map GROWTH

GUIDE

When are students “ready” for Algebra 1?

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Background

Algebra 1 has often been described as a “gatekeeper” course. Its location in the scope and sequence of math standards has changed over time, but its importance has not. Access to advanced courses or a STEM career requires successful completion of Algebra 1. Students who complete Algebra 1 in eighth grade (as opposed to ninth) take more and more-advanced math courses, such as calculus, especially if they enter algebra with the requisite skills and knowledge. Access to advanced math courses in high school is also linked to better career opportunities. Since the 1990s, school systems sought to increase the number of eighth-graders enrolling in Algebra 1, with different degrees of success.

Algebra 1 access intersects with residential segregation and racial inequity. As recently as the 2015–2016 school year, 86% of suburban schools offered eighth-grade algebra, compared to only 75% of urban and rural schools. Asian and White students are two to three times more likely to enroll in eighth-grade Algebra 1 than Hispanic and Black students. If Algebra 1 is indeed such a jumping off point for further math study and STEM-related careers, then school systems need to ensure the following to design an effective and equitable algebra policy: 1) all students have access to it; 2) that placement is based on readiness (and not other factors such as geography or race); and 3) schools design curriculum through all elementary grades to promote algebra readiness by eighth grade.

According to NAEP long-term trend data, the percentage of 13-year-olds taking algebra peaked in 2012 at 34%. When this question was asked again in 2020 and 2023, the percentage dropped to 25% and 24%, respectively. Changes in math policy and the effect of the COVID-19 pandemic influenced this drop. As of Spring 2023, eighth-grade students are approximately 0.27 standard deviations behind pre-COVID norms in math. Learning loss of this size could take nine additional months of school to return students to pre-COVID levels. School systems, especially as they work to help students recover from the pandemic, will have to answer an essential question: how can educators tell when students are ready for algebra coursework? The goal is for more students to be *proficient* in Algebra 1, not to simply enroll in the course. Increasing enrollments in the course without accounting for readiness can have a negative effect on students.

Students’ math content mastery varies widely within any given grade. For example, roughly a third of eighth-grade classrooms have students performing at all four proficiency levels on the Trends in International Mathematics and Science Study (TIMSS). In terms of content mastery, this spectrum covers students who have some knowledge of basic graphs and an elementary understanding of whole numbers (i.e., low benchmark) to the ability to solve systems of linear equations involving two variables (i.e., the advanced benchmark). Thus, students ready for algebra in eighth grade (or even earlier) clearly exist and they are not constrained to only the most high-achieving schools. School systems need clear processes to efficiently and accurately identify those who will benefit from Algebra 1, regardless of their enrolled grade.

Designing identification systems has important equity implications. The absence of a universal readiness screener opens the door to other factors influencing who gets access to eighth-grade algebra. Robinson's recent analysis of course-taking data found systematic biases in eighth-grade algebra enrollment. Black, Hispanic, and Native American students with the same test scores as their White and Asian peers were less likely to enroll in eighth-grade algebra. 72% and 63% of Asian and White students with above-average test scores enrolled in eighth-grade algebra compared to 55% of their Black, Hispanic, or Native American peers. Test scores in this range signal students are likely ready for algebra. The difference in placement decisions for Black, Hispanic, and Native American students signal criteria other than readiness as being used to decide placement. Residential and school segregation affect whether these students have access to a school that offers Algebra 1. And even if the school does offer the course, factors like teacher recommendations likely also influence who is placed. School systems need a universally administered data point to guide placement decisions. Such a criterion will not resolve all inequities in the education system, but it will provide a clear first step toward promoting equal access to an important course.

This guidance document was guided by two research questions:

1. What score on the prior spring's MAP® Growth™ 6+ Math test is predictive of a student being more likely than not to score proficient on a state's end-of-course Algebra 1 proficiency exam?
2. What score on the prior spring's MAP Growth 6+ Math test is predictive of a student being successful in an Algebra 1 course in terms of grades?

