non-participants had the same mean score on the sixth grade math test. APS Pre-K students who were ED scored 17 points higher than non-participants in Reading.

**Figure 36: Sixth Grade Standards of Learning –
Economically Disadvantaged Students**

Group	6th Grade Math		7th Grade Math		8th Grade Math		Reading		Algebra I	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
ED APS Pre-K	47	373	19	465	3	553	69	454		
ED No APS Pre-K	309	373	48	488	3	583	326	437		

In seventh grade, this trend continued. ED students who had enrolled in an APS Pre-K scored 5 to 32 points higher on average in each SOL test for which there were 10 or more students in each group.

**Figure 37: Seventh Grade Standards of Learning –
Economically Disadvantaged Students**

Group	History		Reading		7th Grade Math		8th Grade Math		Algebra I		Algebra II		Geometry	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
ED APS Pre-K	63	458	63	476	39	408	19	537	2	501			1	544
ED No APS Pre-K	317	445	317	444	272	400	43	532	10	520			0	

In eighth grade, once again, ED students who had enrolled in an APS Pre-K program outscored non-participants in each SOL test; this difference ranged from four points in Algebra I to 16 points in Science (for tests in which there were at least 10 students in each group).

**Figure 38: Eighth Grade Standards of Learning –
Economically Disadvantaged Students**

Group	Reading		Science		Writing		8th Grade Math		Algebra I		Algebra II		Geometry		World Geography	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
ED APS Pre-K	63	463	63	467	63	434	36	442	24	501	1	581	2	552	63	440
ED No APS Pre-K	317	449	321	451	317	428	228	435	81	497	0		10	535	316	437

Which Students Take Advanced Courses and SOL Tests

Of the 402 ED APS Pre-K non-participants, 101 (25.1 percent) enrolled in at least one advanced math course during middle school (as evidenced by SOL tests). Of the 74 ED APS Pre-K students, 31 (41.9 percent) enrolled in at least one advanced math course. Both groups were slightly more likely to enroll in such a course during eighth grade than in sixth or seventh.

Figure 39: Advanced Math Course Enrollment
Economically Disadvantaged Students[20]

Group	6th Grade		7th Grade		8th Grade	
	n	%	n	%	n	%
ED APS Pre-K (n=74)	22	29.7%	22	29.7%	27	36.5%
ED No APS Pre-K (n=402)	51	12.7%	53	13.2%	91	22.6%

Which Students Take a World Language

Of the 402 ED APS Pre-K non-participants, 227 (56.5 percent) enrolled in a world languages course. Of the 74 ED APS Pre-K students, 54 (73 percent) enrolled in a world language course. Students in both groups were most likely to initially enroll in such a course during seventh grade.

Figure 40: Initial World Language Course Enrollment
Economically Disadvantaged Students[21]

Group	6th Grade		7th Grade		8th Grade	
	n	%	n	%	n	%
ED APS Pre-K (n=74)	7	9.5%	41	55.4%	6	8.1%
ED No APS Pre-K (n=402)	20	5.0%	171	42.5%	36	9.0%

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[20] Because this table shows the percentage of all students in each group who were enrolled in an advanced math class during each of the three middle school years, the total percentage does not add to 100%.

[21] Because not all students in each group took a world language course at some point during middle school, these percentages do not add to 100%.

Stanford Achievement Test Series, Tenth Edition (Stanford 10)

With respect to the Stanford 10 tests, once again, ED students who had participated in an APS Pre-K program, outscored non-participants by three to five points in every test described in the table below.

**Figure 41: Stanford 10 -
Economically Disadvantaged Students**

Group	Reading Total		Math Total		Science		Social Studies	
	n	Mean	n	Mean	n	Mean	n	Mean
ED APS Pre-K	70	52	69	60	69	54	69	54
ED No APS Pre-K	336	47	336	55	337	50	337	51

Montessori versus VPI

Due to the substantial percentage of economically disadvantaged students in the VPI and Montessori programs, we further break down the ED data set by APS Pre-K program affiliation.

Economically disadvantaged students in the VPI program outscored Montessori students on almost all DRP, SOL and Stanford 10 tests. This trend follows the one described in our 2008 report in which VPI students began outscoring Montessori students in the first grade.

Degrees of Reading Power Program

Mean DRP scores for fall and spring for ED VPI and ED Montessori students were comparable; the average scores of these groups were within 2.5 points of each other. The percentage of students identified for remediation was higher for ED Montessori students in both tests than for ED VPI students.

**Figure 42: Degrees of Reading Power – Economically Disadvantaged Students
Montessori and VPI Comparison**

Group	Fall					Spring				
	Average DRP (.75) Score			Percentage Identified for Remediation		Average DRP (.75) Score			Percentage Identified for Remediation	
	n	Mean	Standard Deviation	n	%	n	Mean	Standard Deviation	n	%
ED Montessori	38	60.53	12.37	15	39.5%	38	65.82	11.88	11	28.9%
ED VPI	21	58.24	10.43	6	28.6%	18	66.33	10.09	2	11.1%

Standards of Learning

When considering the Math SOLs taken at each grade level, ED VPI students outscored ED Montessori students by 21 points in sixth grade and 44 points in seventh grade. With respect to Reading SOLs, ED VPI students scored higher than ED Montessori students by 9 points in sixth grade, 20 points in seventh grade and 33 points in eighth grade.

Mean Scale Scores

Figure 43: Sixth Grade Standards of Learning — Economically Disadvantaged Students - Montessori and VPI Comparison

Group	6th Grade Math		7th Grade Math		8th Grade Math		Reading		Algebra I	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
ED Montessori	26	376	9	473	3	553	38	463	0	
ED VPI	11	397	8	460	0		19	472	0	

Figure 44: Seventh Grade Standards of Learning — Economically Disadvantaged Students - Montessori and VPI Comparison

Group	History		Reading		7th Grade Math		8th Grade Math		Algebra I		Algebra II		Geometry	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
ED Montessori	33	471	33	474	21	397	7	504	2	501			1	544
ED VPI	21	454	21	494	11	441	10	552	0				0	

Figure 45: Eighth Grade Standards of Learning — Economically Disadvantaged Students - Montessori and VPI Comparison

Group	Reading		Science		Writing		8th Grade Math		Algebra I		Algebra II		Geometry		World Geography	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
Montessori	34	459	34	463	34	436	23	453	8	490	1	581	2	552	34	445
VPI	20	492	20	485	21	435	6	434	14	505					20	453

Which Students Take Advanced Courses and SOL Tests

Of 40 ED Montessori students, 15 (37.5 percent) enrolled in at least one advanced math course during middle school (as evidenced by SOL tests). Of the 22 ED VPI students, 14 (63.6 percent) enrolled in at least one advanced math course.

Which Students Take World Languages

Approximately 75 percent of the ED Montessori students enrolled in a world language course during middle school. This compares with 77.3 percent of ED VPI students.

Stanford Achievement Test Series, Tenth Edition (Stanford 10)

In three of the four tests described in the table below, ED VPI students outscored ED Montessori students. This difference was most pronounced in Math. The two groups achieved approximately the same mean score in Social Studies.

Figure 46: Stanford 10 – Economically Disadvantaged Students
Montessori and VPI Comparison

Group	Reading Total		Math Total		Science		Social Studies	
	n	Mean	n	Mean	n	Mean	n	Mean
ED Montessori	38	54	37	59	37	55	37	56
ED VPI	20	56	20	68	20	57	20	56

Limited English Proficient Students

The data set designated students as Limited English Proficient (LEP) beginning in 2004-2005. Through a method comparable to that employed for economically disadvantaged students, we concentrate our analysis on students' initial LEP status upon entry to APS. Please note that this calculation of LEP status does differ from the calculation performed in the 2008 report. In the 2008 report, if a students' LEP status changed as they progressed through school, then these students were excluded from this analysis, beginning in the year during which they changed status

Among APS Pre-K participants, 61 individuals (43.0 percent) were designated as LEP There were 353 (32.5 percent) corresponding non-participants designated as LEP.

APS Pre-K Participants versus Non-Participants

Overall, LEP students who participated in an APS Pre-K program outperformed students who did not participate. The following table presents DRP scores for LEP Pre-K participants and non-participants. Note that LEP APS Pre-K students' mean scores, for both fall and spring, were about five points higher than those of non-participants. There was a large disparity in the percentage of students identified for remediation; 11-12 percent of LEP students who participated in APS Pre-K programs were identified, in comparison with 88-90 percent of LEP non-participants.

Degrees of Reading Power (DRP) Program

Figure 47: Degrees of Reading Power – Limited English Proficient Students

Group	Fall					Spring				
	Average DRP (.75) Score			Percentage Identified for Remediation		Average DRP (.75) Score			Percentage Identified for Remediation	
	n	Mean	Standard Deviation	n	%	n	Mean	Standard Deviation	n	%
LEP APS Pre-K	60	58.37	11.45	23	11.7%	56	64.59	13.26	16	11.0%
LEP No APS Pre-K	319	54.05	13.00	174	88.3%	308	60.08	13.03	129	89.0%

Standards of Learning (SOL)

This trend continues with respect to SOL scores. LEP students who attended an APK Pre-K program scored higher than non-participants on all seventh and eighth grade tests for which there were 10 or more students in each group. However, sixth grade SOL scores are an exception; non-participant scores were higher on this test.

<u>Mean Scale Scores</u>

Figure 48: Sixth Grade Standards of Learning –
Limited English Proficient Students

Group	6th Grade Math		7th Grade Math		8th Grade Math		Reading		Algebra I	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
LEP APS Pre-K	36	378	20	473	2	532	58	458		
LEP No APS Pre-K	270	383	54	491	3	581	290	444		

Figure 49: Seventh Grade Standards of Learning –
Limited English Proficient Students

Group	History		Reading		7th Grade Math		8th Grade Math		Algebra I		Algebra II		Geometry	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
LEP APS Pre-K	53	461	53	478	29	410	20	534	3	514				
LEP No APS Pre-K	295	447	293	446	240	405	51	533	11	519				

Figure 50: Eighth Grade Standards of Learning –
Limited English Proficient Students

Group	Reading		Science		Writing		8th Grade Math		Algebra I		Algebra II		Geometry		World Geography	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
LEP APS Pre-K	53	470	53	475	53	436	27	446	23	501	0		3	568	53	447
LEP No APS Pre-K	288	451	291	454	291	429	194	438	85	499	0		11	543	287	439

<u>Which Students Take Advanced Courses and SOL Tests</u>

Of the 61 LEP APS Pre-K students, 29 (47.5 percent) enrolled in at least one advanced math course during middle school (as evidenced by SOL tests). Of the 353 non-participants, 108 (30.6 percent) enrolled in at least one advanced math course. Students in both groups were most likely to enroll in these courses in eighth grade.

Figure 51: Advanced Math Course Enrollment
Limited English Proficient Students[22]

Group	6th Grade		7th Grade		8th Grade	
	n	%	n	%	n	%
LEP APS Pre-K (n=61)	22	36.1%	23	37.7%	26	42.6%
LEP No APS Pre-K (n=353)	57	16.1%	62	17.6%	96	27.2%

<u>Which Students Take a World Language</u>

Of the 353 LEP students who did not participate in APS Pre-K, 216 (61.2 percent) enrolled in a world languages course. Of the 61 APS Pre-K participants, 46 (75.4 percent) enrolled in a world languages course. Both groups were most likely to initially enroll in these courses during seventh grade.

Figure 52: Initial World Language Course Enrollment
Limited English Proficient Students[23]

Group	6th Grade		7th Grade		8th Grade	
	n	%	n	%	n	%
LEP APS Pre-K (n=61)	7	11.5%	35	57.4%	4	6.6%
LEP No APS Pre-K (n=353)	23	6.5%	164	46.5%	29	8.2%

---

[22] Because this table shows the percentage of all students in each group who were enrolled in an advanced math class during each of the three middle school years, the total percentage does not add to 100%.

[23] Because not all students in each group took a world language course at some point during middle school, these percentages do not add to 100%.

Stanford Achievement Test Series, Tenth Edition (Stanford 10)

In all four tests described in the table below, LEP students who participated in an APS Pre-K program outscored non-participants. The difference in these scores ranged from four points in Social Studies to six points for both Reading and Math.

Figure 53: Stanford 10 – Limited English Proficient Students

Group	Reading Total		Math Total		Science		Social Studies	
	n	**Mean**	**n**	**Mean**	**n**	**Mean**	**n**	**Mean**
LEP APS Pre-K	59	54	58	64	58	56	58	56
LEP No APS Pre-K	294	48	294	58	294	51	294	52

Montessori versus VPI

We examined LEP-designated Montessori and VPI students in order to determine whether students from one program exhibit higher academic performance than students from the other. We found that Montessori LEP students received higher scores than VPI LEP students on almost every assessment during middle school. The following table provides DRP scores for these students. Note that for both fall and spring average (0.75) scores, LEP Montessori students were comparable with LEP VPI students; the scores for each were within 1-2 points of each other. LEP Montessori students were more frequently identified for remediation than LEP VPI students.

Degrees of Reading Power Program

Figure 54: Degrees of Reading Power – Limited English Proficient Students Montessori and VPI Comparison

Group	Fall					Spring				
	Average DRP (.75) Score			Percentage Identified for Remediation		Average DRP (.75) Score			Percentage Identified for Remediation	
	n	**Mean**	**Standard Deviation**	**n**	**%**	**n**	**Mean**	**Standard Deviation**	**n**	**%**
LEP Montessori	28	61.54	10.80	9	32.1%	28	67.71	13.04	8	28.6%
LEP VPI	22	58.68	10.38	6	27.3%	19	66.74	9.97	2	10.5%

Standards of Learning

When considering the Math SOLs taken at grade level, LEP VPI students outscored LEP Montessori students by 33 points in sixth grade and 30 points in seventh grade. There were insufficient data to examine the difference in eighth grade.

With respect to Reading SOLs, ED VPI students scored higher than ED Montessori students by 33 points in sixth grade and by 30 points in seventh grade. With respect to Reading SOLs, LEP VPI students scored higher than LEP Montessori students by 6 points in sixth grade, 15 points in seventh grade, and 23 points in eighth grade.

