education analytics

LINKING STUDY BETWEEN SOUTH CAROLINA COLLEGE- AND CAREER-READY ASSESSMENT (SC READY) AND I-READY 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 Curriculum Associates' i-Ready 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 i-Ready 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 i-Ready Mathematics and ELA/Reading assessments administered in Spring 2024. Students were matched through their state IDs. Only matched students who took the i-Ready assessments within 30 days of SC READY[1] in Spring 2024 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 i-Ready 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 i-Ready 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 i-Ready 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., i-Ready 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 i-Ready, which indicates the i-Ready 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 i-Ready 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 i-Ready scores in each term, subject, and grade in 2023-24 among all SC

students who took the i-Ready 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 i-Ready 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

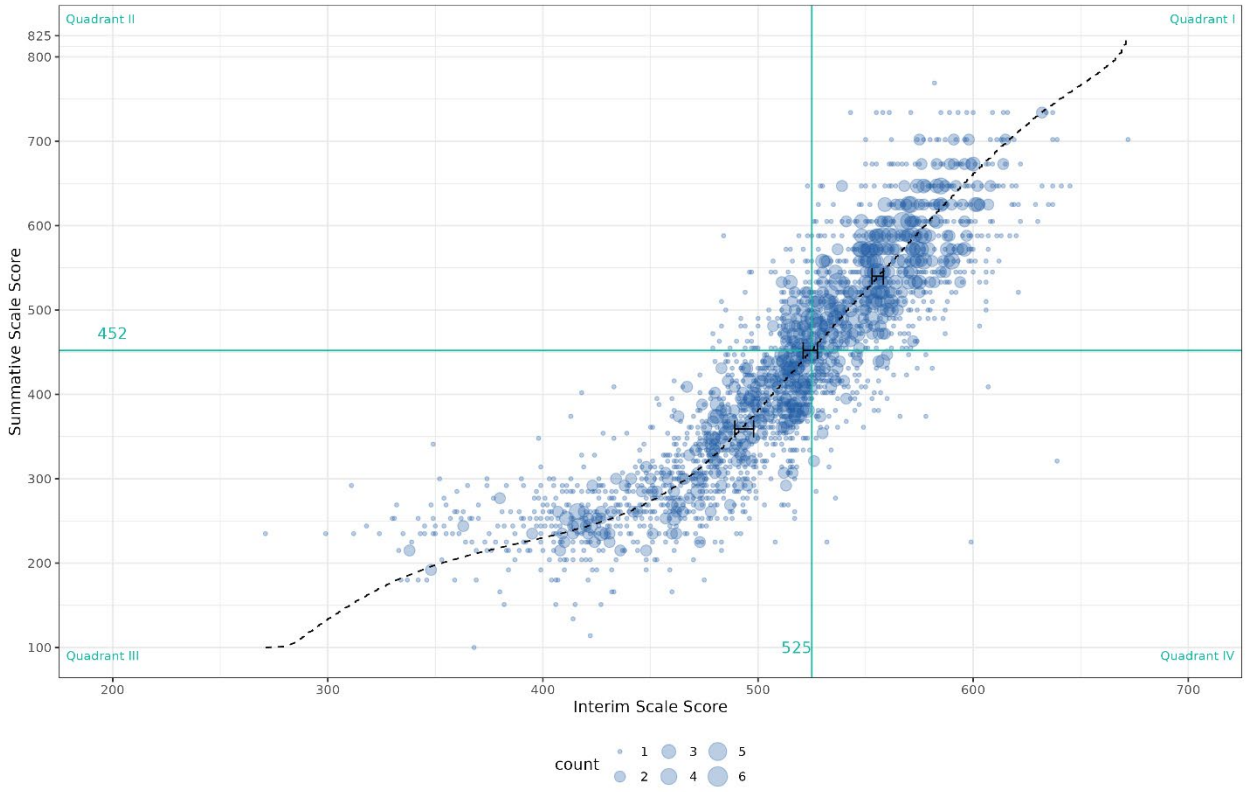
Statistic	Description
Overall Classification Accuracy	Proportion of the study sample with correct proficiency classifications on SC READY based on i-Ready cut scores. Calculated as $(TP+TN)/\text{Total Sample Size}$
False Positive (FP) Rate	Proportion of proficient students based on i-Ready cut scores 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 i-Ready cut scores among those observed as proficient on the SC READY test. Calculated as $FN/(FN+TP)$
Sensitivity	Proportion of proficient students based on i-Ready 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 i-Ready 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 i-Ready 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 i-Ready 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 ELA and i-Ready Reading scores from grade 3 in Spring 2024. The best-fitting curve (i.e., the black dashed line) shows the i-Ready Reading scores that correspond to the SC READY ELA scores through the linking estimation. For example, the SC READY ELA score of 452 is the cut score for "Meets Expectations" at grade 3. This score corresponds to the i-Ready Reading score of 525 with a standard error of 1.65 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 ELA score of 452 and the i-Ready Reading score of 525 should not be used interchangeably. As shown in Figure 1, not all students who scored 525 and above on the i-Ready Reading test also scored 452 or higher on the SC READY ELA test in Spring 2024. Specifically, students in Quadrant IV scored lower than 452. Similarly, students who met

or exceeded expectations (i.e., scored 452 or above) on the SC READY ELA test, had a wide range of scores on the i-Ready Reading test, some of which were below 525 (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 ELA and i-Ready Reading Scores, Grade 3, Spring 2024



RESULTS

Study Sample

The linking study sample includes students who took both the SC READY and i-Ready Mathematics and ELA/Reading assessments within 30 days in Spring 2024 from 23[2] 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)

[2] This is the number of districts using the i-Ready assessment that was available at the time of data sourcing.

