education analytics

LINKING STUDY BETWEEN SOUTH CAROLINA COLLEGE- AND CAREER-READY ASSESSMENT (SC READY) AND STAR ASSESSMENT, GRADES 3-8

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INTRODUCTION

In the fall of 2024, the South Carolina Education Oversight Committee (SC EOC), in collaboration with the South Carolina Department of Education (SCDE), partnered with Education Analytics (EA) to complete a level-linking study between the South Carolina College- and Career-Ready Assessment (SC READY) in Mathematics and English Language Arts (ELA) and Renaissance Learning's Star interim assessments in Mathematics and Reading, respectively. This report outlines the methodology used by EA and the outcomes of the linking study. The goal of this report is to statistically connect the SC READY and Star assessments' scale scores in grades 3-8 to facilitate further comparisons of proficiency status on these two assessments.

METHODS

Data

This linking study used data from the SC READY and Star Mathematics and ELA/Reading assessments administered in Spring 2024. Students were matched through their state IDs or district IDs. Only matched students who took the Star assessments within 30 days of SC READY[1] in spring 2023 were included in this study.

Post-Stratification Weighting

To increase the generalizability of the linking results based on the matched student sample to South Carolina's student population, EA applied post-stratification weights to the calculations. The variables used in the weighting process include gender, race/ethnicity, English learner (EL) status, poverty status, disability status, and whether a student met or exceeded standards on the same subject SC READY assessment. Through post-stratification weighting, the weighted study sample provides a closer match with South Carolina state population on these key demographic and academic performance variables than the original sample.

Raking was used to calculate the post-stratification weights. Raking involves an iterative proportional fitting procedure, which introduces each demographic and academic variable in a sequence so that it ensures the sample accurately represents the population of all variables under consideration. The variables are introduced one at a time, which allows for the incorporation of more variables in the weighting procedure. The raking procedure includes the following steps:

[1] According to communications with SCDE, the SC READY 2023-24 testing window was between April 26 and June 10, 2024.

1. Collect marginal distributions of each weighting variable from South Carolina's student population.
2. Calculate marginal distributions of each weighting variable from the matched sample.
3. Calibrate post-stratification weights using the raking procedure.
4. Trim the weight to be within the range of 0.3 and 3. This is done to minimize the impact of outlier cases which may carry extremely large or small weights.
5. Apply the weights to the matched sample before conducting the linking analyses.

Equipercentile Linking

The linking analyses between SC READY and Star assessments were conducted using the equipercentile linking method (Kolen & Brennan, 2004). The equipercentile linking function is determined by the cumulative distribution functions of the two assessments. In the linking process, the cumulative distribution function of scores on the spring Star assessment converted to the SC READY score scale is aligned to the cumulative distribution function of scores on SC READY. More specifically, this process utilizes percentile ranks, which indicates the percentage of scores in the frequency distribution that fall below a particular score. Equipercentile linking then establishes the relationship between the two sets of test scores by identifying corresponding percentile ranks of the test scores. Thus, we can establish scores on the spring Star assessment that are aligned to the three SC READY achievement level cut scores (i.e., cut score between Does Not Meet Expectations and Approaches Expectations, cut score between Approaches Expectations and Meets Expectations, and cut score between Meets Expectations and Standard Expectations) at grades 3-8. The linking function can be written as:

$$e_Y(x) = G^{-1}[F(x)]$$

where x represent a score on test X (e.g., SC READY ELA), $e_Y(x)$ is its corresponding score on test Y (e.g., Star Reading), $F(x)$ is the cumulative distribution function of a given score on SC READY, and G^{-1} is the inverse of the cumulative distribution function for Star, which indicates the Star scale score corresponding to a given percentile in the distribution.

Prior to the equipercentile linking, the polynomial log-linear pre-smoothing method is applied to reduce irregularities of the test score distributions. This method fits polynomial functions to the log of the sample density to smooth the distributions of the assessments (Holland & Thayer, 1987, 2000; Rosenbaum & Thayer, 1987).

