RENAISSANCE®

Star Assessments™ for Math
Technical Manual

RENAISSANCE
Star
Math®

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Introduction

Star Math: Screening and Progress-Monitoring Assessment

Since the 2011–2012 school year, two different versions of Star Math have been available for use in assessing the mathematical abilities of students in grades K–12. The comprehensive version is a 34-item standards-based adaptive assessment, aligned to state and national curriculum standards, that takes an average of less than 25 minutes. A shorter, 24-item version takes an average of less than 14 minutes, making it a popular choice for progress monitoring in programs such as Response to Intervention. Both versions provide immediate feedback to teachers and administrators on each student's mathematical ability.

Star Math Purpose

As a periodic progress-monitoring assessment, Star Math progress monitoring serves three purposes. First, it provides educators with quick and accurate estimates of students' instructional math levels. Second, it assesses math levels relative to national norms. Third, it provides the means for tracking growth in a consistent manner longitudinally for all students. This is especially helpful to school- and district-level administrators.

The lengthier Star Math test serves similar purposes. While the Star Math test provides accurate normed data like traditional norm-referenced tests, it is not intended to be used as a "high-stakes" test. Generally, states are required to use high-stakes assessments to document growth, adequate yearly progress, and mastery of state standards. These high-stakes tests are also used to report end-of-period performance to parents and administrators or to determine eligibility for promotion or placement. Star Math is not intended for these purposes. Rather, because of the high correlation between the Star Math test and high-stakes instruments, classroom teachers can use Star Math scores to fine-tune instruction while there is still time to improve performance before the regular test cycle. At the same time, school- and district-level administrators can use Star Math to predict performance on high-stakes tests. Furthermore, Star Math results can easily be disaggregated to identify and address the needs of various groups of students.

The Star Math test's repeatability and flexible administration provide specific advantages for everyone responsible for the education process:

- For students, Star Math software provides a challenging, interactive, and brief test that builds confidence in their math ability.
- For teachers, the Star Math test facilitates individualized instruction by identifying children who need remediation or enrichment most.
- For principals, the Star Math software provides regular, accurate reports on performance at the class, grade, and building level.
- For district administrators and assessment specialists, it provides a wealth of reliable and timely data on math growth at each school and districtwide. It also provides a valid basis for comparing data across schools, grades, and special student populations.

This manual documents the suitability of Star Math computer-adaptive testing for these purposes and demonstrates quantitatively how well this innovative instrument in math assessment performs.

Star Math is similar in many ways to the Star Math progress monitoring version, but with some enhanced features, including additional reports and expanded benchmark management.

Design of Star Math

Two Generations of Star Math Assessments

The introduction of the current version of Star Math in 2011 marked the second generation of Star Math assessments. The first generation consisted of the Star Math Progress Monitoring version, which is a fixed-length 24-item adaptive assessment of math levels. This original version of Star Math was published in 1998 and used Item Response Theory (IRT) as the psychometric foundation for adaptive item selection and scoring. Star Math's original item bank contained 2,000+ items spanning more than 200 objectives.

A fundamental design decision involved determining the organization of the content in Star Math Progress Monitoring. Because of the great amount of overlap in content in the math construct, it is difficult to create distinct categories or "strands" for a mathematics achievement instrument. After reviewing the Star Math Progress Monitoring test's content, curricular materials, and similar math achievement instruments, the following eight strands were identified and included in the original Star Math test: Numeration

Concepts; Computation Processes; Word Problems; Estimation, Data Analysis and Statistics; Geometry; Measurement; and Algebra.

The Star Math Progress Monitoring test is further divided into two parts. The first part of the test, the first sixteen items, includes items only from the Numeration Concepts and the Computation Processes strands. The first eight test items (items 1–8) are from the Numeration Concepts strand, and the following eight test items (items 9–16) are from the Computation Processes strand.

The second part of the test, or the final eight items, includes items from all of the remaining strands. Hence, items 17–24 are drawn from the following six strands: Word Problems; Estimation; Data Analysis and Statistics; Geometry; Measurement; and Algebra. The specific makeup of the strands used in the final eight items depends on the student's grade level. For example, a student in grade 1 will not receive items from the Estimation strand, but items from this strand could be administered to a student in grade 12.

The decision to weight the test heavily toward Numeration Concepts and Computation Processes resulted from the fact that these strands are fundamental to all others, and they include the content about which teachers desire the most information. Although this approach emphasizes the two strands in the first part of the test, it provides adequate content balance to assure valid assessment. Additionally, factor analysis of the various content strands supports the fundamental unidimensionality of the construct being measured in the Star Math Progress Monitoring test.

The second generation is the current version of Star Math published in 2011. This is the first version of Star Math to be designed as a standards-based test. The organization of the content in Star Math differs from that of the original Star Math test—the Star Math Progress Monitoring test. Star Math's content organization reflects current thinking, as embodied in many different sets of national and local curriculum standards. The following four domains were identified and included in Star Math: Numbers and Operations; Algebra; Geometry & Measurement; and Data Analysis, Statistics & Probability. Within each of these domains, skills are organized into skill sets; there are 54 skill sets in all, comprising a total of over 790 core skills.

The Star Math test is a 34-item standards-based version, administered as 6 blocks of items in a single section. Each block of items contains a blend of items from the 4 domains. The number of items administered in a block varies by grade band. The item sequencing calls for more content balance at the beginning, middle, and end of the test by "spiraling" the content throughout the test, thus ensuring that the math ability estimate at any point during a test is based on a broad range of content, rather than on a limited sample of skills.

Thus, this second generation differed from the first in three major respects: It organized the content differently, its test length increased to 34 items, and the size of the item banks grew to over 6,000 items. Like the first generation of Star Math tests, the second generation continues to measure a single construct: mathematical achievement.

Overarching Design Considerations

One of the fundamental Star Math design decisions involved the choice of how to administer the test. The primary advantage of using computer software to administer Star Math tests is the ability to tailor each student's test based on his or her responses to previous items. Conventional assessments, including paper-and-pencil tests, typically entail fixed test forms: every student must respond to the same items in the same sequence. Using computer-adaptive procedures, it is possible for students to test on items that appropriately match their current level of proficiency. The item selection procedures, termed Adaptive Branching, effectively customize the test for each student's achievement level.

Adaptive Branching offers significant advantages in terms of test reliability, testing time, and student motivation. Reliability improves over fixed-form tests because the test difficulty is adjusted to each individual's performance level; students do not have to fit a "one test fits all" model. Most of the test items that students respond to are at levels of difficulty that closely match their achievement level. Testing time decreases because, unlike in paper-and-pencil tests, there is no need to expose every student to a broad range of material, portions of which are inappropriate because they are either too easy for high achievers or too difficult for those with low current levels of performance. Finally, student motivation improves simply because of these issues—test time is minimized and test content is neither too difficult nor too easy.

Another fundamental Star Math design decision involved the choice of the content and format of items for the test. Many types of stimulus and response procedures were explored, researched, discussed, and prototyped. The traditional multiple-choice format was chosen. This decision was made for interrelated reasons of efficiency, breadth of construct coverage, and objectivity and simplicity of scoring.

In both Star Math Progress Monitoring and Star Math, all management and test administration functions are controlled using a management system which is accessed by means of a computer with web access. This makes a number of features possible:

- It makes it possible for multiple schools to share a central database, such as a district-level database. Records of students transferring between schools within the district will be maintained in the database; the only information that needs revision following a transfer is the student's updated school and class assignments.

- The same database that contains Star Math data can contain data on other Star tests, including Star Early Literacy and Star Reading. The Renaissance program is a powerful information management program that allows you to manage all your district, school, personnel, and student data in one place. Changes made to district, school, teacher, and student data for any of these products, as well as other Renaissance software, are reflected in every other Renaissance program sharing the central database.
- Multiple levels of access are available, from the test administrator within a school or classroom to teachers, principals, and district administrators.
- Renaissance takes reporting to a new level. Not only can you generate reports from the student level all the way up to the school level, but you can also limit reports to specific groups, subgroups, and combinations of subgroups. This supports "disaggregated" reporting; for example, a report might be specific to students eligible for free or reduced lunch, to English language learners, or to students who fit both categories. It also supports compiling reports by teacher, class, school, grade within a school, and many other criteria such as a specific date range. In addition, the Renaissance consolidated reports allow you to gather data from more than one program (such as Star Math and Accelerated Math) at the teacher, class, school, and district level and display the information in one report.
- Since the Renaissance software is accessed through a web browser, teachers (and administrators) will be able to access the program from home.
- For both versions of Star Math, all shortcuts to the student program will automatically redirect to the browser-based program (the Renaissance Welcome page) each time they are used.

Test Interface

The Star Math test interface was designed to be both simple and effective. Students can use either the mouse or the keyboard to answer questions.

- If using the keyboard, students press one of the four letter keys (**A, B, C,** and **D**) and then press the **Enter** key (or the **return** key on Macintosh computers).

- If using the mouse, students click the answer of choice and then click **Next** to enter the answer.
- On a tablet, students tap their answer choice; then, they tap **Next**.

Practice Session

Star Math software includes a provision for a brief practice test preceding the test itself. The practice session allows students to get comfortable with the test interface and to make sure that they know how to operate it properly. As soon as a student has answered two out of three practice questions correctly, the program takes the student into the actual test. If the student has not successfully answered two of the three items by the end of the practice session, Star Math will present three more questions, and the student can pass the practice session by answering two of those questions correctly. If the student does not pass after the second attempt, the student will not proceed to the actual Star Math test. Even students with low math and reading skills should be able to answer the practice questions correctly. However, Star Math will halt the testing session and tell the student to ask the teacher for help if the student does not pass the practice session after the second attempt.

Students may experience difficulty with the practice questions for a variety of reasons. The student may not understand math even at the most basic level or may be confused by the “not given” response option presented in some of the practice questions. Alternatively, the student may need help using the keyboard or mouse. If this is the case, the teacher (or monitor) should help the student through the practice session during the student’s next Star Math test. If a student still struggles with the practice questions with teacher assistance, he or she may not yet be ready to complete a Star Math test.

Once a student has successfully passed a practice session, the student will not be presented with practice items again on a test of the same type taken within the next 180 days.