Mean Scale Scores

Figure 55: Sixth Grade Standards of Learning –Limited English Proficient Students - Montessori and VPI Comparison

Group	6th Grade Math		7th Grade Math		8th Grade Math		Reading		Algebra I	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
LEP Montessori	16	372	10	488	2	532	28	467	0	
LEP VPI	12	405	8	460	0		20	473	0	

Figure 56: Seventh Grade Standards of Learning –Limited English Proficient Students - Montessori and VPI Comparison

Group	History		Reading		7th Grade Math		8th Grade Math		Algebra I		Algebra II		Geometry	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
LEP Montessori	23	478	23	479	12	402	7	488	3	514	0		0	
LEP VPI	21	455	21	494	10	432	11	555	0		0		0	

Figure 57: Eighth Grade Standards of Learning –Limited English Proficient Students - Montessori and VPI Comparison

Group	Reading		Science		Writing		8th Grade Math		Algebra I		Algebra II		Geometry		World Geography	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
LEP Montessori	24	469	24	475	24	438	14	463	7	489	0		3	568	24	458
LEP VPI	20	492	20	485	21	437	6	434	14	504	0		0		20	451

Which Students Take Advanced Courses and SOL Tests

Of the 29 LEP Montessori students, 13 (44.8 percent) enrolled in at least one advanced math course during middle school (as evidenced by SOL tests). Of the 22 LEP VPI students, 14 (63.6 percent) enrolled in at least one advanced math course.

Which Students Take World Languages

Approximately 79.3 percent of the LEP Montessori students enrolled in a world language course during middle school. This compares with 77.3 percent of ED VPI students who enrolled in at least one of these courses.

Stanford Achievement Test Series, Tenth Edition (Stanford 10)

In three of the four tests described in the table below, LEP VPI student mean scores were comparable to those of LEP Montessori students. This difference was not more than two points for any test.

**Figure 58: Stanford 10 – Limited English Proficient Students
Montessori and VPI Comparison**

Group	Reading Total		Math Total		Science		Social Studies	
	n	Mean	n	Mean	n	Mean	n	Mean
LEP Montessori	28	57	27	66	27	58	27	59
LEP VPI	21	57	21	68	21	58	21	57

Appendix A – Summary Tables

Degrees of Reading Power – Score and Remediation Summary									
	Fall					Spring			
Group	Average DRP (.75) Score			Identified for remediation		Average DRP (.75) Score			Identified for remediation	
	# Tested	Mean	Standard Deviation	n	%	# Tested	Mean	Standard Deviation	n	%
Middle School Cohort	1158	64.47	15.66	332	28.6%	1097	69.61	15.05	234	21.3%
APS Pre-K	136	61.56	13.67	45	33.1%	128	67.15	14.22	31	24.2%
No APS Pre-K	1022	64.86	15.87	287	28.1%	969	69.94	15.13	203	20.9%
VPI	26	57.50	10.80	8	30.8%	23	65.78	10.08	3	13.0%
Special Ed	17	47.65	12.88	13	76.5%	17	52.65	15.51	12	70.6%
Montessori	74	64.80	12.43	20	27.0%	70	70.03	13.61	14	20.0%
Dual Enrolled	19	66.95	13.59	4	21.1%	18	71.39	11.63	2	11.1%

Sixth Grade Standards of Learning – Passing Rates Summary										
Group	**6th Grade Math**		**7th Grade Math**		**8th Grade Math**		**Reading**		**Algebra I**	
	n	%	n	%	n	%	n	%	n	%
Middle School Cohort	359	51.2%	374	97.9%	65	100%	951	85.4%	3	100%
APS Pre-K	31	40.8%	51	94.4%	6	100%	115	84.6%		
No APS Pre-K	328	52.5%	323	98.5%	59	100%	836	85.6%	3	100%
VPI	8	53.3%	9	100%			21	87.5%		
Special Ed	3	18.8%	2	100%			10	55.6%		
Montessori	15	39.5%	27	90.0%	6	100%	64	86.5%		
Dual Enrolled	5	71.4%	13	100%			20	100%		

Seventh Grade Standards of Learning – Passing Rates Summary															
Group	**History**		**Reading**		**7th Grade Math**		**8th Grade Math**		**Algebra I**		**Algebra II**		**Geometry**	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Middle School Cohort	965	88.9%	968	89.1%	354	59.5%	357	100%	126	100%	1	100%	3	100%
APS Pre-K	117	90.7%	119	92.2%	33	51.6%	50	100%	11	100%			1	100%
No APS Pre-K	848	88.7%	849	88.7%	321	60.5%	307	100%	115	100%	1	100%	2	100%
VPI	22	84.6%	24	92.3%	9	64.3%	12	100%						
Special Ed	11	78.6%	11	78.6%	5	41.7%	2	100%						
Montessori	64	92.8%	64	92.8%	14	45.2%	24	100%	10	100%			1	100%
Dual Enrolled	20	100%	20	100%	5	71.4%	12	100%	1	100%				

Eighth Grade Standards of Learning – Passing Rates Summary															
	Reading		Science		Writing		8th Grade Math		Algebra I		Algebra II		Geometry		World Geography	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Middle School Cohort	952	89.6%	987	92.7%	1016	95.5%	330	72.4%	478	99.8%	3	100%	120	100%	923	87.2%
APS Pre-K	111	86.7%	120	93.8%	124	96.9%	40	74.1%	62	100%	1	100%	11	100%	108	85.0%
No APS Pre-K	841	90.0%	867	92.5%	892	95.3%	290	72.1%	416	99.8%	2	100%	109	100%	815	87.4%
VPI	22	88.0%	25	100%	25	96.2%	5	62.5%	17	100%					23	92.0%
Special Ed	11	73.3%	11	73.3%	12	85.7%	8	66.7%	3	100%					10	66.7%
Montessori	59	85.5%	65	94.2%	69	98.6%	22	75.9%	29	100%	1	100%	10	100%	59	85.5%
Dual Enrolled	19	100%	19	100%	18	100%	5	100%	13	100%			1	100%	16	88.9%

Sixth Grade Standards of Learning – Score Summary										
Group	6th Grade Math		7th Grade Math		8th Grade Math		Reading		Algebra I	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
Middle School Cohort	701	401	382	521	65	572	1113	489	3	572
APS Pre-K	76	384	54	496	6	509	136	477		
No APS Pre-K	625	403	328	525	59	578	977	490	3	572
VPI	15	402	9	453			24	471		
Special Ed	16	345	2	511			18	406		
Montessori	38	390	30	505	6	509	74	489		
Dual Enrolled	7	405	13	504			20	501		

Seventh Grade Standards of Learning – Score Summary													
Group	History		Reading		7th Grade Math		8th Grade Math		Algebra I		Algebra II		Geometry	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
Middle School Cohort	1085	493	1086	496	595	422	357	554	126	538	1	600	3	556
APS Pre-K	129	487	129	494	64	415	50	538	11	529			1	544
No APS Pre-K	956	494	957	496	531	423	307	557	115	539	1	600	2	562
VPI	26	457	26	491	14	438	12	550						
Special Ed	14	455	14	456	12	397	2	600						
Montessori	69	496	69	497	31	409	24	524	10	522			1	544
Dual Enrolled	20	516	20	516	7	423	12	545	1	600				

Eighth Grade Standards of Learning – Score Summary															
Group	Reading		Science		Writing		8th Grade Math		Algebra I		Algebra II		Geometry		World Geography	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
Middle School Cohort	1062	495	1065	497	1064	448	456	449	479	505	3	552	120	545	1059	483
APS Pre-K	128	487	128	490	128	446	54	451	62	509	1	581	11	553	127	470
No APS Pre-K	934	496	937	498	936	449	402	448	417	505	2	538	109	544	932	485
VPI	25	487	25	478	26	438	8	447	17	502					25	452
Special Ed	15	435	15	455	14	431	12	430	3	512					15	435
Montessori	69	491	69	495	70	448	29	453	29	509	1	581	10	555	69	474
Dual Enrolled	19	511	19	521	18	457	5	498	13	518			1	534	18	508

Stanford 10 - Score Summary (Part 1 of 2)																
Group	Reading Total		Word Study[24]		Vocabulary		Reading Comprehension		Math Total		Math Problem Solving		Math Procedures		Language	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
Middle School Cohort	1127	63			1127	61	1131	63	1125	68	1127	68	1129	66	1127	63
APS Pre-K	135	59			135	59	135	59	134	66	135	66	134	65	134	60
No APS Pre-K	992	64			992	61	996	64	991	68	992	69	995	66	993	64
VPI	25	56			25	54	25	56	25	67	25	65	25	67	25	59
Special Ed	17	41			17	39	17	44	17	48	17	44	17	53	17	47
Montessori	74	62			74	64	74	60	73	69	74	69	73	66	73	63
Dual Enrolled	19	68			19	63	19	69	19	73	19	74	19	69	19	66

[24] There were no mean scores present in the data sample for Word Study.

Stanford 10 - Score Summary (Part 2 of 2)															
Group	Pre-Writing		Composing		Editing		Spelling		Science		Social Science		Partial		Total	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
Middle School Cohort	1127	61	1127	61	1127	61	1128	58	1129	65	1126	65	1123	63	1123	64
APS Pre-K	134	59	134	58	134	59	134	56	134	61	134	62	134	61	134	61
No APS Pre-K	993	62	993	61	993	61	994	58	995	66	992	66	989	64	989	64
VPI	25	61	25	56	25	57	25	52	25	57	25	59	25	59	25	59
Special Ed	17	46	17	47	17	47	17	48	17	45	17	47	17	46	17	46
Montessori	73	60	73	59	73	61	73	58	73	64	73	65	73	63	73	64
Dual Enrolled	19	63	19	66	19	62	19	57	19	69	19	71	19	66	19	67

Appendix B – Description of Excel File

The Excel file that accompanies this report, entitled "APS Summary Assessment File," includes mean scores, standard deviations, pass rates, and percentages of students identified for remediation for each performance measure that was included in the original raw data file. The first worksheet, entitled "Readme" contains a description of each of the worksheets in the file. A worksheet entitled "Cohort Breakdown," lists the values for each major subset of the data including:

- ❖ Full APS Cohort
- ❖ All APS Pre-K Attendees
- ❖ No APS Pre-K
- ❖ Montessori
- ❖ Virginia Preschool Initiative
- ❖ Special Education
- ❖ Dual Enrolled Special Education

For every measure, each subset has a numerical value (i.e., the number of students who took the test, number of students who passed, number identified for remediation, etc.), a mean score (or percentage in the case of pass rates or remediation), and a standard deviation, if applicable.

A worksheet, titled "ED and LEP" presents similar data for APS Pre-K participants and non-participants, broken down by economically disadvantaged and Limited English Proficient status.

The third and final worksheet provides similar data for Montessori and VPI students, broken down by economically disadvantaged and LEP status.

Project Evaluation Form

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Analysis of Student Performance in APS ELA Program

Prepared for Arlington Public Schools

In this report, Hanover Research examines student success in reading and writing among APS students. We first build a profile of students more likely to succeed, and we then use regression analysis to examine significant predictors of student success. Lastly, we also investigate whether there are key points in time during a student's career that are most critical to future success.

Executive Summary

In this report, Hanover Research examines success in reading and writing among the student cohort consisting of active Grade 9 students in Arlington Public Schools (APS) during the 2008-2009 school year. We present differences in success across various demographic, academic, and other characteristics. We also use regression analysis to examine significant predictors of student success.

Data Analysis – Key Findings

❖ Not surprisingly, successful (non-struggling) students in reading and writing performed better academically at earlier grade levels. Student GPA and scores across various assessments and grade levels were all higher for non-struggling students than for those who were classified as struggling students.

❖ We observed statistically significant positive gains between either pre- and post-intervention assessment scores or between pre- and post-intervention student GPAs when assessing the impact of various interventions. However, only enrollment in summer school courses was seen to lead to positive and statistically significant gains in both students' GPA and assessment scores. Even so, summer schools across various grades were not all equally effective – summer school after Grades 6, 9, and 10 was seen to be more effective.

❖ Only two pre-high school characteristics – reading SOL scores and special education status – proved to be significant predictors of student struggling status. Not surprisingly, higher reading SOL scores were associated with a decreased likelihood of a student struggling. Students with special education status entering high school were also significantly more likely to be struggling students.

❖ No single demographic factor proved to be an effective predictor of student academic performance (measured by GPA) across every grade. Some characteristics were significant factors associated with student GPA in some grades, but not in others. Overall, however, GPA tended to increase as students moved to higher grade levels. The performance of Grade 9 students also differed significantly among students of different demographic backgrounds as compared to students across other grade levels.

Introduction and Methodology

The following section provides an overview of the data used and the methodology employed in this report. We first discuss the data, and then move on to a discussion of each set of characteristics examined.

The Data

The dataset provided to Hanover Research included detailed individual student information related to individual student demographics, academic performance, and performance on assessments conducted across various grade levels. Student data on expected progress or failure to meet grade expectations by the 2011-2012 year were also provided by APS ("*StrugglingStudent*" variable) and are the focus of our analysis in this report. In all, data from 12,201 students who were active Grade 9 students during the 2008-2009 school year were provided.

Methodology

The core of our analysis takes on two forms. First, we use descriptive statistics and cross-tabulations to examine student success as a function of various demographic and academic variables to highlight at-risk students. Second, we use regression analysis to determine whether the differences between various student groups were statistically significant and to examine the effects of each individual factor while holding all other factors constant. We also investigate whether there are key points in time during a student's career that are most critical to future success. Details of the regression analysis are discussed at greater length below.

Section I: Description of Data

We begin our analysis by exploring student success across each of the demographic, academic, and other characteristics to build an overall profile and provide summary statistics of students who were more likely to be successful as well as those most at risk of not being so. The purpose of this section is to describe overall trends and provide a bivariate comparison between student success and each characteristic. Note that we do not use statistical tests to examine whether there exist any statistically significant differences (differences which are not likely due to chance alone) in student success among different groups of students in this initial section. Results from regression analysis are used for this purpose instead because of its added ability to distinguish statistically significant effects while controlling for the effects of the other characteristics that may influence whether or not a student is successful.