Extending from Spring to Fall and Winter

To support the needs of SC EOC and SCDE to extend linked Star test scores from spring to the fall and winter terms, EA also estimated scores needed to meet expectations of the SC READY test in the fall and winter terms prior to the spring term in grades 3-8. This was done by calculating the mean Star scores in each term, subject, and grade in 2023-24 among all SC

students who took the Star test. The average change in scores between fall and spring, and winter and spring were subtracted from the spring cut scores determined by the linking analyses. These fall and winter cut scores are reported along with spring cut scores in the results section.

Classification Accuracy

Classification accuracy statistics are used to evaluate the degree to which the equivalent scores on the spring Star assessment to the SC READY achievement level cut scores can be used to accurately classify students' proficiency status. In this report, we summarize seven types of commonly used classification accuracy statistics (see Table 1) based on the cut score between Approaches Expectations (i.e., not proficient) and Meets Expectations (i.e., proficient).

To facilitate appropriate interpretations of the linking results, a bootstrap analysis was also conducted whereby each linking analysis was replicated 1000 times through iterative resampling of each study sample with replacement. The bootstrap standard errors help us understand the amount of error associated with the estimates. The bootstrap standard errors associated with the test cut scores are reported in Tables 10-11.

Table 1. Description of Classification Accuracy Summary Statistics

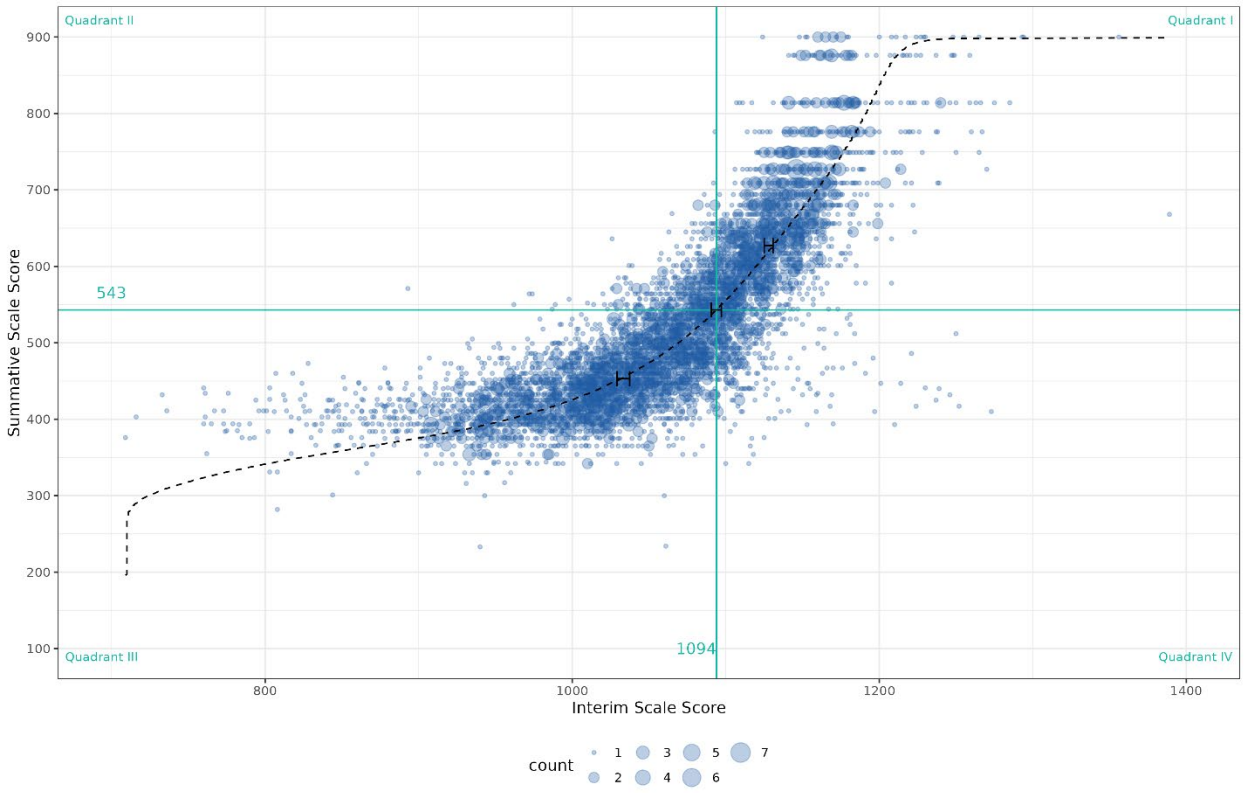
Statistic	Description
Overall Classification Accuracy	Proportion of the study sample with correct proficiency classifications on SC READY based on Star cut scores. Calculated as $(TP+TN)/\text{Total Sample Size}$
False Positive (FP) Rate	Proportion of proficient students based on Star cut scores among those observed as not proficient on the SC READY test. Calculated as $FP/(FP+TN)$
False Negative (FN) Rate	Proportion of students who were not proficient based on Star cut scores among those observed as proficient on the SC READY test. Calculated as $FN/(FN+TP)$
Sensitivity	Proportion of proficient students based on Star cut scores among those observed as proficient on the SC READY test. Calculated as $TP/(TP+FN)$
Specificity	Proportion of students who were not proficient based on Star cut scores among those observed as not proficient on the SC READY test. Calculated as $TN/(TN+FP)$
Precision	Proportion of observed proficient students on the SC READY test among those classified as proficient based on Star cut scores. Calculated as $TP/(TP+FP)$
Area Under the Curve (AUC)	An overall indication of the diagnostic accuracy of a Receiver Operating Characteristic (ROC) curve. AUC tells us how well the Star cut score separates the study sample as proficient and not proficient in accordance with the SC READY ELA test cut score. An AUC above 0.80 is considered "convincing evidence" of classification accuracy.

