Predicting Proficiency on the New York State Regents Examination in Algebra I Based on NWEA MAP Growth Scores

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NWEA Psychometrics and Analytics

Linking Study Updates

Date	Description
2024-10-18	Initial study was conducted for the New York State Regents Examination in Algebra I using the Spring 2024 data and the most recent MAP Growth norms.

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Executive Summary

Linking studies allow partners to use MAP® Growth™ Rasch Unit (RIT) scores throughout the year to predict their students' performance levels on state summative assessments. This is accomplished through statistical analyses that produce RIT cut scores that correspond to state summative performance levels. A "cut score" is the minimum score a student must get on a test to be placed at a certain performance level. The linking study for the New York State Regents Examination in Algebra I described in this report provides RIT cut scores for the fall, winter, and spring MAP Growth administrations that correspond to the state performance levels for the Regents Examination in Algebra I. Educators can use the RIT cut scores to identify students at risk of not meeting state proficiency standards and provide targeted instruction to improve academic outcomes.

The linking study is based on test scores from students who took both the MAP Growth Algebra I test and the Regents Examination in Algebra I in Spring 2024. In total, this study included 22,027 students from 312 schools within the New York City Department of Education.

Prior to initiating the linking analyses, NWEA confirmed that the content standards used to construct the MAP Growth Algebra I interim assessment were aligned with those of the Regents Examination in Algebra I, thus warranting a connection. Further investigation into the relationship between the MAP Growth Algebra I test and the Regents Examination in Algebra I involved calculating correlation coefficients to illustrate the association between the MAP Growth scores and the state summative scores. A high positive correlation (e.g., ≥ 0.70) shows that students who perform well on one assessment also tend to perform well on the other, and vice versa, with 1.00 being a perfect positive correlation. The correlation between the MAP Growth Algebra I test scores and the Regents Examination in Algebra I scores is 0.73, indicating that the MAP Growth Algebra I test is a good assessment for predicting students' performance on the Regents Examination in Algebra I.

The equipercentile linking method and the MAP Growth norms (He, 2022) were then used to produce the RIT cut scores that correspond to performance levels on the Regents Examination in Algebra I. While RIT cut scores were generated for every performance level on the Regents Examination in Algebra I, Table E.1 presents the Level 3 cut scores that indicate the minimum score a student must get to be considered proficient. Details regarding reported cut scores are provided in Section 2.4.

Table E.1. MAP Growth RIT Cut Scores for Proficiency on the Regents Examination in Algebra I

Regents Examination in Algebra I	
Term	**Level 3**
Spring	65
MAP Growth Algebra I Test	
Term	**RIT**
Fall	221
Winter	225
Spring	229

Educators can use these cut scores to determine whether students are on track for proficiency on the state assessment. For example, the Level 3 cut score on the Regents Examination in Algebra I is 65. A student with a MAP Growth Algebra I test score of 221 in the fall is likely to

meet proficiency on the Regents Examination in Algebra I in the spring, whereas a student with a RIT score lower than 221 in the fall is in jeopardy of meeting proficiency.

As further evidence that MAP Growth scores can be used to predict students' proficiency on the state test, NWEA calculated classification accuracy statistics that show how well the RIT scores correctly classified, or predicted, students as Level 3 or higher on the Regents Examination in Algebra I. A high statistic indicates high accuracy. Overall, the MAP Growth Algebra I test has a 0.81 classification accuracy rate (see Table 3.4), meaning it accurately predicted student proficiency on the Regents Examination in Algebra I for 81% of the sample. These results indicate that MAP Growth scores have a high accuracy rate of identifying student proficiency on the Regents Examination in Algebra I.

Please note that the purpose of this report is to explain NWEA's linking study methodology. It is not meant as the main reference for determining a student's likely performance on the state summative assessment. The cut scores in this report are based on the default instructional weeks most encountered for each term (i.e., Weeks 4, 20, and 32 for fall, winter, and spring, respectively), whereas instructional weeks often vary by district. The cut scores in this report may therefore differ from the results in the NWEA reporting system that reflect the specific instructional weeks set by partners. Partners should therefore reference their MAP Growth score reports instead.