In addition to presenting these descriptive statistics, we also analyze the impact of intervention programs on student success. Specifically, we compare pre- and post-

intervention scores on several outcome variables. For example, we compare the SOL scores of a student before and after summer school and examine whether scores were significantly higher after participating in the program. Note, however, that we do not compare gains in student performances among those in the intervention program relative to students that were not. As explained in the outline, the goal here was to examine statistically significant gains in pre- and post-intervention scores among students enrolled in the intervention only. SOL scores were standardized before being examined in order to allow for comparisons across grade levels. A full list of the intervention and outcome variables used in the analysis is available in this section of the report.

Section II: Predictive Logit Model

In the second part or our analysis, we identify predictors of becoming a struggling student based on a variety of student characteristics. Specifically, we use a logit model to test the impact of each student characteristic on student status. The dependent variable is based on the "Struggling Student" indicator in the dataset, with the variable collapsed into a dichotomous variable, with struggling students coded as "1" and all other students (including both those who are not struggling as well as those who were formerly struggling) coded as "0."

The regression model estimates the likelihood that a student will struggle four years after entering high school based on demographic and achievement factors prior to entering high school. In other words, the model shows the relationship between pre-high school factors and struggling status when they should be in 12th grade. Accordingly, no data collected on students from the 9th grade and beyond are used in this model. Focusing on the explanatory nature of pre-high school data is advantageous, because **the results of the model will allow district educators to target certain students as being at-risk as they enter high school**. The ability to recognize at-risk students early in their high school careers might allow educators and counselors to devote specialized attention to these students.

The results of the logit model allow us to conduct inference tests and draw conclusions regarding the impact of each characteristic on student success. In particular, we can determine whether an independent variable (such as race, LEP status, or assessment score) has a positive or negative relationship with the outcome variable (struggling status) while controlling for a variety of student demographic and academic characteristics. We can also tell whether these relationships are statistically significant (i.e., whether the observed relationship is large and consistent enough that it would be unlikely to be observed by chance). For additional detail regarding our conceptual framework and the rationale behind selecting these types of models, please see Appendix B.

Section III: Key Points in Time

In the final section, we attempt to estimate the "danger points" during a student's career, attempting to determine whether certain grade levels are more important than others in having an impact on student success. **Hanover identified two ways to address this question.**

The **first provides the achievement and demographic characteristics of students who fail to advance to the next grade level**. This analysis is conducted for every grade level from the 9th through the 12th grade. We identify the grade levels in high school at which the highest percentage of students are held back, and also examine whether the characteristics of these students change at each grade level.

Secondly, we leverage the temporal nature of the data by estimating a longitudinal regression model. This model is similar to the models presented in Section II, with a few key exceptions. First, the model incorporates data throughout students' high school careers. Secondly, the dependent variable is changed to student GPA, and lastly, the explanatory variables in the model are multiplied by grade levels. These regression coefficients allow us to investigate whether these factors (e.g., absenteeism) matter more at different grade levels.

The next section of this report provides the results of our analysis. We first provide summary statistics from cross-tabulations.

Section I: Description of Data

We begin our analysis by exploring student struggling status across each of the demographic, academic, and other characteristics to build an overall profile and provide summary statistics of students who were more likely to be successful in reading/writing as well as those most at risk of not doing so. The purpose of this section is to describe overall trends and provide a bivariate comparison between student struggling status and each characteristic. For the specific count of students who were struggling or not in each subgroup, please refer to the tables in Appendix A. Note again that we do not use statistical tests to examine whether there are any statistically significant differences (differences which are not likely due to chance alone) in struggling status among different groups of students in this initial section. Results from regression analysis are used for this purpose instead because of its added ability to distinguish statistically significant effects while controlling for the effects of the other characteristics that may influence student success.

Struggling Status Overall

Overall, most (75 percent) of students in the dataset were not struggling in reading/ writing. Of the remaining students, 8 percent were formerly struggling students who struggled at some point in the past, but are not struggling anymore, and about one in five (17 percent) were currently struggling students. Struggling students were either 12th graders who do not have reading/writing verified credits, or students who are currently in a grade lower than 12th grade or students in Grade 77.[1]

Figure 1: Struggling Status (n=1201)

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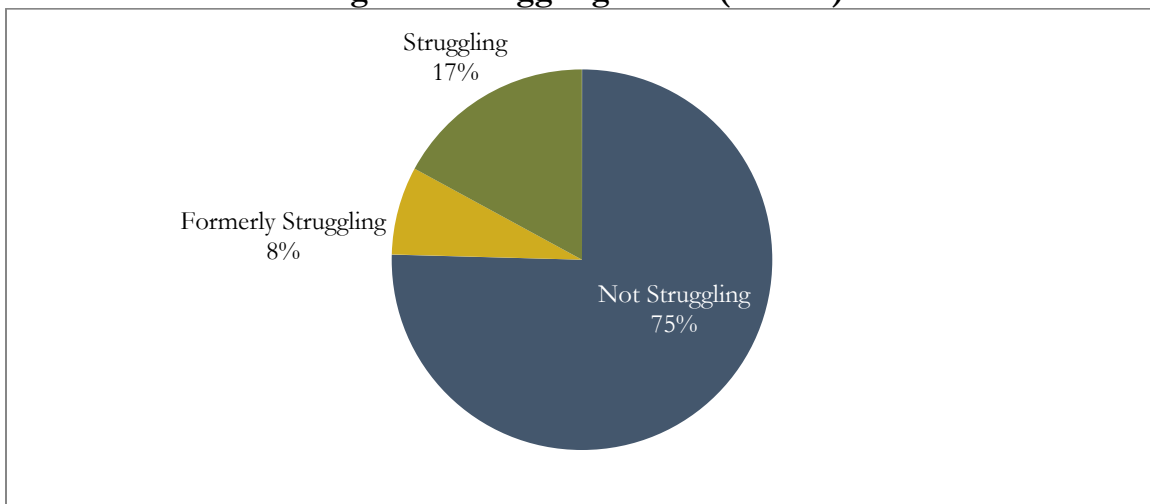
[1] These are adult students – either SPED or ESOL/HILT students who are 22 years old or older and are enrolled in high school continuation.

Demographic Characteristics

Gender – Males formed slightly more than half (52 percent) of active 9th grade students during the 2008-2009 academic year. They were also more likely to be unsuccessful in reading/writing as compared to females. Twenty-one percent of male students were classified as struggling students, compared with only 13 percent of females (Figure 2). The proportion of formerly struggling students was similar across both genders – 7 percent among male students and 8 percent among females.

Figure 2: Gender and Struggling Status
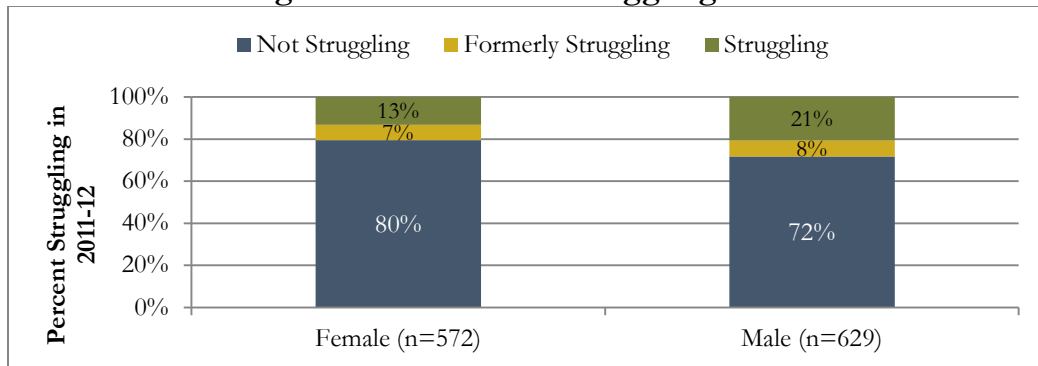
Ethnicity – Roughly three fourths of the cohort consisted of either white students (42 percent) or Hispanic students (31 percent). Black students constituted 13 percent of the cohort, whereas Asian students made up 12 percent. Hispanic students were more likely to struggle in reading/writing as compared to students of other ethnicities. Thirty-three percent of Hispanic students were classified as struggling students. Black and Asian students followed, with 22 percent and 17 percent of students of each ethnicity being classified as struggling students respectively. On the other hand, only 4 percent of white students were struggling students.

Figure 3: Ethnicity and Struggling Status
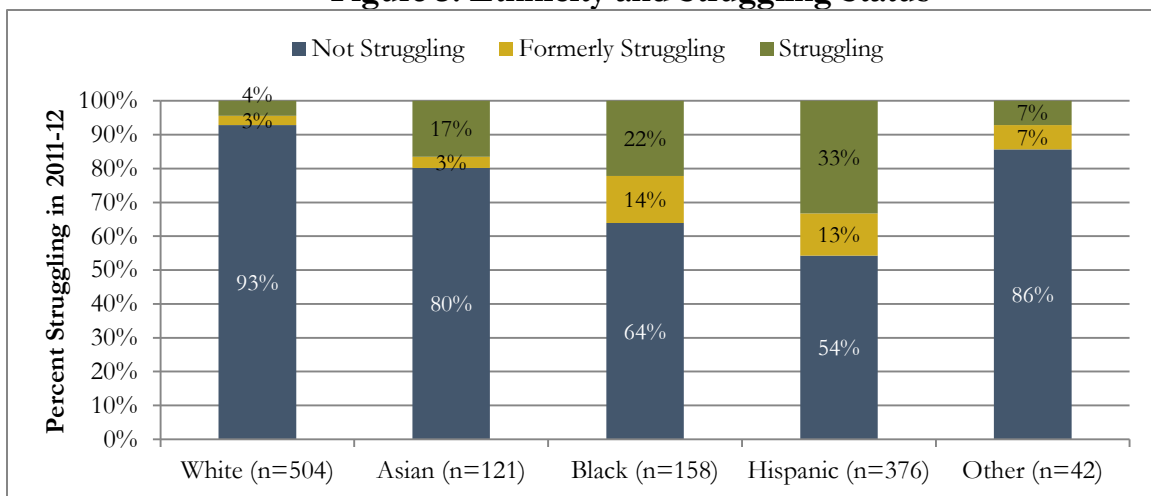
LEP Status – Figure 4 below charts struggling status based on student LEP status in each year. About 44 percent of students with LEP status during the 2008-2009 school year (when most students were beginning high school in grade 9) were struggling students in 2011-2012. Students who were still classified as LEP in later years were even more likely to be struggling students, and the majority (58 percent) of those classified as LEP students during the 2011-2012 school year (when they should be in 12th grade) were struggling students. Overall, students with LEP status were more likely to be struggling students (either formerly or currently), and only minorities of LEP students in each school year were not struggling students.

Figure 4: LEP Status and Struggling Status
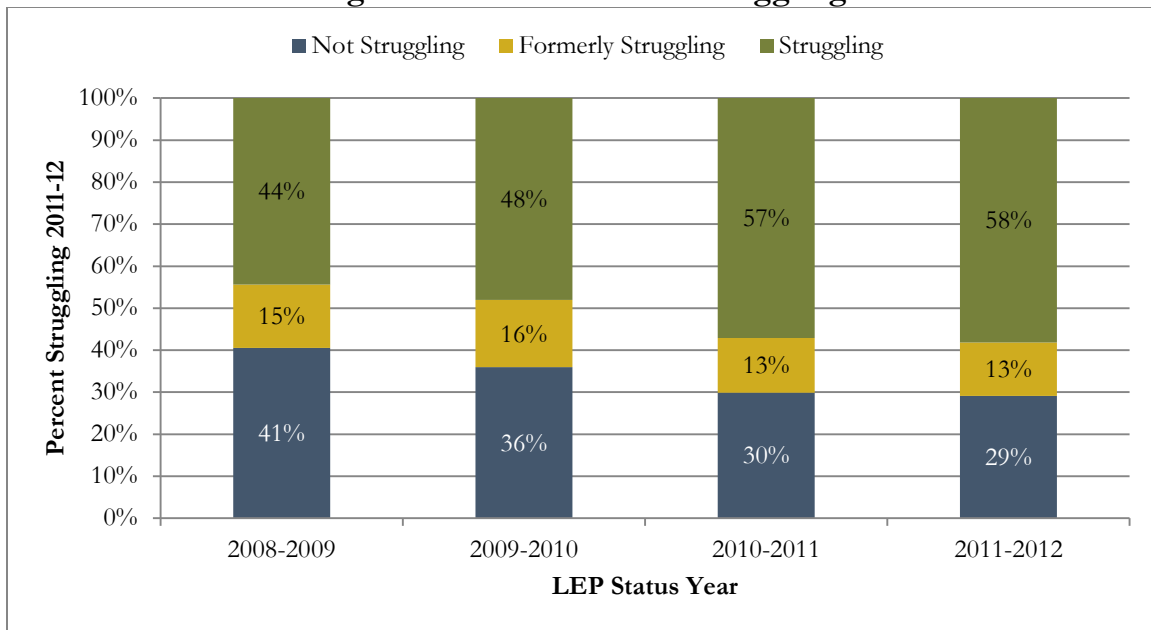
Economic Status – Whereas LEP students were more likely to be struggling or formerly struggling students, the same was not true with regards to economic status. About a third (34 percent) of students with low economic status during their first year in high school (2008-2009) were classified as struggling students three years later. The proportion of low income students in each year who were classified as struggling in 2011-2012 was also similar, ranging from 31 percent to 34 percent. There is no indication that students with low economic status in later years were more likely to be struggling in 2011-2012 than those with low economic status at the beginning of high school.

