MARYLAND STATE DEPARTMENT OF EDUCATION
PREPARING WORLD CLASS STUDENTS

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TO: Members of the Maryland State Board of Education

FROM: Jack R. Smith, Ph.D. JRS/lcla

DATE: February 23, 2016

SUBJECT: Relationship between PARCC Test Scores and College Admission Test Scores

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PURPOSE:

To share with the State Board the results of a research study examining the relationship between PARCC test scores and college admission test scores.

BACKGROUND:

The State Board requested information on the relationship between the PARCC test scores and college admission test (SAT and ACT) scores. At the request of MSDE, the Maryland Assessment Research Center (MARC) conducted a research study examining those relationships.

EXECUTIVE SUMMARY:

The study was conducted following the initial year administration of the PARCC tests to verify initial understandings where possible, as well as to create the model for future research. There was a limited number of Maryland PARCC tested students that also had SAT and/or ACT scores; thus, the matched sample sizes between the PARCC and SAT/ACT test scores for Maryland students were relatively small. PARCC ELA10 was most greatly impacted.

Where sample sizes were large enough for study, the results indicate that there is a moderate relationship between PARCC test scores and the college admissions test scores. In all, the PARCC test scores are statistically significant predictors of SAT and ACT test scores. The table below highlights the concordance relationship for the college admission test scores and the PARCC Performance Levels.

PARCC Performance Level	**PARCC Threshold Score**		**Correlated SAT Score**			**Correlated ACT Score**		
Subject	***Alg II***	***ELA 10***	***Math***	***Reading***	***Writing***	***Math***	***Reading****	***Writing****
Level 1	650	650	210	200	200	12		
Level 2	700	700	400	340	340	17		
Level 3	725	725	480	400	380	20		
Level 4	750	750	530	490	460	23		
Level 5	809	795	690	630	570	32		

* Concordance relationship between PARCC ELA10 and ACT could not be established due to insufficient matched sample sizes.

ACTION:

For information only. No action required.

Attachment: The Relationship between the PARCC Test Scores and the College Admission Tests: SAT/ACT/PSAT

The Relationship between the PARCC Test Scores and the College Admission Tests: SAT/ACT/PSAT

A Research Report Submitted to Maryland State Department of Education (MSDE)

Maryland Assessment Research Center (MARC)

Executive Summary

The purpose of this research project is to explore the relationships between the PARCC test scores and the college admission test scores. Given that the MARC team received data with anonymous student identifiers and the sample sizes after matching students were adequate, data analyses have been performed for the PARCC ALG01, ALG02, ELA10 tests, SAT, ACT, and PSAT to find the relationships between the PARCC test scores and their respective college admission test scores in the same content area. More specifically, based on the approved proposal sent to MSDE, the following analyses have been conducted.

1. Correlational analyses between the PARCC and SAT, ACT, and PSAT test scores;
2. Regression analyses using the PARCC test scores to predict college admission test performance;
3. Concordance relationships established using the matched samples in which students' PARCC test scores and college admission test scores are both available;
4. Graphical presentations of the results prepared in addition to the statistical analysis. This perspective focused on the performance levels obtained on the PARCC tests (levels 1 through 5);
5. A summary provided to report the findings from a series of data analyses.

Major findings are summarized below. The detailed results are reported after this executive summary.

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Major Findings/Talking Points

1. This study was conducted based on **the matched samples** for PARCC/PSAT and SAT/ACT by subject. Only **Grade 12 students' first attempts** were used in the analyses, which usually account for more than 80% of the matched samples. Matched sample sizes for other grades were too small to conduct statistical analyses, which may result in reduced power to detect some significant relationship.
2. The results of various correlational analyses and regression analyses show that there is a moderate linear relationship between PARCC tests and college admissions exams (SAT and ACT) for both Math and English. PARCC tests are statistically significant predictors of SAT/ACT test scores. PARCC scores as predictors, along with PSAT scores, explain 29% to 59% of the total variance in the SAT/ACT outcomes. Also, the PARCC tests are moderately correlated with similar SAT/ACT sub-test scores.

3. Graphical representations show that Grade 12 students with higher performance levels on PARCC tend to score higher on SAT/ACT. Concordance tables linking the PARCC test scores to the SAT or ACT test scores in the same content area are provided in the Appendix. These tables show the linkage between student performance on PARCC tests and the college admission tests, SAT and ACT. Though the PARCC tests and the college admission tests, SAT and ACT do not measure exactly the same content in a similar subject area, such concordance tables could help to see the linkage between these two types of tests: high school graduation tests and the college admission tests.
4. Due to the limited number of administrations of PARCC tests, the matched sample sizes between the PARCC and SAT/ACT test scores were relatively small for the analyses carried out. Caution should be exercised when generalizing the findings from the current study as discrepancies in the test score distributions for the matched Grade 12 students used in the analyses and for all students in the data received were not negligible.

