California Charter Schools Association

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Technical Guide

Technical Guide to the Construction of the California Charter Schools Association's Average Point Difference (APD) and Similar Students Measure (SSM)

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Purpose

This guide explains the theory and methodology behind the metrics used in CCSA's academic accountability framework. CCSA first developed an accountability framework in 2010 after an analysis of public data showed that there were large numbers of both high and low-achieving charter schools across the state. To promote high standards of achievement, CCSA developed an accountability framework to identify schools that are struggling to support student learning, and acknowledge schools achieving high performance.

CCSA has designed two measures for understanding student achievement, the Average Point Difference (APD) and Similar Students Measure (SSM). The APD is a measure that compares a school's Smarter Balanced (SBAC)[1] scale scores by grade to the state standard for "met". It means that the average student in the school scored that many scale score points above or below the SBAC met standard (or Level 3), which approximates achievement of grade level proficiency.[2] The SSM uses publicly available grade-level data to estimate the achievement of schools after controlling for student demographic characteristics. The intent of the SSM is to define a more rigorous minimum bar for school performance that also considers the wide variety of school programs within the charter movement. CCSA designed the SSM to improve upon state efforts by:

- providing a clear and transparent benchmark that is applicable to the majority of charter schools;
- creating a statistical measure of a school's status in meeting academic predictions, as opposed to measuring academic growth or making comparisons with other schools;
- defining minimum performance standards that do not disadvantage schools serving high-risk student populations;
- relying on multiple years of data, when possible, rather than one point in time.

The SSM attempts to identify how much value a school's educational program is adding to its students' performance. The SSM calculation answers the questions: Based on what we know about how school performance varies by student demography, what is the predicted performance for a school given its student body, and is the school meeting or surpassing its predicted performance? These questions are answered using a paired linear regression model that controls for variables proven to influence academic achievement (e.g., parent education, socio-economic status), resulting in a gap score prediction. These results are then used to create the Similar Students Measure, a measure of whether a school is meeting, surpassing, or falling short of its predicted performance. The longitudinal SSM band assesses multiple years of data to determine if a school is *consistently* meeting or surpassing its predicted performance, and adding value to its students' academic proficiency. If, however, the school is *consistently* falling short of its predicted performance, then it is considered an underperforming school.

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[1] The Common Core aligned Smarter Balanced assessments are used by states in the Smarter Balanced Assessment Consortium (SBAC). These tests assess achievement in English Language Arts (ELA) and math and are one test included in the larger California Assessment of Student Performance and Progress (CAASPP) suite of assessments. For the purposes of this technical guide, which only uses the ELA/math assessment in our analyses, we will refer to the Smarter Balanced assessment as the commonly used "SBAC."

[2] For more information on interpreting scale scores and achievement levels, see https://www.smarterbalanced.org/wp-content/uploads/2015/08/Interpretation-and-Use-of-Scores.pdf

CCSA believes chronically underperforming schools should undergo additional scrutiny before a renewal decision is made.

The SSM is a relative measure of school performance, which complements other methods for understanding the spectrum of charter performance, such as those that look at actual performance and growth. While state education code specifies that charters should be authorized on the basis of academic performance above any other criteria, authorizers are inconsistent in applying academic standards over other factors in their determination for renewal. CCSA recommends the SSM as an improvement upon current efforts in the identification of underperforming charters, but does not recommend it as the sole measure for evaluating schools. The SSM is intended to flag consistently underperforming schools for a deeper review of additional measures of school performance, including status, growth and individual student progress metrics.

CCSA's academic accountability framework therefore establishes a uniform set of criteria to focus the authorization process for charters on academics. However, rather than attempting to define school quality, CCSA's accountability framework seeks to identify schools that fall far below a minimum acceptable threshold. For those schools falling below this minimum threshold, CCSA conducts a comprehensive Multiple Measure Review (MMR). This review explores all publicly available data, as well as any documentation from the school showing positive outcomes for students. At the end of the MMR, CCSA may issue a public call for non-renewal for charter schools that do not meet the standards set forth by the framework. With the goal of promoting a high-quality education for all students in mind, CCSA's accountability framework provides insights to authorizers along the entire performance continuum. This technical guide does not cover the process for CCSA's Multiple Measure Review (MMR). More information on CCSA's minimum criteria can be found here.[3] An explanation of our MMR process can be found here.[4]

In the following sections, the methodology of CCSA metrics are described along with their purpose, strengths and limitations. In the development of these metrics, CCSA incorporated the feedback of many stakeholders to ensure the APD and SSM were valid and reliable tools for evaluating charter achievement. These stakeholders included leading national researchers, statisticians and policymakers, charter developers and leaders, members of California Department of Education (CDE)'s Technical Design Group, and members of the state Advisory Commission on Charter Schools, as well as other state membership organizations. The development work was spearheaded by CCSA's Member Council, which consists of charter school leaders from across California.

Data Source

CCSA's Academic Accountability Framework relies on publicly available school testing and demographic data provided by the CDE. For CCSA's 2016 Academic Accountability Framework, CCSA used publicly released testing data from October of 2016. CCSA's 2015 Academic Accountability Framework used testing data from August of 2015. As of 2014,

[3] http://www.ccsa.org/advocacy/accountability/#tab-framework
[4] http://www.ccsa.org/2016/09/multiple-measures-review-explanation.html

California adopted the Common Core State Standards as its new state academic standards and the aligned assessment developed by the Smarter Balanced Assessment Consortium (SBAC) which is part of the California Assessment of Student Performance and Progress or the CAASPP suite of assessments. The Smarter Balanced assessment has been administered twice since its adoption (spring 2015 and 2016) for students in 3rd through 8th and 11th grades in English Language Arts (ELA) and math. Test-scores are publicly released for any group of students greater than or equal to 11.

The SBAC is a two-part test, consisting of (1) a computer adaptive test, and (2) a performance task.[5] Students' scores are reported as "scale scores," which represent each student's raw test score results converted to a vertical scale for ease of cross-grade comparison. The SBAC data file provides grade level scale scores and percent of students scoring at each of four performance levels across subjects and subgroups. These cut points were set by SBAC and adopted by the California State Board of Education (SBE) for both ELA and math. The four score achievement levels per grade are: (1) Not Met, (2) Nearly Met, (3) Met, and (4) Exceeds standards. Students with scale score results at or above the level for the met standard are considered proficient for their grade (levels 3 and 4).[6]

Average Point Difference (APD)

The SBE originally intended to track the percentage of students considered proficient in a subject, or the "percent met/exceeded," as a way of measuring academic achievement at schools in California. However, by only tracking the percentage of students meeting or exceeding standards, the state could not measure how far above or below students were from the met standard. Teachers making significant progress with their students would only be recognized if those students' test score results moved from below the met standard to above it. For parents and the general public, grade-level test results are available, but assessing schools' academic achievement quickly was difficult. With over 10,000 schools in California as of 2016, CCSA identified a need for an academic status measure which took into account the data provided by the state and also easily organized schools based on their test results. The Average Point Difference (APD) metric was created to help schools and parents better understand SBAC scale scores and interpret growth.

CCSA designed its achievement status measure, the APD, to compare a school's CAASPP scale score results by grade to the grade-level standard for "met". We believe that rather than using a percent met or exceeded measure, which incentivizes schools to only focus on whether a student has met standards or not, an APD-based accountability system encourages schools to raise each student's score as high as possible each year.[7] The SBE adopted the same measure calling it "distance from met" as the state academic indicator in its January 2017 board meeting. The state academic indicator will be based in the same methodology as CCSA's APD measure, calculating the average student's distance from Level 3,

[5] http://caaspp.cde.ca.gov/sb2016/AboutCAASPP

[6] Performance levels are an approximation of proficiency and should not be interpreted as a precise scale score threshold (https://www.smarterbalanced.org/wp-content/uploads/2015/08/Interpretation-and-Use-of-Scores.pdf)

[7] http://www.ccsa.org/advocacy/accountability/apd.html

however, CCSA uses publicly available school-level data which may produce slightly different results than the state will generate with more precise student-level scale scores.

Methodology

Table 1 shows the minimum threshold for the met standard set by California for grades 3-8 and 11 in both ELA and Math.[8] This is the standard which approximates subject proficiency for students of that grade. CCSA calculates the difference between the scale score threshold needed to meet the state-determined met standard for each grade/subject and each school's actual performance in that grade/subject. The full formula for calculating APD can be found in Figure 1 below. APD is calculated separately for ELA and Math at each grade level.