Adaptive Branching/Test Length

Star Math’s branching control uses a proprietary approach somewhat more complex than the maximum information criterion based on the Rasch model. The Star Math approach was designed to yield reliable test results for both the criterion-referenced and norm-referenced scores by adjusting item difficulty to the responses of the individual being tested while striving to minimize test length and student frustration.

In order to minimize student frustration, the first administration of the Star Math test begins with items that have a difficulty level that is below what a typical student at a given grade can handle—usually one or two grades below grade placement. On the average, about 85 percent of students will be able to answer the first item correctly. Teachers can override the use of grade placement for determining starting difficulty by entering the current level of mathematics instruction for the student using the MIL (Math Instructional Level). When an MIL is provided, the program uses that value to raise or lower the starting difficulty of the first test. On the second and subsequent administrations, the test begins about one grade lower than the ability last demonstrated within 180 days. Students generally have an 85 percent chance of answering the first item correctly on second and subsequent tests.

Test Length

Once the testing session is underway, the Star Math test administers 34 items (or 24 items for the Star Math Progress Monitoring test) of varying difficulty based on the student's responses; this is sufficient information to obtain a reliable Scaled Score and to determine the student's math Level.

The length of time needed to complete a Star Math test varies across students.

Table 1 provides an overview of the testing time by grade for the students who took the full-length 34-item version of Star Math during the 2018–2019 school year. The results of the analysis of test completion time indicate that half or more of students completed the test in less than 25 minutes, depending on grade, and even in the slowest grade (grade 6) 95% of students finished their Star Math test in less than 42 minutes.

Table 1: Average and Percentiles of Total Time to Complete the 34-item Star Math Assessment During the 2018–2019 School Year

Grade	Sample Size	Time to Complete Test (in Minutes)					
		Mean	Standard Deviation	5th Percentile	50th Percentile	95th Percentile	99th Percentile
K	88,566	13.24	5.67	8.28	11.62	23.45	34.00
1	1,381,713	15.16	6.21	8.58	13.62	26.85	35.85
2	2,010,310	17.90	7.12	9.27	16.52	31.13	40.22
3	2,110,198	22.32	8.58	10.80	21.07	37.95	47.73
4	2,093,035	23.85	8.69	11.85	22.68	39.57	49.30
5	2,061,995	24.59	8.58	12.50	23.53	40.10	49.23
6	1,685,463	25.85	8.69	13.12	25.02	41.27	49.92
7	1,413,980	25.53	8.51	12.82	24.82	40.40	48.53
8	1,339,122	24.82	8.27	12.50	24.10	39.32	47.18
9	601,062	22.97	8.51	10.85	21.98	38.25	46.57
10	443,006	22.32	8.44	10.43	21.32	37.48	45.77
11	278,229	21.74	8.53	10.03	20.60	37.23	45.77
12	154,255	21.01	8.68	9.57	19.63	36.97	46.10

Table 2 provides an overview of the Star Math Progress Monitoring testing time by grade for the students using data from the 2017–2018 and 2018–2019 school years. For that version of the test, about half of the students at every grade completed the Star Math Progress Monitoring test in less than 13 minutes, and even in the slowest grade (grade 4) 95% of students finished in less than 23 minutes.

Table 2: Average and Percentiles of Total Time to Complete the 24-item Star Math Progress Monitoring Assessment During the 2017–2018 and 2018–2019 School Years

Grade	Sample Size	Time to Complete Test (in Minutes)					
		Mean	Standard Deviation	5th Percentile	50th Percentile	95th Percentile	99th Percentile
1	9,239	10.14	4.25	5.45	9.05	18.50	23.90
2	17,873	11.19	4.60	5.67	10.22	20.05	25.53
3	16,445	12.86	5.20	6.15	11.95	22.53	28.28
4	18,372	13.40	5.08	6.60	12.65	22.92	28.48
5	15,733	13.93	5.05	6.93	13.22	23.18	28.68
6	10,390	13.86	5.04	6.78	13.22	23.13	28.55
7	8,741	13.57	4.83	6.67	13.05	22.32	26.85
8	7,699	12.82	4.75	6.32	12.13	21.73	26.37
9	875	10.95	4.89	5.68	9.85	19.70	26.28
10	731	10.70	4.46	5.55	9.63	18.85	25.78
11	518	10.73	4.10	5.83	9.89	18.63	23.30
12	362	10.62	4.38	5.68	9.49	19.78	26.98

Test Repetition

Star Math score data can be used for multiple purposes such as screening, placement, planning instruction, benchmarking, and outcomes measurement. The frequency with which the assessment is administered depends on the purpose for assessment and how the data will be used. Renaissance Learning recommends assessing students only as frequently as necessary to get the data needed. Schools that use Star for screening purposes typically administer it two to five times per year. Teachers who want to monitor student progress more closely or use the data for instructional planning may use it more frequently. Star Math may be administered monthly for progress monitoring purposes, and as often as weekly when needed.

Star Math keeps track of the questions presented to each student from test session to test session and will not ask the same question more than once in any 120-day period.

Item Time Limits

The Star Math tests place no limits on total testing time. However, there are time limits for each test item. The per-item time limits are generous and ensure that more than 90% of students can complete each item within the normal time limits. Each practice question has a 90-second time limit and each test question has a 3-minute time limit.

Standard Time Limits:

- Practice questions: 90 seconds (1.5 minutes) for each question
- Test questions 180 seconds (3 minutes) for each question

Star Math also provides the option of extended time limits for selected students who, in the judgment of the test administrator, require more than the standard amount of time to read and answer the test questions. Extended time limits are twice as long as standard time limits.

Extended Time Limits:

- Practice questions: 180 seconds (3 minutes) for each question
- Test questions: 360 seconds (6 minutes) for each question

Extended time may be a valuable accommodation for English language learners as well as for some students with disabilities. Test users who elect the extended time limit for their students should be aware that Star Math norms, as well as other technical data such as reliability and validity, are based on test administration using the standard time limits. When the extended time limit accommodation is elected, students have two times longer than the standard time limits to answer each question.

At all grades, regardless of the extended time limit setting, when a student has only 15 seconds remaining for a given item, a time-out warning appears, indicating that he or she should make a final selection and move on. Items that time out are counted as incorrect responses unless the student has the correct answer selected when the item times out. If the correct answer is selected at that time, the item will be counted as a correct response.

If a student doesn't respond to an item, the item times out and briefly gives the student a message describing what has happened. Then the next item is presented. The student does not have an opportunity to take the item again. If a student doesn't respond to any item, all items are scored as incorrect.

Accessibility and Test Accommodations

The Star Math test can be accessed in an accessible format that is in compliance with WCAG 2.1 AA. This format allows for users with different ability levels to access the test utilizing different modalities, including assistive technology such as the JAWS screen reader. The content of the item bank is nearly identical to the traditional item delivery format, with the user interface modified slightly and a small number of visually biased items removed from the item bank. A student will be presented with the WCAG 2.0 AA version of the test after educators select one of the relevant test accommodations available in that student's Personal Needs Profile. Some of the available accommodations are the ability to change the size of the text or the color contrast, a highlighter, a line reader, an answer choice eliminator, a calculator or unlimited time to answer questions. In order to provide the best experience for students and teachers, the available accommodations could be modified during the school year.

Unlimited Time

Beginning with the 2022–23 school year, a new preference has been added: the Accommodations Preference. Among other things, this preference allows teachers to give students virtually unlimited time to answer questions: 15 minutes for both practice questions and test questions. When this preference is set, the student will not see a time-out warning when there are 15 seconds left; however, if there is no activity at all from the student within 15 minutes of a question first being presented, the student will be shown a dialog box. The student will have 60 seconds to close the dialog box and return to the test. If the student does not close the dialog box within 60 seconds, the student's current progress on the test will be saved and the test will be ended (and can be resumed the same way as a paused test).

Test Security

Star Math software includes a number of security features to protect the content of the test and to maintain the confidentiality of the test results.

Split Application Model

When students log into Star Math, they do not have access to the same functions that teachers, administrators, and other personnel can access. Students are allowed to take the test, but no other features available in Star Math are available to them; therefore, they have no access to confidential information. When teachers and administrators log in, they can manage student and class information, set preferences, and create informative reports about student test performance.

Individualized Tests

Using Adaptive Branching, every Star Math test consists of items chosen from a large number of items of similar difficulty based on the student's estimated ability. Because each test is individually assembled based on the student's past and present performance, identical sequences of items are rare. This feature, while motivated chiefly by psychometric considerations, contributes to test security by limiting the impact of item exposure.

Data Encryption

A major defense against unauthorized access to test content and student test scores is data encryption. All of the items and export files are encrypted. Without the appropriate decryption code, it is practically impossible to read the Star Math data or access or change it with other software.

Access Levels and Capabilities

Each user's level of access to a Renaissance program depends on the primary position assigned to that user. Each primary position is part of a user permission group. There are six of these groups: district level administrator, district dashboard owner, district staff, school level administrator, school staff, and teacher. By default, each user permission group is granted a specific set of user permissions; each user permission corresponds to one or more tasks that can be performed in the program. The user permissions for these groups can be changed, and user permissions can be granted or removed on an individual level.

Renaissance also allows you to restrict students' access to certain computers. This prevents students from taking Star Math tests from unauthorized computers (such as home computers). For more information, see https://help2.renaissance.com/setup/22509.

The security of the Star Math data is also protected by each person's username (which must be unique) and password. Usernames and passwords identify users, and the program only allows them access to the data and features that they are allowed based on their position and the user permissions that they have been granted. Personnel who log in to Renaissance (teachers, administrators, or staff) must enter a username and password before they can access the data and create reports. Without an appropriate username and password, personnel cannot use the Star Math software.

Test Monitoring/Password Entry

Test monitoring is another useful Star Math security feature. Test monitoring is implemented using the Password Requirement preference, which specifies whether monitors must enter their passwords at the start of a test. Students are required to enter a username and password to log in before taking a test. This ensures that students cannot take tests using other students' names.

Final Caveat

While Star Math software can do much to provide specific measures of test security, the most important line of defense against unauthorized access or misuse of the program is the user's responsibility. Teachers and test monitors need to be careful not to leave the program running unattended and to monitor all testing to prevent students from cheating, copying down questions and answers, or performing "print screens" during a test session. Taking these simple precautionary steps will help maintain Star Math's security and the quality and validity of its scores.