Data Cleaning and Preparation

Based on the four datasets received, PARCC, SAT, ACT, and PSAT, data cleaning has been conducted to prepare for data analyses. Summary tables are provided below to provide an overview of the tests and the issues in data cleaning and preparation. The sub-content areas for different subjects covered in the four tests are summarized in Table 1. PARCC tests include Algebra I (ALG01) and Algebra II (ALG02), and English/ Languages Arts (ELA10). For the other three college admission tests, the subsections differ. In general, PARCC Algebra I and II are assumed to be related to SAT, ACT, and PSAT math while PARCC ELA10 is assumed to be related to SAT reading and Writing, ACT Reading and English, and PSAT Verbal and Writing.

Table 1
Subjects in Each Test

Test	Subjects
PARCC	ALG01, ALG02, ELA10
SAT	Math, Reading, Writing
ACT	Math, Reading, English, Science
PSAT	Math, Verbal, Writing

The numbers of records in the data files are summarized in Table 2. Most students are first-time takers on PARCC, SAT, and ACT, while 50% of the students have multiple records on PSAT (259,883 out of 515,109).

Table 2
The Number of Records in the Four Datasets

	PARCC	SAT	ACT	PSAT
Number of records	158077	301349	73119	842414
Total number of students (unique)	138232	296753	72755	515109
Number of students with multiple records	19775	4585	364	259883

Students with multiple records were checked to investigate the nature of the repetition. Most of the multiple records were valid for PARCC and PSAT indicating attempts in different test administrations. Most often, students with two records on PARCC took ELA10 and ALG01/ALG02. However, many students with multiple records on SAT/ACT were not really retakers. Table 3 shows such an example. This student has two records with exactly the same scores in 2010 and 2011, but in 2011 many other variables such as grade, gender, race, and special education were missing. It is also observed that some records are repetitions except differences in the academic year and the grade. Table 4 shows an example of a student with multiple records on SAT who is a real retaker. The scores are different and there are no missing values for other variables.

Table 3
An Example of Two Possible Duplicated Records

No.	Year	SASID	Grade	Gender	Race	Reading Score	Math Score	Writing Score	Combined Score
78732	2010	9380449262	12	F	WH	520	500	440	1460
114728	2011	9380449262	*NA*	*NA*	*NA*	520	500	440	1460

Table 4
An Example of Actual Retakers

No.	Year	SASID	Grade	Gender	Race	Reading Score	Math Score	Writing Score	Combined Score
240841	2014	9363963321	12	M	MU	440	530	340	1310
240842	2014	9363963321	12	M	MU	490	530	380	1400

As the study is to explore the relationship between the PARCC test scores and the college admission test scores, the following 20 samples were matched with respect to different content areas. Matched sample sizes are reported in Table 5 by grade for each matched sample. The matched sample sizes are the same for both first-time takers and retakers. It is noted that the sample sizes for samples 3, 4, 6, 11, 13, 14, 16 to 20 in the shaded area are not sufficient to conduct the proposed analyses. For the matched samples with sufficient sample sizes, the numbers of retakers were checked and reported in parentheses if there were any (see Table 5). As some matched samples such as sample 5 and 15 contain a large proportion of retakers, correlation analyses were conducted between SAT/ACT and PARCC/PSAT for both the first attempts and the highest scores respectively.

As the majority of the matched samples were from Grade 12, all the proposed analyses were conducted using the matched samples for Grade 12 only. The descriptive statistics for Grade 12 students' PARCC test scores and all the cases in the data files received were compared to check whether Grade 12 students in the matched samples were representative.

The descriptive statistics for all the data and Grade 12 students on PARCC tests are summarized in Table 6. It is noted that the means and standard deviations for Grade 12 students are consistently lower than those for the whole data. This indicates that the Grade 12 students are not completely representative of the population. This is consistent with the expectations that students who took high school graduation tests (in this case it is the PARCC tests) at Grade 12 are usually relatively lower performing students. Thus it is highlighted that **caution should be exercised in generalizing the findings** from this present study based on Grade 12 data to all Maryland students taking PARCC tests.