1. Introduction

1.1. Purpose of the Study

NWEA® is committed to providing partners with useful tools to help make inferences about student learning from MAP® Growth™ test scores. One important use of MAP Growth results is to predict a student's performance on state summative assessments at different times throughout the year. This allows educators and parents to determine if a student is on track in their learning to meet state standards by the end of the year or, given a student's learning profile, is on track to obtain rigorous, realistic growth in their content knowledge and skills.

This report outlines findings from a linking study performed by NWEA aiming to statistically connect the Rasch Unit (RIT) scores obtained from the MAP Growth Algebra I test with the results of the New York State Regents Examination in Algebra I. Specifically, this report presents the following results:

1. Student demographics
2. Descriptive statistics of test scores
3. MAP Growth cut scores from fall, winter, and spring that correspond to the performance levels on the Regents Examination in Algebra I
4. Classification accuracy statistics to determine the degree to which MAP Growth accurately predicts student proficiency status on the Regents Examination in Algebra I
5. The probability of achieving proficiency on the Regents Examination in Algebra I based on MAP Growth RIT scores from fall, winter, and spring

1.2. Assessment Overview

The New York State Regents Examination in Algebra I is a part of the New York State Testing Program (NYSTP) aligned to the New York State Next Generation Mathematics Learning Standards. Based on their test scores, students are placed into one of five performance levels: Level 1, Level 2, Level 3, Level 4, and Level 5. The Level 3 cut score demarks the minimum level of achievement considered to be proficient for accountability purposes.

MAP Growth tests are adaptive interim assessments aligned to state-specific content standards and administered in the fall, winter, and spring. Scores are reported on the RIT vertical scale with a range of 100 to 350. To aid the interpretation of scores, NWEA conducts norming studies of student and school performance on MAP Growth. Growth norms provide expected score gains across test administrations (e.g., the relative evaluation of a student's growth from fall to spring), which are used to conduct the linking studies. The most recent norms study was conducted in 2020 (Thum & Kuhfeld, 2020) for the general mathematics and reading tests. The norms study for the MAP Growth course-specific tests was conducted and published in December 2022 (He, 2022).

2. Methods

2.1. Data Collection

This linking study is based on data from the Spring 2024 administration of the MAP Growth Algebra I test and the New York State Regents Examination in Algebra I. Each student's state testing record was matched to their MAP Growth score based on the student's state identifier. Only students who have scores on both the MAP Growth and the Regents Examination in Algebra I assessments in Spring 2024 were included in the study sample.

2.2. Post-Stratification Weighting

Post-stratification weights were applied to the calculations to ensure that the linking study sample represented the state's test-taking student population in terms of race, sex, and performance level. These variables were selected because they are known to be correlated with students' academic achievement and are often available in state summative assessment reports. The weighted sample will match the target population as closely as possible for the key demographics and performance characteristics defined by the state.

A raking procedure was used to calculate the post-stratification weights that either compensate for the underrepresentation of certain groups or attenuate the overrepresentation of certain groups. Raking uses iterative procedures to obtain weights that match sample marginal distributions to known population margins. The following steps were taken during this process:

1. Calculate marginal distributions of race, sex, and performance level for the sample and population.
2. Calculate post-stratification weights with the rake function from the survey package in R (Lumley, 2019).
3. Apply the weights to the sample before conducting the linking study analyses.