Test Administration Procedures

In order to ensure consistency and comparability of results to the Star Math norms, students taking Star Math tests should follow standard administration procedures. The testing environment should be as free from distractions for the student as possible.

The Test Administration Manual included with the Star Math product (https://help2.renaissance.com/US/PDF/SM/SM_TAM.pdf) describes the standard test orientation procedures that teachers should follow to prepare their students for the Star Math test. These instructions are intended for use with students of all ages and were successfully field-tested with students ranging from grades 1–12. It is important to use these same instructions with all students before they take the Star Math test.

Content and Item Development

Content of the Star Math test has evolved through three stages of development. The first stage involved specifying the content specifications to be reflected in the test. Because rules for writing the items influenced the exact ways in which this content finally appeared in the test, these rules may be considered part of this first stage of development. The following section describes these rules. In the second stage, items were empirically tested in a calibration research program, and items most suited to the test model were retained. The third stage occurs dynamically as each student completes a Star Math test. The content of each Star Math test depends on the selection of items for that individual student according to the computer-adaptive testing mode.

Content Specification: Star Math

Since the introduction of the initial version of the Star Math test in 1998, it has undergone a process of continuous research and improvement, and has evolved into the two distinct versions now in use. The Star Math Progress Monitoring version is the direct descendant of Star Math version 1: a 24-item test of general math achievement based on content that is heavily weighted towards numeration concepts and operations. Star Math itself is now a 34-item standards-based assessment, with a content distribution that changes as grade levels increase between the primary and high school grades.

Relative to Star Math Progress Monitoring, Star Math is an expanded test with new content and several technical innovations. The Star Math item bank has expanded from the original bank of 1,900 test items to more than 6,200 test items and will continue to grow as standards and curriculums evolve. The Star Math test content began with 210 skills and has expanded to include 790 skills that significantly enhance the test's ability to measure math skills in various state learning progressions.

For information regarding the development of Star Math items, see "Item Development Guidelines: Star Math" on page 5. Before inclusion in the Star Math item bank, all Star Math items are reviewed to ensure they meet the content specifications for Star Math item development. Items that do not meet the specifications are revised and recalibrated or discarded. All new item development adheres to the content specifications.

The first stage of the expanded Star Math development was identifying the set of skills to be assessed. Multiple resources were consulted to determine the set of skills most appropriate for assessing the mathematics development of K–12 US students, typical mathematics curricula, and current mathematics standards. The resources include, but are not limited to:

- *Common Core State Standards for Mathematics*
- National Mathematics Advisory Panel, *Foundations for Success: The final report of the National Mathematics Advisory Panel*
- National Council of Teachers of Mathematics (NCTM), *Curriculum Focal Points for Prekindergarten Through Grade 8 Mathematics*
- NCTM, *Principles and Standards for School Mathematics*
- US State standards from all 50 states, updated annually
- *National Assessment of Educational Progress* (NAEP)
- *Trends in International Mathematics and Science Study* (TIMSS)

The development of the skills list included iterative reviews by mathematicians, mathematics educators, assessment experts, and psychometricians specializing in educational assessment. See "Appendix A: Star Math Blueprint Skills" on page 115 for the Star Math Skills List.

For the purpose of content development, the skills list has been organized into four domains: Numbers and Operations; Algebra; Geometry and Measurement; and Data Analysis, Statistics, and Probability. To ensure appropriate distribution of items within each individual test, the assessment blueprint uses six content domains by treating Numbers, Operations, Geometry, and Measurement as separate domains.

The second development stage included item creation and calibration. Assessment items are developed according to established specifications for grade-level appropriateness and then reviewed to ensure the items meet the specifications. Grade-level appropriateness is determined by multiple factors, including math skill, reading level, cognitive load, vocabulary grade level, sentence structure, sentence length, subject matter, and interest level. All writers and editors have content-area expertise and relevant classroom experience and use those qualifications in determining grade-level appropriateness for subject matter and interest level. A strict development process is maintained to ensure quality item development.

Assessment items, once written, edited, and reviewed, are field tested and calibrated to estimate their Rasch difficulty parameters and goodness of fit to the model.

Following these analyses, each assessment item, along with both traditional and IRT analysis information (including fit plots) and information about the test level, form, and item identifier, are stored in an item statistics database. A panel of content reviewers then examines each item to determine whether the item meets all criteria for use in an operational assessment. More detailed information about the field testing and calibration of Star Math items may be found in the Item and Scale Calibration chapter of this manual.

Star Math and the Reorganization of Objective Clusters

The original version of Star Math organized items into 8 content strands, spanning 17 skill sets and 210 discrete skills. Star Math assesses 790 skills in four standards-based blueprint domains, as outlined inTable 3:

Table 3: Comparison of Domains and Skill Sets: Star Math Progress Monitoring versus Star Math

	Star Math Progress Monitoring Strands	Star Math Blueprint Domains
Skills assessed in:	1. Numeration 2. Computation 3. Word Problems 4. Geometry 5. Measurement 6. Algebra 7. Estimation 8. Data Analysis and Statistics	1. Numbers and Operations 2. Algebra 3. Geometry & Measurements 4. Data Analysis, Statistics & Probability
Skill sets	17	54
Number of skills	210	790

Many of the Star Math Progress Monitoring strands are still represented in the new domains; they are just grouped differently. The organization of Star Math domains and skill sets is modeled after the state standards and the Renaissance Core Progress for Math Learning Progression.

Within each domain, skills are organized into sets of closely related skills sets. The resulting hierarchical structure is blueprint domain, blueprint skill set, and blueprint skill. There are four math domains, 54 skill sets, and 790 skills. See "Appendix A: Star Math Blueprint Skills" on page 115 for a complete list of the Star Math blueprint domains, blueprint skill sets, and blueprint skills.

Calculator and Formula Reference Sheets

For specific Star Math skills, a calculator or formula reference sheet is made available to the student alongside of the test item. Depending on the item and the skill addressed, either the calculator, a formula reference sheet specific to the skill, or both may be used. For the purpose of test validity, these tools are provided in the application rather than the student using their own to ensure that they are used only for appropriately identified skills.

Calculator or Formula Reference sheets are available for two general circumstances: 1) the calculation is overly difficult to perform without either a calculator or a reference chart or 2) the ability to perform the calculations is not the focus of the skill, and the calculations are difficult or time-consuming (e.g., word problems, solving equations, or finding the terms of a sequence).

Formula reference sheets are available for upper-grade skills in which the formula and math relations needed are not expected for student memorization. This decision is based on analysis of the ACT, SAT, ADP, and formula reference sheets used on state end-of-year tests.

An analysis of state assessments produced the following guidelines in determining when a calculator should be made available for Star Math:

Table 4: Determination of Calculator Availability in Star Math

Calculation	Upper Limits of Not Using a Calculator[a]
Division (1–2 step problems)	Divisors may be 1-digit, multiples of 25, fractions with 1-digit denominators, or related to basic math facts (1440/120). Other 2-digit divisors may be included if the division is carried out to only 2 or 3 places.
Multiplication (1–2 step problems)	3-digit by 2-digit, 1-digit by 4-digit (non-zero digits).
Multi-step problems (3+ steps)	2-digit by 2-digit multiplication, 1-digit divisors, other limits listed below.
Powers	2-digit numbers squared, 1-digit numbers raised to the 4th power, 2 or 3 raised to a higher power.
Square roots	Perfect squares related to square of the numbers 1–13 (e.g., square root of 144).
Nth roots	Cube roots resulting in one-digit numbers, nth roots resulting in 2 or 3.
Mean (average)	Up to 6 one- or two-digit numbers or 4 multi-digit numbers.

a. When calculation is not the focus of the skill.

Read-Aloud Audio Guidance

For students challenged by textual reading and the language involved in a Star Math test, read-aloud audio guidance was developed as an accommodation. Read-aloud guidance is turned off for all students by default, but teachers may choose to turn it on either for individual students or an entire class. The accommodation is not intended to be used for all students, blind or low-vision students, but instead is intended to assist teachers to work with students whose language skills are at a lower level than their math skills or who have reading challenges that might prevent them from understanding the item. Audio scripts are not intended to read the entire item aloud for students who cannot read or have extreme visual disabilities.

In order to ensure students receiving read-aloud audio guidance do not have an advantage over other students, some items receive a standard audio prompt of “Choose the best answer.” Examples of items receiving this prompt would be if the stem included a single below-grade word such as “solve,” or “simplify.” Another example would be an item that includes a graphic of a coin and the student is asked to identify the value. Referring to the coin as “a quarter” in the audio prompt may make the item easier for a student who knows a quarter is worth $.25, but cannot identify the quarter visually. For content-specific scripts, only numbers and math expressions embedded within sentences are read. Audio is not included for labels on charts and graphs. Content-specific scripts will be provided for answer choices in items that would pose significant difficulty for struggling readers.

For technical reasons, a single audio file is used for each item requiring audio support, even when audio support contains both the stem and answer options. Students may replay the audio at any time, and may answer the item before the audio has finished playing.

Content Specification: Star Math Progress Monitoring

Item development for the original Star Math Progress Monitoring test predates the bank for Star Math, although both tests were developed with the same overarching goals in mind: to accurately measure the target skill in an accurate and concise manner.

Prior to development of the current Star Math test, content for Star Math Progress Monitoring was intended to reflect the objectives commonly taught in the mathematics curriculum of contemporary schools (primarily in the United States). Four major sources helped to define this curriculum content. First, an extensive review of content covered by leading mathematics textbook series was conducted. Second, state curriculum guides or lists of objectives were reviewed. Third, the *Principles and Standards for School Mathematics* of the National Council of Teachers of Mathematics (NCTM) was employed. Finally, content specifications from the National Assessment of Educational Progress (NAEP) and the Trends in International Mathematics and Science Study (TIMSS) were consulted. There is reasonable, although not universal, agreement among these sources about the content of mathematics curricula.

The final Star Math content specifications were intended to cover the objectives most frequently found in these four sources. In the end, the Star Math content was organized into eight strands: Numeration Concepts; Computation Processes; Word Problems; Estimation; Data Analysis and Statistics; Geometry; Measurement; and Algebra.