Table 5

Sample Sizes for Twenty Matched Samples

No.	College Admission Tests	PARCC and PSAT Tests	Grade 9	Grade 10	Grade 11	Grade 12	Total
1	SAT Math	PARCC ALG01	1	1	6	58	66
2	SAT Math	PARCC ALG02	0	11	106	1454 (2)	1571 (2)
3	SAT Math	PARCC ALG01, PARCC ALG02	0	0	0	7	7
4	SAT Math	PARCC ALG01, PSAT Math	0	1	2	35	38
5	SAT Math	PARCC ALG02, PSAT Math	0	7	95 (40)	1253 (416)	1355 (456)
6	SAT Math	PARCC ALG01, PARCC ALG02, PSAT Math	0	0	0	5	5
7	SAT Reading	PARCC ELA10	1	7	10	76	94
8	SAT Reading	PARCC ELA10, PSAT Verbal, PSAT Writing	1	5	6	46	58
9	SAT Writing	PARCC ELA10	1	7	10	76 (1)	94 (1)
10	SAT Writing	PARCC ELA10, PSAT Verbal, PSAT Writing	1	5 (1)	6 (3)	46 (9)	58 (13)
11	ACT Math	PARCC ALG01		0	0	6	6
12	ACT Math	PARCC ALG02		1	8	314 (1)	323 (1)
13	ACT Math	PARCC ALG01, PARCC ALG02		0	0	1	1
14	ACT Math	PARCC ALG01, PSAT Math		0	0	4	4
15	ACT Math	PARCC ALG02, PSAT Math		1	7 (2)	277 (108)	285 (110)
16	ACT Math	PARCC ALG01, PARCC ALG02, PSAT Math		0	0	1	1
17	ACT Reading	PARCC ELA10		1	0	9	10
18	ACT Reading	PARCC ELA10, PSAT Verbal, PSAT Writing		1	0	8	9
19	ACT English	PARCC ELA10		1	0	9	10
20	ACT English	PARCC ELA10, PSAT Verbal, PSAT Writing		1	0	8	9

Table 6

Descriptive Statistics on PARCC Tests for Student from All Grades and Grade 12 Students

Subject	Mean		SD		Min.		Max.	
	All	G12	All	G12	All	G12	All	G12
ALG01	734.29	714.67	32.80	25.62	650	650	850	817
ALG02	718.32	692.59	36.04	26.10	650	650	850	794
ELA10	737.79	695.15	44.95	33.40	650	650	850	807

Data Analysis and Results

Correlational Analyses between PARCC/PSAT and SAT/ACT

Correlational analyses were conducted to evaluate the relationships between PARCC/PSAT and SAT/ACT using the matched samples. As samples 5 and 15 contain a large proportion of retakers, pairwise correlations were examined for both the first attempts and the highest scores respectively. Table 7 summarizes the correlation coefficients with the correlations using the highest scores reported in the parenthesis. In general, there are moderate relationships between PARCC tests and the college admission tests, with significant correlations ranging from .52 to .75 at a significance level of 0.001. Overall, the association between the PARCC tests and the college admission tests are similar for the first attempts and the highest scores. The largest difference is the correlation between the SAT Writing and the PSAT Verbal for sample 10, which increases from .52 to .61. Note that in this case, the sample size is relatively small. The sample size for sample 10 is only 46, and 9 of them are retakers. It is likely that using the highest scores would have a larger impact on this kind of sample; compared to other samples with a larger sample size and a smaller number of retakers such as sample 9. As the majority of the correlations were very similar, the subsequent analyses were conducted using first attempts for Grade 12 students only.

Table 7
Correlations between College Admission Tests and PARCC/PSAT Tests for First Attempts (and Highest Scores)

No.	College Admission Tests	PARCC/PSAT Tests					
		PARCC ALG01	PARCC ALG02	PARCC ELA10	PSAT Math	PSAT Verbal	PSAT Writing
1	SAT Math	0.63 (0.63)					
2	SAT Math		0.54 (0.54)				
5	SAT Math		0.54 (0.54)		0.65 (0.67)		
7	SAT Reading			0.60 (0.60)			
8	SAT Reading			0.62 (0.62)		0.64 (0.64)	0.52 (0.52)
9	SAT Writing			0.74 (0.74)			
10	SAT Writing			0.75 (0.75)		0.52 (0.61)	0.61 (0.66)
12	ACT Math		0.55 (0.55)				
15	ACT Math		0.55 (0.55)		0.63 (0.60)		

Note. All correlations in the table are significant at 0.001 level.

In addition, Figure 1 displays two example scatterplots showing the relationships between the SAT subtests and the PARCC tests. Both plots show an approximately linear pattern. Such plots are available for other pairwise relationships in the correlational analyses and the regression analyses. Therefore, the results from both the correlational and regression analyses conducted in the next section are warranted.