Note: TP = true positive; TN = true negative; FP = false positive; FN = false negative.

Figure 1 is a scatterplot of the SC READY and Star Mathematics scores from grade 6 in Spring 2024. The best-fitting curve (i.e., the black dashed line) shows the Star Mathematics scores that correspond to the SC READY Mathematics scores through the linking estimation. For example, the SC READY Mathematics score of 543 is the cut score for "Meets Expectations" at grade 6. This score corresponds to the Star Mathematics unified score of 1094 with a standard error of 1.66 in the linking results. The narrow black bands plotted around the dashed curve shows the 95% confidence interval. The small standard errors provide evidence of the accuracy of the linking model. However, the SC READY Mathematics score of 543 and the Star Mathematics score of 1094 should not be used interchangeably. As shown in Figure 1, not all students who scored 1094 and above on the Star Mathematics test also scored 543 or higher on the SC READY Mathematics test in Spring 2024. Specifically, students in Quadrant IV

scored lower than 543. Similarly, students who met or exceeded expectations (i.e., scored 543 or above) on the SC READY Mathematics test, had a wide range of scores on the Star Mathematics test, some of which were below 1094 (i.e., students in Quadrant II). We recommend users examine the scatterplot of observed test scores and bootstrap standard errors to gain a more complete understanding of the linking results and associated limitations.

Figure 1. Scatterplot of the SC READY and Star Mathematics, Grade 6, Spring 2024



RESULTS

Study Sample

The linking study sample includes students who took both the SC READY and Star Mathematics and ELA/Reading assessments within 30 days in Spring 2024 from 9 school districts in South Carolina. Tables 2 and 3 summarize the sample characteristics, including student demographic subgroups (i.e., gender, race/ethnicity, poverty, EL, and disability status) and percent of students who met or exceeded standards on the SC READY Mathematics and ELA assessments at each grade in the original sample before post-stratification weighting.