Level of Difficulty: Cognitive Load, Content Differentiation, Depth of Knowledge, and Presentation

Each item is constructed with consideration to cognitive load, content differentiation, and presentation as appropriate for the ability and experience of a typical student at that grade level.

- **Cognitive Load:** Cognitive load involves the type and amount of knowledge and thinking that a student must have and use in order to answer the item correctly. The entire impact of the stem and answer choices must be taken into account.
- **Content Differentiation:** Content differentiation involves the level of detail that a student must address to correctly answer the item. Determining and/or selecting the correct answer should not be dependent on noticing subtle differences in the stem or answer choices.

- **Depth of Knowledge:** Depth of Knowledge is a language system used as an evaluative tool for differentiating among the different levels, 1 through 4, of complexity of specific learning expectations. Items are written to engage students at the targeted depth of knowledge identified for each skill within the assessment.
- **Presentation:** The presentation of the item includes consistent placement of item components, including directions, stimulus components, questions, and answer choices. Each of these should have a typical representation for the discipline area and grade level. The level of visual differentiation needed to read and understand the item components must be grade-level appropriate.

Metadata Requirements and Goals

Due to the restrictions for modifying text, the content may not meet the following goals; however, new item development works to bring the content into alignment with these goals:

- **Gender:** After removing gender-neutral items, an equal number of male and female items should be represented. In addition to names (Sara) and nouns (sisters), gender is also represented by pronoun (she). Gender is not indicated by subject matter or appeal. For instance, an item on cooking is not female unless there is a female character in it.
- **Ethnicity:** The goal is to provide students with an assessment that reflects the ethnic diversity of our school children within the US: 48% White, 15% Black or African American, 27% Hispanic, 5% Middle Eastern, and 5% Asian or Indian. Ethnicity can be based on name or subject matter.
- **Subject:** A variety of subject areas should be present across the items, such as Arts/Humanities, Science, History, Physical Education, Math, and Technology.

Metadata is tagged with codes for Genres, Ethnicity, Occupations, Subjects, Topics, and Regions.

Item Development Guidelines: Star Math

Star Math assesses more than 790 grade-specific blueprint skills. Item development is skill-specific. Each item in the item bank is developed for and clearly aligned to one skill. Answering an item correctly does not require math knowledge beyond the expected knowledge for the skill being assessed. The reading level and math level of the item are grade-level appropriate.The ATOS readability formula is used to identify reading level.

Star Math items are multiple-choice. Most items have four answer choices. An item may have two or three answer choices if appropriate for the skill. Items are distributed among difficulty levels. Correct answer choices are equally distributed by difficulty level.

Item development meets established demographic and contextual goals that are monitored during development to ensure the item bank is demographically and contextually balanced. Goals are established and tracked in the following areas: gender, ethnicity, occupation, age, and disability. Items adhere to strict bias and fairness criteria. Items are free of stereotyping, representing different groups of people in non-stereotypical settings. Items do not refer to inappropriate content that includes, but is not limited to content that presents stereotypes based on ethnicity, gender, culture, economic class, or religion; presents any ethnicity, gender, culture, economic class, or religion unfavorably; introduces inappropriate information, settings, or situations; references illegal activities; references sinister or depressing subjects; references religious activities or holidays based on religious activities; references witchcraft; or references unsafe activities.

The majority of items within a skill are homogeneous in presentation, format, or scenario, but have differing computations. A skill may have two or three scenarios which serve as the basis for homogeneous groupings of items within a skill. All items for a skill are unique. Text is typically presented as 18-point Arial, but smaller text may be necessary to label charts or graphs. Every complete item is presented on screen with stimulus, stem and answer choices visible. Scroll bars are never used, to minimize cognitive load and confusion created by not having all relevant information available at once. Graphics are included in an item only when necessary to solve the problem.

Item stems meet the following criteria with limited exceptions. When possible, the stem is presented in purely mathematic form or may be limited to a single direction such as “simplify.” When an item requires more complex language, the question is concise, direct, and a complete sentence. The question is written so students can answer it without reading the distractors. Generally, completion (blank) stems are not used. If a completion stem is necessary, the stem contains enough information for the student to complete the stem without reading the distractors, and the completion blank is as close to the end of the stem as possible. The stem does not include verbal or other clues that hint at correct or incorrect distractors. The syntax and grammar are straightforward and appropriate for the grade level.

Negative construction is avoided. The stem does not contain more than one question or part. Concepts and information presented in the items are accurate, up-to-date, and verifiable. This includes but is not limited to dates, measurements, locations, and events.

Distractors meet the following criteria with limited exceptions. All distractors are plausible and reasonable. Distractors do not contain clues that hint at correct or incorrect distractors. Incorrect answers are created based on common student mistakes. Distractors that are not common mistakes may vary between being close to the correct answer or close to a distractor that is the result of a common mistake. Distractors are independent of each other, are approximately the same length, have grammatically parallel structure, and are grammatically consistent with the stem. *None of these, none of the above, not given, all of the above,* and *all of these* are generally avoided as distractors.

Item Development Guidelines: Star Math Progress Monitoring

- When preparing specific items to test student knowledge of the content selected for Star Math Progress Monitoring, several item-writing rules were employed. These rules helped to shape the final appearance of the content and hence became part of the content specifications:
- The first and perhaps most important rule was to have the item content, wording, and format reflect the typical appearance of the content in curricular materials. In some testing applications, one might want the item to look different from how the content typically appears in curricular materials. However, the goal for the Star Math test was to have the items reflect how the content appears in curricular materials that students are likely to have used.
- Second, every effort was made to keep item content simple and to keep the required reading levels low. Although there may be some situations in which one would want to make test items appear complex or use higher levels of reading difficulty, for the Star Math test, the intent was to simplify when possible.
- Third, efforts were made both in the item-writing and in the item-editing phases to minimize cultural loading, gender stereotyping, and ethnic bias in the items.
- Fourth, the items had to be written in such a way as to be presented in the computer-adaptive format. More specifically, items had to be presentable on the types of computer screens commonly found in schools. This rule

had one major implication that influenced item presentation: artwork was limited to fairly simple line drawings, and colors were kept to a minimum.

- Finally, items were all to be presented in a multiple-choice format. Answer choices were to be laid out in either a 4 × 1 matrix, a 2 × 2 matrix, or a 1 × 4 matrix.

In all cases, the distractors chosen were representative of the most common errors for the particular question stem. A “not given” response option was included only for the Computation Processes strand. This option was included to minimize estimation as a response strategy and to encourage the student to actually work the problem to completion.

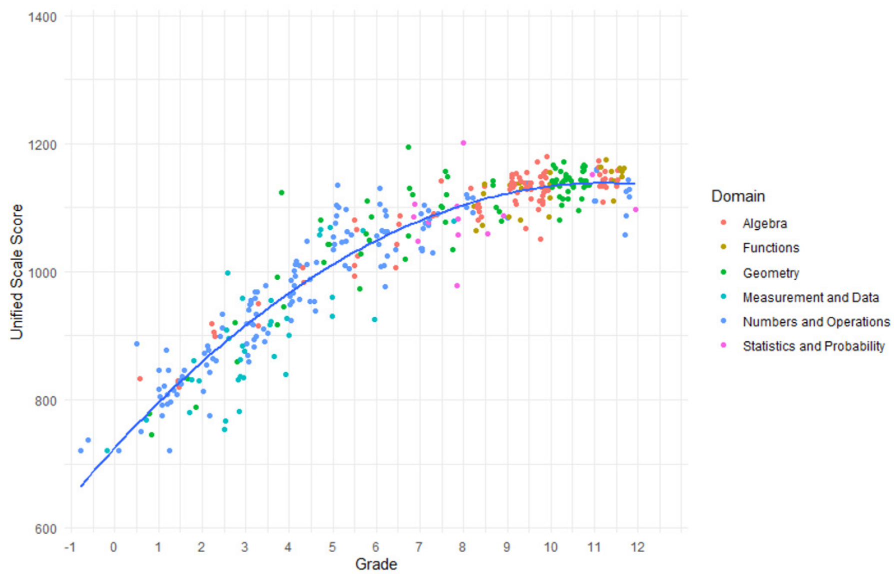
Star Math and Renaissance Learning Progressions for Math

Star Math bridges assessment and instruction through research-based learning progressions to help teachers make effective instructional decisions and to adjust instruction to meet the needs of student at different achievement levels. Star Math assesses more than 790 grade-specific blueprint skills with items developed and aligned to each skill. The skills measured by Star Math are drawn from an overarching pool of skills known as the universal skills pool. The universal skills pool contains the full range of skills reflected in state content standards from all 50 US states and the District of Columbia from early numeracy to high-school level algebra and geometry. The universal skills pool continues to grow and evolve as state standards change and are updated. Learning progressions are created by mapping the skills in the universal skills pool to different content standards. Learning progressions define coherent and continuous pathways in which students acquire knowledge and skills and present the knowledge and skills in teachable orders that can be used to inform instructional decisions.

The first learning progression created for Star Math was the Renaissance Core Progress for Math Learning Progression, which identifies a continuum of math skills that span from early numeracy through high-school level algebra and geometry. It was developed in consultation with leading experts in mathematics by reviewing research and curricular documents and standards, including the National Council of Teachers of Mathematics Curriculum Focal Points, the early work of the National Mathematics Advisory Panel, state and international mathematics standards, and the American Diploma Project Benchmarks. The Renaissance Core Progress for Math Learning Progression is supported by calibration data and psychometric analyses and is regularly refined and updated. Item calibration data from Star Math continually shows that there is a strong correlation between rank ordering of skills in the Renaissance Core Progress for Math Learning Progression and the item difficulty estimates of items written to measure those skills that are used in Star Math.

Figure 1 illustrates the relationship between the sequential order of skills in the Renaissance Core Progress for Math Learning Progression and the average difficulty of the Star Math items measuring that skill on the Star Math Unified scale. Each skill is represented by a single data point with skills in each learning progression domain represented by different color points. The figure shows that skills that are ordered later in the Renaissance Core Progression for Math Learning Progression are often more difficult than skills that are represented earlier in the progression.