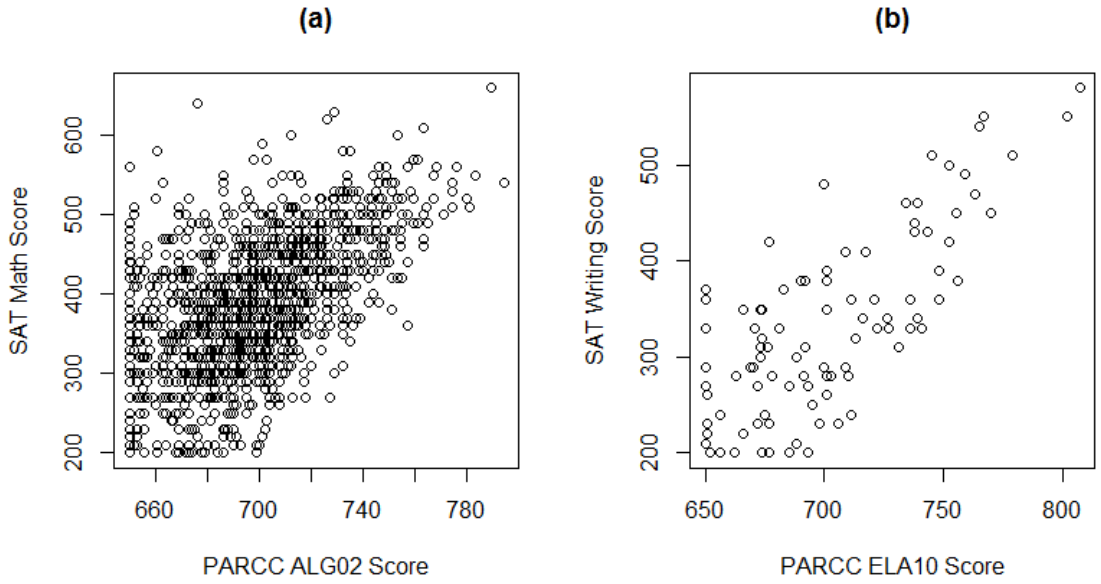

Figure 1. Scatterplots for (a) SAT Math scores vs. PARCC ALG02 scores; (b) SAT Writing scores vs. PARCC ELA10 scores.

Regression Analyses using Test Scores on PARCC/PSAT to Predict SAT/ACT

Regression analysis results are summarized in Table 8 and Table 9 for samples 1, 2, 5, 7 to 10, 12, and 15 with sufficient sample sizes. Unstandardized regression coefficients and standardized coefficients are reported in Table 8 and Table 9, respectively. Again, the regression analyses were conducted using the matched samples using Grade 12 students' first attempt's test scores. It is noted that all coefficients of PARCC tests are statistically significant in predicting SAT/ACT test scores at a significance level of 0.05. For example, the unstandardized coefficient of the PARCC ALG01 is 1.99 in the regression analysis for matched sample 1, indicating that one unit increase in the PARCC ALG01 scale score will lead to 1.99 units increase in the SAT Math scale score after controlling for other variables' effects. The adjusted R^2 for each regression is also reported in the tables. As one can see, the adjusted R^2 ranges from .29 to .59, meaning that the predictors, PARCC (and PSAT) explain 29% to 59% of the total variance in the outcome variables, SAT or ACT subtest scores.

Only two coefficients are not statistically significant: PSAT Writing test in predicting the SAT Reading scores and the PSAT Verbal test in predicting the SAT Writing scores. The potential multi-collinearity issues among predictors were examined when more than one predictor was included (samples 5, 8, 10, and 15). There is no serious multi-collinearity issue observed, thus all predictors were kept in the regression equations.

Table 8
Unstandardized Regression Coefficient Estimates

No.	Outcome	Predictors						R^2_{adj}
		PARCC ALG01	PARCC ALG02	PARCC ELA10	PSAT Math	PSAT Verbal	PSAT Writing	
1	SAT Math	1.99***						0.39
2	SAT Math		1.64***					0.29
5	SAT Math		0.94***		5.81***			0.50
7	SAT Reading			1.70***				0.35
8	SAT Reading			1.03*		5.73**	1.42	0.48
9	SAT Writing			1.92***				0.55
10	SAT Writing			1.38***		0.55	3.09*	0.59
12	ACT Math		0.06***					0.30
15	ACT Math		0.04***		0.20***			0.48

Note. *p<0.05, **p<0.01, ***p<0.001.

Table 9
Standardized Regression Coefficient Estimates

No.	Outcome	Predictors						R^2_{adj}
		PARCC ALG01	PARCC ALG02	PARCC ELA10	PSAT Math	PSAT Verbal	PSAT Writing	
1	SAT Math	0.63***						0.39
2	SAT Math		0.54***					0.29
5	SAT Math		0.31***		0.51***			0.50
7	SAT Reading			0.60***				0.35
8	SAT Reading			0.35*		0.38**	0.10	0.48
9	SAT Writing			0.74***				0.55
10	SAT Writing			0.57***		0.04	0.27*	0.59
12	ACT Math		0.55***					0.30
15	ACT Math		0.34***		0.48***			0.48

Note. *p<0.05, **p<0.01, ***p<0.001.

The standardized regression coefficient estimates are presented in Table 9. These standardized regression coefficients provide us with another perspective about the relationship between the PARCC tests and the SAT/ACT test performances. For instance, the standardized coefficient of the PARCC ALG01 is 0.63 in the regression analysis for matched sample 1, indicating that one standard deviation increase in the PARCC ALG01 scale score will lead to 0.63 standard deviations increase in the SAT Math scale score.

One advantage of using standardized regression coefficients is to provide a common scale to compare the prediction power of predictors in the same regression equation. For example, PSAT Math has more prediction power of SAT Math compared with PARCC ALG02 based on the sample 5 results; PARCC ELA10 and PSAT verbal have similar prediction power of SAT Reading based on sample 8 results; PARCC ELA10 has more prediction power of SAT Writing than PSAT Verbal and Writing as shown in sample 10.