Table 1: SBAC Standard Met Threshold

Grade	ELA	Math
3	2432	2436
4	2473	2485
5	2502	2528
6	2531	2552
7	2552	2567
8	2567	2586
11	2583	2628

Figure 1: Formula for Calculating APD

1. Calculate each grade's average distance from the met standard, for both Math and ELA

$$Distance\ from\ Met_{\ grade} = Average\ Scale\ Score_{\ grade} - SBAC\ Met\ Standard\ Threshold_{grade}$$

2. Weight this distance by the number of students in that grade

$$Weighted\ Distance\ from\ Met_{grade} = \left(\frac{Total\ students_{grade}}{Total\ Students_{schoolwide}}\right) x\ Distance\ from\ Met_{\ grade}$$

3. Add all the weighted distances from the met standard, by subject

$$Average\ Point\ Difference_{ELA} = \sum\left(Weighted\ Distance\ from\ Met_{grade} + \cdots + Weighted\ Distance\ from\ Met_{max\ grade}\right)$$

$$Average\ Point\ Difference_{Math} = \sum\left(Weighted\ Distance\ from\ Met_{grade} + \cdots + Weighted\ Distance\ from\ Met_{max\ grade}\right)$$

4. Average the subject-level APD

$$Average\ Point\ Difference_{school} = \frac{Average\ Point\ Difference_{ELA} + Average\ Point\ Difference_{Math}}{2}$$

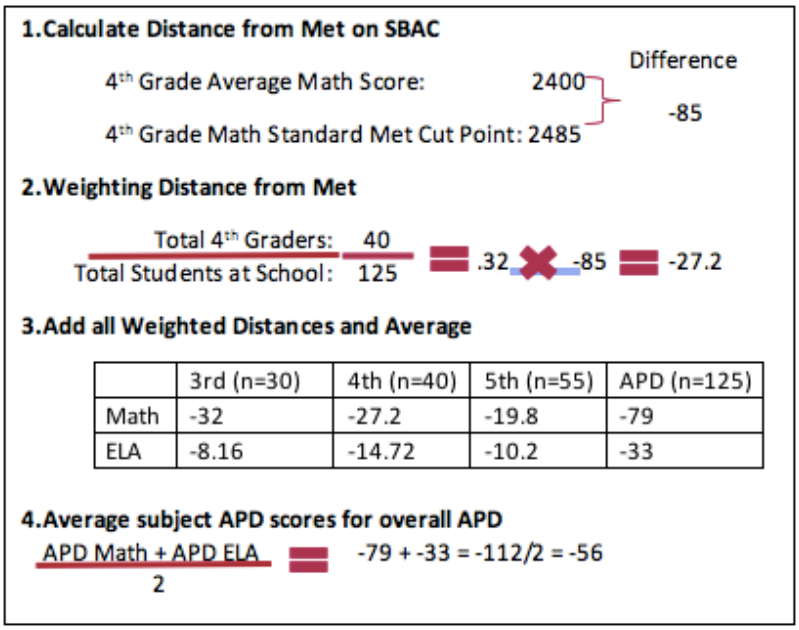
As detailed in the example provided in Figure 2, if a school's 4th grade math average was 2400, the 4th grade's math Point Difference (PD) would be -85 as the met standard threshold score for 4th grade is 2485. This process is repeated for every grade's average math score. The grade-level math PDs are weighted by the number of test takers in each grade and averaged to create an overall school level math Average Point Difference (APD). The same

[8] http://caaspp.cde.ca.gov/sb2015/ScaleScoreRanges#a

process is followed for each grade's ELA scores, arriving at grade-level PDs before calculating a schoolwide ELA APD. The school's math and ELA APD are averaged to reach a final, schoolwide APD.

To understand a school's academic achievement in relation to achievement throughout California, each school's APD is also converted to a percentile ranking based on the distribution of APD for all other schools in California. A school where the average student is achieving the met standard in both ELA and math (an APD of at least 0) was at or above the 71st percentile in the 2015-16 academic year.

Figure 2: Example Calculation for a Grade 3-5 School's APD



	3rd (n=30)	4th (n=40)	5th (n=55)	APD (n=125)
Math	-32	-27.2	-19.8	-79
ELA	-8.16	-14.72	-10.2	-33

APD Growth

CCSA also calculates school-level change in APD across years, or "APD Growth." This allows for year-to-year comparisons in the average student's distance from met at a school. APD Growth is calculated using the following formula:

$$APD_{growth} = APD_{2016} - APD_{2015}$$

Applications and Limitations

The APD measures students' achievement relative to the met standard for ELA and math, in contrast to a measure of the percent of students meeting or exceeding standards. Consider a scenario of two schools each with 100 students, School A and School B. In year one, all of School A's students are just below the met standard on the CAASPP, they are nearly meeting the state's standards. School B's students, on the other hand, are all far below the met standard. Using a percent met/exceeded measure, both Schools A and B will have the same low score (0%), since all the students at both schools are below the met standard. School A's students however, are much closer on average to achieving the met standard. Not only are students below the met standard excluded from the percent met/exceeded measure, the degree to which students are above or below the measure is also lost. Rather than focusing all attention on whether students achieve standards, APD accounts for every student's distance from the met standard.

With a quick glance, the APD tells us a story of a school's academic success. However, there are some limitations to the APD:

- **A school-level average does not describe the variability in students' scores.** A school with an APD of 0 tells us that the "average student" is meeting state standards,

however, as only school-level data is available, we do not know how far above or below the met standard each individual student is. Students may be doing better than the met standard on average in ELA, but be below the met standard on average in math. Additionally, there is no way to know if students are concentrated around the met standard or at extremes above and below proficient. APD should be used not to understand individual student achievement, but as a comparison of achievement across schools.

- **State testing is not conducted for all K-12 students.** Since only grades 3rd-8th and 11th are tested in the CAASPP, schools of certain grade spans will have a limited sub-section of their students being tested. High schools in particular will have academic achievement measured only through 11th grade test scores.
- **Not-continuously enrolled students are included in data.** In prior years, CCSA's measures were based on the state-provided Academic Performance Index (API) data file which only reported test scores for students continuously enrolled from fall to spring. The SBAC scale score data now includes all students at a school regardless of their enrollment date. This could affect average scale scores, and therefore APD, in ways we are unable to quantify with school-level data.
- **APD "growth" is not a student-level measure.** Year-to-year changes in a school's APD do not necessarily reflect the growth of students at the school, because it is not a direct cohort comparison. This is particularly true for schools serving 9-12th graders, where a new cohort participates in the CAASPP every year. Yearly change in APD is therefore not a true measure of student "growth," but a comparison of current average student achievement to the prior year's average.
- **There are no demographic controls.** Research shows that there are significant achievement gaps between demographic groups on standardized tests.[9] The demographics of a school are not captured in this measure, so some schools may have consistently low APD scores compared to other schools in the state due to their demographics.

Similar Students Measure (SSM)

CCSA has developed an additional method for understanding student achievement, which incorporates the differences between students of different demographic backgrounds. It is based on the CDE's School Characteristics Index (SCI), which was a calculated measure based on students' results in the state testing system that existed prior to Common Core. The SCI incorporated the demographics of the student body when reporting academic achievement, acknowledging systemic differences between certain demographic subgroups. Since moving to the Common Core standards, the CDE has not updated this measure, and instead provides all schools' test score results at the grade and subject level, for all subgroups of 11 or more students. It was with this state history and available academic data, and with the intention to respect historical differences between groups, that CCSA developed the Similar Students Measure (SSM).

[9] Valerie E. Lee and David T. Burkam, "Inequality at the Starting Gate: Social Background Differences in Achievement as Children Begin School," (Washington, D.C.: Economic Policy Institute, 2002).

The SSM strives to answer two questions: Based on what we know about how academic performance varies by student demographics, what is the predicted performance for a school given its student body? Is the school meeting or surpassing its predicted performance? Academic researchers have sought to answer these questions in a number of ways, and generally accept that a student-level model incorporating prior year test scores is the most effective way of measuring the value being added by schools to students' learning. For reasons of student privacy however, student-level data is not provided by the CDE. CCSA must instead rely on the CAASPP's grade-level scale score data. CCSA partnered with Education Analytics to review the SSM model and investigate preferable approaches to measuring school level impact without having access to student-level scores. In the absence of student-level data, findings supported the recommendation for a demographically controlled regression model like the SSM as a considerably better academic predictor than a simple attainment model (i.e. percent proficient).[10] Their findings show that a model including prior year test data provides even stronger predictive power, and CCSA is working to move forward with this recommendation as we continue to develop the SSM as part of our academic accountability framework.

The SSM calculated from a series of linear regression models using grade-level scale score data to predict each grade's academic achievement in both ELA and math, while controlling for or holding constant the effects of student demographics on school performance. Evidence shows that when statistical models of academic achievement cannot incorporate student-level data, reliability of predictions can be increased by including demographic controls.[11] SSM models are run for each grade tested under the SBAC tests, in both English Language Arts (ELA) and math. The SSM's linear regression models control for student demographic variables associated with academic achievement, such as socio-economic status and parents' education levels.[12]

While it is the responsibility of schools and districts to ensure the reporting of accurate data, voluntarily reported parent education level is more often an item that parents may prefer not to answer compared to other demographic questions. This leads to response rate differences that can present an issue for model reliability. To account for differences in the reporting of parent education data, two separate models are run for each combination of grade and subject, one including average parent education and one excluding it. This process replicates the methodology used by the state to calculate the School Characteristics Index (SCI) that was the underlying measure for their Similar Schools Rank (SSR). A single year's SSM for all schools in California therefore incorporates the results from 28 individual regression models.