Figure 1: Renaissance Core Progress Learning Progression for Math



The relationships shown in Figure 1 continue to evolve as the validation process is ongoing and new Star Math items continue to be written. The continual updating of the Renaissance Core Progress for Math Learning Progression is important to ensure that the ordering of the skills in the Renaissance Core Progress for Math Learning Progression is an accurate representation of the order in which students learn math skills and concepts. To that end, item calibration data collected from Star Math is continuously used to validate and refine learning progressions.

Renaissance now develops individualized learning progressions for all 50 states and the District of Columbia. These state specific learning progressions are also updated yearly as state standards change. The state specific learning progressions cover specific skills represented in each state's grade-level content standards. To create these state specific learning progressions, each state's content standards are analyzed, tagged, and mapped to skills in the universal skills pool. When standards address areas of learning not yet addressed in the universal skills pool, new skills are developed and added to the universal skills pool and potentially added as new Star Math skills. Since Star Math CAT items are written to specific skills which are in turn mapped to skills in the universal skills pool, this allows data from Star Math CAT items to inform state specific learning progression and allows Star Math to report results on state specific content standards and learning progressions. This mapping of Star Math CAT items to skills in the universal skills pool which are in turn mapped to each state's grade-level content standards is one way in which Renaissance works to ensure alignment between Star Math and state content standards.

When a student completes a Star Math assessment, the program uses that student's performance to place the student at the appropriate point in the learning progression designated for that school. This learning progression is usually the state specific learning progression in which the school is located. Locating students in the learning progression helps teachers to identify the skills that students are likely to have already learned and the skills they are ready to learn next. It also indicates whether students are meeting the grade-level performance expectations established by state content standards.

Item and Scale Calibration

Background

Item calibration entails estimating the scaled difficulty of test items by administering them to examinees whose ability is known or estimated, then fitting response models that express the probability of a correct response to each item as a function of examinee ability. To provide accurate item difficulty parameter estimates requires an adequate number of responses to each item, from examinees spanning a broad range of ability. The distribution of ability in the examinee samples need not be closely representative of the distribution of ability in the population, but it needs to be diverse, with large enough numbers of observations above and below the middle of the ability range, as well as from the middle itself.

The introduction of the second generation of Star Math marks the third major evolution in the calibration of Star Math items. For the original 1998 version of Star Math, data for item calibration were collected using printed test booklets and answer sheets, in which the items were formatted to closely match the appearance those items would later take when displayed on computer screens. For the first revision of Star Math in 2002, data collection was done entirely by computer, using a special-purpose application program that administered fixed test forms, but did so on screen, with the same display format and user interface later used in the adaptive version of Star Math 2 (the current Progress Monitoring version). For Star Math versions released since 2011, new test items to be calibrated were embedded as unscored items in Star Math itself, and the data for calibration were collected by the Star Math software. Renaissance Learning calls this data collection process dynamic calibration.

For the original version of Star Math, approximately 2,450 items were prepared according to the defined Star Math content specifications. These items were subjected to empirical tryout in 1997 in a national sample of students in grades 3–12. Following both traditional and item response theory (IRT) analyses of the resulting item response data, 1,434 of the items were chosen for use in the original Star Math item bank.

In the development of Star Math 2, about 1,100 new items were written. The new items extended the content of the Star Math item bank to include grades 1–12 and expanded the algebra coverage by adding a number of new algebra objectives. Where needed, items measuring other objectives were written to supplement existing items. (Later versions of the program used this same item bank.)

All of the new items had to be calibrated on the same difficulty scale as the original Star Math item bank. Because a number of changes in item display features were introduced with Star Math 2, Renaissance Learning decided to recalibrate the original Star Math adaptive item bank simultaneously with the new items written specifically for Star Math 2. During that Calibration Study, 2,471 items, including both the existing and the new items, were administered to a national sample of more than 44,000 students in grades 1–12 in the spring of 2001.

For the development of the 34-item Star Math, several thousand new items spanning content appropriate for grades 1–10 were developed. Data for calibrating them were collected using the dynamic calibration feature of Star Math. Using that feature, which was introduced in 2008, small numbers of new, uncalibrated items are randomly selected for each student, and embedded at appropriate random points in Star Math tests. Each student may be administered a small number of these new, uncalibrated items. When a sufficient quantity of response data on the new items has accumulated, calibration analyses take place. Star Math is an application of the Rasch, 1-parameter logistic item response model. For each new item, its location on the Rasch difficulty scale is estimated by fitting a logistic response function to the item responses and Rasch ability scores of the participating examinees. This chapter will describe Rasch item response model, and the criteria applied to screen calibrated items for inclusion in the Star Math item banks. Following that, it will summarize two major item calibration efforts.

The first of these was the calibration of items for use in Star Math Version 2. As noted above, that effort included re-calibration of the original Star Math items, along with new items developed specifically for Star Math 2. Those analyses established the Star Math Rasch ability/item difficulty scale that continues in use today with both versions of Star Math: the 24-item Star Math Progress Monitoring version, an assessment of general math achievement; and the current Star Math, a 34-item standards-based assessment.

The second calibration effort described below was done in advance of the introduction of the current Star Math, a 34-item standards-based version first introduced in 2011. To support the longer test, which assesses a more extensive variety of math skills, a much larger item bank was developed.

The Rasch Item Response Model

In addition to traditional item analyses, the Star Math calibration data are analyzed using item response theory (IRT) methods. Item response theory is widely recognized as the most sophisticated testing approach today.

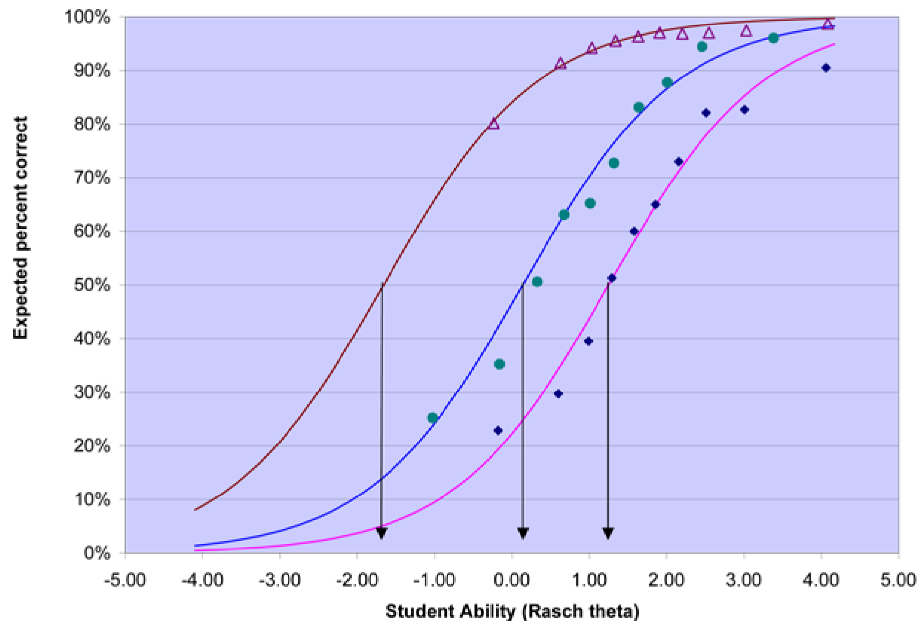
With IRT, the performance of students and the items they answer are placed on the same scale. To accomplish this, every test question is calibrated. Calibration is an IRT-based analytical method for estimating the location of a test question on a common scale used to measure both examinee ability and item difficulty. It is done by administering each question to hundreds and sometimes thousands of students with known performance levels. As a result of calibration, Star "knows" the relative difficulty of every item from kindergarten through grade 12, and expresses it on a developmental scale spanning from the easiest to the hardest questions in the item bank. After taking a Star assessment, a student's score can be plotted on this developmental scale. Placing students and items on the same scale is the breakthrough of IRT because it makes it possible to assign scores on the same scale even though students take different tests. IRT also provides a means to estimate what skills a student knows and doesn't know, without explicitly testing each and every skill.

IRT methods develop mathematical models of the relationship of student ability to the difficulty of specific test questions; more specifically, they model the probability of a correct response to each test question as a function of student ability and item difficulty. Although IRT methods encompass a family of mathematical models, the one-parameter IRT (or Rasch) model was selected for the Star Math data both for its simplicity and its ability to accurately model the performance of the Star Math items.

Within IRT, the probability of answering an item correctly is a function of the student's ability and the difficulty of the item. Since IRT places the item difficulty and student ability on the same scale, this relationship can be represented graphically in the form of an item response function (IRF).

Figure 2 on page 29 is a plot of three item response functions: one for an easy item, one for a more difficult one, and one for an even harder item. Each plot is a continuous S-shaped (ogive) curve. The horizontal axis is the scale of student ability, ranging from very low ability (–5.0 on the scale) to very high ability (+5.0 on the scale). The vertical axis is the percent of students expected to answer each of the three items correctly at any given point on the ability scale. Notice that the expected percent correct increases as student ability increases, but varies from one item to another.

Figure 2: Three Examples of Item Response Functions



In Figure 2, each item's difficulty is the scale point where the expected percent correct is exactly 50. These points are depicted by vertical lines going from the 50% point to the corresponding locations on the ability scale. The easiest item has a difficulty scale value of about –1.67; this means that students located at –1.67 on the ability scale have a 50-50 chance of answering that item right. The scale values of the other two items are approximately +0.20 and +1.25, respectively.

Calibration of test items estimates the IRT difficulty parameter for each test item and places all item parameters onto a single scale used to assess the difficulty of test items, and the ability of students, ranging from Kindergarten through 12th grade level. The difficulty parameter for each item is estimated, along with measures to indicate how well the item conforms to (or "fits") the theoretical expectations of the presumed IRT model.

Also plotted in Figure 2 are the actual percentages of correct responses of groups of students to all three items. Each group is represented as a small triangle, circle, or diamond. Each of those geometric symbols is a plot of the percent correct against the average ability level of the group. Ten groups' data are plotted for each item; the triangular points represent the groups responding to the easiest item. The circles and diamonds, respectively, represent the groups responding to the moderate and to the most difficult item.