Concordance Relationships between Test Scores on PARCC and SAT/ACT

To demonstrate the linkage of scores on different tests, an equipercentile linking procedure was carried out for pairwise matched samples between PARCC ALG01 and SAT Math, PARCC ALG02 and SAT Math, PARCC ELA10 and SAT Reading, PARCC ELA10 and SAT Writing, and PARCC ALG02 and ACT Math. The common-group design was used in linking based on the 12th graders' first attempt scores on the tests. Due to the extremely small sample sizes for the matched groups of students taking both tests as shown in Table 5, such concordance relationship could not be established for PARCC ELA10 and ACT Reading, PARCC ELA10 and ACT English, and PARCC ALG01 and ACT Math.

Equipercentile linking based on the matched samples was carried out using the software program, Linking with Equivalent Group or the Single Group Design, abbreviated as LEGS (Kolen & Brennan, 2004). The reported scale scores were used to link the pairwise tests listed above. After specifying the format of the data input, subgroup information, input data file names, smoothing values, the score range for the old test form and the truncation choice, the program conducts equipercentile linking and outputs the results in the window. In Appendix A, a screenshot captures the input window for linking the PARCC ALG02 and SAT Math tests. Two smoothing values were compared in post-linking: 0.3 and 1. The choice of using smoothing values is supported by the results from simulation studies that the smoothed results outperform non-smoothed method in reducing linking errors when the population test scores are in fact smooth (Cui & Kolen, 2009; Hanson et al., 1994). The results with a smoothing value of 1 are presented in this report due to the fact that after rounding there was little difference between the results based on the two smoothing values. As some scale scores were not present in the matched samples, extrapolation had to be done. A scatterplot was generated to examine the relationship between each pair of tests linked. Based on the total variance explained and visual inspections of the scatterplots of scores between two linked tests, a prediction equation was developed using Excel's best fitting line function. Using the prediction equation, values not presented in the matched samples were extrapolated. The extrapolation equations for all pairs of linked tests are presented in Table 10. One thing worth of note is that when doing extrapolation for PARCC ALG02 and ACT Math based on the prediction equation, linked ACT scores for PARCC ALG02 scores 784-799 are actually lower than the linked ACT score for a PARRC ALG02 score of 783 yielded from LEGS. As ACT Math scores should keep ascending as PARCC ALG02 scores

ascending which is a pattern based on the available data in the matched sample, linked ACT Math scores for PARCC ALG02 scores from 784 to 799 have been changed to be equal to the linked ACT score for a PARCC ALG02 score of 783. Table 11 is the concordance table between PARCC ALG01 and SAT Math. Concordance tables for the other four pairs of linked tests can be found in Appendix B.

Table 10

Prediction Equations for Linked Tests

Linked Tests	Prediction Equation
PARCC ALG01 and SAT Math	$y = 2.9927x - 1792.7$
PARCC ALG02 and SAT Math	$y = 2.67x - 1474.6$
PARCC ELA10 and SAT Reading	$y = 4*10^{-13}x^{5.246}$
PARCC ELA10 and SAT Writing	$y = 2.5913x - 1484.9$
PARCC ALG02 and ACT Math	$y = 3.79729*10^{-4}x^2 - 0.43115757x + 132.53$

Table 11

Concordance Table for PARCC ALG01 and SAT Math

Performance Level	PARCC ALG 01	SAT Math
1	650	200
1	651	200
1	652	200
1	653	200
1	654	200
1	655	200
1	656	200
1	657	200
1	658	200
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1	660	200
1	661	200
1	662	200
1	663	200
1	664	200
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1	683	220
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1	688	230
1	689	230
1	690	240
1	691	260
1	692	260
1	693	260
1	694	260
1	695	260
1	696	260
1	697	260
1	698	270
1	699	290

1	700	290
2	701	290
2	702	300
2	703	300
2	704	300
2	705	300
2	706	310
2	707	310
2	708	310
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5	838	720
5	839	720
5	840	720
5	841	720
5	842	730
5	843	730
5	844	730
5	845	740
5	846	740
5	847	740
5	848	750
5	849	750
5	850	750

Graphical Presentations of the Relationships between the Performance Levels on PARCC Tests and SAT/ACT Scores

In addition to the exploration of the relationships between the PARCC test scores and the college admission test scores, the performance levels on the PARCC tests were also examined in relation with the SAT and ACT test scores. Again given the adequacy of the matched sample sizes, five analyses were conducted to examine the relationships between the PARCC performance levels and the college admission test scores for Grade 12 students' first attempts. The sample sizes at each PARCC performance level in the matched samples are reported in Table 12. There are five performance levels on the PARCC tests with 5 indicating the highest performance level. Generally speaking, the sample size decreases as the performance level increases. This pattern indicates that the majority of students in the matched samples fall in low performance levels, while fewer students fall in high performance levels. Table 5 summarizes the number of students in each PARCC performance level for each of the matched samples with columns 2 to 6 corresponding to the matched samples 1, 2, 12, 7, and 9 5 respectively.