2.3. Descriptive Statistics

Descriptive statistics are provided to summarize the test scores for both the MAP Growth and Regents Examination in Algebra I assessments, including the test score mean, standard deviation (SD), minimum, and maximum. The mean presents the average test scores across all students in the study sample, and the SD indicates the variability of test scores, revealing how students' scores are distributed around the average score, or mean. Correlation coefficients between the MAP Growth RIT scores and Regents Examination in Algebra I scores are also provided to answer the question "How well do the test scores from MAP Growth (that reference the RIT scale) correlate to the scores obtained from the Regents Examination in Algebra I (that reference some other scale) in the same subject?" The correlations were calculated as:

$$r = \frac{\sum(x_i - \overline{x})(y_i - \overline{y})}{\sqrt{\sum(x_i - \overline{x})^2 \sum(y_i - \overline{y})^2}}$$

where r is the correlation coefficient, x_i and y_i are the values of the *x*- and *y*-variables in a sample, and $\overline{x}$ and $\overline{y}$ are the mean of the values of the *x*- and *y*-variables.

2.4. MAP Growth Cut Scores

Since the Regents Examination in Algebra I is not grade dependent (i.e., any students in grades 9–12 can take the assessment once they have finished the course), the spring RIT cuts were

established based on all the students in the study sample regardless of their grade. Fall and winter RIT cut scores were then projected using the growth norms and the spring RIT cuts. Percentile ranks based on the most recent NWEA norms are also provided. These are useful for understanding how students' scores compare with peers nationwide and the relative rigor of a state's performance level designations for its summative assessment.

The equipercentile linking method (Kolen & Brennan, 2004) was used to identify the spring MAP Growth RIT scores that correspond to the performance level cut scores of the Regents Examination in Algebra I. The equipercentile linking procedure matches scores on the two scales that have the same percentile rank (i.e., the proportion of tests at or below each score). For example, let x represent a score on Test X (e.g., the Regents Examination in Algebra I). Its equipercentile equivalent score on Test Y (e.g., the MAP Growth Algebra I test), $e_y(x)$, can be obtained through a cumulative-distribution-based linking function defined as:

$$e_y(x) = G^{-1}[P(x)]$$

where $e_y(x)$ is the equipercentile equivalent of score x on the Regents Examination in Algebra I on the scale of the MAP Growth Algebra I test, $P(x)$ is the percentile rank of a given score on the Regents Examination in Algebra I, and G^{-1} is the inverse of the percentile rank function for MAP Growth that indicates the score on MAP Growth corresponding to a given percentile rank. Polynomial loglinear pre–smoothing was applied to reduce irregularities of the score distributions and equipercentile linking curve.

The MAP Growth conditional growth norms provide students' expected score gains across terms, such as growth from fall to spring within the same grade or from spring of a lower grade to spring of the adjacent higher grade. Additionally, NWEA has developed course-specific growth norms to predict students' expected score gains in specific courses, such as Algebra I. This information was used to calculate the fall and winter cut scores. The equation below was used to determine the previous term's or grade's MAP Growth score needed to reach the spring cut score, considering the expected growth associated with the previous RIT score:

$$RIT_{PredSpring} = RIT_{previous} + g$$

where:
- $RIT_{PredSpring}$ is the predicted MAP Growth spring score,
- $RIT_{previous}$ is the previous term's or grade's RIT score, and
- g is the expected growth from the previous (e.g., fall or winter) RIT score to the spring RIT score.

2.5. Classification Accuracy
The degree to which MAP Growth predicts student proficiency status on the Regents Examination in Algebra I can be described using classification accuracy statistics based on the MAP Growth spring RIT cut scores. The results show the proportion of students correctly classified by their RIT scores as proficient (i.e., Level 3 or higher) or not proficient on the Regents Examination in Algebra I. Table 2.1 describes the classification accuracy statistics provided in this report (Pommerich et al., 2004).