The paired models (with and without parent education) generate a prediction of average grade-level achievement, based on the unique characteristics of every school's grade. These predicted scores are compared with each grades' actual achievement, calculating a "gap," the distance between the prediction and the actual average scores. These comparisons are

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[10] Michael Christian, Constanza Liborio, and Andrew Rice, (August 2016). "Measuring the Impacts of Schools Using Assessments in the Absence of Student-Level Data," Education Analytics, Madison, WI. Available at http://www.ccsa.org/christian_liborio_rice_16.pdf

[11] Dale Ballou, William Sanders, and Paul Write, "Controlling for Student Background in Value-Added Assessment of Teachers," (Journal of Educational and Behavioral Statistics, Vol 29, No 1, pp37-65, 2004)

[12] Jeanne Brooks-Gunn & Greg J Duncan, "The Effects of Poverty on Children," (The Future of Children CHILDREN AND POVERTY, Vol. 7, No. 2, 1997).

averaged across grades for the entire school, and the schoolwide average gap size becomes the basis of the Similar Students Measure. The SSM has 5 categories (Far Below, Below, Within, Above, Far Above) which reflect how far the predicted scores are above or below the school's actual average scale score results. A multi-year SSM, the SSM Performance Band, establishes a longitudinal trend of whether a school is meeting, surpassing, or underperforming its predicted achievement over three years of testing.

School Exclusion Criteria

The SSM includes all public charter and non-charter schools in California. However, there are several types of schools excluded from the SSM regression model. Each of these exclusions and the rationale for exclusion are described below. Refer to Table 2 for a breakdown of how many schools are affected by CCSA's exclusion criteria.

CCSA's School Exclusion list:

- Alternative Schools Accountability Model (ASAM) and Special Education schools: Alternative criteria for ASAM qualification include schools that serve at least 70% high-risk students or schools that are community day, continuation, opportunity, county community, county court, Division of Juvenile Justice, and other schools that meet criteria set by the State Board of Education.[13] While the CDE has yet to update the ASAM criteria since its suspension of the program in 2012-13, CCSA continues to use it as a guideline for schools that would otherwise qualify for alternative accountability criteria. The California State Board has indicated that an alternative accountability task force has been created and will make a recommendation in the months and years to come.
- Alternative school types designated in the Public Schools Database: This list of school exclusions includes the following nine types as identified in the Public Schools Database: community day, county community, continuation, adult education, state special education, special education, juvenile hall, opportunity, and alternative.
- Schools with fewer than 30 valid student standardized test scores: Since test scores are unavailable for any grade with fewer than 11 test takers, schools of a very small size simply do not have the data available to be included in the SSM. In alignment with the federal Every Student Succeeds Act (ESSA) and to include as many schools as possible, the current SSM model only excludes those schools with fewer than 30 valid tests in both the prior two years of testing (excluding 7% of charters and 4% of non-charters).

	All Schools	Charter Schools Only
Total Schools in CA file	10,649	1,228
Exclude ASAM and SPED schools	9,834	1,157
Exclude Alternative schools	8,829	1,218
Exclude missing SBAC	9,211	1,126
Exclude Fewer than 30 test takers in '15 or '16	8,882	1,074
Total to be included in SSM	8,335	1,023

[13] http://www.cde.ca.gov/ta/ac/am/considerpart.asp

Grade-level, school type, and school size considerations

Three transformations of the data occur to prepare the final SSM calculation: (1) to account for the size of a school's population with respect to its contribution in the regression formulas, (2) to calculate schoolwide averages from each grade-level regression output, (3) to rank schools according to their schoolwide average results.

- School size: Schools in California range in enrollment size from less than 30 to more than 4,500, and the average differences are notable when comparing charters (<400) to non-charters (>600). To control for these vast differences, school size was weighted in each of the models using the grade-level number of students who had valid test score results on the SBAC. Within each grade's model, the variable for valid test score results is weighted against all other schools' number of valid test scores, producing a weight coefficient ("weight term") for each school included. Each weight term is then rescaled so that the sum of the weight terms equals the total number of grade-level school test results being assessed in each model. These new rescaled weight terms were then used as weights in the regression models.
- Grade Level averaged to School-level: The CDE provides SBAC results at the grade and subject level. This allows for predictions to be generated at the grade level, based on the academic and demographic characteristics within that grade. As will be explained below in the section on variables, the percentage of continuously enrolled students is the only variable that is calculated at the school level and included in these grade-level regressions. The results of each grade-level set of regressions are weighted and averaged with all the grades in a school.
- School type: After schoolwide averages are determined, the averages are ranked into percentiles according to grade span, including 5,614 elementary, 1,429 middle, and 1,272 high schools (in 2016). Separate rankings are created for each grade span to account for the ways performance and student demography differ within these major grade groupings.

Academic Performance Variable

The SSM regression models measure the effect of student demographic variables on students' achievement on the SBAC assessments. The CDE publicly provides students' scaled ELA and math test results for all students in grades 3-8 and 11 for any demographic groups with 11 or more valid test results. The SSM regression models are calculated separately by grade and subject, with the grade-level average scale score results in ELA and math functioning as the dependent variables.

Grade-level Variables

In addition to providing students' overall grade level test score averages, the CDE includes the number of valid test-scores for students of several demographic types. CCSA calculates demographic percentages at the grade-level based on the number of valid test-takers identified in that particular subgroup, as a share of the total valid test-takers in each grade. These variables are included as both a linear and quadratic independent variable in the model because non-linear relationships were observed between scaled test score results and demographics. See Appendix II for an example scatterplot of demographics with scale scores, and Table 3 for a list of school level correlations between the demographic variable in the model and average scale score results.

The SSM regressions were designed so as not to capture all the variation in school achievement (i.e., best prediction), but rather only the variation caused by student population demographics (i.e., base prediction). That is why all but one of the independent variables in the SSM are grade-level student background variables, and all the variables are outside of a school's control (e.g., income status, ethnicity). The SSM does not include variables describing school structure or administration, which are characteristics of the way a school chooses to operate (e.g., school calendar, class size, teacher credentialing, etc.). These operational freedoms distinguish charters from traditional public schools, and it is CCSA's intention to study the effect of these choices on achievement through these demographics-based regressions.

School-level Variables

The only school-level variable included in the analysis is the percent of continuously enrolled students (student retention rate, also called "mobility"). High levels of student mobility are negatively correlated with schools' average test results (see Table 3), but mobility is caused by factors outside of school leaders' control, most notably by housing issues.[14]

Until 2014, the CDE released the percentage of continuously enrolled students as part of the state assessment results public data file. These test results were modified to only include those students that were continuously enrolled at each school. Since the move to Common Core however, the CDE provides grade-level test results regardless of whether students were continuously enrolled. Release of continuous enrollment for schools no longer coincides with the release of test results data and required a written data request from CCSA. As a result, CCSA is researching alternative methods of including continuous enrollment and for the 2016 SSM, a weighted average of continuous enrollment in 2015 and 2016 was used.

[14] Garber, et al, "COLUMBUS PUBLIC SCHOOLS 2005 STUDENT MOBILITY RESEARCH REPORT," (The Columbus Foundation, 2006).

SSM Independent Variables list

All relationships between the demographic variable and CAASPP scale scores described below are statistically significant. Refer to Table 3 for the correlation coefficients and levels of significance.

- % Socioeconomically Disadvantaged (SD): The percentage of students in the school who are classified as Socioeconomically Disadvantaged (SD) by the CDE. SD Students include students eligible for the free and reduced priced meal program (FRPM), foster youth, homeless students, migrant students, and students for whom neither parent is a high school graduate.[15] Higher percentages of socioeconomically disadvantaged students are significantly negatively correlated with scale scores.
- Average Parent Education Level: Each grade's average parental education level is used as another measure of family socioeconomic status. These averages range from 1 to 5, where 1 = Not high school graduate, 2 = High school graduate, 3 = Some college, 4 = College graduate, and 5 = At least some graduate school/post graduate training. Higher averages indicate the school serves students from families with higher education levels. As Table 3 shows, higher parent education levels are positively correlated with higher test scores. Of all the variables in the SSM models, parents' average education level and students' socioeconomic status have the strongest association with average test score results. They are also highly correlated with one another (see Appendix III).
- % English Learners and Reclassified Fluent English Proficient: The percentage of students in the school who are designated as English Learners (EL) or Reclassified Fluent English Proficient (RFEP) by the CDE. Traditional English learners are classified as students whose primary language is not English, and who have scored below proficient (as determined by state standards) on an initial English Language Assessment.[16] Local Educational Agencies determine subsequent proficiency standards for reclassifying a student as fluent English proficient (RFEP).[17] The CDE reports the number of valid test takers in each grade at a school who fit into either definition, and a percentage is obtained by dividing this by the total number of valid tests in each grade. Higher levels of English Learners and RFEP students are significantly associated with lower scale scores.
- % Students with Disabilities: The percentage of students who receive special education services and have a valid disability code are also included as independent variables. This percentage was calculated by dividing the number of valid test takers with disabilities by the total number of valid tests. Higher levels of students with disabilities in a school are significantly correlated with lower test scores. However, the correlation coefficient is low compared to other variables in the model, indicating it has less influence on average scale score than other variables.
- % Students by Ethnicity: The percentage of students in each of five ethnic categories (see list below) are also entered in the regression models. These percentages are calculated by dividing the number of valid test takers of a specific ethnicity in a grade

[15] http://www.cde.ca.gov/nr/ne/yr15/yr15rel69.asp
[16] http://www.cde.ca.gov/ds/sd/cb/glossary.asp#el
[17] http://www.cde.ca.gov/ds/sd/cb/glossary.asp#fep

by the total number of valid tests in the grade. Since the National Center for Educational Statistics first published a report in 1966 documenting disparities in educational opportunities for minorities in the US, researchers have acknowledged the existence of a persistent relationship between race with educational opportunities and academic outcomes.[18] The inclusion of racial percentages does not set different expectations for different students. Rather, it isolates those effects to better identify the effect of the school's program. All five of the following ethnic subgroups are significantly correlated with schools' average scale scores, with varying strengths and directions.