Table 12
Matched Sample Size at Each PARCC Performance Level

Performance Level	SAT Math & ALG01	SAT Math & ALG02	ACT Math & ALG02	SAT Reading & ELA10	SAT Writing & ELA10
1	15	859	185	37	37
2	21	388	86	17	17
3	16	155	30	13	13
4	5	52	13	8	8
5	1	0	0	1	1
Total	58	1454	314	76	76

The mean scale scores at each performance level are reported for the five matched samples in Table 13. There is a clear pattern that the mean scale score on SAT/ACT for all five samples monotonically increases as the performance level increases from 1 to 5. While Table 13 compares the mean score locations across performance levels, the probability density plots displayed in Figure 2 provide a more detailed picture about how the distributions of SAT/ACT test scores change across PARCC performance levels. As the sample size for performance level 5 was too small to fit a density plot, only the plots for performance levels 1 to 4 were generated. As displayed in Figure 2, the center of each score distribution of SAT/ACT gradually shifts to the right as the performance level increases from 1 to 4. The dispersion of the distributions also vary across samples and performance levels. Generally speaking, students with higher performance levels on the PARCC tests tend to have higher scores on SAT/ACT.

Table 13

Mean Scale Scores at Each PARCC Performance Level

Performance Level	SAT Math & ALG01	SAT Math & ALG02	ACT Math & ALG02	SAT Reading & ELA10	SAT Writing & ELA10
1	288.67	348.92	15.46	313.51	278.38
2	325.24	402.50	16.86	318.82	338.24
3	364.38	460.32	19.20	428.46	390.77
4	464.00	509.23	23.15	472.50	475.00
5	610.00	NA	NA	640.00	580.00

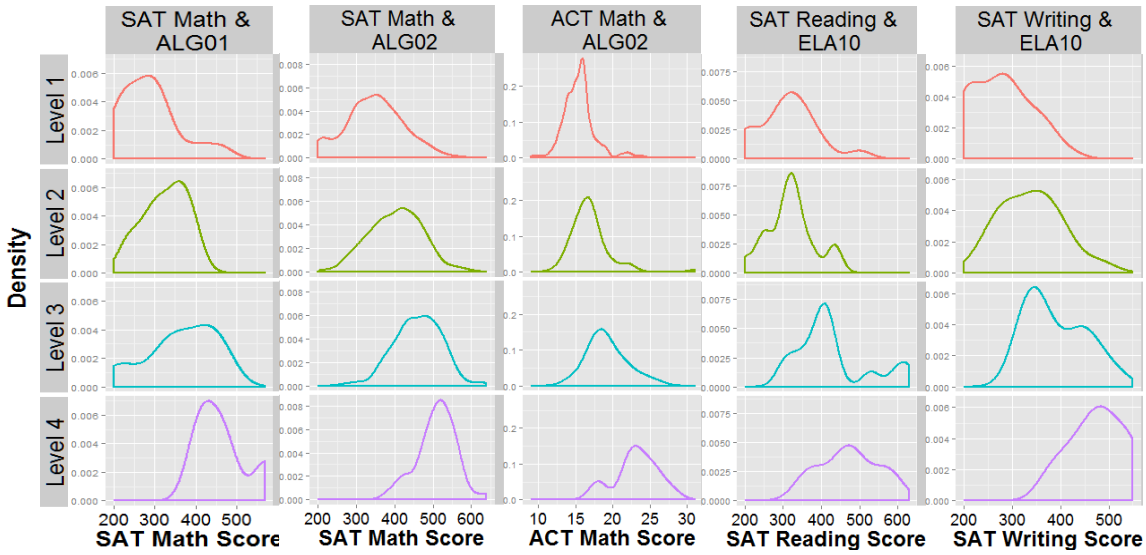


Figure 2. Probability density plots of SAT/ACT scores by PARCC performance level.

Summary

A series of statistical analyses have been conducted to explore the relationship between the PARCC tests (ALG01, ALG02, and ELA10) and the college admission tests (SAT, ACT, and PSAT). Data cleaning and exploratory analyses were carried out for each of the four tests to understand the first-time takers and retakers. Descriptive statistics on the PARCC test scores for all the data received and Grade 12 students were summarized and compared. Correlational and regression analyses were conducted to examine the relationship between the scores on the PARCC and the SAT/ACT tests using the Grade 12 first-time takers. Equipercentile linking based on the matched samples for different pairwise PARCC and SAT/ACT tests was used to establish the concordance table for scores on PARCC and SAT/ACT. Last, the relationships between SAT/ACT and the PARCC performance levels were investigated as well.

Although data were available for retakers with the highest scores, only first attempts were included in the analysis for the following reasons. First, the correlations

between PARCC and SAT/ACT test scores were similar for the first attempts and the highest scores. It was expected that the findings would be similar, had we used the highest scores instead. Second, there are some issues in the data with the highest scores. For example, both PARCC ALG02 and PSAT Math were included as predictors for regression analysis for matched sample 5. Some students have the highest scores on ALG02 in the first attempt but the highest score on the PSAT Math in the second attempt. It would be difficult to decide whether to use the highest score on each test, the attempt with the highest ALG02 score and that with the highest PSAT Math score, or the attempt with the highest combined score. Third, from a diagnostic point of view, using the first attempt data gives teachers the most information to develop remedial instruction to help students improve and prepare for the college admission tests.