Table 2.1. Description of Classification Accuracy Summary Statistics

Statistic	Description	Interpretation
Overall Classification Accuracy Rate	(TP + TN) / (total sample size)	Proportion of the study sample whose proficiency classification on the state test was correctly predicted by MAP Growth cut scores
False Negative (FN) Rate	FN / (FN + TP)	Proportion of students identified by MAP Growth as not proficient in those observed as proficient on the state test
False Positive (FP) Rate	FP / (FP + TN)	Proportion of students identified by MAP Growth as not proficient in those observed as not proficient on the state test
Sensitivity	TP / (TP + FN)	Proportion of students identified by MAP Growth as proficient in those observed as such on the state test
Specificity	TN / (TN + FP)	Proportion of students identified by MAP Growth as not proficient in those observed as such on the state test
Precision	TP / (TP + FP)	Proportion of students observed as proficient on the state test in those identified as such by the MAP Growth test
Area Under the Curve (AUC)	Area under the receiver operating characteristics (ROC) curve	How well MAP Growth cut scores separate the study sample into proficiency categories that match those from the state test cut scores. An AUC at or above 0.80 is considered "good" accuracy.

Note. FP = false positives; FN = false negatives; TP = true positives; TN = true negatives.

2.6. Proficiency Projections

Given that all test scores contain measurement errors, reaching the Level 3 RIT cut does not guarantee that the student is proficient on the state test. Instead, it can be claimed that a student meeting the RIT cut score has a 50% chance of reaching proficiency on the state test, with their chances increasing the greater their score is from the cut. The proficiency projections indicate these probabilities for various RIT scores throughout the year.

In addition to calculating the MAP Growth fall and winter cut scores, the MAP Growth conditional growth norms data were also used to calculate the probability of reaching proficiency on the Regents Examination in Algebra I based on a student's MAP Growth RIT scores from fall and winter:

$$Pr(Achieving\ proficiency\ in\ spring|\ starting\ RIT) = \Phi\left(\frac{RIT_{previous}\ +\ g\ -\ RIT_{SpringCut}}{SD}\right)$$

where:
- Φ is the standard normal cumulative distribution function,
- $RIT_{previous}$ is the student's RIT score in fall or winter,
- g is the expected growth from the previous (e.g., fall or winter) RIT score to the spring RIT score,
- $RIT_{SpringCut}$ is the MAP Growth Level 3 cut score for spring, and
- SD is the conditional standard deviation of the expected growth, g.

The equation below was used to estimate the probability of a student achieving Level 3 or higher performance on the Regents Examination in Algebra I based on their spring RIT score (RIT_{Spring}):

$$Pr(Achieving\ proficiency\ in\ spring\ |\ spring\ RIT) = \Phi\left(\frac{RIT_{Spring} - RIT_{SpringCut}}{SE}\right)$$

where SE is the standard error of measurement for MAP Growth.

3. Results

3.1. Study Sample

The data used in this study were collected from 312 schools within the New York City Department of Education in Spring 2024. Only students who have scores on both the MAP Growth Algebra I test and the Regents Examination in Algebra I were included in the study sample. Table 3.1 presents the distributions of students by race, sex, and performance level in three groups: the original unweighted study sample, the target population of students who took the Regents Examination in Algebra I, and the sample after post-stratification weighting. The demographic distributions in the weighted sample are nearly identical to those of the target population. The analyses in this study were conducted using the weighted sample.

Table 3.1. Linking Study Demographics

Demographic Subgroup		Unweighted Sample (%)	State Target Population (%)	Weighted Sample (%)
Total N-Count		**22,027**	**223,049**	**22,027**
Race	AI/AN	1.1	0.7	0.7
	Asian/NH/PI	18.7	9.8	9.8
	Black	21.7	17.4	17.4
	Hispanic	43.2	33.7	33.7
	Multiracial	1.2	3.2	3.2
	White	14.0	35.3	35.3
Sex	Female	48.1	48.1	48.1
	Male	51.9	51.8	51.8
	Non-Binary	0.0	0.1	0.1
Performance Level	Level 1	19.3	18.0	18.0
	Level 2	23.0	20.0	20.0
	Level 3	30.7	27.0	27.0
	Level 4	17.9	21.0	21.0
	Level 5	9.1	14.0	14.0

Note. AI/AN = American Indian or Alaska Native; NH/PI = Native Hawaiian/Pacific Islander

3.2. Descriptive Statistics

Table 3.2 presents descriptive statistics of the MAP Growth and Regents Examination in Algebra I scores from Spring 2024, including the correlation coefficients (r) between the two assessments. The coefficient between the scores is 0.73. This value indicates a high positive correlation between the scores, which is important validity evidence for the claim that MAP Growth scores are good predictors of performance on the Regents Examination in Algebra I.