- % African American or Black students (not of Hispanic origin)
- % Asian students
- % Hispanic students
- % White students (not of Hispanic origin)
- % Other (student is not of any the above ethnicities)

- % Student Retention: Also included is the percentage of students who were continuously enrolled from the October California Basic Educational Data System (CBEDS) data collection to the first date of SBAC testing in the spring. This measure of student retention is an indicator of student stability/mobility. For this variable, higher percentages indicate higher retention levels. For example, a 90% rate indicates that 90% of the fall students were still enrolled in spring. Student retention is positively correlated with test score results, the higher the retention rate, the higher the average test scores. This is the only variable included in the SSM models at the school level, which is the format at which it is provided by the CDE.

Table 3 below provides the descriptive statistics for each independent variable for the 2015-16 school year, as well as the correlation coefficient for each variable's relationship with a school's average scale score. The relationships seen here often shift once all of these variables are put together in a regression model due to interactions among these variables. See Appendix III for a table showing how the variables correlate to one another.

Variable	Mean	Std. Deviation	Minimum	Maximum	Correlation Coefficient (relationship with APD)
% SD	63%	0.29	0%	100%	-0.82***
Average Parent Education Level	2.85	0.78	1.22	5	0.82***
% English Language Learners	20%	0.17	0%	93%	-0.51***
% Students with Disabilities	11%	0.04	0%	41%	-0.26***
% African American	6%	0.10	0%	95%	-0.26***

[18] James S Coleman et al, "Equality of Educational Opportunity," (National Center for Educational Statistics, 1966)

% Asian	8%	0.14	0%	98%	0.50***
% Hispanic	54%	0.29	0%	100%	-0.63***
% White	25%	0.24	0%	99%	0.51***
% Other	7%	0.07	0%	95%	0.28***
% Retention	94%	0.06	2%	100%	0.39***

*** Correlation is significant at the 0.001 level (2-tailed)

Publicly Available Data Not Included in the Model

The percentage of students of certain demographics are not included in the SSM models because their numbers are not significant at enough schools to form accurate projections (includes American Indians, Pacific Islanders, etc.). The CDE also provides school level data measuring aspects of a school which charter leaders have control over and are therefore purposefully not included, such as the percentage of certified teachers at a school. Many models of student achievement and growth also include measures of school culture, such as student satisfaction surveys, but this information is not currently gathered by the state of California and so is not included formally in the regression.

Predicted Scale Scores and Forecast Errors

CCSA runs two paired regression models per grade served predicting scale scores in both ELA and math, one that includes parent education and a second predicted scale score from a model without parent education (see Appendix I for the output of each model). The predictions from both models are then combined to create one predicted scale score for each grade and subject combination. This computation consists of three steps:

1. Predicted Scale Score from Parent Ed. Model * percentage of Parent Ed. Question responses = Predicted Scale Score 1 (weighted by parent response)
2. Predicted Scale Score from Model without Parent Ed. * percentage that did not respond to the Parent Ed. Question = Predicted Scale Score 2 (weighted by non-parent response)
3. Predicted Scale Score 1 (weighted by parent response) + Predicted Scale Score 2 (weighted by non-response) = Grade/Subject Predicted Score

In addition to the Predicted Scores, each model also generates forecast errors. The forecast error is a single number, representing the standard error of the predicted scale score for every school's grade and subject, in both the parent education model and the model without parent education. Since the models do not perfectly account for the differences in test score results seen between grades at different schools, we cannot be certain that the predictions are accurate. The forecast error is one way of addressing this uncertainty, with a large forecast error suggesting a larger amount of uncertainty over the accuracy of a given predicted scale score. A single forecast error is generated for every grade and subject by averaging the error terms generated by the parent education and non-parent education models, in the same way that predicted scale scores are combined.

Gap Scores & Forecast Errors

After predicted scale scores and forecast errors are generated for every grade and subject, each grade's actual test score results in ELA and math are compared to the predicted scores. The predicted scores are subtracted from each grade's actual average test score results in ELA and math to create grade-level gap scores. Table 4 shows the scale score ranges for each grade achieved on the SBAC in 2016, and the minimum and maximum predictions created by the SSM models. Since the SBAC is a vertically aligned test, there is no floor or cap on the score students can receive, although the CDE does define the range of scores historically associated with each grade by subject. As Table 4 shows, this caused some predicted scale scores to be below the "minimum" values observed by Smarter Balanced in California. There are no cases where a predicted score for a grade was above the maximum score received a student in that grade.

Table 4: Scale Score Ranges of Test-Takers, Model Predictions, and Gaps

ELA	Observed Scale Score Ranges		Predicted Score Ranges		Gap Score Ranges	
Grade	Min	Max	Min	Max	Min	Max
3	2114	2623	2084	2526	-100	208
4	2131	2663	2133	2582	-137	201
5	2201	2701	2183	2623	-114	151
6	2210	2724	2387	2638	-122	104
7	2258	2754	2444	2669	-171	140
8	2288	2769	2460	2741	-321	113
11	2299	2795	2475	2760	-322	91
Math	Observed Scale Score Ranges		Predicted Score Ranges		Gap Score Ranges	
Grade	Min	Max	Min	Max	Min	Max
3	2274	2562	2086	2543	-129	214
4	2315	2607	2260	2596	-111	92
5	2317	2644	2242	2637	-81	116
6	2285	2684	2397	2670	-229	132
7	2333	2698	2410	2703	-163	148
8	2322	2752	2405	2741	-334	137
11	2327	2782	2381	2803	-223	110

Each grade and subject's gap score is expressed as a negative or positive value, because it tells us whether each grade's actual test score results are above or below their predicted test results. A gap score of 0 indicates that, on average, the students of that grade are exactly meeting their predicted test results in that subject, while all values above 0 indicate over-achievement and all negative values indicate under-achievement. The ELA and math gap scores are then averaged for each grade to create a single gap score at each grade level. The forecast error of every predicted score is also averaged between ELA and math, creating a grade level forecast error.

Schoolwide Averages

The gap scores for every grade at a school are then weighted by the total number of test takers in that grade. Each of these weighted gap scores are then aggregated into a single schoolwide average gap score. A similar process is repeated for each grade's forecast error, to create a schoolwide forecast error.

Schoolwide Average Gap Score = $\frac{(Test\text{-}Takers_k \times Gap\ Score_k) + \cdots + (Test\text{-}Takers_{12} \times Gap\ Score_{12})}{Total\ Valid\ Test\text{-}takers}$

Schoolwide Average Forecast Error = $\frac{(Test\text{-}Takers_k \times Forecast\ Error_k) + \cdots + (Test\text{-}Takers_{12} \times Forecast\ Error_{12})}{Total\ Valid\ Test\text{-}takers}$

Gap scores represent the difference between our models' best prediction of a school's possible achievement compared with the school's actual achievement. Therefore, there is no linear relationship between gap scores and actual test-score results. Schools that have very different actual test results could have the same average gap score. Illustrated in Table 5, School A and School B have the same average gap scores for 4th grade. However, the actual 4th grade scale score of School A is much higher than that of School B. These differences are a result of the particular demographics at each school. School A's demographics are associated with higher scale scores statewide, and so the regression models generated a higher predicted score. School B's predicted scores are equally high above its actual average achievement as School A, but because of School B's particular demographics, its predicted scores are not as high as School A's. The table below also provides an example of two schools (Schools C and D) that have the same actual fourth grade scale scores, but different predicted scores, and thus very different gap scores. This is possible because the predictions rely on student demographic variables, which differ even though the schools have the same scale scores. As these examples show, predictions, forecast errors, and gap scores vary on a school-by-school basis.

Table 5: Schoolwide Average APD and Gap Score

Example Schools	Actual Average 4th Grade Scale Scores	Gap Score
School A	2445	-58
School B	2365	-58
School C	2473	-11
School D	2473	-22

Consideration of Error in Predicted Scores

There is some level of uncertainty inherent in any regression analysis, and CCSA took this into consideration when interpreting results. Rather than use the standard error of the mean in our analysis, which is based on the overall model, we used the error associated with individual grade and subject predicted scale scores. Unlike the standard error for the mean, forecast error considers the uncertainty associated with each school's grade and subject test results. Remarkably, and as shown in the table below, these forecast errors had little variation between schools' grade and subject results.