Major Findings

1. This study is conducted based on **the matched samples** for PARCC/PSAT and SAT/ACT by subject. Only **Grade 12 students' first attempts** were used in the analyses, which usually account for more than 80% of the matched samples. Matched sample sizes for other grades were too small to conduct statistical analysis, which may result in reduced power to detect some significant relationship.
2. The results of various correlational analyses and regression analyses show that there is a moderate relationship between PARCC tests and college admissions exams (SAT and ACT) for both Math and English. PARCC tests are statistically significant predictors of SAT/ACT test scores. PARCC scores as predictors, along with PSAT scores, explain 29% to 59% of the total variance in the SAT/ACT outcomes. The PARCC tests are moderately correlated with similar SAT/ACT sub-test scores.
3. Graphical representations show that Grade 12 students with higher performance levels on PARCC tend to score higher on SAT/ACT. Concordance tables linking the PARCC test scores to the SAT or ACT test scores in the same content area are provided. These tables show the linkage between student performance on the PARCC tests and the college admission tests, SAT and ACT. Though the PARCC tests and the college admission tests, SAT and ACT do not measure exactly the same content in a similar subject area, such concordance tables could help to show the linkage between these two types of tests: high school graduation tests and the college admission tests.

Limitations

Due to the limited number of administrations of the PARCC tests, the matched sample sizes between the PARCC and SAT/ACT test scores were relatively small for the analyses carried out. Caution should be exercised when generalizing the findings from the current study based on the matched Grade 12 samples to all Maryland students. This is due to the un-negligible discrepancies in the test score distributions for the matched Grade 12 students used in the analyses and for all students in the data received.

References

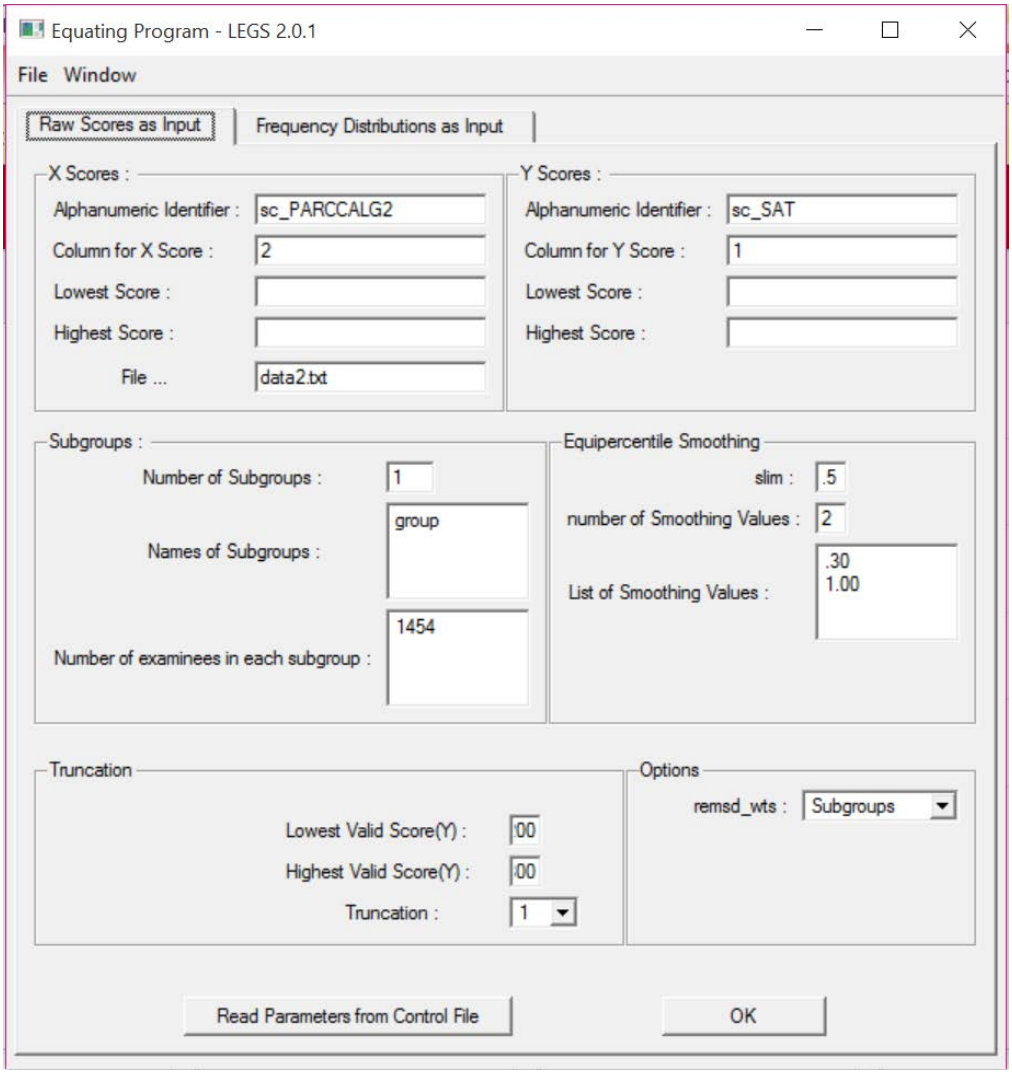
Cui, Z., & Kolen, M. J. (2009). Evaluation of Two New Smoothing Methods in Equating: The Cubic B- Spline Presmoothing Method and the Direct Presmoothing Method. *Journal of Educational Measurement, 46*(2), 135-158.