Table 3.2. Descriptive Statistics of Test Scores

Assessment	N	r	Mean	SD	Min.	Max.
Regents Examination in Algebra I	22,027	0.73	68.2	15.1	0	100
MAP Growth Algebra I			235.7	24.9	168	315

Note. SD = standard deviation; Min. = minimum; Max. = maximum.

3.3. MAP Growth Cut Scores

Table 3.3 presents the scale score ranges for the Regents Examination in Algebra I along with the corresponding MAP Growth RIT cut scores and percentile ranges. Bold numbers indicate the cut scores to be considered at least proficient. This table can be used to predict a student's likely performance level on the Regents Examination in Algebra I when MAP Growth is taken in the fall, winter, or spring. For example, a student who obtained a MAP Growth Algebra I RIT score of 221 in the fall is likely to achieve Level 3 performance on the Regents Examination in Algebra I. The spring cut score is higher than the fall cut score because growth is expected between fall and spring as students receive more instruction during the school year.

Within this report, the cut scores for fall and winter are derived from the spring cuts and the typical growth scores from fall to spring or winter to spring. The typical growth scores are based on the default instructional weeks most encountered for each term (i.e., Weeks 4, 20, and 32 for fall, winter, and spring, respectively). Since instructional weeks often vary by district, the cut scores in this report may differ slightly from the MAP Growth score reports that reflect instructional weeks set by partners. If the actual instructional weeks deviate substantially from the default ones, a student's expected performance level could be different from the projections presented in this report. Partners are therefore encouraged to use the projected performance level in students' score reports since these reflect the specific instructional weeks set by partners.

Table 3.3. Cut Scores—Regents Examination in Algebra I & MAP Growth Algebra I Test

Regents Examination in Algebra I									
Level	Level 1		Level 2		Level 3		Level 4		Level 5
Scale Score	0–54		55–64		**65**–74		75–84		85–100
MAP Growth Algebra I Test									
Term	Level 1		Level 2		Level 3		Level 4		Level 5	
	RIT	Pct	RIT	Pct	RIT	Pct	RIT	Pct	RIT	Pct
Fall	100–206	1–8	207–220	9–30	**221**–236	31–68	237–253	69–93	254–350	94–99
Winter	100–209	1–9	210–224	10–32	**225**–240	33–66	241–258	67–92	259–350	93–99
Spring	100–213	1–11	214–228	12–33	**229**–244	34–65	245–262	66–90	263–350	91–99

Note. Pct = Percentile

3.4. Classification Accuracy

Table 3.4 presents the classification accuracy summary statistics, including the overall classification accuracy rate. These results indicate how well MAP Growth spring RIT scores predict proficiency on the Regents Examination in Algebra I, providing insight into the predictive validity of MAP Growth. The overall classification accuracy rate is 0.81. This value suggests that the RIT cut scores are good at classifying students as proficient (Level 3 or higher) or not proficient on the Regents Examination in Algebra I.

Although the results show that MAP Growth scores can be used to predict student proficiency on the Regents Examination in Algebra I, there is a notable limitation to how these results should be used and interpreted. The Regents Examination in Algebra I and MAP Growth assessments are designed for different purposes and measure slightly different constructs even within the same content area. Therefore, scores on the two tests cannot be assumed to be interchangeable.

Table 3.4. Classification Accuracy Results

N	Proficient Cut		Class. Accuracy	Rate		Sensitivity	Specificity	Precision	AUC
	RIT	State		FP	FN				
22,027	229	65	0.81	0.19	0.18	0.82	0.81	0.87	0.81

Note. Class. Accuracy = overall classification accuracy rate; FP = false positives; FN = false negatives; AUC = area under the ROC curve.