Figure 5: Low Economic Status and Struggling Status
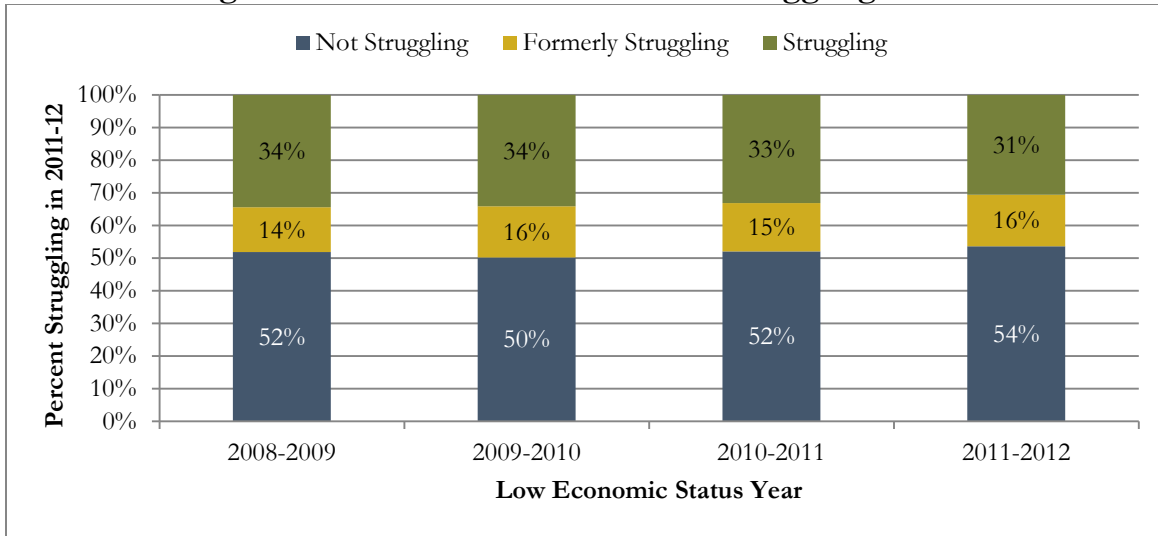
SPED Status – Figure 6 below charts struggling student status in 2011-2012 based on student SPED status in each year. About 44 percent of students with SPED status during their first year in high school (2008-2009) were classified as struggling students in their fourth year. Generally, the proportion of SPED students in each year who were classified as struggling in 2011-2012 was also similar, ranging from 41 percent (2009-2010) to 46 percent (2011-2012).

Figure 6: SPED Status by Struggling Status
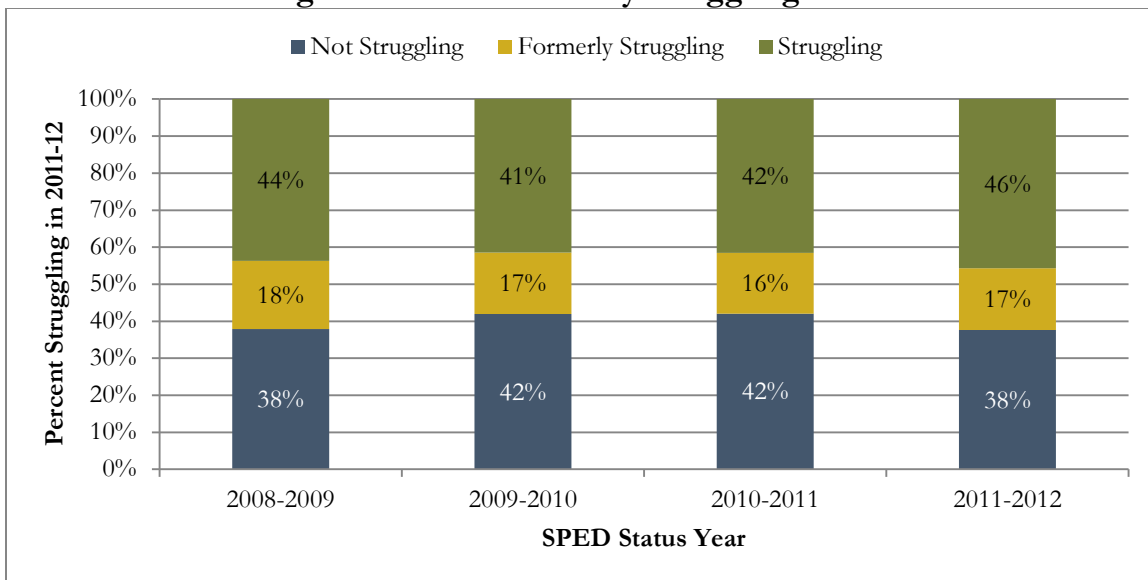
Absenteeism – Figure 7 below charts the average number of days absent of students in each school year by struggling status. Note that the averages given below are calculated for each academic year, and while most students were at the indicated grade levels, some may have been a year behind or ahead. Non-struggling students

had the lowest average number of days absent in every prior academic year. Data was not available to calculate absenteeism by struggling status for 2011-2012.

**Figure 7: Absenteeism by Struggling Status**
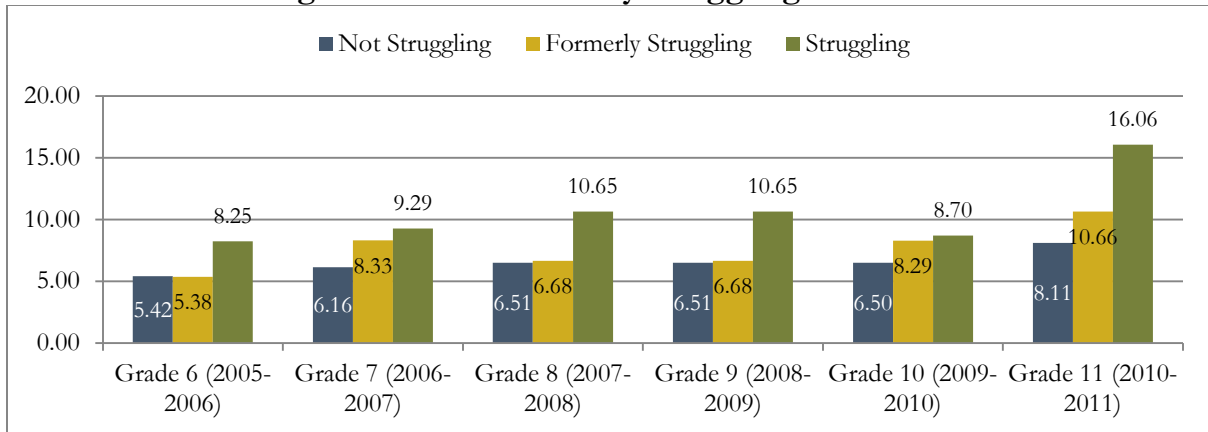
Struggling Status by Academic Characteristics

DRP Scores – Figure 8 below charts the average DRP scores of students on the Grade 2, Grade 4, and Grade 6 fall and spring assessments by struggling status in 2011-2012. Successful (not struggling) students clearly had higher scores on average on each assessment, going as far back as the Grade 2 DRP. The difference in scores between formerly struggling and struggling students, however, was negligible. Across all three groups of students, average scores also increase with each assessment (which is expected considering that the DRP tests use the same scale of readability across different grade levels to measure how well students understand the meaning of text). This suggests that low DRP scores in early grades may help predict whether a student will ever be classified as struggling, but that they may be less useful for separating students who will recover before graduation from those who will still be struggling four years after entering high school.

Figure 8: DRP Scores by Struggling Status
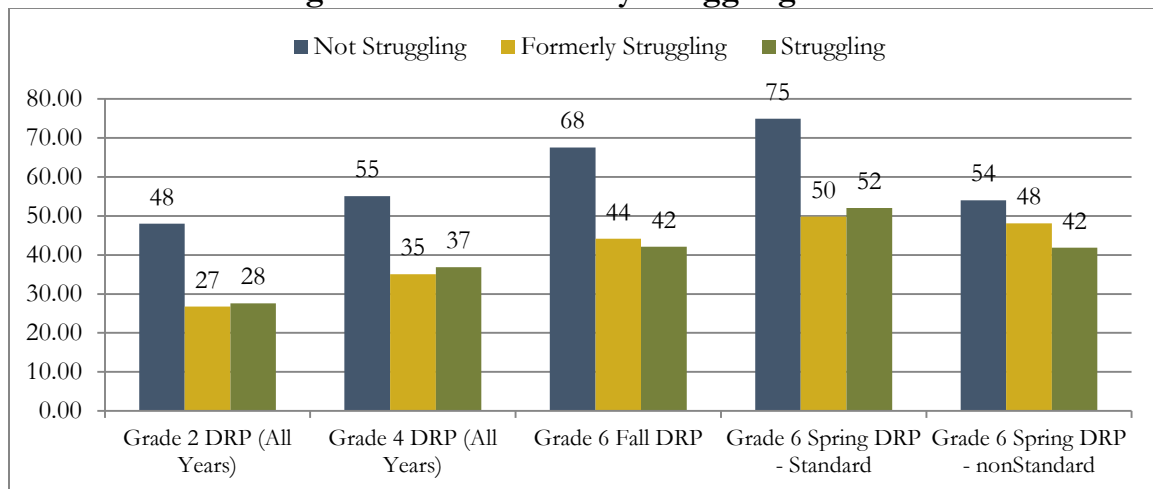
GPA – Figure 9 below charts the average GPA of students in each school year by struggling status. Note that the averages given below are calculated for each academic year, and while most students were at the indicated grade levels, some may have been a year behind or ahead. Not surprisingly, successful non-struggling students in 2011-2012 had the highest average GPA in every prior academic year. There was also no major variation in average student GPA across years – non-struggling students maintained approximately the same lead over peers who would be struggling in 2011-2012 in every prior year. The average GPA for non-struggling students ranged between 3.13 and 3.26. There was also similarly very little variation in the average GPA of formerly struggling or struggling students across academic years.
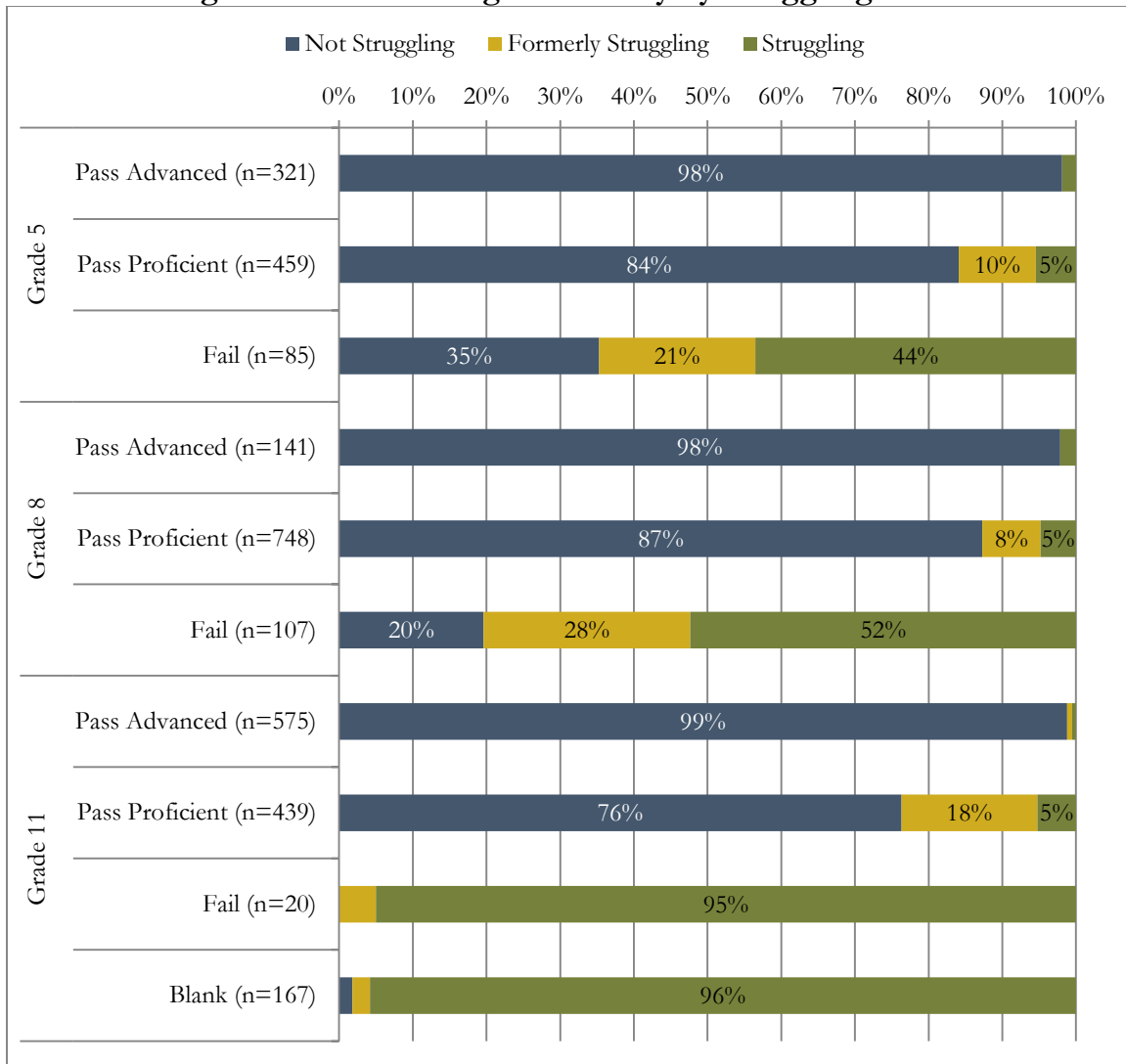
Figure 9: GPA by Struggling Status
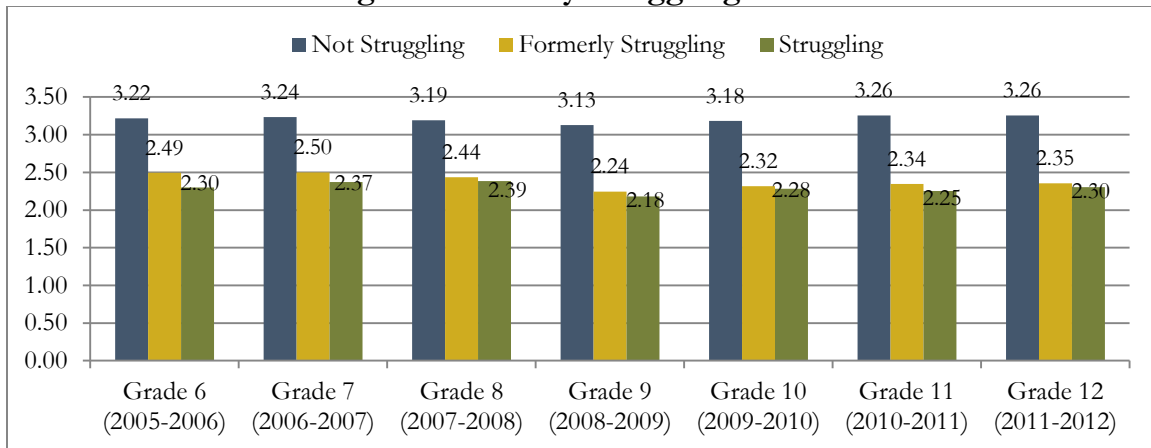
SOL Reading Proficiency – Figure 10 below charts student performance (proficiency level) on the SOL Reading Assessments. Almost all students who performed at the advanced or proficient levels in each grade were successful students who were classified as not struggling in the 2011-2012 school year. On the other hand, those who failed were more likely to be struggling students. There is also a trend evident over time, with a higher proportion of those who failed the SOL in higher grades being classified as struggling students. This suggests that some students who fail tests in lower grades are able to recover in subsequent years, but that those who fail tests in later grades are less likely to recover (which is not surprising, given that these students have fewer years in which to make their recovery).