These questions and the analyses conducted and described below provide a first-look at providing guidance for MAP Growth partners on making Algebra 1 placement decisions. We will update our guidance as we learn about students' long-term success on math courses beyond Algebra 1 and into post-secondary education.

What does success in Algebra 1 look like?

We used two outcomes as indicators of "success" in Algebra 1 to answer these questions. The first was performance on state end-of-course (EoC) Algebra 1 exams. These focus on algebra-specific skills and learning objectives. Second, we looked at student grades in Algebra 1 courses. These outcomes measure different aspects of math skills and knowledge. An Algebra 1 EoC assessment is a single, standardized measure designed around algebra state standards. Conversely, course grades measure any number of skills, dispositions, and behaviors that may or may not be related to student algebra content mastery. Teachers also vary in how they measure and report grades. The use of both balances each of their strengths and weaknesses as measures of successful algebra completion.

End-of-course proficiency exams

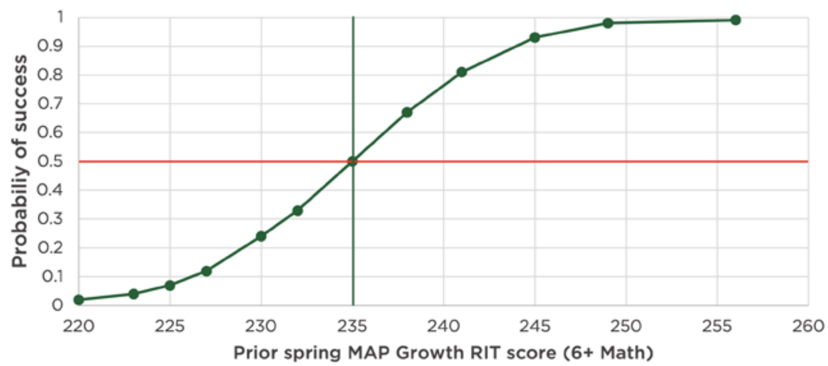
Ohio, Georgia, and Texas administer specific Algebra 1 EoC exams to all students in the spring of their Algebra 1 course. These EoC exams take the place of general "math" accountability exams administered in other grades.

NWEA® has conducted linking studies between the MAP Growth 6+ Math test and the Algebra 1 EoC assessments administered in Ohio (spring 2022 data), Georgia (spring 2019 data), and Texas (spring 2022 data). These linking studies identified the MAP Growth 6+ Math score that predicts students having at least a 51% probability of scoring proficient on the state EoC Algebra 1 exam. Across Ohio, Georgia, and Texas these scores were 235, 240, and 240, respectively. This variability highlights: a) differences across states in terms of students and policies; and b) differences in the tests (and content measured by those tests) used to measure proficiency.

We chose 238 (the average of the three) as the target Spring Algebra 1 MAP Growth score. Students with this score have a 51% chance of scoring proficient on a state Algebra 1 EoC exam. This decision balances the potential rate of false positives (i.e., students being placed who end up not being successful) and false negatives (i.e., students being denied placement even though they would have been successful). Although as we will discuss further on, schools may choose to err more on one side than the other by setting a higher or lower benchmark for success in Algebra 1.

The NWEA 2020 norms allow us to backward plan where students need to score on prior assessments to likely attain a target score later on. **If the goal is a 238 by the spring of Algebra 1, then a student needs to score ~233 that fall or ~235 the prior spring**. This guidance assumes average growth and 28 weeks of school exposure between fall and spring tests. Averages help us understand broad patterns across many students. Individual student growth can and does vary widely. Figure 1 presents this visually and calls attention to the fact that some students who score lower than a 235 the prior spring will still go on to be successful in Algebra 1. For example, a student with a 230 the prior spring shows a ~22% chance of reaching a 238 by spring due to atypically high growth (i.e., 8 pts as opposed to 5). Likewise, some students who score above a 235 the prior spring will fall short of a 238 a year later because they showed atypically low levels of growth. Because of this inherent variability, schools should account for their local context and available supports when deciding on their cut score. Systems with lots of available supports may want a lower cut score (because they can assume higher growth). Places with fewer available supports may want a higher cut score.