Calibration of Items for Star Math Version 2

This section summarizes the psychometric research and development undertaken to prepare the large pool of calibrated math test items for use in Star Math version 2 (now called Star Math Progress Monitoring). As already described above, about 1,100 items spanning grades 1 to 12 were added to the original bank of about 1,400 items and data were collected in the Spring of 2001. The calibration analyses of those items established the underlying Star Math Rasch scale that persists today. The methodology used to develop that scale is summarized below.

Sample Description

To obtain a sample that was representative of the diversity of mathematics achievement in the US school population, school districts, specific schools, and individual students were selected to participate in the Star Math 2 Calibration Study. The sampling frame consisted of all US schools, stratified on three key variables: geographic region of the country, school size, and socioeconomic status. The Star Math calibration sample included students from 261 schools from 45 of the 50 United States. Table 5 and Table 6 present the characteristics of the calibration sample.

Table 5: Sample Characteristics, Star Math 2 Calibration Study—Spring 2001 (N = 44,939 Students)

		Students	
		National %	Sample %
Geographic Region	Northeast	20.4%	7.8%
	Midwest	23.5%	22.1%
	Southeast	24.3%	37.3%
	West	31.8%	32.9%
District Socioeconomic Status	Low	28.4%	30.2%
	Average	29.6%	38.9%
	High	31.8%	23.1%
	Non-Public	10.2%	8.1%
School Type and District Enrollment	Public		
	< 200	15.8%	24.2%
	200–499	19.1%	26.2%
	500–1,999	30.2%	26.4%
	2,000 or More	24.7%	15.1%
	Non-Public	10.2%	8.1%

Table 6: Ethnic Group and Gender Participation, Star Math 2 Calibration Study—Spring 2001 (N = 44,939 Students)

		Students	
		National %	Sample %
Ethnic Group	Asian	3.9%	2.8%
	Black	16.8%	14.9%
	Hispanic	14.7%	10.3%
	Native American	1.1%	1.6%
	White	63.5%	70.4%
Gender	Female	Not available	49.8%
	Male	Not available	50.2%

Item Presentation

The Star Math 2 calibration data were collected by administering test items on screen, with display characteristics identical to those implemented in the earlier Star Math version. However, the calibration items were administered in forms consisting of fixed sequences of items, as opposed to the adaptive testing format.

Seven levels of test forms were constructed corresponding to varying grade levels. Because growth in mathematics is much more rapid in the lower grades, there was only one grade per level for the first four levels. As grade level increases, there is more variation among both students and school curricula, so a single test level can cover more than one grade level. Grades were assigned to test levels after extensive consultation with mathematics instruction experts, and assignments were consistent both with the Star Math item development framework and with assignments used in other math achievement tests. To create the levels of test forms, therefore, items were assigned to grade levels such that resulting test forms sampled an appropriate range of objectives from each of the strands that are typically represented at or near the targeted grade levels. Table 7 on page 32 describes the various test form designations used for the Star Math 2 Calibration Study.

Table 7: Test Form Levels, Grades, Numbers of Items per Form and Numbers of Test Forms, Star Math 2 Calibration Study—Spring 2001

Level	Grades	Items per Form	Forms	Items
A	1	36	14	152
B	2	36	22	215
C	3	36	32	310
D	4	36	34	290
E	5–6	46	36	528
F	7–9	46	32	516
G	10–12	46	32	464

Students in grades 1–4 (Levels A, B, C, and D) took 36-item tests consisting of three practice items and 33 actual test items. Expected testing time for these students was 30 minutes. Students in grades 5–12 (Levels E, F, and G) took 46-item tests consisting of three practice items and 43 actual test items. Expected testing time for these students was 40 minutes.

Items within each level were distributed among a number of test forms. Consistent with the previous version of Star Math, the content of each form was balanced between two broad categories of items: items measuring Numeration Concepts and Computation Processes and items measuring Other Applications. Each form was organized into three sections: A, B, and C. Sections A and C each consisted of approximately 40% of the test length, and contained items from both categories.

Section A began with items measuring Numeration Concepts and Computation Processes, followed by items measuring Other Applications. Section C reversed this order, with Other Applications items preceding Numeration Concepts and Computation Processes items.

Section B comprised approximately 20% of the test length, and contained two types of anchor items. “Horizontal anchors” were common to a number of test forms at the same level, and “vertical anchors” were common to forms at adjacent levels. The anchor items were used to facilitate later analyses that placed all item difficulty parameters on a common scale.

With the exception of Levels A and G, approximately half of the vertical anchor items in each form came from the next lower level, and the other half came from the next higher level. Items chosen as vertical anchor items were selected partially based on their difficulty; items expected to be answered correctly by more than 80 percent or fewer than 50 percent of out-of-level students were not used as vertical anchor items. Two versions of each form were used: version A and version B. Each version A form consisted of Sections

A, B, and C in that order. Each version B form contained the same items, arranged in reverse order, with Section C followed by Sections B and A. The alternate forms counterbalanced the order of item presentation, as a defense against possible order effects influencing the psychometric properties of the items. In all three test sections, items were chosen so that content was balanced at each level, with the numbers of items measuring each of the content domains roughly proportional to the distribution of items among the domains at each level.

In Levels A–G combined, there were 101 unique sets of test items. Each set was arranged in two alternate forms, versions A and B, that differed only in terms of item presentation order. Therefore, there was a total of 202 test forms.

Calibration of New Items for Current Star Math Versions

As described above, beginning in 2008 and continuing with the current version of Star Math, data needed for item calibration have been collected on-line, by embedding small numbers of uncalibrated items within Star Math tests. After sufficient numbers of item responses have accumulated, the Rasch difficulty of each new item is estimated by fitting a logistic model to the item response data and the Star Math Rasch scores of the students' tests. Renaissance Learning calls this overall process "dynamic calibration."

Typically, dynamic calibration is done in batches of several hundred new test items. Each student's test may include between 1 and 5 uncalibrated items. Each item is tagged with a grade level, and is typically administered only to students at that grade level and the next higher grade. The selection of the uncalibrated items to be administered to each student is at random, resulting in nearly equivalent distributions of student ability for each item at a given grade level.

Both traditional and IRT item analyses are conducted of the item response data collected. The traditional analyses yielded proportion correct statistics, as well as biserial and point-biserial correlations between scores on the new items and actual scores on the Star Math tests.

For dynamic calibration, a minimum of 1,000 responses per item is the data collection target. In practice, because of the very large number of Star Math tests administered each year, the average number of students responding to each new test item is typically several times the target. The calibration analysis proceeds one item at a time, using SAS/STAT™ software to estimate the threshold (difficulty) parameter of every new item by calculating the non-linear regression of item scores (0 or 1) on the Star Math Rasch ability estimates. The accuracy of the non-linear regression approach has been corroborated by conducting parallel analyses using Winsteps software. In tests, the two methods yielded virtually identical results.

The “dynamic calibration” approach taken to obtain response data for Star Math new item calibration today is quite different from the approaches taken in the development of item banks for the original Star Math and Star Math 2.

The earlier approaches employed multiple fixed-form field tests as the vehicle for new item response data collection; the analyses themselves fit response models to the new items, using the response data itself as the basis for estimating examinee ability. In today’s Star Math, items to be calibrated are embedded as unscored items in Star Math, and the Star Math scores are employed as the ability estimates against which the response models are fit. To ensure a broad diversity of examinee ability, uncalibrated items are selected randomly and administered to students at the target grade level of each item, as well as one grade level above the target, and in some cases one grade level below. Although a nationally representative examinee sample is not required for item calibration, it is useful to evaluate the diversity of the samples who contributed to the calibration data.

This section describes an example of one large dynamic calibration cycle. Table 8, Table 9, and Table 10 on the next page summarize demographic data on about 1.5 million students and 2,473 new items that were part of this process between February 2010 and July 2011. Similar-sized student and item samples were calibrated during other periods, throughout the 2008, 2009, and 2010 school years.

Over 1.5 million students from 7,340 schools in 49 states in addition to Canada and the US Virgin Islands contributed to the overall response data set. Many of those students took two or more Star Math tests during that interval; the total number of tests taken was over 3 million. The number of responses per item ranged from 520 to 58,805, with a median of 2,561.

Of the students participating, 1,446,760 were in US schools; selected demographic data on the U.S. students are in the following tables. Table 8 displays the recorded demographic characteristics of those examinees. Table 9 displays the distribution of the examinees by region of the US; examinees from Canada and outside North America also participated, but their numbers were quite small and are not reported here. Table 10 displays the distribution by gender. Entering the data for each of these analyses was optional; each table tallies only those cases for which the relevant data elements were recorded.

Table 8: Sample Ethnicity, Star Math Calibration Study—February 2010–July 2011 (N = 1,446,760 US Students)

Ethnicity Description	Observations	Observed Percentage	Population Percentage
American Indian or Alaskan Native	16,058	2.99	1.1
Asian or Pacific Islander	16,332	3.04	3.9
Black	156,416	29.13	16.8
Hispanic	105,433	19.64	14.7
Other Race or Ethnicity	1,577	0.29	–
White	241,103	44.90	63.5
Total Observations	536,919		

Table 9: Sample by US Region, Star Math Calibration Study—February 2010–July 2011 (N = 1,446,760 US Students)

Region	Observations	Observed Percentage	Population Percentage
Midwest	169,311	26.13	23.50
Northeast	39,810	6.14	20.40
Southeast	231,819	35.78	24.30
West	207,042	31.95	31.80
Total	647,982		

Table 10: Sample by Gender, Star Math Calibration Study—February 2010–July 2011 (N = 1,446,760 US Students)

Gender	Observations	Observed Percentage	Population Percentage
Female	490,357	48.22	Not available
Male	526,471	51.78	
Total	1,016,828		

Star Math calibration analyses since 2008 followed similar courses. Following extensive quality control checks, the item response data are analyzed using both traditional item analysis techniques and item response theory (IRT) methods. For each test item, the following information is derived using traditional psychometric item analysis techniques:

- The number of students who attempted to answer the item.
- The number of students who did not attempt to answer the item.
- The percentage of students who answered the item correctly (a traditional measure of difficulty).

- The percentage of students answering each option and the alternatives.
- The correlation between answering the item correctly and the total score (a traditional measure of discrimination).
- The correlation between the endorsement of each alternative answer and the total score.