3.5. Proficiency Projections

Table 3.5 presents the estimated probability of achieving Level 3 or higher performance on the Regents Examination in Algebra I based on RIT scores from fall, winter, or spring. Due to measurement errors in all test scores, the Level 3 MAP Growth cuts do not guarantee that a student will reach proficiency on the Regents Examination in Algebra I. Instead, they indicate a 50% chance that a student will achieve the proficient level. Therefore, these projections further elucidate the Level 3 cut scores by providing the likelihood of reaching proficiency on the state test at a given percentile throughout the year. For example, an educator can use Table 3.5 to estimate that a student who obtained a MAP Growth Algebra I RIT score of 223 in the fall has a 58% probability of reaching Level 3 or higher on the Regents Examination in Algebra I in the spring.

Table 3.5. Proficiency Projections Based on RIT Scores—Algebra I

Pct	Spring RIT Cut	Fall			Winter			Spring		
		RIT	Projected Proficiency		RIT	Projected Proficiency		RIT	Projected Proficiency	
			Level 3	Prob.		Level 3	Prob.		Level 3	Prob.
5	229	202	No	0.02	204	No	0.01	204	No	<0.01
10	229	208	No	0.08	210	No	0.04	212	No	<0.01
15	229	212	No	0.16	214	No	0.11	216	No	<0.01
20	229	215	No	0.25	218	No	0.21	220	No	0.01
25	229	218	No	0.35	221	No	0.33	224	No	0.08
30	229	220	No	0.46	224	No	0.45	227	No	0.28
35	229	223	Yes	0.58	226	Yes	0.55	229	Yes	0.5
40	229	225	Yes	0.65	228	Yes	0.63	232	Yes	0.8
45	229	227	Yes	0.72	231	Yes	0.75	234	Yes	0.92
50	229	229	Yes	0.78	233	Yes	0.82	237	Yes	0.99
55	229	231	Yes	0.84	235	Yes	0.87	239	Yes	>0.99
60	229	233	Yes	0.88	238	Yes	0.93	242	Yes	>0.99
65	229	235	Yes	0.92	240	Yes	0.96	245	Yes	>0.99
70	229	237	Yes	0.94	242	Yes	0.97	247	Yes	>0.99
75	229	240	Yes	0.98	245	Yes	0.99	250	Yes	>0.99
80	229	243	Yes	0.99	248	Yes	>0.99	254	Yes	>0.99
85	229	246	Yes	0.99	252	Yes	>0.99	257	Yes	>0.99
90	229	250	Yes	>0.99	256	Yes	>0.99	262	Yes	>0.99
95	229	256	Yes	>0.99	263	Yes	>0.99	269	Yes	>0.99

Note. Pct = percentile; Prob. = probability.

References

He, W. (2022). *Achievement and growth norms for course-specific MAP Growth tests*. NWEA Research Report. NWEA. https://www.nwea.org/uploads/2023/02/2022–MAP–Growth–HS–Math–Norms–Report–02–07–2023.pdf

Kolen, M. J., & Brennan, R. L. (2004). *Test equating, scaling, and linking: Methods and practices* (2nd ed.). Springer. https://doi.org/10.1007/978–1–4939–0317–7

Lumley, T. (2019). *Survey: Analysis of complex survey samples*. (R package version 3.36) [Computer software]. Available from https://CRAN.R–project.org/package=survey.

Pommerich, M., Hanson, B., Harris, D., & Sconing, J. (2004). Issues in conducting linkage between distinct tests. *Applied Psychological Measurement*, *28*(4), 247–273. https://doi.org/10.1177/0146621604265033

Thum, Y. M., & Kuhfeld, M. (2020). *Achievement and Growth Norms for Course–Specific MAP Growth Tests.* NWEA Research Report. NWEA. https://teach.mapnwea.org/impl/normsResearchStudy.pdf