Figure 10: SOL Reading Proficiency by Struggling Status
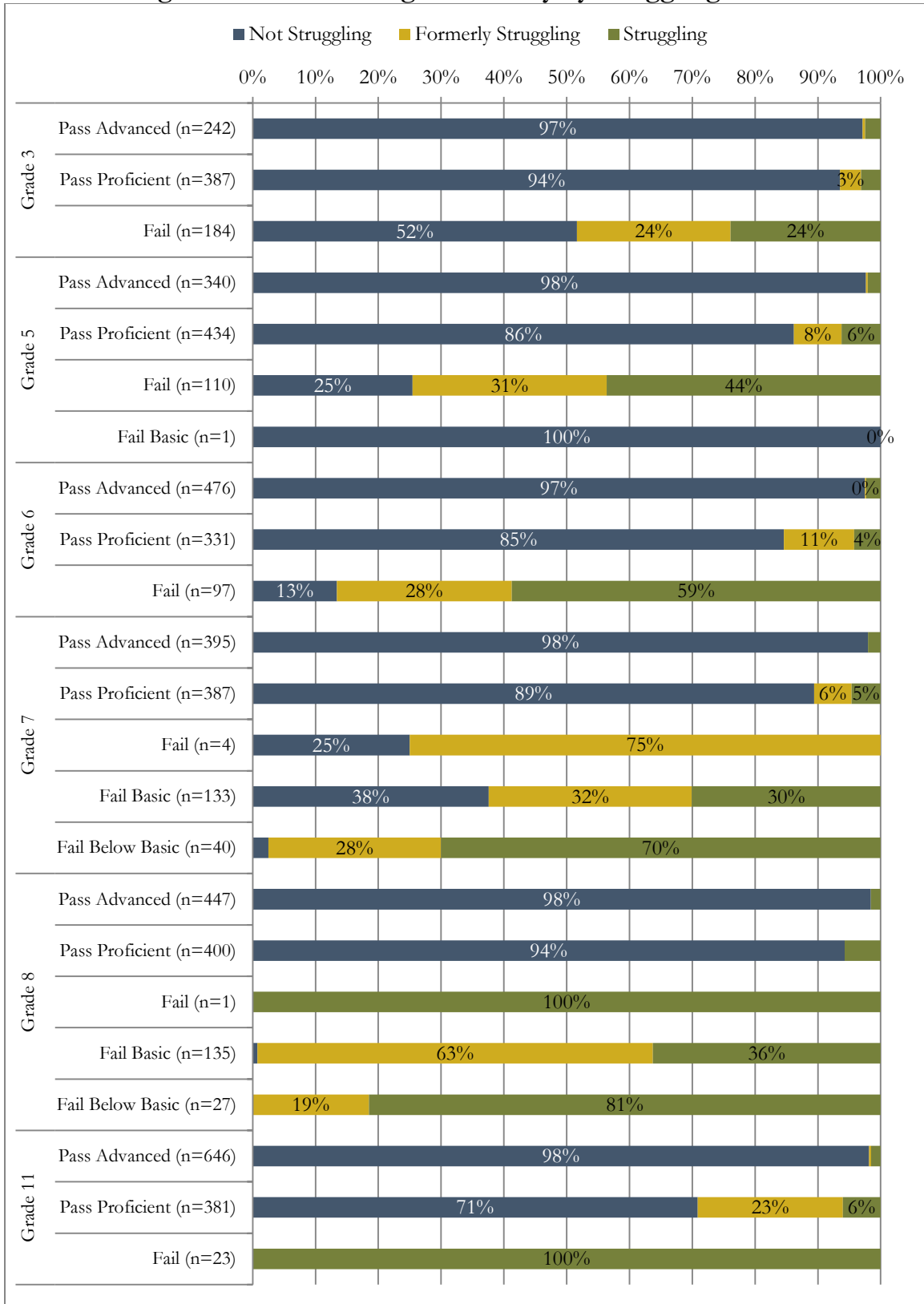
SOL Writing Proficiency – SOL writing data were available for Grades 5, 8 and EOC 11. Trends were similar to those seen on the reading SOL: students who performed well on the assessment tended not to be struggling students. Almost no students who performed at the advanced proficiency level were struggling students, and those who performed at the proficient level were also not very likely to be struggling students. On the other hand, those who failed were much more likely to be struggling students by 2011-2012. Of the 167 students with no records on the Grade 11 assessment, almost all were struggling students as well (96 percent).

**Figure 11: SOL Writing Proficiency by Struggling Status**

Stanford 10 – Figure 12 below charts the average scores of students on the Stanford 10 by subject area and struggling status. Successful students had the highest scores on each subject area, followed by formerly struggling students. Struggling students had the lowest averages.

**Figure 12: Stanford 10 Scores by Struggling Status**
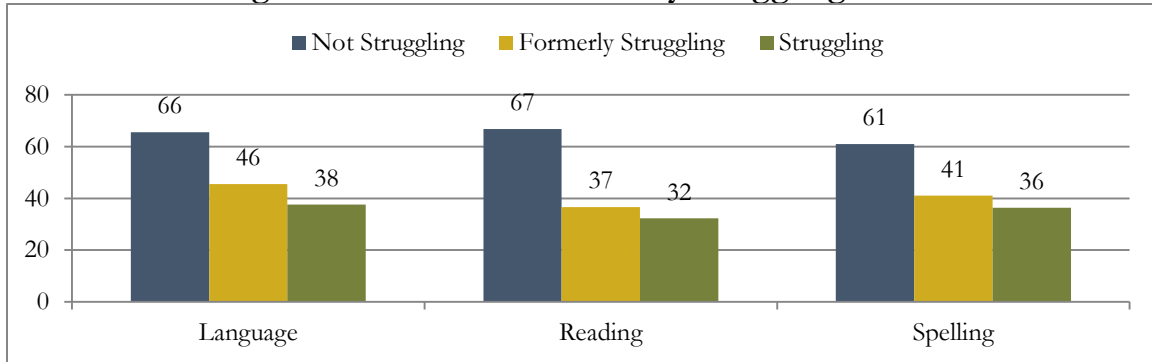
Verified Reading and Writing Credit Scores – By definition, students who were classified as formerly struggling were those who failed the 8th grade SOL, but have verified credits for reading and writing. Verified credits was set equal to 1 if a student passed their English course and passed the reading or writing end-of-course SOL test. Thus all students who were not struggling or formerly struggling had verified credits for both reading and writing. However, although most students who had verified credits in either subject were successful (non-struggling) students in 2011-2012, a small minority were still classified as struggling despite having verified credits in reading and writing. About 3 percent of students who had verified credits in reading or writing were struggling students in 2011-2012.

Figure 13: Struggling Status of Students with Verified Reading and Writing Credits
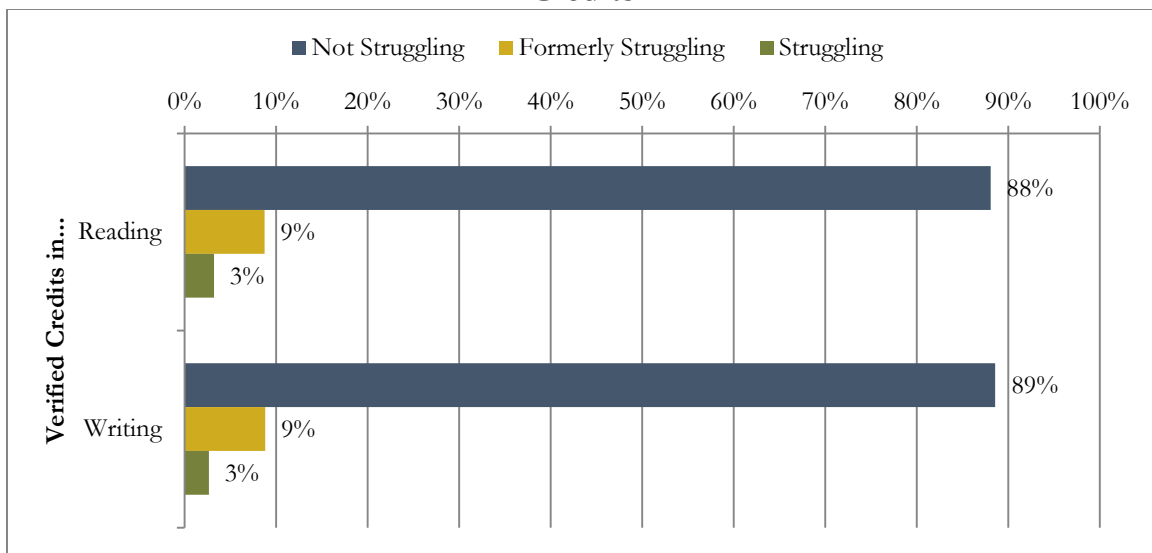
AP Scores – The majority of students (67 percent) did not take the English Language AP in Grade 11. Regardless of their scores on the AP examination itself, however, almost all students who did take the exam were successful (not-struggling) students in 2011-2012. Among the few struggling or formerly struggling students who did take the exam, the vast majority earned a score of 1 or 2.

Figure 14: AP Scores by Struggling Status
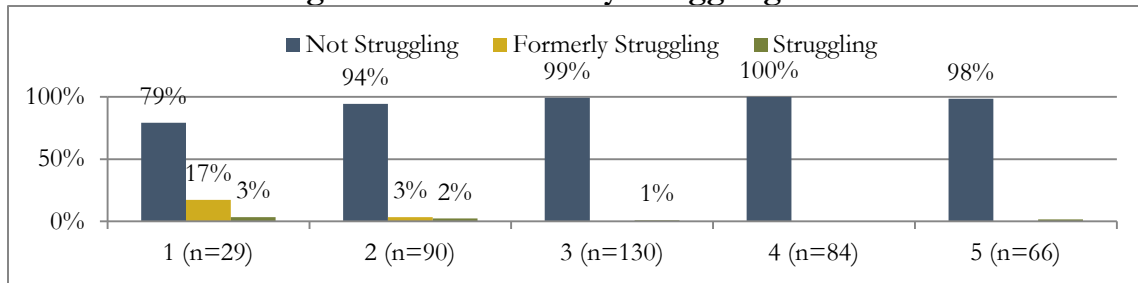
ACCESS Scores – Figure 15 below charts average ACCESS Literacy and Overall scores among English language learners (ELLs) in APS. Not surprisingly, the highest average scores were generally seen among students who were not struggling students in later years. Interestingly, however, there were also sizable differences in the average scores of formerly struggling and struggling students for each exam. Unlike most other measures examined in this report, formerly struggling students tended to perform more similarly to non-struggling students than to struggling students, suggesting that ACCESS scores might be useful for predicting which potentially struggling students will recover before graduation.

Figure 15: ACCESS Scores by Struggling Status
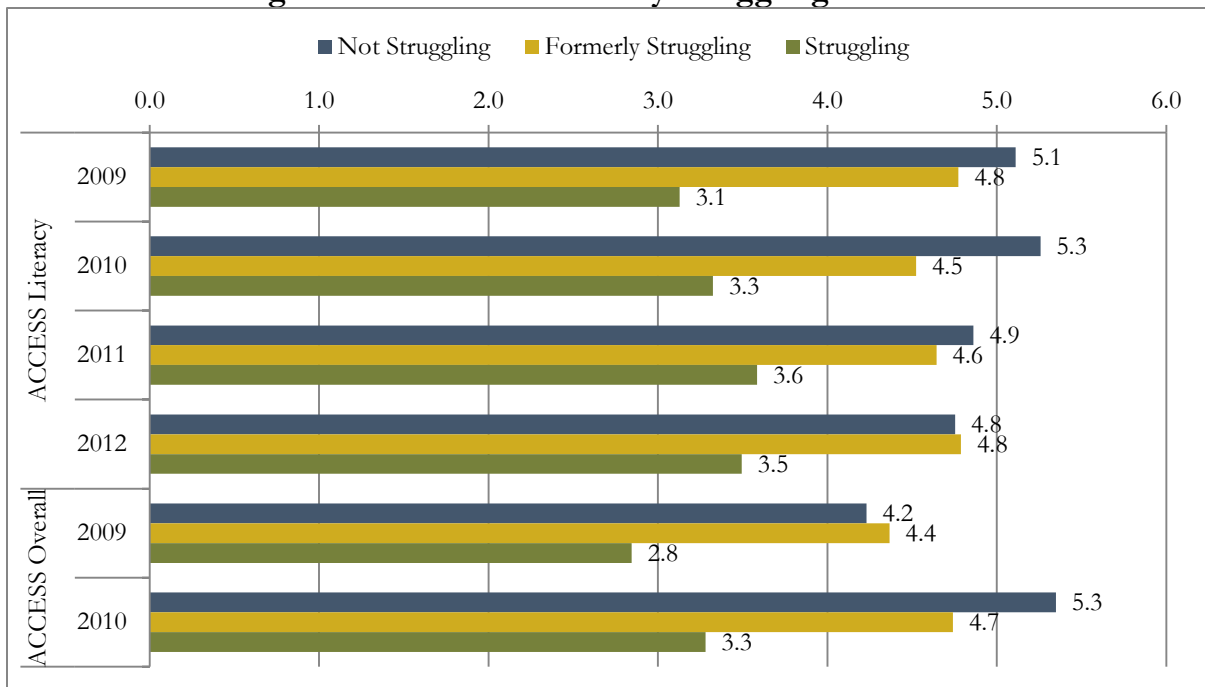
Impact of Intervention Programs on Student Success

Having established the basic trends in student scores, we next examine the impact of intervention programs on student success. Specifically, we compare pre- and post-scores on several outcome variables among students enrolled in an intervention program. In the sections below, we evaluate the effectiveness of each type of intervention program (reading course, element and strategies of reading course, reading strategies course, and summer school enrollment) on several outcomes. These pre- and post-scores are also listed in their separate tables below. Note that this focus on pre- and post-scores means that the analysis may detect significant increases that appeared for all students, not just those in the intervention program. While we do provide basic comparisons between gains in the intervention group and gains among other APS students here, we do not make these comparisons in a statistically rigorous manner. While this analysis presents a basic view of whether students in each program achieved any gains at all, a full evaluation of any of these programs would require a more in-depth analysis that compared the students in the program to a suitable control group of students not in the program, which is beyond the scope of this report.