Table 2. Unweighted Linking Study Sample Characteristics: Mathematics

Subgroup	Percent of Students by Grade					
	3	4	5	6	7	8
Female	49.3	49.3	49.5	50.0	49.8	49.5
Male	50.7	50.7	50.5	50.0	50.2	50.5
Black	35.3	35.2	35.5	40.4	39.3	39.6
Hispanic	11.7	10.9	11.5	10.8	11.2	10.9
White	41.5	42.5	41.8	38.5	39.0	39.8
Other	11.4	11.3	11.2	10.3	10.5	9.7
Pupil in Poverty	59.7	58.4	59.1	60.3	59.2	58.1
English Learner	11.5	7.6	7.5	7.4	7.4	7.3
Student with Disabilities	12.7	13.8	13.1	12.3	12.8	12.3
SC READY: Meets Expectations or Exceeds Expectations	56.3	51.4	47.0	37.9	34.9	34.6
SC READY: Does Not Meet Expectations or Approaches Expectations	43.7	48.6	53.0	62.1	65.1	65.4

Table 3. Unweighted Linking Study Sample Characteristics: ELA

Subgroup	Percent of Students by Grade					
	3	4	5	6	7	8
Female	49.3	49.4	49.5	50.1	50.0	49.7
Male	50.7	50.6	50.5	49.9	50.0	50.3
Black	35.0	34.9	35.6	40.3	39.6	39.6
Hispanic	11.6	11.0	11.5	10.7	11.1	11.1
White	42.2	42.7	41.7	38.7	38.9	39.8
Other	11.2	11.4	11.3	10.3	10.4	9.6
Pupil in Poverty	59.2	58.2	58.7	60.0	59.2	58.0
English Learner	11.3	7.7	7.5	7.3	7.3	7.4
Student with Disabilities	12.8	13.9	13.0	12.3	12.7	12.0
SC READY: Meets Expectations or Exceeds Expectations	55.8	59.4	59.2	54.7	52.3	55.6
SC READY: Does Not Meet Expectations or Approaches Expectations	44.2	40.6	40.8	45.3	47.7	44.4

Distributions of the weighting variables in the South Carolina student population are listed in Table 4. After adjusting for post-stratification weights, the sample characteristics were recalculated. They are shown in Tables 5 and 6 at each grade level for mathematics and ELA, respectively. After weighting, the sample distributions are almost identical to the population distributions.

Table 4. South Carolina Student Population Characteristics

Subgroup	Percent of Students by Grade					
	3	4	5	6	7	8
Female	49.5	48.8	49.0	49.1	48.9	49.2
Male	50.5	51.2	51.0	50.9	51.1	50.8
Black	29.8	29.8	30.2	31.0	31.0	31.4
Hispanic	14.1	13.5	13.5	13.7	13.8	14.0
White	47.0	47.9	47.6	47.0	47.1	46.8
Others	9.0	8.8	8.8	8.3	8.1	7.8
Pupil in Poverty	63.4	62.6	63.0	62.4	61.8	61.5
English Learner	13.0	9.8	9.6	9.8	9.9	10.4
Student with Disabilities	16.7	16.4	15.5	14.0	13.9	13.5
SC READY Math: Meets Expectations or Exceeds Expectations	54.6	51.0	45.7	38.4	33.7	30.3
SC READY Math: Does Not Meet Expectations or Approaches Expectations	45.4	49.0	54.3	61.6	66.3	69.7
SC READY ELA: Meets Expectations or Exceeds Expectations	53.8	57.2	55.6	53.7	50.3	50.3
SC READY ELA: Does Not Meet Expectations or Approaches Expectations	46.2	42.8	44.4	46.3	49.7	49.7

Sources: https://ed.sc.gov/data/test-scores/state-assessments/sc-ready/2024/state-scores-by-grade-level-and-demographic/?districtCode=9999&schoolCode=1001

Note: Information in this table is based on students who took the 2024 SC READY Mathematics and ELA statewide tests. In the few cases where students' race/ethnicity and poverty status differ by 0.1%, numbers shown are the average of percentages from mathematics and ELA.