Figure 1. Probability of a student scoring proficient in Algebra 1 (238) in spring of eighth grade conditional on spring of seventh grade MAP Growth Math RIT score



Course grades

Test scores capture one aspect of measuring student learning and are one lens through which to view proficiency. Course grades provide an additional look at student content mastery. NWEA collected course grades in Algebra 1 from three partner school districts. We conducted a parallel analysis to link prior-spring MAP Growth 6+ Math scores to certain grades at the end of Algebra 1.

Each district used a different form of grading. District 1 used a percentage system to assign grades. We coded a 70% or higher as being "proficient" in Algebra 1. District 2 used standards-based grading: extending beyond the standard (4), meeting the standard, (3) approaching the standard (2), and beginning to learn the standard (1). We averaged grades on each of the algebra learning standards and coded an average of at least 2 as "proficient" in Algebra 1. District 3 used traditional letter grades (A, B, C, D, or F) for the first and second halves of the semester. We averaged these two grades and coded students whose average score was at least a C as "proficient" in Algebra 1. Importantly, we do not have work samples or other means to validate or compare the districts' grading practices. As a result, the way we operationalized "proficiency" across these districts likely represents different degrees of Algebra 1 content mastery.

Two of the three districts provided student grades from before and after the pandemic. This was especially important for us because there is evidence of grade inflation, specifically in Algebra 1 courses, following the pandemic. If higher grades were given to more students, including those with lower-levels of Algebra 1 proficiency, then this would show up as lower readiness cut scores in the analyses (i.e., students would only need to have a lower-level of content mastery to earn a proficient grade). To understand if this happened, we analyzed each of the district-by-time periods separately (two pre-COVID and three post-covid) and compared the results.

For each of the analyses we present two metrics. Our first measure, area under the curve (AUC), captures the general ability of prior spring math scores to predict earning a proficient grade. It ranges from zero (equal to guessing) to 1.0 (perfectly classifying both groups). This metric communicates an overall degree of classification effectiveness. It doesn't identify an "optimal" readiness cut score. Our second metric generated a score at which a student has an estimated 51% chance of earning a "proficient" grade. Students scoring above this level would have a greater-than 51% chance of earning a "proficient" grade. Students scoring below would have a less-than 51% chance.

Table 1. Area under the curve and prior spring cut scores by cohort and district

COHORT	DISTRICT	AUC	51% CUT SCORE
Pre-COVID cohorts	1 (n=1340)	0.762	236
	3 (n=3411)	0.798	239
COVID cohorts	1 (n=1434)	0.761	235
	2 (n=204)	0.605	242
	3 (n=3117)	0.822	238

In Table 1, we show that pre- and post-COVID, prior spring MAP Growth 6+ Math scores effectively classify students based on Algebra 1 course grades. The prior spring scores associated with a 51% chance of earning a proficient grade range from 235 to 242. The average of these five is 238, which is close to the 235 from the EoC analysis. District 2 is a K–8 district that reserves eighth-grade algebra for "advanced" students. However, the average across the districts is not sensitive to the inclusion of this district. Also important is the 1 point drop from pre- to post-pandemic for Districts 1 and 3 (236 to 235 and 239 to 238). This could be a result of grade inflation, but it could also indicate little more than sampling effects.

Does the prior-spring readiness cut score vary by grade?

The short answer is yes, but not by much. Returning to the NWEA 2020 norms, we can quantify how much growth varies over the course of sixth grade compared to seventh or eighth. On average, students grow more in terms of raw RIT points over the course of seventh grade than they do eighth grade. Eighth-graders in turn grow more, on average, than those in ninth grade. What this means is that the older the student, the higher he or she needs to score the prior spring to be on-track to score proficient. Again, districts can base their Algebra 1 placement criteria on different growth assumptions for their students. Table 2 presents how prior-spring readiness cut scores might differ based on the amount of growth students can be expected to show. For example, if a district wants to assume students will show atypically high levels of growth over the course of Algebra 1, it could place students in eighth-grade algebra if they scored a 230 the prior spring.