As mentioned in our methodology section earlier, students' scaled scores on the reading SOL assessments were standardized to allow us to compare performances across different grade levels. Since this standardization was relative to other APS students, the standardized score represents the students' performance relative to the district-wide average, measured in standard deviations. An increase means that a given group of students is performing better relative to their peers in the district, while a decrease means the opposite. Improvements on the writing SOL were not examined, as the assessment was only implemented in Grades 5, 8, and 11. In our discussion to follow, we discuss results for each intervention program type, focusing on the statistically significant differences.

Reading Intervention Programs – In examining the effectiveness of the reading course in each grade, we evaluate gains in student GPA and scores on the SOL assessment from the previous school year.

Figure 16: Outcomes Examined, Reading Intervention Programs

Grade Level	Outcomes Examined	Statistically Significant Gains (Among Intervention Students)
Grade 7	GPA, Grades 6 and 7	Yes (+.05)
	SOL, Grades 6 and 7	--
Grade 8	GPA, Grades 7 and 8	--
	SOL Reading, Grades 7 and 8	--

Effectiveness of Grade 7 Reading Course

❖ GPA - Students enrolled in a reading course during the 2006-2007 school year showed small but significant gains in their GPA (+0.05). These students had a higher mean GPA in 2007 (2.41) as compared to 2006 (2.36). The difference was statistically significant. Students who were not enrolled in any Grade 7 reading course also exhibited positive, but had lower gains (+0.02; 3.18 for 2007 as compared to 3.16 for 2006).

❖ SOL Reading, Grades 6 and 7 – Standardized scaled score results from the Grade 6 and 7 reading SOLs were used to examine whether enrollment in a reading course in 2007 led to significantly higher student performance on the 2007 assessment. The assessment is implemented in the spring, which also allows us to measure improvements in student performances after a suitable time of enrollment in a reading course in 2007. However, no statistically significant differences between standardized Grade 6 and 7 SOL scores were observed for students enrolled in any reading course program during grade 7.

Effectiveness of Grade 8 Reading Course

❖ GPA, Grades 7 and 8 – There were no statistically significant differences observed in the 2008 and 2007 GPA of students who were enrolled in a Grade 8 reading course.

❖ SOL Reading, Grades 7 and 8 – There were no significant gains in student performances on the Grades 7 and 8 SOL for students enrolled in any reading course in Grade 7.

Elements and Strategies of Reading Course – As requested by APS, we also examine the effectiveness of particular reading courses (Course 11111 in Grade 7 and course 11121 in Grade 8). For each, we again evaluate gains in student GPA and scores on the SOL assessment from the previous school year.

Figure 17: Outcomes Examined, Elements and Strategies of Reading Course

Course	Outcomes Examined	Statistically Significant Gains (Among Intervention Students)
Enrollment in 7th Grade Reading (course code 11111)	GPA, Grades 6 and 7	--
	SOL Reading, Grades 6 and 7	(+ .217 stdev)
Enrollment in 8th Grade Reading (course code 11121)	GPA, Grades 7 and 8	--
	SOL Reading, Grades 7 and 8	--

Enrollment in 7th Grade Reading (course code 11111)

❖ GPA, Grades 6 and 7 – There were no statistically significant differences in the 2006 and 2007 GPA of students who were enrolled in Course Code 11111 during the 2006-2007 school year.

❖ SOL Reading, Grades 6 and 7 – Students who were enrolled in Course Code 11111 in Grade 7 averaged a score 0.952 standard deviations below the mean on the Grade 6 SOL. Their average on the Grade 7 SOL was 0.734 standard deviations below the mean on the Grade 7 SOL, a statistically significant gain of 0.217 standard deviations compared with results from Grade 6.

Enrollment in 8th Grade Reading (course code 11121)

❖ No statistically significant gains were observed in student Grades 7 and 8 GPAs or standardized SOL reading scores on the Grade 8 and 7 assessments among those enrolled in the 11121 reading course in Grade 8.

Reading Strategies Course – As requested by APS, we also examine the effectiveness of particular Grade 9 reading strategies courses (Courses 21180 and 21184). For each, we evaluate gains in student GPA from the previous school year and scores on the ACCESS Overall and ACCESS Literacy. Note, however, that the comparisons requested for the ACCESS assessments cover data from the 2009 and 2010 years – assessments which most took as Grade 9 and Grade 10 students. As students only took the exam later in the school year (March), using Grade 9 scores is thus not a very accurate measure of pre-intervention level of performance. Effectively, a student who enrolled in either 21180 or 21184 in Grade 9 would have been enrolled in the course through most of the school year but the pre-intervention is measured very late. Examining ACCESS Overall 2009 and ACCESS Overall 2010 using enrollment in a 10th grade reading strategies course may perhaps yield more relevant results.

Figure 18: Outcomes Examined, Reading Strategies Course

Course	Outcomes Examined	Statistically Significant Gains (Among Intervention Students)
9th Grade Strategies of Reading (21180)	GPA, Grades 8 and 9	--
	ACCESS Overall 2009 and ACCESS Overall 2010	NA
	ACCESS Literacy 2009 and ACCESS Literacy 2010	--
9th Grade Reading Strategies (21184)	GPA, Grades 8 and 9	Yes (-.47)
	ACCESS Overall 2009 and ACCESS Overall 2010	NA
	ACCESS Literacy 2009 and ACCESS Literacy 2010	NA

Enrollment in 9th Grade Strategies of Reading (course code 21180)

❖ GPA, Grades 8 and 9 – There were no statistically significant differences observed in the 2009 and 2008 GPA of students who were enrolled in the 21180 course.

❖ ACCESS Overall – Statistical testing was not possible here as not a single student was enrolled in 21180 during 2008-2009 (when most students were in Grade 9) and had test scores for the two ACCESS assessments.

❖ ACCESS Literacy – There were no statistically significant differences observed in the mean 2010 and 2009 ACCESS Literacy scores among students enrolled in 21180. The sample size was also limited to only 5 students.

Enrollment in 9th Grade Reading Strategies (course code 21184)

❖ GPA, Grades 8 and 9 – Students enrolled in 21184 in the 9th grade had a significantly lower mean GPA in 9th grade (2.02), as compared to their mean Grade 8 GPA (2.49). A similar decrease, however, was also observed among all students who were not enrolled in the course, suggesting that this is a result of GPAs dropping as students enter high school and probably not a direct effect of the course itself.

❖ ACCESS Overall/Literacy – There were no students enrolled in the course with test scores for the two ACCESS assessments (Overall or Literacy) who were also enrolled in the course, making comparisons of pre- and post-intervention scores impossible.

Summer School – Lastly, we examine the effectiveness of summer school courses in improving student performances. Figure 19 below lists the different student outcomes examined.

Figure 19: Outcomes Examined, Summer School

Summer School Grade	Outcomes Examined	Statistically Significant Gains (Among Summer School Students)
Grade 6	GPA, Grades 6 and 7	Yes (+0.10)
	SOL Reading, Grades 6 and 7	Yes (+ 0.23 stdev)
Grade 7	GPA, Grades 7 and 8	--
	SOL Reading, Grades 7 and 8	--
Grade 8	GPA, Grades 8 and 9	--
Grade 9	GPA, Grades 9 and 10	Yes (+0.14)
	ACCESSOverall2009 and ACCESSOverall2010	Yes (+0.63)
	ACCESSLiteracy2009 and ACCESSLiteracy2010	Yes (+0.49)
Grade 10	GPA, Grades 10 and 11	Yes (+.03)
	ACCESSLiteracy2010 and ACCESSLiteracy2011	Yes (+0.35)

Enrollment in 6th Grade Summer School

- ❖ GPA, Grades 6 and 7 – Students enrolled in summer school at the end of 6th grade had an average GPA of 2.32. In 2007, the same group of students had a statistically significantly higher average GPA of 2.43 (+0.099) in 7th grade. Students who were not enrolled in summer school had average GPAs of 3.23 and 3.24 in Grades 6 and 7 respectively, but the difference was not statistically significant.

- ❖ SOL Reading, Grades 6 and 7 – Statistically significant improvements in student performances on the SOL were also observed among those enrolled in 6th grade summer school. Students who were enrolled in summer school in the 6th grade had an average score about 0.879 standard deviations below the mean on the Grade 6 SOL, whereas their average ranking on the Grade 7 SOL was 0.645 standard deviations below the mean on the Grade 6 SOL, a statistically significant gain of +0.234 standard deviations.

Enrollment in 7th Grade Summer School

- ❖ GPA, Grades 7 and 8 – There were no statistically significant differences observed in the mean 2007 and 2008 GPA of students who were enrolled in summer school in 7th grade.

- ❖ SOL Reading, Grades 7 and 8 – No statistically significant differences were observed between students' mean standardized SOL reading scores in Grade 7 as compared to Grade 8.

Enrollment in 8th Grade Summer School

- ❖ GPA, Grades 8 and 9 – All students, those who were enrolled in the 8th grade summer school or otherwise, exhibited lower average GPAs during their first year in high school.

Enrollment in 9th Grade Summer School

- ❖ GPA, Grades 9 and 10 – Both students who were enrolled in the 9th grade summer school and those who were not exhibited statistically significant higher mean GPAs in grade 10. However, students enrolled in summer school had higher gains (+0.14) as compared to students who were not enrolled in the summer school (+0.05).

- ❖ ACCESS Overall, Grades 9 and 10 – Both groups of students also had statistically significantly higher averages on the ACCESS Overall in Grade 10 as compared to Grade 9. Students enrolled in Grade 9 summer school averaged a gain of +0.63, whereas other students averaged a gain of +0.45.

❖ ACCESS Literacy, Grades 9 and 10 – Students enrolled in Grade 9 summer school had a statistically significant higher average on the Grade 10 ACCESS Literacy (+0.49). The gains were also only observed among students enrolled in the Grade 9 summer school. Students who were not enrolled in any summer school course during the year did not exhibit similar gains.

Enrollment in 10th Grade Summer School

❖ GPA, Grades 10 and 11 – Students enrolled in the Grade 10 summer school had a statistically significantly higher mean GPA in Grade 11. The gains, however, were minimal (+0.03). Students who were not enrolled in any summer school course during the year exhibited higher gains relative to summer school students (+0.06), but the gains were again relatively small.

❖ ACCESS Literacy, Grades 10 and 11 – Both groups of students also had a statistically significantly higher ACCESS Literacy average score in Grade 11 than in Grade 10. Students enrolled in the Grade 10 summer school averaged a higher gain of +0.35, whereas students who were not in summer school averaged a gain of +0.29.

Section II: Predictive Logit Model

Next, we construct logit models that use pre-high school student characteristics to predict struggling student status at the end of high school. This analysis allows us to identify the main factors influencing struggling status that can be identified at the time a student enters high school. The full set of predictors we examine is given in Figure 20 below. In the section following the figure, we discuss these variables in greater detail and note any modifications or manipulations required to create the variables.

Independent Variables

Figure 20: Independent Variables Examined

Area	Characteristic	Summary	Variable Type
Student Demographics	Gender	Male or Female	Categorical
	Ethnicity	White, Black, Hispanic, Asian or Other	Categorical
	Economic Status	Economic Status (entering 9th grade)	Categorical
Academic Variables	LEP Status	Limited English Proficiency Status (entering 9th grade)	Categorical
	Special Education Status	Special Education Status (entering 9th grade)	Categorical
	DRP Scores	DRP Score (Grade 6 Spring)	Continuous
	Grade 6 Spring DRP Type	Standard or non-Standard	Categorical
	Grade 6 DRP Type and Score	Interaction of Grade 6 Spring DRP Type and Score	Continuous
	Reading SOL Scores	Reading SOL Scores (Weighted Average)	Continuous
	Writing SOL Scores	Writing SOL Scores (Weighted Average)	Continuous
	GPA	GPA (Weighted Average)	Continuous
	Stanford 10 Scores	Stanford 10 Scores (Language, Reading, Spelling)	Continuous
Other Characteristics	Absenteeism	Absenteeism (Weighted Average)	Continuous

* Scores in recent years were weighted more heavily, according to the following schedule: 2008 (1/3), 2007 (1/6), and 2006 (1/9).

Dependent Variables

❖ **Student Struggling Status**: The dependent variable in our analysis takes on a value of one if a student was classified as struggling in the 2011-2012 school year and zero otherwise (even if the student had been classified as struggling at some point in the past).

Independent Variables

The demographic characteristics examined in this report for their influence on student success are student gender, ethnicity, and economic status. Details on each are provided below. For each categorical variable, one of the categories was chosen as a reference group to be used as the point of comparison when examining regression models.