Table 5. Weighted Linking Study Sample Characteristics: Mathematics

Subgroup	Percent of Students by Grade					
	3	4	5	6	7	8
Female	49.5	48.8	49.0	49.1	48.9	49.2
Male	50.5	51.2	51.0	50.9	51.1	50.8
Black	29.8	29.8	30.2	31.0	31.0	31.4
Hispanic	14.2	13.5	13.5	13.7	13.8	14.0
White	47.0	47.9	47.6	47.0	47.1	46.8
Other	9.0	8.8	8.8	8.3	8.1	7.8
Pupil in Poverty	63.4	62.7	63.0	62.4	61.8	61.5
English Learner	13.0	9.8	9.6	9.8	9.9	10.4
Student with Disabilities	16.7	16.4	15.5	14.0	13.9	13.5
SC READY: Meets Expectations or Exceeds Expectations	54.6	51.0	45.7	38.4	33.7	30.3
SC READY: Does Not Meet Expectations or Approaches Expectations	45.4	49.0	54.3	61.6	66.3	69.7

Table 6. Weighted Linking Study Sample Characteristics: ELA

Subgroup	Percent of Students by Grade					
	3	4	5	6	7	8
Female	49.5	48.8	49.0	49.1	49.0	49.2
Male	50.5	51.2	51.0	50.9	51.0	50.8
Black	29.8	29.8	30.2	31.0	31.0	31.4
Hispanic	14.2	13.5	13.5	13.7	13.8	14.0
White	47.0	47.9	47.6	47.0	47.1	46.8
Other	9.0	8.8	8.8	8.4	8.1	7.8
Pupil in Poverty	63.4	62.7	63.0	62.4	61.7	61.5
English Learner	13.0	9.8	9.6	9.8	9.9	10.4
Student with Disabilities	16.7	16.4	15.5	14.0	13.9	13.5
SC READY: Meets Expectations or Exceeds Expectations	53.8	57.2	55.6	53.7	50.3	50.3
SC READY: Does Not Meet Expectations or Approaches Expectations	46.2	42.8	44.4	46.3	49.7	49.7

Descriptive Statistics of Test Scores

Table 7 presents summary statistics of the SC READY and Star Mathematics and ELA/Reading scores using the unweighted linking sample, which include the sample size, mean and standard deviation, and correlation (*r*) between the tests at each grade level. The correlations range from 0.72 (grade 8, Mathematics) to 0.82 (grades 3, ELA) which indicate moderate to strong associations between the two tests. This provides a good foundation for conducting a linking study between the SC Ready and Star Mathematics and ELA/Reading tests.

Table 7. Descriptive Statistics of SC READY and Star Mathematics and ELA/Reading Scores

		Grade					
		3	**4**	**5**	**6**	**7**	**8**
		Mathematics					
	N	5752	5550	5678	5351	5451	5329
	r	0.78	0.80	0.79	0.77	0.78	0.72
SC READY	Mean	472.3	496.4	543.1	524.4	548.0	586.0
	S.D.	129.3	120.2	115.7	116.9	110.6	107.9
	Min.	100	100	189	233	214	100
	Max.	825	850	875	900	925	950
Star	Mean	974.8	1019.1	1046.6	1059.8	1075.4	1094.2
	S.D.	68.8	74.0	76.0	80.4	85.5	84.0
	Min.	662	694	672	709	714	612
	Max.	1261	1298	1284	1389	1376	1379
		ELA					
	N	5584	5447	5612	5246	5449	5284
	r	0.82	0.81	0.81	0.79	0.79	0.78
SC READY	Mean	470.9	535.9	584.2	587.8	624.4	654.9
	S.D.	138.9	130.4	127.2	134.8	134.8	120.5
	Min.	100	206	251	236	241	284
	Max.	825	850	875	900	925	950
Star	Mean	976.0	1009.6	1039.2	1049.0	1067.3	1087.2
	S.D.	88.0	89.7	79.5	88.6	87.3	84.2
	Min.	615	615	615	615	615	615
	Max.	1187	1224	1258	1276	1316	1307

SC READY and Star Cut-Score Equivalents

Tables 8 and 9 present the linking results between SC READY and Star spring tests for mathematics and ELA, respectively. The top panel shows the ranges of SC READY scale scores at each proficiency level and each grade in 2023-24. The bottom panel shows the corresponding Star scores.