Table 6: Forecast Errors of Predicted Scale Scores

Grade	ELA		Math	
	Mean	Standard Deviation	Mean	Standard Deviation
3	21.94	0.12	20.88	0.11
4	22.36	0.14	20.05	0.11
5	21.94	0.16	22.14	0.15
6	21.80	0.16	22.97	0.19
7	19.08	0.15	19.78	0.17
8	19.60	0.19	24.13	0.23
11	21.69	0.32	21.30	0.37

Similar Student Measure Categories

With the SSM models' results averaged to the school level, the SSM predictions can be used to assess school-level achievement based on each school's unique demographic profile. To assess this achievement while also addressing the uncertainty associated with the SSM models, gap score ranges equal to one and two forecast errors (68% and 95%) are established for each school. Each school's SSM category is defined to be where their actual scale score average fell in relation to the school's average predicted scale score, while considering the forecast error associated with the predictions.

The SSM Categories ensure that the school's average gap score is not interpreted with undue precision. Schools are organized into SSM categories based on the average distance of a school's real scores in relation to their predicted scores (i.e., the size of the school's average gap score):

Far below: Schoolwide average scale scores were more than two forecast errors below the predicted scale scores, on average

Below: School's test scores were on average between one and two forecast errors below its Predicted Scale Scores

Within: School's test scores were on average within one forecast error above or below its Predicted Scale Scores

Above: School's test scores were on average between one and two forecast errors above its Predicted Scale Scores

Far above: School's test scores were on average more than two forecast errors above its Predicted Scale Scores

The range of the "Within" category accounts for schools with scale score averages within one standard error above or below their predicted scale scores. A school whose actual scale score results were between one and two standard errors below their predictions was categorized as "Below," and a school between one and two standard errors above their predictions was categorized as "Above." A school with average scale scores more than two standard errors below their prediction would be "Far Below Predicted," and more than two standard errors above would be "Far Above." The Far Below and Far Above categories correspond with a 95% level of confidence, and therefore represent schools whose average test score results were statistically significantly different from their predicted scale scores. For a

walk-through of how SSM is calculated using a real school example, visit CCSA's Snapshot report here.[19]

SSM Performance Bands

Since the CAASPP moved into its second year of testing in the 2015-16 academic year, the SSM Categories were extended into two-year performance bands. The SSM Performance Bands are used to profile all schools that have more than one SSM Category. In this way, the SSM also serves as a broader assessment of the charter movement as a whole, as well as an early warning system for schools in danger of being classified as underperforming in their coming years. These longitudinal SSM Performance Bands consist of the following seven categories:

Far Below All Years:	Schools with SSM category of Far Below for all years for which we have data
Below All Years:	Schools with SSM Category of Below or Far Below for all years for which we have data
Below Most Years:	Schools with SSM Category of Below or Far Below in two out of three years
Within/Fluctuating:	Schools with SSM Category of Within most years for which we have data, or fluctuating with no more than one year in a Below or Above category
Above Most Years:	Schools with SSM Category of Above or Far Above in two out of three years
Above All Years:	Schools with SSM Category of Above or Far Above all years for which we have data
Far Above All Years:	Schools with SSM Category of Far Above All Years for which we have data

The SSM Performance Bands were created in alignment with the yearly SSM Categories. The bands for Far Below All Years and Far Above All Years are inclusive of schools that were Far Below or Far Above for all years with SSM Categories. The Below All Years and Above All Years bands were based on consistently receiving an SSM Category of Below or Far Below or on the high end of Above or Far Above. Schools that were Below Most Years or Above Most Years demonstrated a pattern of being in one of the Above or Below categories for two, but not all three years. Schools that fell in the Within/Fluctuating category either consistently had an SSM category of Within, or deviated above or below the Within range not more than once in either direction out of the past three years, thereby not demonstrating a clear pattern in either direction (see Table 7 below for examples).

[19] http://snapshots.ccsa.org/similar-students-measure/

Table 7: Examples of SSM Categories and Performance Bands

Example School	2016 SSM	2015 SSM	2-year Band
School X	Far Below	Below	Below All Years
School Y	Within	Below	Within/Fluctuating
School Z	Within	Above	Within/Fluctuating
School AA	Far Above	Far Above	Far Above All Years

Limitations

CCSA recommends the SSM as an additional tool in the identification of underperforming charters, but does not recommend it as the sole system for evaluating schools. As with all measures, there are limitations, some of which are described below.

- The SSM regression models reach high levels of validity and have been found to be reliable, but regression predictions are still just estimates of relationships between variables. There is an inherent level of imprecision in any statistical measure, which are exacerbated when test results are aggregated to the grade-level, and that any grade with fewer than 11 test-takers had its students' scores redacted, thus getting excluded from the model entirely. Forecast errors are included in the model to account for at least some of this uncertainty.
- The regression models are grade-level calculations, but the percentage of continuously enrolled students is a school-level independent variable. A school may have grade-specific within-year changes in enrollment that are not being accounted for in the regressions.
- With the CAASPP, only grades 3-8 and 11 are tested, so the academic achievement of some schools is being measured based on a small segment of the total students at the school. Schools serving grades 9-12 will have both SSM and APD calculated using the test results of just 11th graders. Since high schools are unduly affected by the limited number of grades being tested, a school's A-G rate is also considered in CCSA's Accountability Framework.
- As outlined as a limitation of the APD measure, not-continuously enrolled students are included in testing data. In prior years, CCSA's measures were based on the state-provided Academic Performance Index (API) data fie which only reported test scores for students continuously enrolled from fall to spring. The SBAC scale score data now includes all students at a school regardless of their enrollment date. This could affect average scale scores, and therefore SSM predictions, in ways we are unable to quantify with school-level data. Mobility is included in the SSM modeling in an attempt to account for this limitation.
- In prior years, student retention rates were included in the state-provided Academic Performance Index (API) data file, however, it is not included in the SBAC data set and not made publicly available. In order to calculate the SSM, CCSA directly

requested the mobility file from the CDE in 2015 and 2016. The data file received from the CDE was a partial file that did not include California Alternative Assessment (CAA) data. In an attempt to mediate this known fluctuation in access to and completeness of the data, CCSA used a weighted average of the last two years' mobility in calculating the 2016 SSM. The CDE has stated that the mobility file will be made publicly available again in the future.

- Because non-charters comprise the vast majority of the sample being assessed, those schools' performance and variable relationships are primarily driving the regression models.
- The SSM is only one measure of school performance, and it is a relative measure. That being the case, this measure cannot and should not stand alone as the only assessment of a school's performance or as the arbitrator of a school's future. This is particularly the case for schools that either have a specific research-based program such as Waldorf or Montessori (where the curriculum is designed to culminate in high performance at higher grade levels, which may not be evident in earlier grade levels), or that have a high percentage of students with a disability or other special needs, but are not a special education school. These metrics were designed to serve as a trigger for further review and a deeper assessment of a school's effectiveness, not as the only point upon which to make those decisions.
    - While CCSA's Multiple Measure Review provides additional nuance to the academic information publicly available to charters facing renewal, longitudinally linked, individual student data would be the ideal source for most appropriately assessing a school's performance. Because the SSM is calculated with aggregate grade level data, it approximates value-added modeling. True value-added modeling requires individual student data connected to the schools and educators instructing those students.

SSM as an Accountability Tool

Given the SSM was primarily developed to inform renewal review processes, charter schools that have been in operation fewer than 4 years are excluded from the application of SSM as an accountability tool, though they are still included in the SSM model.

As an accountability tool, we recommend that the SSM be combined with measures of actual test results (APD) and growth over time to identify schools that are demonstrating patterns of under-performance relative to that predicted, as well as low performance on absolute measures. The contribution of the SSM to a school's picture of achievement is that the SSM adds the ability to identify schools that consistently fail to meet minimum predicted test scores controlling for their student populations. For more information on how the SSM plays a part in CCSA's Accountability Framework and the CCSA Minimum Criteria for Renewal, see our website at ccsa.org/accountability.