- ❖ **Gender –** Gender had two straightforward categories: male and female. Females were used as the reference groups, so the regression results show the expected difference in the odds of struggling for a male student as opposed to a female student.

- ❖ **Ethnicity –** To examine for differences in struggling status with respect to each ethnicity, our analysis includes separate binary (0/1) variables to denote Black students, Hispanic students, Asian students, and students of other ethnicities. White students were used as the reference group, and regression results report the predicted effect on the odds of being struggling for each ethnicity relative to a white student.

- ❖ **Economic Status –** Another demographics-related characteristic we examine is the influence of economic status on student success. The variable was set equal to 1 for low income students and the regression results report the predicted effect on the odds of graduation of being classified as having low income status.

Academics

- ❖ **Limited English Proficiency Status (entering 9th grade) –** The first academics-related variable included in our analysis was based on student LEP status. LEP status potentially changes with each school year, and for the sake of simplicity, we use LEP status for a student in the 2008-2009 school year (when most students were in 9th grade) as an indicator for LEP status before high school. Non-LEP students were used as the reference group, and regression results report the predicted effect on the odds of struggling status of being a LEP student.

- ❖ **Special Education Status (entering 9th grade) –** Similarly, student special education (SPED) status could potentially change each year, and we use SPED status for students in the 2008-2009 academic year to take into account SPED status prior to high school. Regression results here report the predicted effect on the odds of struggling status of being a SPED student.

- ❖ **Grade 6 Spring DRP and related variables –** The DRP was implemented at four different instances – in Grades 2 and 4, and twice in Grade 6 (fall and spring). As results for the DRP are measured using the same scale of

readability across different grade levels, we use student performances on the most recent (Grade 6 Spring DRP). However, because two different types of the DRP were administered at that date (standard and non-standard), a dummy variables was also included in order to take the difference into account. The variable was set equal to 1 for the standard DRP, and the coefficient on this variable reports the predicted effect on the odds of struggling status of simply taking the Grade 6 Spring standard DRP as opposed to the non-standard DRP. To allow for the possibility that equivalent increases in student scores on each type of exam have different effects, an interaction term, or a variable which multiplies the earlier variable with the actual scores on the assessment, was also included.

❖ **Reading SOL Scores –** Similarly, the scaled scores of student performances on the SOL assessment in Grades 3, 5, 6, 7, and 8 were weighted to place more emphasis on more recent scores and included in the regression model to examine whether SOL scores were a significant predictor of student struggling status.

❖ **Writing SOL Scores –** In addition to the reading SOL scores mentioned above, the weighted writing SOL scores were also included in the regression model (again weighted to place more emphasis on more recent scores).

❖ **GPA –** The weighted average of student GPA data at the end of the each school year (Grades 2, 3, 4, 5, 6, 7, and 8) are also included in order to examine the relationship between academic performance and struggling status.

❖ **Stanford 10 Scores –** The final set of academic variables measured student performance on each section (Reading, Language, and Spelling) of the Stanford 10.

Other Characteristics

❖ **Absenteeism –** The weighted average of the number of days a students was absent in each year was included to examine the relationship between overall absenteeism prior to high school and struggling status at the end of high school.

Regression Results: Struggling Status

Next, we examine results from the logit models and discuss how the likelihood of a student being unsuccessful (struggling status) is influenced by each of the factors outlined above. The figure below provides results from the regression models explaining the influence of various factors on student success in reading/writing. Note again that the results from the regression analysis below give the effects of changes in each individual factor while holding all the other factors in the model constant. The results below represent the percent increase or decrease in the likelihood of struggling status associated with a one-unit change in the variable in question or, for categorical variables such as gender, the percent difference in the likelihood of struggling between the group in question and the reference group. In the section below, we focus our discussion on the statistically significant variables.

Figure 21: Struggling Status – Results from Logit Models

Variable	Effect on Struggling Status
Male (vs. female)	-29.8%
Asian (vs. white)	-68.5%
Black (vs. white)	-22.5%
Hispanic (vs. white)	27.6%
Other (vs. white)	38.3%
Low Income Status (entering 9th grade)	12.1%
Limited English Proficiency Status (entering 9th grade)	43.5%
Special Education Status(entering 9th grade)	143.4%*
DRP Score (Grade 6 Spring)	-2.6%[1]
Grade 6 DRP Type (Non-Standard vs. Standard)	-2.5%
Grade 6 Spring DRP Type*Score	26.4%[1]
Reading SOL Scores (Weighted Average)	-87.2%***[1]
Writing SOL Scores (Weighted Average)	-30.1%[1]
GPA (Weighted Average)	-40.8%
Stanford 10 Language	12.8%[1]
Stanford 10 Reading	0.5%[1]
Stanford 10 Spelling	51.5%[1]
Absenteeism (Weighted Average)	-2.2%
Number of Observations	829

* $p<0.05$; ** $p<0.01$; *** $p<0.001$; [1] Percentage change in odds per standard deviation increase (rather than a one unit increase)

Struggling Status

Only two factors – the weighted average of the reading SOL scores and special education status (entering 9th grade) – proved to be significant factors associated with student struggling status.

❖ *Reading SOL Scores (weighted average)* – Higher reading SOL scores were associated with a decreased chances for struggling status – a standard deviation increase (0.91) in weighted average of SOL scores is associated with about an 87.2 percent decreased likelihood of struggling.

❖ *Special Education Status (entering 9th grade)* – Special education status entering 9th grade was linked with an increased likelihood of struggling status. SPED students entering the 9th grade were about 143 percent more likely to be struggling students.

Section III: Key Points in Time

Finally, we attempt to estimate the "danger points" during a student's career, attempting to discover whether certain grade levels are more important than others in having an impact on student success. Hanover addresses this question in the two ways – first by examining the achievement and demographic characteristics of students who fail to advance to the next grade level, and then using a longitudinal regression model to dig further into key points in time that may influence success status.

Achievement and Demographic Characteristics

Our **first approach provides the achievement and demographic characteristics of students who fail to advance to the next grade level**. This analysis is conducted for every grade level from 9th through the 12th grade. This was necessary because the dataset only includes students who were active Grade 9 students in APS during the 2008-2009 school year. It does not include students who dropped out of APS or who were held back a grade prior to the 2008-2009 school year. We can, however, not only identify the grade levels in high school at which the highest percentage of students are held back, but also examine whether the characteristics of these students change at various points in time.

Figure 22 below charts the percentage of students who progressed normally through high school as well as the percentage who were held back.[2] Noticeably, the majority of students progressed normally – the proportion of students who were held back was less than 6 percent. Most students who progressed normally in each grade were also likely to be successful non-struggling students. Among those who were 10th grade students in 2010, about 14 percent were classified as a struggling student in 2012 (Figure 23). Among 11th grade students in 2010-2011 and 12th grade students in 2011-2012, 12 and 11 percent respectively were held back. Demographically, those who were held back and did not progress normally were more likely to be male, Hispanic, be low economic status, and be LEP students. Those held back in tenth grade were also more likely to be SPED students than those who were not held back, though this was not true in later grade levels. Most students who were held back did not have special education status (Figure 24).

All students who were not grade 12 students in the 2011-2012 school year were struggling students, as this was part of the definition of a struggling student.

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[2] Normal progression is used to denote all students who advanced in grade, including those who may have skipped a grade e.g. this would include grade 11 students in 2009-2010. Held back includes students who stayed at the same grade level in the following school year, those who dropped out, or were enrolled in Grade 77.

Figure 22: Percentage of Students Held Back
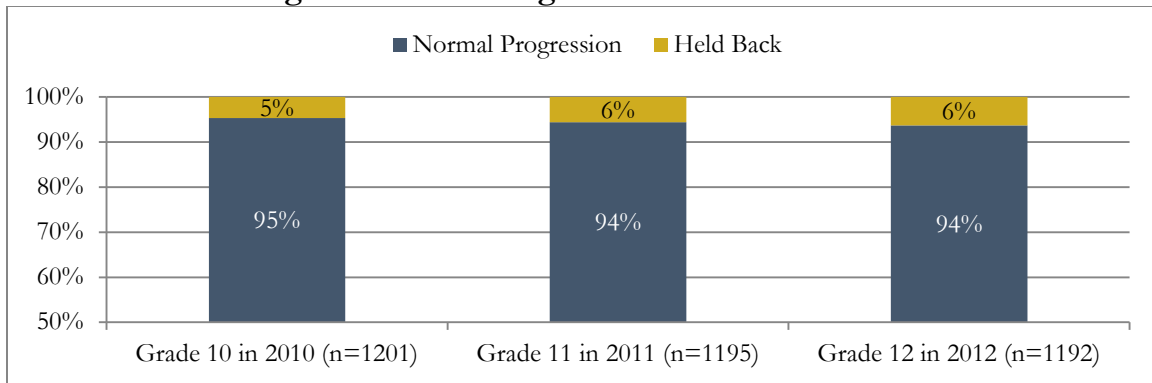
*n refers to the sample of students enrolled in the previous grade

Figure 23: Normal Progression and Struggling Status
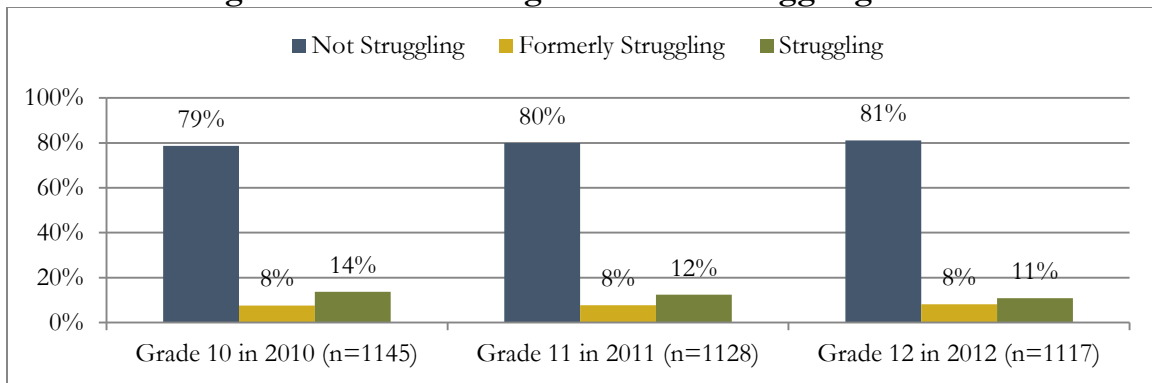
*n refers to the number of students who progressed i.e. 80 percent of the 1,128 grade 11 students in 2011 students were successful (non-struggling) students.

Figure 24: Demographic Characteristics of Students without Normal Progression

Gender						
	Not Grade 10 in 2010		Not Grade 11 in 2011		Not Grade 12 in 2012	
	Count	Percentage	Count	Percentage	Count	Percentage
Females	24	43%	26	39%	24	32%
Males	32	57%	41	61%	51	68%
Total	**56**	**100%**	**67**	**100%**	**75**	**100%**
Ethnicity						
	Not Grade 10 in 2010		Not Grade 11 in 2011		Not Grade 12 in 2012	
	Count	Percentage	Count	Percentage	Count	Percentage
Asian	9	16%	12	18%	12	16%
Black	9	16%	8	12%	9	12%
Hispanic	35	63%	40	60%	48	64%
White	3	5%	6	9%	4	5%
Other	0	0%	1	1%	2	3%
Total	**56**	**100%**	**67**	**100%**	**75**	**100%**
Economic Status*						
	Not Grade 10 in 2010		Not Grade 11 in 2011		Not Grade 12 in 2012	
	Count	Percentage	Count	Percentage	Count	Percentage
non-Economic Status	17	30%	25	37%	22	29%
Low Economic Status	39	70%	42	63%	53	71%
Total	**56**	**100%**	**67**	**100%**	**75**	**100%**
LEP Status*						
	Not Grade 10 in 2010		Not Grade 11 in 2011		Not Grade 12 in 2012	
	Count	Percentage	Count	Percentage	Count	Percentage
non-LEP	11	20%	11	16%	11	15%
LEP	45	80%	56	84%	64	85%
Total	**56**	**100%**	**67**	**100%**	**75**	**100%**
SPED Status*						
	Not Grade 10 in 2010		Not Grade 11 in 2011		Not Grade 12 in 2012	
	Count	Percentage	Count	Percentage	Count	Percentage
non-SPED	43	77%	57	85%	64	85%
SPED	13	23%	10	15%	11	15%
Total	**56**	**100%**	**67**	**100%**	**75**	**100%**

*Based on status during the 2008-2009 year (as active 9th grade students)

Longitudinal Regression Model

Lastly, we provide the results of the longitudinal regression model. This model is similar to the model presented in Section II, with a few key exceptions. The model incorporates data through all years of a students' high school career rather than focusing on data from before they begin high school. The dependent variable is changed to student GPA, and the explanatory variables in the model are multiplied by grade levels. This model also includes random effects for each student. This random effects approach represents a compromise between including indicator variables for each student (thus assuming that the constant term in the model is different for every student) and including no indicators at all for students (thus assuming that the constant term in the model is the same for every student). The regression coefficients from this model allow us to investigate whether the factors included in the model (e.g. absenteeism) matter more at different grade levels. The complete set of independent variable included is included in Figure 25 below.

Figure 25: Independent Variables Examined

Area	Characteristic	Summary	Variable Type
Student Demographics	Gender	Male or Female	Categorical
	Ethnicity	White, Black, Hispanic, Asian or Other	Categorical
	Economic Status	Economic Status	Categorical
Academic Variables	LEP Status	Limited English Proficiency Status	Categorical
	Special Education Status	Special Education Status	Categorical
	GPA	GPA	Continuous
	Reading Course	Enrollment in a Reading Course	Categorical
Other Characteristics	Absenteeism	Absenteeism (Weighted Average)	Continuous
	Grade	Grade 9, Grade 10, Grade 11 or Grade 12	Categorical

Results from the regression model are given below. Note again that the results from the regression analysis below give the effects of each individual factor while controlling for student demographic, academic, and other characteristics included in the model.