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	49.0	50.4	49.8	48.5	49.4	48.8
Male	51.0	49.6	50.2	51.6	50.7	51.2
Black	30.3	30.1	31.0	34.9	32.1	34.4
Hispanic	11.6	10.5	11.6	11.2	10.4	11.1
White	51.8	53.1	51.0	48.1	51.9	50.0
Other	6.4	6.3	6.3	5.8	5.5	4.6
Pupil in Poverty	73.9	73.8	73.8	76.1	69.5	69.4
English Learner	12.2	8.7	8.8	8.8	9.4	9.8
Student with Disabilities	16.4	17.6	16.7	14.4	14.4	13.0
SC READY: Meets Expectations or Exceeds Expectations	48.1	47.6	37.9	31.7	29.9	25.8
SC READY: Does Not Meet Expectations or Approaches Expectations	51.9	52.4	62.2	68.3	70.1	74.2

Table 3. Unweighted Linking Study Sample Characteristics: ELA

Subgroup	Percent of Students by Grade					
	3	4	5	6	7	8
Female	48.7	50.2	49.7	48.1	49.2	48.4
Male	51.3	49.8	50.3	51.9	50.9	51.6
Black	31.8	29.9	31.2	34.5	32.5	34.8
Hispanic	11.9	10.3	11.8	11.3	10.4	11.1
White	50.7	53.9	51.0	48.5	52.4	50.1
Other	5.7	5.9	6.0	5.7	4.7	4.0
Pupil in Poverty	75.3	74.4	75.4	76.5	73.4	73.0
English Learner	11.3	8.1	8.7	9.0	9.0	10.0
Student with Disabilities	17.1	17.2	16.0	14.4	15.1	14.0
SC READY: Meets Expectations or Exceeds Expectations	45.3	51.0	46.3	45.1	42.0	43.1
SC READY: Does Not Meet Expectations or Approaches Expectations	54.7	49.0	53.7	54.9	58.0	56.9

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	48.2
Male	50.5	51.2	51.0	50.9	51.1	50.8
Black	29.9	29.9	30.2	31.0	31.1	31.5
Hispanic	14.1	13.5	13.4	13.7	13.8	13.9
White	47.1	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	62.6	63.0	62.4	61.7	61.4
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	29.9	30.2	31.0	31.1	31.6
Hispanic	14.2	13.5	13.5	13.7	13.8	13.8
White	47.0	47.9	47.6	47.0	47.2	47.0
Other	9.0	8.8	8.8	8.3	7.9	7.6
Pupil in Poverty	63.3	62.7	63.0	62.4	61.8	61.6
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	50.2	50.2
SC READY: Does Not Meet Expectations or Approaches Expectations	46.2	42.8	44.4	46.3	49.8	49.8

Descriptive Statistics of Test Scores

Table 7 presents summary statistics of the SC READY and i-Ready 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 0.75 (grade 8, Mathematics) to 0.87 (grade 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 i-Ready Mathematics and ELA/Reading tests.

Table 7. Descriptive Statistics of SC READY and i-Ready Mathematics and ELA/Reading Scores

		Grade					
		3	**4**	**5**	**6**	**7**	**8**
		Mathematics					
	N	2947	3011	3175	2932	2980	2955
	r	0.83	0.84	0.84	0.80	0.78	0.75
SC READY	Mean	445.8	483.5	518.3	506.0	532.9	560.4
	S.D.	118.0	114.1	105.3	102.5	99.2	103.8
	Min.	183	210	255	196	251	314
	Max.	825	850	875	900	925	950
i-Ready	Mean	443.1	462.1	473.0	479.6	489.0	497.6
	S.D.	29.7	31.9	34.6	38.2	42.7	45.8
	Min.	302	306	284	292	297	290
	Max.	543	555	592	613	624	633
		ELA					
	N	2674	2771	2979	2781	2485	2512
	r	0.87	0.85	0.84	0.82	0.80	0.81
SC READY	Mean	432.5	504.7	544.6	557.3	592.1	619.4
	S.D.	129.2	120.5	117.4	126.9	125.8	117.9
	Min.	100	206	270	286	310	326
	Max.	769	850	875	900	925	950
i-Ready	Mean	512.7	539.8	559.8	567.8	576.8	589.6
	S.D.	57.1	58.1	58.1	62.3	64.8	63.0
	Min.	271	280	302	315	242	314
	Max.	672	688	726	719	751	747