Appendix I: SSM Scale Score Prediction Regressions

Grade 3 Scale Score Prediction Regressions

	ELA		Math	
	w/ Parent Ed	w/out Parent Ed	w/ Parent Ed	w/out Parent Ed
Continuous Enrollment	-2.784	-3.247	-2.410	-2.752
	(34.22)**	(39.04)**	(30.68)**	(34.88)**
Continuous Enrollment^2	0.025	0.028	0.024	0.027
	(52.14)**	(58.23)**	(51.74)**	(57.59)**
% SpEd	42.587	34.422	22.045	14.012
	(22.15)**	(17.48)**	(12.05)**	(7.48)**
% Low-Income	-59.615	-103.880	-55.943	-97.744
	(65.03)**	(157.60)**	(64.10)**	(156.15)**
% English Learner	-42.113	-45.584	-34.583	-37.373
	(59.66)**	(63.70)**	(51.50)**	(54.97)**
% Reclassified EFP	-19.685	-31.223	-4.654	-16.240
	(18.22)**	(28.56)**	(4.51)**	(15.57)**
% African American	-67.563	-68.933	-73.795	-74.168
	(65.82)**	(65.72)**	(75.61)**	(74.42)**
% Asian American	32.574	42.925	40.275	50.522
	(31.51)**	(41.00)**	(40.99)**	(50.79)**
% Latino	-5.481	-27.913	-17.024	-39.111
	(4.09)**	(21.25)**	(13.43)**	(31.47)**
% Other	-12.693	-15.652	-24.930	-27.496
	(9.10)**	(10.99)**	(18.85)**	(20.37)**
Avg Parent Ed	7.966		6.734	
	(15.51)**		(13.76)**	
% SpEd^2	-316.223	-306.546	-300.130	-290.585
	(44.02)**	(41.63)**	(43.67)**	(41.28)**
% Low-Income^2	15.186	24.619	21.548	30.468
	(20.74)**	(42.23)**	(30.89)**	(55.01)**
% EL^2	11.352	0.766	20.810	10.749
	(13.81)**	(0.94)	(26.61)**	(13.84)**
% RFEP^2	133.956	122.560	122.036	112.242
	(42.92)**	(38.42)**	(40.59)**	(36.55)**
% African American^2	37.616	30.141	49.865	42.029
	(24.81)**	(19.54)**	(34.60)**	(28.67)**
% Asian American^2	-27.056	-31.681	-25.702	-30.988
	(26.10)**	(30.44)**	(26.15)**	(31.45)**
% Latino^2	-2.555	7.974	0.686	11.317
	(3.23)**	(10.40)**	(0.92)	(15.57)**
% White^2	-23.188	-29.158	-25.735	-31.335
	(25.55)**	(31.77)**	(29.88)**	(35.98)**
% Other^2	-19.373	-33.267	8.875	-4.039
	(7.12)**	(11.97)**	(3.42)**	(1.53)
Avg Parent Ed^2	1.934		1.960	
	(22.11)**		(23.53)**	
_cons	2,464.693	2,554.797	2,450.456	2,529.785
	(681.59)**	(705.30)**	(701.55)**	(736.49)**
R^2	0.76	0.75	0.75	0.73
N	447,943	453,133	449,861	455,293

* $p<0.05$; ** $p<0.01$

Grade 4 Scale Score Prediction Regressions

	ELA		Math	
	w/ Parent Ed	w/out Parent Ed	w/ Parent Ed	w/out Parent Ed
Continuous Enrollment	-3.927	-4.585	-3.118	-3.420
	(46.07)**	(52.27)**	(41.63)**	(44.85)**
Continuous Enrollment^2	0.032	0.037	0.028	0.030
	(64.00)**	(71.23)**	(63.73)**	(67.76)**
% SpEd	36.178	32.598	-14.362	-18.743
	(18.80)**	(16.43)**	(8.31)**	(10.58)**
% Low-Income	-68.160	-120.472	-61.475	-109.325
	(73.23)**	(174.93)**	(74.09)**	(178.26)**
% English Learner	-48.548	-53.415	-36.140	-39.493
	(64.32)**	(69.13)**	(53.52)**	(57.36)**
% Reclassified EFP	6.013	3.643	14.665	13.395
	(5.85)**	(3.45)**	(15.77)**	(14.08)**
% African American	-58.232	-57.667	-62.623	-62.570
	(56.47)**	(54.24)**	(67.67)**	(65.93)**
% Asian American	21.633	35.494	31.518	42.815
	(20.81)**	(33.33)**	(33.85)**	(45.12)**
% Latino	4.311	-16.255	-23.624	-44.001
	(3.26)**	(12.30)**	(20.00)**	(37.49)**
% Other	-11.113	-11.491	-21.606	-24.495
	(8.50)**	(8.54)**	(18.50)**	(20.48)**
Avg Parent Ed	9.103		3.127	
	(17.78)**		(6.90)**	
% SpEd^2	-294.068	-299.321	-127.363	-127.259
	(42.48)**	(41.91)**	(20.38)**	(19.84)**
% Low-Income^2	16.792	28.004	19.042	31.892
	(22.58)**	(46.18)**	(28.76)**	(59.09)**
% EL^2	18.677	5.591	23.320	13.278
	(19.50)**	(5.81)**	(27.25)**	(15.49)**
% RFEP^2	69.687	42.263	58.301	36.510
	(30.24)**	(17.82)**	(27.66)**	(16.92)**
% African American^2	20.277	13.356	18.487	11.730
	(13.55)**	(8.68)**	(13.74)**	(8.52)**
% Asian American^2	-6.838	-16.543	-6.520	-16.609
	(6.82)**	(16.17)**	(7.26)**	(18.25)**
% Latino^2	-9.204	0.339	0.904	10.888
	(11.76)**	(0.44)	(1.29)	(15.80)**
% White^2	-20.453	-25.586	-24.774	-30.792
	(22.62)**	(27.69)**	(30.60)**	(37.41)**
% Other^2	-20.646	-34.072	-12.434	-22.217
	(8.86)**	(14.17)**	(5.97)**	(10.39)**
Avg Parent Ed^2	2.173		2.494	
	(25.03)**		(32.48)**	
_cons	2,544.591	2,651.039	2,529.281	2,603.868
	(671.71)**	(694.91)**	(759.70)**	(785.95)**
R^2	0.78	0.77	0.79	0.78
N	466,057	468,502	468,010	470,514

* $p<0.05$; ** $p<0.01$

Grade 5 Scale Score Prediction Regressions

	ELA		Math	
	w/ Parent Ed	w/out Parent Ed	w/ Parent Ed	w/out Parent Ed
Continuous Enrollment	-3.887	-4.507	-3.850	-4.609
	(48.28)**	(54.08)**	(47.16)**	(54.87)**
Continuous Enrollment^2	0.031	0.036	0.032	0.037
	(65.78)**	(72.78)**	(66.70)**	(75.24)**
% SpEd	13.107	1.634	-6.624	-16.870
	(6.54)**	(0.78)	(3.25)**	(7.99)**
% Low-Income	-51.963	-116.886	-55.290	-126.320
	(55.29)**	(173.44)**	(58.17)**	(186.59)**
% English Learner	-51.456	-63.036	-35.774	-48.059
	(62.30)**	(73.96)**	(42.89)**	(55.97)**
% Reclassified EFP	26.511	30.003	38.622	42.295
	(27.35)**	(29.73)**	(39.14)**	(41.38)**
% African American	-61.374	-62.298	-73.257	-74.627
	(60.28)**	(58.74)**	(71.34)**	(70.11)**
% Asian American	21.499	39.796	20.389	36.440
	(20.84)**	(37.32)**	(19.61)**	(34.06)**
% Latino	-6.232	-22.553	-34.606	-54.718
	(4.87)**	(17.35)**	(26.84)**	(42.06)**
% Other	-10.608	-8.872	-24.368	-24.437
	(8.04)**	(6.47)**	(18.36)**	(17.80)**
Avg Parent Ed	9.636		1.693	
	(18.48)**		(3.23)**	
% SpEd^2	-251.712	-231.891	-157.119	-141.863
	(35.27)**	(31.25)**	(21.41)**	(18.68)**
% Low-Income^2	7.857	24.958	15.859	39.132
	(10.52)**	(41.75)**	(21.06)**	(65.18)**
% EL^2	25.962	16.263	25.778	20.974
	(21.87)**	(13.43)**	(21.56)**	(17.21)**
% RFEP^2	6.708	-27.856	-0.382	-32.652
	(3.95)**	(15.85)**	(0.22)	(18.20)**
% African American^2	21.228	21.088	19.851	18.220
	(14.58)**	(13.93)**	(13.50)**	(11.98)**
% Asian American^2	-9.180	-23.390	3.932	-8.768
	(9.37)**	(23.07)**	(3.97)**	(8.60)**
% Latino^2	-0.985	5.382	3.431	12.461
	(1.29)	(7.03)**	(4.46)**	(16.22)**
% White^2	-24.701	-27.370	-28.084	-32.407
	(28.09)**	(30.13)**	(31.71)**	(35.60)**
% Other^2	-13.186	-25.063	2.369	-9.234
	(5.59)**	(10.19)**	(0.99)	(3.73)**
Avg Parent Ed^2	2.668		3.846	
	(30.21)**		(43.25)**	
_cons	2,578.317	2,692.072	2,578.457	2,689.370
	(719.55)**	(744.08)**	(709.41)**	(737.23)**
R^2	0.79	0.77	0.80	0.78
N	456,924	459,278	458,571	461,091