Traditional Item Difficulty

The difficulty of an item in traditional item analysis is the percentage (or proportion) of students who answer the item correctly. This is typically referred to as the “p-value” of the item. Low p-values (such as 15%) indicate that the item is difficult since only a small percentage of students answered it correctly. High p-values indicate that the majority of students answered the item correctly and thus, the item is easy. It should be noted that the p-value only has meaning for a particular item relative to the characteristics of the sample of students who responded to it.

Item Discriminating Power

The traditional measure of the discriminating power of an item is the correlation between the “score” on the item (correct or incorrect) and the total test score. Items that correlate highly with total test score will also tend to correlate with one another more highly and produce a test with more internal consistency. For the correct answer, the higher the correlation between the item score and the total score, the better the item is at discriminating between low-scoring and high-scoring individuals. When the correlation between the correct answer and the total test is low (or negative), the item is most likely not performing as intended. The correlation between endorsing incorrect answers and the total score should generally be negative, since there should not be a positive relationship between selecting an incorrect answer and scoring higher on the overall test.

At least two different correlation coefficients are commonly used during item analysis: the point-biserial and the biserial coefficients. The former is a traditional product-moment correlation that is readily calculated, but is known to be somewhat biased in the case of items with p-values that deviate from 0.50. The biserial correlation is derived from the point-biserial and the p-value, and is preferred by many because it in effect corrects for the point-biserial’s bias at low and high p-values. For item analysis of Star Math 2 data, the correlation coefficient of choice was the biserial.

Urry (1975) demonstrated that in cases where items could be answered correctly by guessing (e.g., multiple choice items) the value of the biserial correlation is itself attenuated at p-values different from 0.50, and particularly as the p-value approaches the chance level. He derived a correction for this attenuation, which we will refer to as the "Urry biserial correlation." Urry demonstrated that multiple choice adaptive tests are more efficient than conventional tests only if the adaptive tests use items with Urry biserial values that are considerably higher than the target levels often used to select items for conventional test use. His suggestion was to reject items with Urry biserial values lower than 0.62. Item analyses of the Star Math have used the Urry biserial as the correlation coefficient of choice; item selection/rejection decisions have been based in part on his suggested target of 0.62.

Rules for Item Retention

Following these analyses, each test item, along with both traditional and IRT analysis information and information about the test level, form, and item identifier, is stored in a specialized item statistics database system. A panel of internal reviewers then examines each item's statistics to determine whether the item met all criteria for inclusion in the bank of Star Math items. The item statistics database system allows experts easy access to all available information about an item in order to interactively designate items that, in their opinion, meet acceptable standards for inclusion in the Star Math item bank.

Items are eliminated when they meet one or more of the following criteria:

- Item-total correlation (item discrimination) less than the minimum (Urry biserial < 0.62)
- One or more incorrect answer options has a positive item discrimination value
- Sample size of students responding to the item less than 1,000
- The traditional item difficulty indicates that the item is too difficult or too easy
- The item does not appear to fit the Rasch IRT model

In the case of the batch of 2,473 items used in the example of Star Math item calibration above, 884 items (36%) met all the retention rules above, and were accepted for operational use as part of the Star Math adaptive test item bank. Another 538 items met all criteria except the Urry biserial target. Such items would meet commonly applied criteria for use in most conventional tests; those 538 items were retained for use for certain analytical purposes, but will not be used for adaptive testing in Star Math.

Computer-Adaptive Test Design

An additional level of content specification is determined by the student's performance during testing. In conventional paper-and-pencil standardized tests, items retained from the item tryout or item calibration program are organized by level. Then, each student takes all items within a given test level. Thus, the student is only tested on those mathematical operations and concepts deemed to be appropriate for his or her grade level.

On the other hand, in computer-adaptive tests, such as Star Math, the items taken by a student are dynamically selected in light of that student's performance during the testing session. Thus, a low-performing student's knowledge of math operations may branch to easier operations to better estimate math achievement level, and high-performing students may branch to more challenging operations or concepts to better determine the breadth of their math knowledge and their math achievement level.

During an adaptive test, a student may be "routed" to items at the lowest level of difficulty within the overall pool of items, dependent upon the student's unfolding performance during the testing session. In general, when an item is answered correctly, the student is routed to a more difficult item. When an item is answered incorrectly, the student is instead routed to an easier item. In the case of Star Math, the brancher selects items with a 67 percent expectation of a correct response, given the student's estimated ability, and the item's calibrated difficulty.

A Star Math test consists of a fixed-length, 34-item adaptive test; Star Math Progress Monitoring tests are 24 items in length. Students who have not taken a Star Math test within 180 days initially receive an item whose difficulty level is relatively easy for students at that grade level. This minimizes any effects of initial anxiety that students may have when starting the test and serves to better facilitate the students' initial reactions to the test. The starting points vary by grade level and are based on research conducted as part of the norming process.

When a student has taken a Star Math test within the previous 180 days, the appropriate starting point is based on his or her previous test score information. Following the administration of the initial item, and after the student has entered an answer, the program determines an updated estimate of the student's math achievement level. Then, it selects the next item randomly from among all of the available items having a difficulty level that closely match a target based on the estimated achievement level. Randomization of items with difficulty values near the target level allows the program to avoid overexposure of test items.

Items that have been administered to the same student within the past 120 days are not available for administration. In addition, to avoid frustration, items that are intended to measure advanced mathematical concepts and operations that are more than three grade levels beyond the student's grade level, as determined by where such concepts or operations are typically introduced in math textbooks, are also not available for administration. Because the item pools make a large number of items available for selection, these minor constraints have a negligible impact on the quality of each Star Math computer-adaptive test.

Scoring in the Star Math Tests

Following the administration of each Star Math item, and after the student has selected a response, an updated estimate of the student's underlying math achievement level is computed based on the student's responses to all of the items administered up to that point. A proprietary Bayesian-modal IRT estimation method is used for scoring until the student has answered at least one item correctly and at least one item incorrectly. Once the student has met this 1-correct/1-incorrect criterion, the software uses a proprietary Maximum-Likelihood IRT estimation for scoring.

This approach to scoring enables the software to provide Scaled Scores that are statistically consistent and efficient. Scaled Scores are expressed on a common scale that spans all grade levels covered by the Star Math test. Because the software expresses Scaled Scores on a common scale, Scaled Scores are directly comparable with each other, regardless of grade level. Other scores, such as Percentile Ranks and Grade Equivalents, are derived from the Scaled Scores obtained during the Star Math norming studies.

A New Scale for Reporting Star Math Test Scores

In 1998, Renaissance Learning released the initial 24-item version of Star Math. In 2011, the 34-item standards-based Star Math test was published. Although Star Math measures constructs that are different from those assessed in Star Reading, a common scale—the Unified Score Scale—that can be used to report scores on both tests was recently developed. The Unified Score Scale was introduced into use in the 2017–2018 school year as an optional alternative scale for reporting achievement on all Star tests.

The Unified Score Scale is derived from the Star Reading Rasch scale of ability and difficulty, which was first introduced with the development of Star Reading Version 2.

The Unified Star Math scale was developed by performing the following steps:

- The Rasch scale used by Star Math was linked (transformed) to the Star Reading Rasch scale.
- A linear transformation of the transformed Rasch scale was developed that spans the entire range of knowledge and skills measured by both Star Math and Star Reading.

Details of these two steps are presented below.

1. The Rasch scale used by Star Math was linked to the Star Reading Rasch scale.

   In this step, a linear transformation of the Star Math Rasch scale to the Rasch scale used by Star Reading was developed, using a method for linear equating of IRT (item response theory) scales described by Kolen and Brennan (2004, pages 162–165).

2. Because Rasch scores are expressed as decimal fractions, and may be either negative or positive, a more user-friendly scale score was developed that uses positive integer numbers only. A linear transformation of the extended Star Reading Rasch scale was developed that spans the entire range of knowledge and skills measured by both Star Math and Star Reading. The transformation formula is as follows:

   Unified Scale Score = INT (42.93 * Star Reading Rasch Score + 958.74)

   where the Star Reading Rasch score has been extended downwards to values as low as –20.00.

   Following are some features and considerations in the development of that scale, called here the "Unified scale."

   a. For both Star Math and Star Reading, the range of reported Unified scales is from 600 to 1400. Anchor points were chosen such that the Unified scale score of 600 is approximately equivalent to a Star Math scale score of 0, and a Unified score of 1400 is the approximate equivalent of 1300 on the Star Math scale.

   b. The scale is extensible upwards and downwards. Currently, the highest reported Star Math Unified scale score is 1400, but there is no theoretical limit: if Star Math content were extended beyond the high school level, the range of the new scale can be extended upward without limit, as needed. The lowest point is now set at 600, but the Unified scale can readily be extended downward as low as 0, if a reason arises to do so.

Table 11 contains a table of selected Star Math Rasch ability scores and their equivalents on the Star Math and Unified Score scales.

Table 11: Some Star Math Rasch Scores and their Equivalents on the Star Math and Unified Score Scales

Minimum Rasch Score	Star Math Scaled Score	Unified Scale Score
−8.35	0	600
−7.72	50	638
−7.08	100	668
−6.45	150	699
−5.81	200	730
−5.18	250	761
−4.54	300	791
−3.91	350	822
−3.27	400	853
−2.64	450	884
−2.00	500	914
−1.37	550	945
−0.74	600	976
−0.10	650	1007
0.54	700	1037
1.17	750	1068
1.81	800	1099
2.44	850	1130
3.07	900	1160
3.71	950	1191
4.34	1000	1222
4.98	1050	1253
5.61	1100	1283
6.25	1150	1314
6.88	1200	1345
7.52	1250	1376
8.15	1300	1400

Reliability and Measurement Precision

Measurement is subject to error. A measurement that is subject to a great deal of error is said to be imprecise; a measurement that is subject to relatively little error is said to be *reliable*. In psychometrics, the term *reliability* refers to the degree of measurement precision, expressed as a proportion. A test with perfect score precision would have a reliability coefficient equal to 1, meaning that 100 percent of the variation among persons' scores is attributable to variation in the attribute the test measures, and none of the variation is attributable to error. Perfect reliability is probably unattainable in educational measurement; for example, a test with a reliability coefficient of 0.90 is more likely. On such a test, 90 percent of the variation among students' scores is attributable to the attribute being measured, and 10 percent is attributable to errors of measurement. Another way to think of score reliability is as a measure of the consistency of test scores. Two kinds of consistency are of concern when evaluating a test's measurement precision: internal consistency and consistency between different measurements. First, internal consistency refers to the degree of confidence one can have in the precision of scores from a single measurement. If the test's internal consistency is 95 percent, just 5 percent of the variation of test scores is attributable to measurement error.