Also note that this model includes both main effects and interactions. The main effects represent the effect of a given variable at the 9th grade level, since this is the reference level for grade. So, for example, the main effect on the "Male" variable is the difference in GPA between a 9th grade male student and a 9th grade female student, holding all other factors constant. The interaction variables then represent the additional combined effect of a given variable and a higher grade level. So, for example, the difference between a Grade 10 male student and a Grade 9 female student (holding all other variables in the model constant) is the value of the "Male" main effect plus the "Grade 10 * Male" interaction. The interactions therefore allow

the differences between groups of students to vary by grade level: the difference between male and female students, for example, can be different in Grade 9 than in Grade 10.

The tests of significance on the main effects therefore tell us whether there is any significant difference between the two groups of students at the 9th grade level, while the tests of significance on the interactions tell us whether this difference changes significantly in higher grade levels.

In the section below, we again focus our discussion on the statistically significant variables.

Figure 26: Factors Affecting Student GPA – Longitudinal Regression Model

Variable	Effect on GPA
Main Effects	
Constant	3.52***
Grade 10 (Vs. Grade 9)	0.05**
Grade 11 (Vs. Grade 9)	0.17***
Grade 12 (Vs. Grade 9)	0.83*
Grade 77 (Vs. Grade 9)	0.72**
Males (Vs. Females)	-0.24***
Asian Students (Vs. White)	-0.13*
Black Students (Vs. White)	-0.86***
Asians (Vs. White)	-0.72***
Other (Vs. White)	-0.33**
LEP (Vs. non-LEP)	-0.1***
SPED (Vs. non-SPED	-0.16***
low-Economic (Vs. High economic)	-0.03
Days Absent	-0.01***
Reading Course	0.04
Gender * Grade Interactions	
Grade 10 * Males (Vs. Females)	-0.01
Grade 11 * Males (Vs. Females)	0
Grade 12 * Males (Vs. Females)	-0.6*
Ethnicity * Grade Interactions	
Grade 10 * Asian Students (Vs. White)	0
Grade 11 * Asian Students (Vs. White)	-0.03
Grade 10 * Black Students (Vs. White)	0.04
Grade 11 * Black Students (Vs. White)	-0.01
Grade 10 * Hispanic Students (Vs. White)	0
Grade 11 * Hispanic Students (Vs. White)	-0.03

Variable	Effect on GPA
Grade 12 * Hispanic Students (Vs. White)	-0.16
Grade 10 * Other Students (Vs. White)	-0.01
Grade 12 * Other Students (Vs. White)	-0.03
LEP * Grade Interactions	
Grade 10 * LEP Students (Vs. non-LEP)	0.08**
Grade 11 * LEP Students (Vs. non-LEP)	0.03
Grade 12 * LEP Students (Vs. non-LEP)	0.34
SPED * Grade Interactions	
Grade 10 * SPED Students (Vs. non-SPED)	0.01
Grade 11 * SPED Students (Vs. non-SPED)	-0.02
Grade 12 * SPED Students (Vs. non-SPED)	0.14
Economic Status * Grade Interactions	
Grade 10 * Economic Students (Vs. non-Economic)	-0.02
Grade 11 * Economic Students (Vs. non-Economic)	-0.05*
Grade 12 * Economic Students (Vs. non-Economic)	0.49
Absenteeism * Grade Interactions	
Grade 10 * Days Absent	0
Grade 11 * Days Absent	0
Grade 12 * Days Absent	-0.02
Reading Course * Grade Interactions	
Grade 10 * Reading Course	-0.02
Grade 11 * Reading Course	0
Grade 12 * Reading Course	0

$* p<0.05; ** p<0.01; *** p<0.001;$
Note: some variables were dropped from the model due to collinearity

Discussion of Results

Overall, the main effects in this model tended to be significant, indicating that most of the variables in our model were associated with significant differences in student GPA. Most of the interactions, however, were not significant, indicating that there was little evidence that the differences between different types of students changed over the course of their high school careers. Overall, GPA tended to increase over time. Grade 10 students were predicted to have a +0.05 GPA as compared to Grade 9 students, whereas Grade 11 and 12 students were predicted to have GPAs of +0.17 and +0.83 relative to Grade 9 students. Adult students (labeled as Grade 77) had GPAs 0.72 points higher than Grade 9 students on average. Performance also differed significantly among students of different demographic backgrounds. Statistically significant results across different demographic segments among students in the same grade included:

Main Effects (Grade 9)

- ❖ Grade 9 male students were likely to have lower GPAs than female students (-0.24)
- ❖ Grade 9 Asian students were predicted to have a lower GPA than white students (-0.13). The same was true among black students (-0.86), Hispanic students (-0.72), and other students (-0.33).
- ❖ Grade 9 LEP students were predicted to have a lower GPA than non-LEP students (-0.1).
- ❖ Grade 9 SPED students were predicted to have a lower GPA than non-SPED students (-0.16).
- ❖ A student who missed a day is expected to see his/her GPA decrease by 0.01 in Grade 9 or approximately by about 0.1 points upon missing 10 days.

Grade 10 Interactions

- ❖ The difference between LEP and non-LEP students was 0.08 points lower in Grade 10 than in Grade 9.

Grade 11 Interactions

- ❖ The gap between students with low economic status and those without low economic status was 0.05 points wider in Grade 11 than in Grade 9.

Grade 12 Interactions

- ❖ The gap between male and female students was 0.6 points wider in Grade 11 than in Grade 9.

Appendix A: Demographics of Struggling Students

Figure 27: Student Gender and Struggling Status

Gender	Not Struggling		Formerly Struggling		Struggling		Total
	Count	Percentage	Count	Percentage	Count	Percentage	
Female	455	79.55%	42	7.34%	75	13.11%	100% (n=572)
Male	451	71.70%	48	7.63%	130	20.67%	100% (n=629)
Total	906	75.44%	90	7.49%	205	17.07%	100% (n=1201)

Figure 28: Student Race and Struggling Status

Race	Not Struggling		Formerly Struggling		Struggling		Total
	Count	Percentage	Count	Percentage	Count	Percentage	
Asian	97	80.17%	4	3.31%	20	16.53%	100% (n=121)
Black	101	63.92%	22	13.92%	35	22.15%	100% (n=158)
Hispanic	204	54.26%	47	12.50%	125	33.24%	100% (n=376)
White	468	92.86%	14	2.78%	22	4.37%	100% (n=504)
Other	36	85.71%	3	7.14%	3	7.14%	100% (n=42)
Total	906	75.44%	90	7.49%	205	17.07%	100% (n=1201)

Figure 29: Student LEP Status and Struggling Status

Year	LEP Status	Not Struggling		Formerly Struggling		Struggling		Total
		Count	Percentage	Count	Percentage	Count	Percentage	
2009	LEP	126	40.51%	47	15.11%	138	44.37%	100% (n=311)
	non-LEP	780	87.64%	43	4.83%	67	7.53%	100% (n=890)
	Total	**906**	**75.44%**	**90**	**7.49%**	**205**	**17.07%**	**100% (n=1201)**
2010	LEP	83	35.93%	37	16.02%	111	48.05%	100% (n=231)
	non-LEP	823	84.85%	53	5.46%	94	9.69%	100% (n=970)
	Total	**906**	**75.44%**	**90**	**7.49%**	**205**	**17.07%**	**100% (n=1201)**
2011	LEP	55	29.89%	24	13.04%	105	57.07%	100% (n=184)
	non-LEP	851	83.68%	66	6.49%	100	9.83%	100% (n=1017)
	Total	**906**	**75.44%**	**90**	**7.49%**	**205**	**17.07%**	**100% (n=1201)**
2012	LEP	55	29.10%	24	12.70%	110	58.20%	100% (n=189)
	non-LEP	851	84.09%	66	6.52%	95	9.39%	100% (n=1012)
	Total	**906**	**75.44%**	**90**	**7.49%**	**205**	**17.07%**	**100% (n=1201)**

Figure 30: Student Economic Status and Struggling Status

Year	Economic Status	Not Struggling		Formerly Struggling		Struggling		Total
		Count	Percentage	Count	Percentage	Count	Percentage	
2009	Yes	204	51.91%	54	13.74%	135	34.35%	100% (n=393)
	No	702	86.88%	36	4.46%	70	8.66%	100% (n=808)
	Total	**906**	**75.44%**	**90**	**7.49%**	**205**	**17.07%**	**100% (n=1201)**
2010	Yes	186	50.27%	58	15.68%	126	34.05%	100% (n=370)
	No	719	87.47%	31	3.77%	72	8.76%	100% (n=822)
	Total	**1**	**11.11%**	**1**	**11.11%**	**7**	**77.78%**	**100% (n=1201)**
2011	Yes	184	52.12%	52	14.73%	117	33.14%	100% (n=353)
	No	722	86.47%	38	4.55%	75	8.98%	100% (n=835)
	<Blank>	0	0.00%	0	0.00%	13	100.00%	100% (n=13)
	Total	**906**	**75.44%**	**90**	**7.49%**	**205**	**17.07%**	**100% (n=13)**
2012	Yes	174	53.70%	51	15.74%	99	30.56%	100% (n=324)
	No	732	83.47%	39	4.45%	106	12.09%	100% (n=877)
	Total	**906**	**75.44%**	**90**	**7.49%**	**205**	**17.07%**	**100% (n=1201)**

Figure 31: Student SPED Status and Struggling Status

Year	Economic Status	Not Struggling		Formerly Struggling		Struggling		Total
		Count	Percentage	Count	Percentage	Count	Percentage	
2009	Yes	72	37.89%	35	18.42%	83	43.68%	100% (n=190)
	No	834	82.49%	55	5.44%	122	12.07%	100% (n=1011)
	Total	**906**	**75.44%**	**90**	**7.49%**	**205**	**17.07%**	**100% (n=1201)**
2010	Yes	86	41.95%	34	16.59%	85	41.46%	100% (n=205)
	No	820	82.33%	56	5.62%	120	12.05%	100% (n=996)
	Total	**906**	**75.44%**	**90**	**7.49%**	**205**	**17.07%**	**100% (n=1201)**
2011	Yes	87	42.03%	34	16.43%	86	41.55%	100% (n=207)
	No	819	82.39%	56	5.63%	119	11.97%	100% (n=994)
	Total	**906**	**82.39%**	**90**	**7.49%**	**205**	**17.07%**	**100% (n=1201)**
2012	Yes	70	37.63%	31	16.67%	85	45.70%	100% (n=186)
	No	836	82.36%	59	5.81%	120	11.82%	100% (n=1015)
	Total	**906**	**75.44%**	**90**	**7.49%**	**205**	**17.07%**	**100% (n=1201)**

Appendix B: Conceptual Framework

The logit model used for the purposes of this study is directly linked with the most commonly used method of statistical prediction – multiple regression analysis, which is also called ordinary least squares (OLS). Multiple regression analysis is useful because it can: (a) establish whether a group of independent variables are related to a particular outcome, and (b) indicate what proportion of the variation in the outcome (dependent variable) is explained by the predictors, at a given level of confidence. Thus, the relationship between a dependent variable and a set of independent variables is modeled as a linear regression equation which features a constant and a set of slope values, also called regression coefficients. The absolute value of the standardized regression coefficients can be compared to one another in order to discern which independent variable or variables are more strongly related, and therefore more predictive of, the outcome of interest. The *p-value* from the regression also gives the chance of a 'type 1 error' (a rejection of the null hypothesis when it is in fact true, where we conclude that an effect is significant and appears in the population we are studying as a whole, when it is in fact due to random chance, and due purely to the particular data sample we happened to draw).

Multiple regression is appealing because its interpretation is straightforward and intuitive. For example, say a researcher is interested in explaining variation in annual income among female employees at company ABC. She may test a series of independent variables and discover that two are significantly related to income: number of hours worked and number of children, which have coefficients equal to 10 and -200, respectively. In this case, a female worker would expect to earn an additional 10 dollars per year for each additional hour she worked, but 200 dollars less for every child she has.

However, when the outcome we are studying is categorical, such as passage status on the state science exam, the ordinary least squares (OLS) model is inappropriate because its basic assumptions are violated. Most importantly, multiple regression assumes that the dependent variable is continuous, as annual income is in the example above. In part, this is because interpretation is nonsensical when the outcome has discrete categories. To take a relevant example, the use of multiple regression in the current study might produce a result indicating that a one point increase in average GPA is associated with a 0.15 unit decrease in student success. Since 15 percent of struggling status is not an inherently meaningful concept, such a result would be awkward to interpret and difficult to understand.

Thus, in cases such as this, a more appropriate method is the logistic model, which expresses the odds of passage versus the odds of not passing. In logistic regression, the dependent variable is converted into a *logit*, which is the logarithm of the odds of passing versus not passing; exponentiation of the logit results in the simple odds of

passing versus not passing when other variables are held constant. So, instead of predicting a value of *y* given the value of *x*, as is the case in multiple regression, logistic regression can calculate for example, the effect of an independent variable on the odds of passing, given values of a set of independent variables.

In this report, we present the results of the logistic regressions as percents, which indicate the percent increase in the likelihood of struggling associated with a one unit increase in the predictor variable in question. So, for example, a coefficient of 20 percent for Stanford 10 Language indicates that a one point increase in the assessment is associated with a 20 percent increase in the odds of a student struggling. In a few cases (which are noted in the tables in the report), we standardize the variables so that the percent indicates the effect of a single **standard deviation** increase rather than an increase of a single **unit**. This is done primarily for assessment scores, where the effect of a single point is very small, meaning that the reported coefficient would also be very small if we did not standardize it, even if the effect was in fact significant. Measuring the effect of a larger increase for these variables is simply a way of making the reported results slightly easier to interpret.

For categorical variables, the coefficient represents the effect on the odds of struggling of being in the category in question rather than the reference category. So, for example, the coefficient for the 'Male' variable indicates the predicted percent increase (or decrease, for negative coefficients) in the odds of struggling due to being male rather than female (the reference category). The choice of reference category is arbitrary and does not affect the results – in this example, switching the reference category from female to male would simply cause the reported coefficient to change from negative to positive or vice versa, since it would then indicate the effect of being female rather than the effect of being male.

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