Table 8. SC READY and Star Cut Score Equivalents (Spring): Mathematics

Grade	SC READY			
	Does Not Meet Expectations	**Approaches Expectations**	**Meets Expectations**	**Exceeds Expectations**
3	100–359	360-437	438-542	543-825
4	100-400	401-480	481-562	563-850
5	100-447	448-534	535-621	622-875
6	100-452	453-542	543-626	627-900
7	100-487	488-576	577-648	649-925
8	100-526	527-614	615-682	683-950
	Renaissance Star			
	Does Not Meet Expectations	**Approaches Expectations**	**Meets Expectations**	**Exceeds Expectations**
3	600-931	932-971	972-1015	1016-1400
4	600-978	979-1027	1028-1064	1065-1400
5	600-998	999-1062	1063-1103	1104-1400
6	600-1031	1032-1093	1094-1130	1131-1400
7	600-1049	1050-1114	1115-1150	1151-1400
8	600-1070	1071-1133	1134-1170	1171-1400

Table 9. SC READY and Star Cut Score Equivalents (Spring): ELA

Grade	SC READY			
	Does Not Meet Expectations	**Approaches Expectations**	**Meets Expectations**	**Exceeds Expectations**
3	100-358	359-451	452-539	540-825
4	100-418	419-508	509-591	592-850
5	100-448	449-556	557-652	653-875
6	100-454	455-574	575-666	667-900
7	100-511	512-614	615-703	704-925
8	100-536	537-641	642-736	737-950
	Renaissance Star			
	Does Not Meet Expectations	**Approaches Expectations**	**Meets Expectations**	**Exceeds Expectations**
3	600-937	938-988	989-1027	1028-1400
4	600-961	962-1009	1010-1049	1050-1400
5	600-982	983-1036	1037-1079	1080-1400
6	600-990	991-1056	1057-1097	1098-1400
7	600-1022	1023-1076	1077-1114	1115-1400
8	600-1028	1029-1090	1091-1140	1141-1400

The bootstrap standard errors of each equivalent Star cut scores are listed in Tables 10 and 11 for Mathematics and ELA, respectively. They are relatively small across all linking studies conducted across grades 3-8, test subjects, and performance levels. This gives us evidence supporting the accuracy of the linking results. However, it is also important to keep in mind that linking is a statistical procedure to estimate the equivalence between two sets of test scores and, therefore, linking results contain estimation error.

Table 10. Equivalent Star Cut Score (Spring) Bootstrap Standard Errors: Mathematics

Grade	Renaissance Star Scores Reaching Performance Level...					
	Approaches Expectations		**Meets Expectations**		**Exceeds Expectations**	
	Cut Score	S.E.	Cut Score	S.E.	Cut Score	S.E.
3	932	1.90	972	1.39	1016	1.19
4	979	2.02	1028	1.40	1065	1.26
5	999	2.32	1063	1.50	1104	1.34
6	1032	2.10	1094	1.66	1131	1.49
7	1050	2.10	1115	1.69	1151	1.66
8	1071	1.88	1134	1.54	1171	1.67

Table 11. Equivalent Star Cut Score (Spring) Bootstrap Standard Errors: ELA

Grade	Renaissance Star Scores Reaching Performance Level...					
	Approaches Expectations		Meets Expectations		Exceeds Expectations	
	Cut Score	S.E.	Cut Score	S.E.	Cut Score	S.E.
3	938	2.44	989	1.68	1028	1.34
4	962	2.45	1010	1.68	1050	1.44
5	983	2.39	1037	1.54	1080	1.31
6	991	2.52	1057	1.60	1098	1.44
7	1023	2.08	1077	1.64	1115	1.54
8	1029	2.33	1091	1.68	1141	1.53

The section above summarizes the linking results from the spring term. Linked Star test scores were also extended from the spring to the fall and winter terms for the scores reaching performance level "Meets Expectations." These scores are summarized in Table 12. Note that these linked scores were calculated based on the mean Star scores within each term among all SC students who took the Star test. Therefore, they reflect expected score equivalents on average among these students and thereby should not be interpreted as accurate estimations for every individual student. The estimation errors around the fall and the winter scores are larger than those around the spring scores.