Hanson, B. A. (1994). A Comparison of Presmoothing and Postsmoothing Methods in Equipercentile Equating. ACT Research Report Series 94-4.

Kolen, M. J., & Brennan, R. L. (2004). *Test equating, scaling, and linking* (pp. 201-205). New York: Springer.

Appendix A

LEGS example input window for linking PARCC AlG02 and SAT Math



MARYLAND STATE DEPARTMENT OF EDUCATION
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Relationship Between PARCC and College Admission Test Scores

Maryland State Board of Education
Assessment Update

February 23, 2016

Purpose

- To share with the State Board the results of a research study examining the relationship between PARCC test scores and college admission test scores.

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Background

- The State Board requested information on the relationship between PARCC test scores and college admission test, SAT and ACT scores.
  - The Maryland Assessment Research Center (MARC) conducted a research study examining those relationships.

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Methods

- This study was conducted based on matched samples for PARCC/PSAT and SAT and PARCC/PSAT and ACT, by subject.
- Grade 12 students' first attempts at college admission tests were used in the analyses.
  - Accounted for more than 80% of the matched samples.

*At the time of the research study, there was only one administration of the PARCC tests; therefore, the matched sample sizes between the PARCC and SAT/ACT test scores were relatively small. See the full report for the limitations of the study.

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Matched Samples for Algebra

College Admission Tests	PARCC and PSAT Tests	Total
SAT	PARCC ALG01	58
SAT	PARCC ALG02	1454
SAT	PARCC ALG02, PSAT	1253
ACT	PARCC ALG02	314
ACT	PARCC ALG02, PSAT	277

Matched Samples for English

College Admission Tests	PARCC and PSAT Tests	Total
SAT Reading	PARCC ELA10	76
SAT Reading	PARCC ELA10 PSAT Verbal and Writing	46
SAT Writing	PARCC ELA10	76
SAT Writing	PARCC ELA10 PSAT Verbal and Writing	46

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Results

- Results indicate that there is a moderate relationship between PARCC test scores and the college admissions test scores.

- PARCC test scores are statistically significant predictors of SAT and ACT test scores.

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Findings for PARCC and SAT

PARCC Performance Level	PARCC Threshold Score		Correlated SAT Score		
Subject	***Alg II***	***ELA 10***	***Math***	***Reading***	***Writing***
Level 1	650	650	210	200	200
Level 2	700	700	400	340	340
Level 3	725	725	480	400	380
Level 4	750	750	530	490	460
Level 5	809	795	690	630	570

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Findings for PARCC and ACT

PARCC Performance Level	PARCC Threshold Score		Correlated ACT Score	
Subject	Alg II	ELA 10	Math	*Reading/ Writing
Level 1	650	650	12	
Level 2	700	700	17	
Level 3	725	725	20	
Level 4	750	750	23	
Level 5	809	795	32	

*Given the small sample sizes for the matched groups of students taking both tests, such concordance relationship could not be established.

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MD Proposed College and Career Readiness (CCRD) Minimum Scores

Content	PARCC	SAT	ACT
English Language Arts (ELA)	Score of 750 or greater on English 10 and English 11	Score of 500 or greater on Evidence-based Reading & Writing (EBRW) Section	Score of 21 or greater on Composite/ Average of English Test & Reading Test scores
MATH	Algebra II score of 750 or greater	Score of 500 or greater Mathematics Section	Score of 21 or greater on Mathematics Test

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Study Findings Summary

PARCC Performance Level	PARCC Threshold Score		Correlated SAT Score			Correlated ACT Score
Subject	Alg II	ELA 10	Math	Reading	Writing	Math
Level 1	650	650	210	200	200	12
Level 2	700	700	400	340	340	17
Level 3	725	725	480	400	380	20
Level 4	750	750	530	490	460	23
Level 5	809	795	690	630	570	32

MD minimum College and Career Determination scores: PARCC-750; SAT-500; ACT-21

Maryland State Department of Education
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Summary

- Despite limited information, the results support Maryland's proposed College and Career Ready determination scores.
  - Subsequent research studies will be conducted when additional administrations of PARCC data is available.