Table 2. Prior spring cut scores associated with meeting a 238 one year later by growth

	CUT SCORE ASSUMING:		
GRADE*	30TH PERCENTILE GROWTH	AVERAGE GROWTH	70TH PERCENTILE GROWTH
Spring of 6th	238 (+0)	233 (+5)	230 (+8)
Spring of 7th	237 (+1)	235 (+3)	230 (+8)
Spring of 8th	239 (-1)	236 (+2)	232 (+6)

**These cut scores are for placement during 7th, 8th, and 9th grades, respectively.*

Synthesizing algebra EoC and grade guidance

The estimated cut scores from the Algebra 1 EoC linking studies and Algebra 1 course grades provide similar but not identical guidance (e.g., readiness benchmarks of 235 vs. 238). These two scores represent the 67th and 72nd percentiles for the spring of seventh-grade math. Some difference is to be expected given test scores and course grades do represent different measures of algebra success.

How should a school decide?

Algebra 1's role in math education policy debates continues to get a lot of attention. It plays an important role in students' foundational knowledge. Success in Algebra 1 prepares students for advanced math courses and careers in STEM fields. Its success also depends on a school systems' broader math curriculum and instruction. A strong curriculum and instruction that starts in early education maximizes Algebra 1's benefit. Our guidance assumes districts have such a system in place. Without it, placement policies will have a small effect on students' overall math achievement or long-term outcomes.

With a well-established curriculum, districts can then focus on defining the goal for Algebra 1 and measuring success in the course. Is the goal to have as many students take the course regardless of preparation? Does it hold an advanced label in the course trajectory? Are there big educational inequities in access to math curriculum? Answers to these questions set the stage for designing and implementing Algebra 1 placement policy.

Our guidance gives districts a starting place to design their own placement threshold. A first step is to apply our guidance and reflect on the population of students it would identify. How does it influence the share of students taking Algebra 1 in eighth grade? In seventh grade? Does it capture the students who are likely to meet the local definition of success, which might be higher than the definition used here? Districts should update the guidance, moving the readiness benchmark up or down depending on their context. If they want to see more students enroll in early Algebra 1, they can lower the benchmark but need to be aware that more students will require support. Alternatively, if the district only wants to place students in early Algebra 1 who are likely to score *advanced* (as opposed to proficient), it might consider raising the readiness benchmark. Regardless of where the readiness benchmark ends up, it is important to universally apply it across students. Allowing deviations from the guidance opens the door for biases to perpetuate patterns of historical injustice (e.g. underrepresentation of Black students from advanced courses).

Finally, districts should approach this topic as a multiyear learning process. They should create a team to evaluate whether the placement policy meets the district's needs. How successful are students near the cut score? Are the students who just missed taking Algebra 1 doing well in their course? Or do they appear underchallenged? Do the current staffing levels and support structures allow for more students in Algebra 1? Or are there curricular modifications that need to be made following a new policy? And is a policy working equally well for students from all subgroups? These are some of the questions districts should consider as they implement these guidelines and transition toward a more effective and equitable placement policy.

About the author

Scott J. Peters specializes in educational assessment and data use, gifted and talented student identification, equity within advanced educational opportunities, and effectiveness of educational policy. His research focuses on how schools can leverage assessment data for maximum school and student benefit. His ongoing projects relate to balancing cost, sensitivity, and equity in gifted and talented student identification; how to proactively screen students for advanced learning opportunities; examining growth trajectories for advanced learners; and how to ensure all students have access to advanced learning opportunities.

Prior to coming to NWEA, for 13 years, Dr. Peters served as a professor of assessment and research methodology at the University of Wisconsin—Whitewater. His scholarly work has appeared in the *Australian Educational Researcher*, *AERA Open*, *Teaching for High Potential*, the *British Journal of Educational Psychology*, *Exceptional Children*, *Gifted Child Quarterly*, and many other publications. He received his PhD from Purdue University in educational psychology and applied research methodology.

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