* $p<0.05$; ** $p<0.01$

Grade 6 Scale Score Prediction Regressions

	ELA		Math	
	w/ Parent Ed	w/out Parent Ed	w/ Parent Ed	w/out Parent Ed
Continuous Enrollment	-2.485	-3.247	-1.933	-2.787
	(33.11)**	(41.74)**	(23.90)**	(33.01)**
Continuous Enrollment^2	0.023	0.028	0.021	0.027
	(50.42)**	(60.70)**	(43.96)**	(54.36)**
% SpEd	-64.161	-70.453	-114.196	-122.687
	(32.88)**	(34.74)**	(55.50)**	(56.96)**
% Low-Income	-43.799	-111.051	-47.202	-134.145
	(41.84)**	(156.10)**	(42.66)**	(177.83)**
% English Learner	-79.748	-100.467	-101.831	-122.786
	(83.10)**	(102.04)**	(101.19)**	(118.05)**
% Reclassified EFP	12.595	18.751	10.227	17.199
	(12.30)**	(17.62)**	(9.43)**	(15.15)**
% African American	-65.036	-60.688	-79.710	-75.975
	(62.20)**	(55.82)**	(72.41)**	(65.87)**
% Asian American	68.198	88.449	79.274	101.094
	(64.60)**	(81.23)**	(71.57)**	(87.77)**
% Latino	53.187	36.323	37.268	9.989
	(39.81)**	(26.92)**	(26.59)**	(7.01)**
% Other	-18.679	-26.503	-24.307	-38.370
	(14.46)**	(19.87)**	(17.92)**	(27.18)**
Avg Parent Ed	16.000		10.575	
	(28.44)**		(17.93)**	
% SpEd^2	-1.028	-15.393	150.788	136.056
	(0.15)	(2.15)*	(20.66)**	(17.79)**
% Low-Income^2	3.684	20.377	10.905	37.335
	(4.52)**	(32.27)**	(12.70)**	(55.79)**
% EL^2	81.523	79.502	122.079	118.189
	(52.57)**	(49.83)**	(75.66)**	(70.65)**
% RFEP^2	28.257	-15.633	48.283	-0.350
	(17.22)**	(9.28)**	(27.64)**	(0.19)
% African American^2	49.497	39.562	48.520	35.490
	(30.69)**	(23.61)**	(28.48)**	(19.90)**
% Asian American^2	-32.553	-44.533	-19.106	-34.872
	(31.70)**	(41.92)**	(17.74)**	(31.08)**
% Latino^2	-34.441	-27.250	-34.946	-21.739
	(43.18)**	(34.15)**	(41.68)**	(25.74)**
% White^2	0.494	-1.719	-4.620	-10.864
	(0.54)	(1.81)	(4.76)**	(10.80)**
% Other^2	24.147	32.149	21.905	34.607
	(11.99)**	(15.36)**	(10.34)**	(15.59)**
Avg Parent Ed^2	1.985		3.596	
	(20.44)**		(35.18)**	
_cons	2,510.279	2,642.659	2,473.442	2,620.746
	(753.73)**	(790.33)**	(689.13)**	(721.51)**
R^2	0.78	0.76	0.82	0.80
N	452,401	454,700	453,815	456,284

* $p<0.05$; ** $p<0.01$

Grade 7 Scale Score Prediction Regressions

	ELA		Math	
	w/ Parent Ed	w/out Parent Ed	w/ Parent Ed	w/out Parent Ed
Continuous Enrollment	-4.785	-5.379	-4.467	-5.080
	(84.11)**	(91.23)**	(75.31)**	(82.39)**
Continuous Enrollment^2	0.037	0.041	0.038	0.042
	(104.87)**	(113.66)**	(102.75)**	(111.18)**
% SpEd	-100.148	-110.248	-106.231	-115.129
	(47.34)**	(49.92)**	(48.54)**	(50.21)**
% Low-Income	-41.147	-102.647	-47.190	-125.765
	(42.28)**	(155.73)**	(46.85)**	(183.22)**
% English Learner	-86.709	-115.011	-96.543	-125.524
	(91.66)**	(118.03)**	(99.05)**	(124.77)**
% Reclassified EFP	-19.603	-10.333	-9.146	0.316
	(20.14)**	(10.16)**	(9.02)**	(0.30)
% African American	-73.288	-73.682	-93.168	-94.049
	(76.59)**	(73.60)**	(93.81)**	(90.18)**
% Asian American	40.121	60.393	41.767	60.684
	(40.95)**	(59.54)**	(41.24)**	(57.63)**
% Latino	24.405	17.218	-6.178	-22.503
	(19.82)**	(13.76)**	(4.86)**	(17.36)**
% Other	-22.986	-17.816	-12.220	-11.621
	(19.25)**	(14.34)**	(9.91)**	(9.02)**
Avg Parent Ed	23.307		14.133	
	(43.62)**		(25.76)**	
% SpEd^2	93.394	112.303	124.096	136.827
	(11.16)**	(12.85)**	(14.21)**	(14.94)**
% Low-Income^2	-0.299	13.142	6.360	30.923
	(0.38)	(21.83)**	(7.86)**	(49.38)**
% EL^2	83.584	97.387	118.268	133.966
	(47.58)**	(53.45)**	(66.16)**	(72.01)**
% RFEP^2	64.075	22.189	81.290	39.128
	(46.23)**	(15.50)**	(56.02)**	(26.01)**
% African American^2	39.322	43.020	31.776	31.855
	(27.49)**	(28.80)**	(21.29)**	(20.35)**
% Asian American^2	-0.785	-13.461	27.758	14.403
	(0.82)	(13.51)**	(28.02)**	(13.92)**
% Latino^2	-24.765	-23.907	-21.880	-15.611
	(33.53)**	(32.12)**	(28.64)**	(20.20)**
% White^2	-17.521	-16.224	-20.453	-23.229
	(20.50)**	(18.35)**	(23.15)**	(25.32)**
% Other^2	-4.509	-14.470	-32.506	-41.486
	(2.26)*	(6.93)**	(15.75)**	(19.14)**
Avg Parent Ed^2	0.576		2.446	
	(6.35)**		(26.22)**	
_cons	2,636.312	2,763.016	2,605.174	2,731.864
	(1,060.24)**	(1,125.40)**	(1,004.51)**	(1,064.04)**
R^2	0.83	0.82	0.87	0.86
N	449,990	451,340	451,290	452,663

* $p<0.05$; ** $p<0.01$

Grade 8 Scale Score Prediction Regressions

	ELA		Math	
	w/ Parent Ed	w/out Parent Ed	w/ Parent Ed	w/out Parent Ed
Continuous Enrollment	-3.907	-4.559	-4.778	-5.439
	(71.33)**	(80.23)**	(68.95)**	(75.70)**
Continuous Enrollment^2	0.032	0.037	0.042	0.047
	(92.74)**	(103.62)**	(98.16)**	(106.30)**
% SpEd	-153.288	-160.095	-151.684	-167.886
	(62.04)**	(62.35)**	(50.03)**	(53.28)**
% Low-Income	-42.806	-98.401	-43.335	-131.358
	(43.11)**	(143.32)**	(35.57)**	(155.63)**
% English Learner	-104.666	-128.154	-111.309	-133.763
	(103.36)**	(123.76)**	(89.09)**	(104.97)**
% Reclassified EFP	-7.441	0.482	13.265	19.545
	(7.80)**	(0.49)	(11.23)**	(15.93)**
% African American	-70.193	-73.859	-95.304	-101.213
	(71.42)**	(72.18)**	(78.68)**	(80.26)**
% Asian American	47.405	67.076	61.157	80.140
	(47.42)**	(65.05)**	(49.82)**	(63.27)**
% Latino	30.872	17.274	-11.654	-43.071
	(24.30)**	(13.50)**	(7.48)**	(27.46)**
% Other	-14.359	-12.989	-18.863	-25.894
	(11.81)**	(10.35)**	(12.67)**	(16.83)**
Avg Parent Ed	25.880		13.590	
	(47.78)**		(20.57)**	
% SpEd^2	300.074	293.321	300.901	325.237
	(28.51)**	(26.80)**	(23.14)**	(24.06)**
% Low-Income^2	4.774	15.841	4.062	34.091
	(5.94)**	(25.31)**	(4.13)**	(44.29)**
% EL^2	123.027	126.388	164.103	163.753
	(59.94)**	(59.76)**	(65.50)**	(63.48)**
% RFEP^2	38.336	-1.194	36.743	-3.984
	(30.36)**	(0.93)	(23.40)**	(2.49)*
% African American^2	49.875	57.568	42.529	46.975
	(33.60)**	(37.34)**	(23.07)**	(24.53)**
% Asian American^2	-5.112	-17.263	23.472	10.003
	(5.13)**	(16.70)**	(19.18)**	(7.88)**
% Latino^2	-24.206	-18.781	-7.264	8.891
	(31.67)**	(24.56)**	(7.74)**	(9.47)**
% White^2	-12.176	-12.231	-8.989	-16.742
	(13.98)**	(13.68)**	(8.41)**	(15.25)**
% Other^2	11.622	3.522	-2.010	-8.867
	(5.59)**	(1.63)	(0.79)	(3.33)**
Avg Parent Ed^2	0.007		2.988	
	(0.07)		(26.57)**	
_cons	2,610.528	2,740.124	2,599.854	2,739.814
	(1,086.10)**	(1,164.45)**	(856.66)**	(921.73)**
R^2	0.80	0.79	0.83	0.82
N	441,712	443,206	442,791	444,322