SC READY and i-Ready Cut-Score Equivalents

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

Table 8. SC READY and i-Ready 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
	Curriculum Associates i-Ready			
	Does Not Meet Expectations	**Approaches Expectations**	**Meets Expectations**	**Exceeds Expectations**
3	100-427	428-446	447-466	467-800
4	100-444	445-467	468-484	485-800
5	100-455	456-483	484-504	505-800
6	100-467	468-498	499-519	520-800
7	100-478	479-510	511-532	533-800
8	100-492	493-525	526-546	547-800

Table 9. SC READY and i-Ready 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
	Curriculum Associates i-Ready			
	Does Not Meet Expectations	Approaches Expectations	Meets Expectations	Exceeds Expectations
3	100-491	492-524	525-555	556-800
4	100-510	511-546	547-578	579-800
5	100-526	527-570	571-607	608-800
6	100-533	534-582	583-616	617-800
7	100-553	554-596	597-626	627-800
8	100-561	562-607	608-644	645-800

The bootstrap standard errors of each equivalent i-Ready 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 i-Ready Cut Score (Spring) Bootstrap Standard Errors: Mathematics

Grade	Curriculum Associates i-Ready Scores Reaching Performance Level...					
	Approaches Expectations		Meets Expectations		Exceeds Expectations	
	Cut Score	S.E.	Cut Score	S.E.	Cut Score	S.E.
3	428	1.08	447	0.78	467	0.68
4	445	1.10	468	0.83	485	0.79
5	456	1.20	484	0.89	505	0.87
6	468	1.23	499	1.06	520	1.16
7	479	1.24	511	1.11	533	1.28
8	493	1.35	526	1.36	547	1.52

Table 11. Equivalent i-Ready Cut Score (Spring) Bootstrap Standard Errors: ELA

Grade	Curriculum Associates i-Ready Scores Reaching Performance Level...					
	Approaches Expectations		Meets Expectations		Exceeds Expectations	
	Cut Score	S.E.	Cut Score	S.E.	Cut Score	S.E.
3	492	2.22	525	1.65	556	1.41
4	511	2.41	547	1.79	579	1.40
5	527	2.47	571	1.64	608	1.33
6	534	2.68	583	1.77	617	1.45
7	554	2.50	597	1.84	627	1.64
8	562	2.85	608	1.77	645	1.44

The section above summarizes the linking results from the spring term. Linked i-Ready 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 i-Ready scores within each term among all SC students who took the i-Ready 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. i-Ready Cut Score Equivalents

Grade	Mathematics			ELA		
	Fall	Winter	Spring	Fall	Winter	Spring
3	420	436	447	492	511	525
4	445	457	468	521	537	547
5	464	476	484	548	562	571
6	484	493	499	568	577	583
7	497	505	511	584	592	597
8	512	521	526	594	602	608

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 Curriculum Associates i-Ready 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 0.89, and the AUC statistics are above 0.90 at all grade levels. These diagnostics provide convincing evidence of good classification accuracy for using

the linked i-Ready 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	0.87	0.14	0.11	0.89	0.86	0.86	0.94
4	0.87	0.12	0.14	0.86	0.88	0.87	0.94
5	0.88	0.10	0.14	0.86	0.90	0.83	0.94
6	0.87	0.10	0.19	0.81	0.90	0.79	0.94
7	0.89	0.08	0.17	0.83	0.92	0.81	0.93
8	0.87	0.08	0.24	0.76	0.92	0.76	0.90
ELA							
3	0.88	0.11	0.14	0.86	0.89	0.87	0.95
4	0.86	0.14	0.13	0.87	0.86	0.86	0.93
5	0.87	0.14	0.12	0.88	0.86	0.84	0.94
6	0.85	0.15	0.16	0.84	0.85	0.83	0.93
7	0.86	0.14	0.15	0.85	0.86	0.82	0.93
8	0.84	0.16	0.15	0.85	0.84	0.80	0.92

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 Curriculum Associates i-Ready 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 i-Ready Diagnostic Reading test measures students' reading strategies and skills in the following domains – "High-Frequency Words, Phonics, Phonological Awareness, Reading Comprehension: Literature, Reading Comprehension: Informational Text, and Vocabulary" (Curriculum Associates, 2019, p.11). 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 Curriculum Associates i-Ready 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 i-Ready will necessarily reach the associated score on SC READY. For example, as we saw in Figure 1 above, while the SC READY 452 cut score for "Meets Expectations" in grade 3 corresponds to the i-Ready Reading score of 525 on average, there is a wide range of i-Ready scores among students who reached a 452 on SC READY. The interpretation of the estimated 525 i-Ready Reading score is that 3rd grade students with this i-Ready score have a 50% probability of scoring 452 or higher (i.e., reaching "Meets Expectations") on the SC READY ELA test. The results are more accurate for students on average than as associated with individual students.

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