Table 12. Star Cut Score Equivalents

Grade	Mathematics			ELA		
	Fall	Winter	Spring	Fall	Winter	Spring
3	925	953	972	951	972	989
4	984	1009	1028	980	999	1010
5	1030	1049	1063	1012	1027	1037
6	1069	1083	1094	1040	1050	1057
7	1092	1107	1115	1059	1068	1077
8	1110	1122	1134	1072	1082	1091

Classification Accuracy

Table 13 summarizes results from the classification accuracy statistics described in Table 1. These are diagnostics used to evaluate the accuracy of using the Renaissance Star test scores to classify students as proficient (Meets Expectations and Exceeds Expectations) or not proficient (Does Not Meet Expectations and Approaches Expectations) on the SC READY Mathematics and ELA summative assessments. The overall classification accuracy statistics range from 0.84 to 0.87, and the AUC statistics are above 0.89 at all grade levels. These diagnostics provide convincing evidence of good classification accuracy for using the linked Star scores to estimate students' proficiency status on the SC READY assessments at grades 3-8.

Table 13. Classification Accuracy Results

Grade	Overall Classification Accuracy	False Positive Rate	False Negative Rate	Sensitivity	Specificity	Precision	AUC
Mathematics							
3	0.86	0.19	0.11	0.89	0.81	0.86	0.92
4	0.86	0.14	0.14	0.86	0.86	0.87	0.93
5	0.86	0.14	0.14	0.86	0.86	0.84	0.93
6	0.86	0.11	0.18	0.82	0.89	0.82	0.92
7	0.87	0.11	0.17	0.83	0.89	0.80	0.93
8	0.84	0.14	0.21	0.79	0.86	0.75	0.89
ELA							
3	0.85	0.12	0.17	0.83	0.88	0.90	0.93
4	0.86	0.17	0.12	0.88	0.83	0.88	0.93
5	0.86	0.18	0.12	0.88	0.82	0.88	0.93
6	0.86	0.14	0.14	0.86	0.86	0.88	0.93
7	0.86	0.15	0.14	0.86	0.85	0.86	0.93
8	0.84	0.17	0.15	0.85	0.83	0.86	0.91

CONCLUSIONS

It is important to note that equipercentile linking is a statistical procedure used to facilitate interpretation of scores on the SC READY Mathematics and ELA assessments and the Renaissance Star Mathematics and Reading assessments. Despite good classification accuracy results from this study, there are still important notes of caution to call out in interpreting and using the linked scores.

First, the two tests are constructed differently with regard to test content specifications, test design, and test purpose. For example, the Star Reading test measures students' reading strategies and skills in five domains – "Word Knowledge and Skills, Comprehension Strategies and Constructing Meaning, Analyzing Literary Text, Understanding Author's Craft, and Analyzing Argument and Evaluating Text" (Renaissance Learning, 2023, p.16). The SC READY ELA assessment is composed of two subtests – writing and reading, and measures student performance on Reading – Literary Text, Reading – Informational Text, Inquiry, and Writing (SCDE, 2023). The statistical adjustments in linking do not adjust for differences in content. Therefore, scores on the SC READY and Renaissance Star assessments should not be used interchangeably. The linked scores facilitate comparisons of proficiency status between two assessments, but do not imply equivalence.

Second, while there is a high level of confidence associated with the models, the linked scores are based on a 50% likelihood estimation. This means that not all students who reach a proficiency cut score on Star will necessarily reach the associated score on SC READY. For example, as we saw in Figure 1 above, while the SC READY 543 cut score for "Meets Expectations" in grade 6 corresponds to the Star Mathematics score of 1094 on average, there is a wide range of Star scores among students who reached a 543 on SC READY. The interpretation of the estimated 1094 Star Mathematics score is that 6th grade students with this Star score have a 50% probability of scoring 543 or higher (i.e., reaching "Meets Expectations") on the SC READY Mathematics test. The results are more accurate for students on average than as associated with individual students.

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