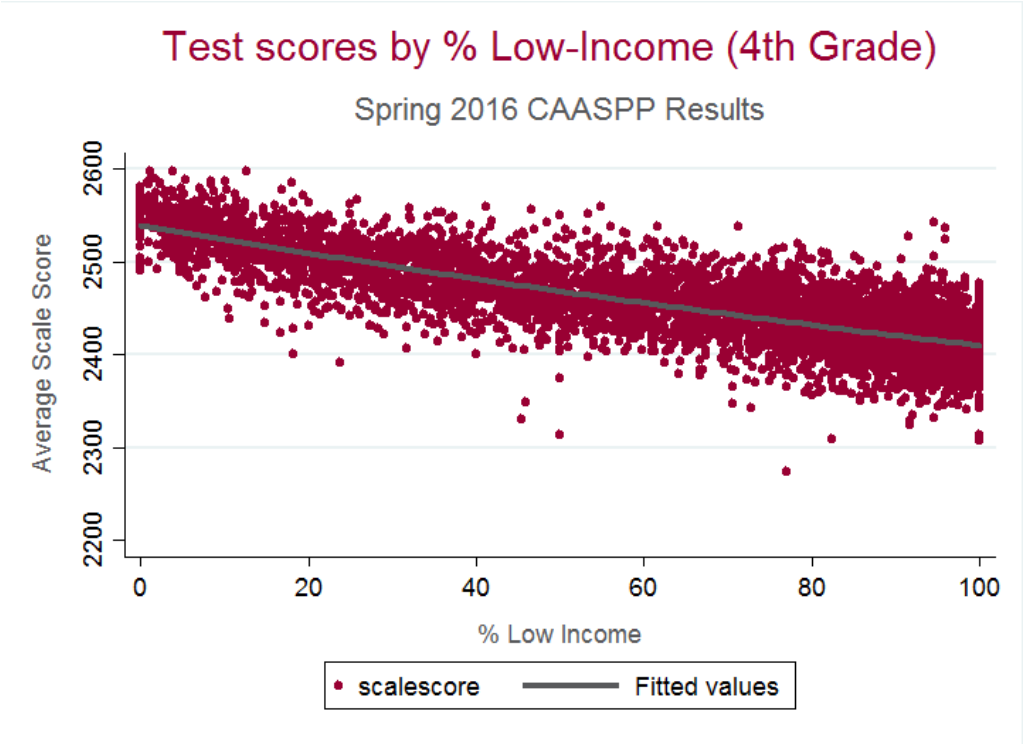
* $p<0.05$; ** $p<0.01$

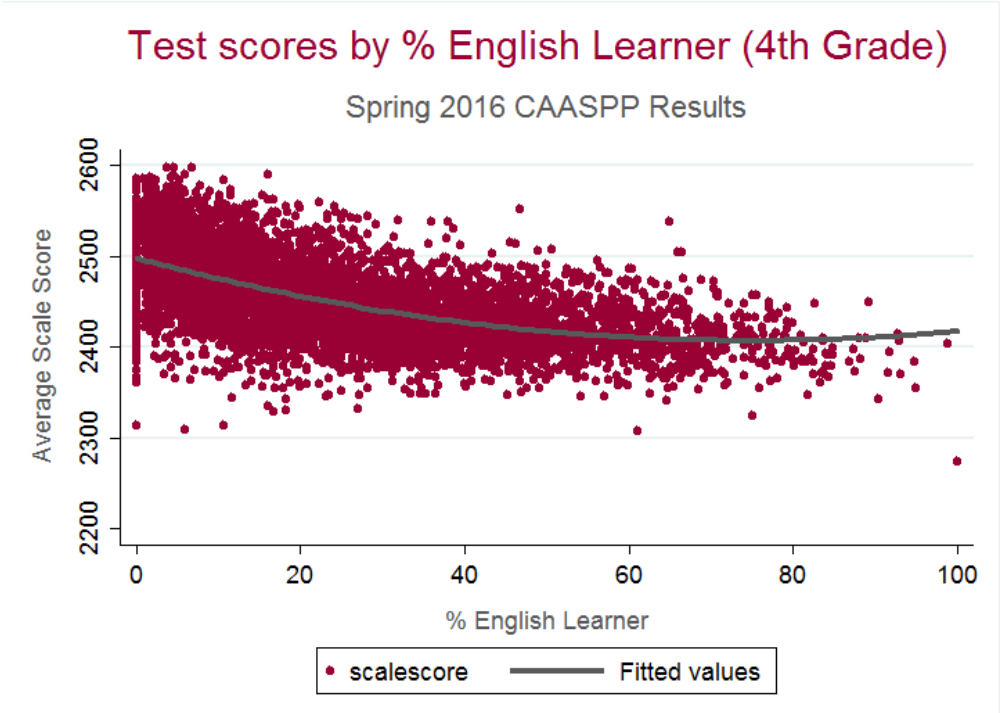
Grade 11 Scale Score Prediction Regressions

	ELA		Math	
	w/ Parent Ed	w/out Parent Ed	w/ Parent Ed	w/out Parent Ed
Continuous Enrollment	-2.137	-2.204	-2.474	-2.392
	(59.68)**	(60.58)**	(69.80)**	(64.62)**
Continuous Enrollment^2	0.022	0.023	0.028	0.027
	(90.87)**	(93.52)**	(114.16)**	(109.02)**
% SpEd	-154.084	-157.789	-162.542	-185.910
	(43.86)**	(44.17)**	(47.14)**	(51.61)**
% Low-Income	-51.013	-92.983	-69.225	-178.430
	(45.40)**	(114.48)**	(62.99)**	(217.92)**
% English Learner	-249.796	-267.078	-210.648	-228.460
	(167.89)**	(177.25)**	(146.18)**	(152.37)**
% Reclassified EFP	-19.616	-18.988	52.183	49.053
	(17.50)**	(16.64)**	(47.37)**	(42.59)**
% African American	-95.715	-88.151	-94.699	-90.886
	(76.56)**	(69.55)**	(77.35)**	(71.28)**
% Asian American	55.254	74.666	68.014	87.576
	(45.39)**	(60.99)**	(57.08)**	(71.13)**
% Latino	36.417	14.291	-6.631	-72.541
	(23.27)**	(9.49)**	(4.33)**	(47.94)**
% Other	80.264	72.099	88.912	56.616
	(50.11)**	(44.89)**	(56.60)**	(34.99)**
Avg Parent Ed	18.359		-22.751	
	(25.20)**		(31.88)**	
% SpEd^2	289.857	284.553	238.996	314.189
	(17.02)**	(16.43)**	(14.22)**	(17.89)**
% Low-Income^2	17.999	23.646	30.443	83.656
	(17.85)**	(30.51)**	(30.82)**	(107.01)**
% EL^2	276.830	290.145	237.980	249.382
	(74.84)**	(77.01)**	(67.55)**	(67.64)**
% RFEP^2	63.761	43.163	-27.465	-43.875
	(44.05)**	(29.73)**	(19.27)**	(29.90)**
% African American^2	80.041	66.975	54.025	26.441
	(42.57)**	(35.05)**	(29.33)**	(13.75)**
% Asian American^2	10.553	-9.542	44.279	12.512
	(8.74)**	(7.83)**	(37.55)**	(10.23)**
% Latino^2	-6.753	6.520	9.462	50.611
	(7.21)**	(7.30)**	(10.30)**	(56.27)**
% White^2	-4.551	-8.787	-10.893	-33.730
	(4.20)**	(8.17)**	(10.28)**	(31.21)**
% Other^2	-161.643	-154.660	-208.299	-186.032
	(46.92)**	(44.08)**	(61.44)**	(52.45)**
Avg Parent Ed^2	0.351		8.654	
	(2.96)**		(74.66)**	
_cons	2,585.608	2,670.995	2,592.759	2,667.225
	(1,481.50)**	(1,821.72)**	(1,506.27)**	(1,793.33)**
R^2	0.73	0.72	0.85	0.83
N	389,771	389,771	388,777	388,777

* $p<0.05$; ** $p<0.01$

Appendix II: Example Graphical Relationship Between Demographics and Scale Scores





Appendix III: Demographic Independent Variables Correlation Table

	bmob	vg_ed	_el	_rfep	_di	_sd	_aa	_as	_la	_wh	_other
bmob	00%										
vg_ed	3%***	00%									
_el	%***	62%***	00%								
_rfep	%**	52%***	9%***	00%							
_di	5%***	9%***	%***	12%***	00%						
_sd	%***	92%***	1%***	6%***	1%***	00%					
_aa	16%***	11%***	8%***	9%***	%***	9%***	00%				
_as	%***	1%***	11%***	%***	14%***	38%***	7%***	00%			
_la	7%***	81%***	5%***	5%***	%***	9%***	11%***	43%***	00%		
_wh	%***	8%***	60%***	58%***	%	71%***	25%***	5%***	77%***	00%	
_other	%***	9%***	30%***	28%***	1%	36%***	%***	9%***	51%***	0%**	00%

*** = p<.01, ** = p<.05, * = p<.1

Variable key

School Level

- Cbmob: Percent continuously enrolled students

Grade Level

- Avg_ed: Average parents' education
- p_el: Percent English Learners
- p_rfep: Percent Reclassified Fluent English Proficient
- p_di: Percent Students with Disabilities
- p_sd: Percent Socioeconomically Disadvantaged
- p_aa: Percent African American
- p_as: Percent Asian American
- p_la: Percent Latino
- p_wh: Percent White
- p_other: Percent Other