Second, reliability as a measure of consistency between two different measurements indicates the extent to which a test yields consistent results from one administration to another and from one test form to another. Tests must yield somewhat consistent results in order to be useful; this reliability coefficient is obtained by calculating the coefficient of correlation between students' scores on two different occasions, or on two alternate versions of the test given at the same occasion.

Because the amount of the attribute being measured may change over time, and the content of tests may differ from one version to another, the internal consistency reliability coefficient is generally higher than the correlation between scores obtained on different administrations.

There are a variety of methods of estimating the reliability coefficient of a test. Methods such as Cronbach's alpha and split-half reliability are single administration methods and assess internal consistency. Coefficients of correlation calculated between scores on alternate forms, or on similar tests administered two or more times on different occasions, are used to assess alternate forms reliability, or test-retest reliability (stability).

In a computerized adaptive test such as Star Math, content varies from one administration to another, and it also varies with each student's performance. Another feature of computerized adaptive tests based on Item Response

Theory (IRT) is that the degree of measurement error can be expressed for each student's test individually.

The Star Math tests provide two ways to evaluate the reliability of scores: reliability coefficients, which indicate the overall precision of a set of test scores, and conditional standard errors of measurement (CSEM), which provide an index of the degree of error in an individual test score. A reliability coefficient is a summary statistic that reflects the average amount of measurement precision in a specific examinee group or in a population as a whole. In Star Math, the CSEM is an estimate of the unreliability of each individual test score. While a reliability coefficient is a single value that applies to the test in general, the magnitude of the CSEM may vary substantially from one person's test score to another's. Another part of evaluating reliability is looking at the reliability of classification decisions. In many applications of Star Math, three normative benchmarks, set at the 10th, 25th, and 40th percentile ranks, are used to classify students into the performance categories of intensive intervention, intervention, on watch, and at/above benchmark. These classifications are often used in a response-to-intervention (RTI) and multi-tiered system of supports (MTSS) framework by schools. To look at reliability of classifications based on benchmarks, decision accuracy and decision consistency indices can be computed. Like reliability coefficients based on test scores, decision accuracy and consistency indices range from 0 to 1 with values close to 1 indicating more accurate and consistent classifications.

This chapter presents three different types of reliability coefficients: generic reliability, split-half reliability, and alternate form reliability. This is followed by statistics on the conditional standard error of measurement of Star Math test scores. The chapter also presents indices of decision accuracy and consistency.

The reliability and measurement error presentation is divided into two sections below: First is a section describing the reliability coefficients, standard errors of measurement, and decision accuracy and consistency indices for the 34-item Star Math tests. Second, another brief section presents reliability coefficients, standard errors of measurement, and decision accuracy and consistency indices for the 24-item Star Math progress monitoring tests.

34-Item Star Math Tests

Generic Reliability

Test reliability is generally defined as the proportion of test score variance that is attributable to true variation in the trait the test measures. This can be expressed analytically as:

$$\textit{Reliability} = 1 - \frac{\sigma^2_{error}}{\sigma^2_{total}}$$

where σ^2_{error} is the variance of the errors of measurement, and σ^2_{total} is the variance of test scores. In Star Math, the variance of the test scores is easily calculated from Scaled Score data. The variance of the errors of measurement may be estimated from the conditional standard error of measurement (CSEM) statistics that accompany each of the IRT-based test scores, including the Scaled Scores, as depicted below.

$$\sigma^2_{error} = \frac{1}{n}\sum_{i=1}^{n} SEM_i^2$$

where the summation is over the squared values of the reported CSEM for students i = 1 to n. In each Star Math test, CSEM is calculated along with the IRT ability estimate and Scaled Score. Squaring and summing the CSEM values yield an estimate of total squared error; dividing by the number of observations yields an estimate of mean squared error, which in this case is tantamount to error variance. "Generic" reliability is then estimated by calculating the ratio of error variance to Scaled Score variance, and subtracting that ratio from 1.

Using this technique with the Star Math 2018–2019 school year data resulted in the generic reliability estimates shown in the third column of Table 12. Because this method is not susceptible to error variance introduced by repeated testing, multiple occasions, and alternate forms, the resulting estimates of reliability are generally higher than the more conservative alternate form reliability coefficients. These generic reliability coefficients are, therefore, plausible upper-bound estimates of the internal consistency of the Star Math computerized adaptive test.

Table 12: Reliability Estimates from the Star Math 2018–2019 Data on both the Unified Scale and the Enterprise Scale

Grade	Reliability Estimates: For Both Unified and Enterprise Scales						
	Generic		Split-Half		Alternate Form		
	N	ρxx	N	ρxx	N	ρxx	Average Days between Testing
K	50,000	0.90	20,000	0.90	10,000	0.71	102
1	1,000,000	0.89	20,000	0.89	172,500	0.75	97
2	1,000,000	0.90	20,000	0.90	250,000	0.80	92
3	1,000,000	0.91	20,000	0.91	250,000	0.82	90
4	1,000000	0.91	20,000	0.91	250,000	0.83	91
5	1,000,000	0.92	20,000	0.92	250,000	0.85	92
6	1,000,000	0.92	20,000	0.92	225,000	0.85	101
7	1,000,000	0.93	20,000	0.93	200,000	0.85	106
8	1,000,000	0.93	20,000	0.93	200,000	0.85	105
9	400,000	0.93	20,000	0.93	85,000	0.85	113
10	400,000	0.93	20,000	0.93	65,000	0.85	114
11	100,000	0.93	20,000	0.93	40,000	0.84	113
12	100,000	0.94	20,000	0.94	20,000	0.83	109
Overall	9,050,000	0.98	260,000	0.98	2,017,500	0.94	98

Generic reliability estimates for scores on both the Unified score scale and the Enterprise score scale are shown in Table 12. Because both the Unified scaled and the Enterprise scale are linear transformations of the underlying Star Math Rasch scores, the reliability estimates are the same across both scales. Results in Table 12 indicate that the overall generic reliability of the scores was about 0.98. Coefficients ranged from a low of 0.89 in grade 1 to a high of 0.94 in grade 12.

As the data in Table 12 show, Star Math generic reliability is quite high, grade by grade and overall. Star Math also demonstrates high consistency between alternate forms as shown in the rightmost columns of the same table. Star Math's technical quality for an interim assessment is on a virtually equal footing with the highest-quality summative assessments in use today.

Split-Half Reliability

While generic reliability does provide a plausible estimate of measurement precision, it is a theoretical estimate, as opposed to traditional reliability coefficients, which are more firmly based on item response data. Traditional internal consistency reliability coefficients such as Cronbach's alpha and Kuder-Richardson Formula 20 (KR-20) are not meaningful for adaptive tests. However, an estimate of internal consistency reliability can be calculated using the split-half method.

A split-half reliability coefficient is calculated in three steps. First, the test is divided into two halves, and scores are calculated for each half. Second, the correlation between the two resulting sets of scores is calculated; this correlation is an estimate of the reliability of a half-length test. Third, the resulting reliability value is adjusted, using the Spearman-Brown formula, to estimate the reliability of the full-length test.

In internal simulation studies, the split-half method provided accurate estimates of the internal consistency reliability of adaptive tests, and so it has been used to provide estimates of Star Math reliability. These split-half reliability coefficients are independent of the generic reliability approach discussed earlier and more firmly grounded in the item response data. Split-half scores were based on all of the 34 items of the Star Math tests; scores based on the odd- and the even-numbered items were calculated separately. The correlations between the two sets of scores were corrected to a length of 34 items, yielding the split-half reliability estimates displayed in Table 12.

Results indicated that the overall split-half reliability of scores was 0.98. The coefficients ranged from a low of 0.89 in grade 1 to a high of 0.94 in grade 12. These reliability estimates were consistently high across grades 1–12, as a result of the measurement efficiency inherent in the adaptive nature of the Star Math test.

Alternate Form Reliability

Another method of evaluating the reliability of a test is to administer the test twice to the same examinees. Next, a reliability coefficient is obtained by calculating the correlation between the two sets of test scores. This is called a test-retest reliability coefficient if the same test was administered both times and an alternate form reliability coefficient if different, but parallel, tests were used.

Content sampling, temporal changes in individuals' performance, and growth or decline over time can affect alternate form reliability coefficients, usually making them appreciably lower than internal consistency reliability coefficients. The alternate form reliability study provided estimates of Star Math reliability using a variation of the test-retest method. In the traditional approach to test-retest reliability, students take the same test twice, within a short time interval, usually a few days, between administrations. In contrast, the Star Math alternate form reliability study administered two different tests by avoiding during the second test the use of any items the student had encountered in the first test. All other aspects of the two tests were identical. The correlation coefficient between the scores on the two tests was taken as the reliability estimate.

The alternate form reliability estimates for the Star Math test were calculated using the Star Math Unified scale scores. Checks were made for valid test data on both test administrations and cases of apparent motivational discrepancies were removed.

Table 12 on page 45 includes overall and within-grade alternate form reliability, along with an indication of the average number of days between testing occasions, ranging from 91–114 days. Results indicated that the overall reliability of the scores was about 0.94. The alternate form coefficients ranged from a low of 0.71 in grade K to a high of 0.85 in grades 5 to 10.

Because errors of measurement due to content sampling and temporal changes in individuals' performance can affect this correlation coefficient, this type of reliability estimate provides a conservative estimate of the reliability of a single Star Math administration. In other words, the actual Star Math reliability is likely higher than what the alternate form reliability estimates indicate.

Star Math was designed to be a standards-based assessment, meaning that its item bank measures skills identified by exhaustive analysis of national and state standards in Math, from grades K–12, including Algebra and Geometry. The 34-item Star Math content covers many more skills than previous versions of Star Math, which administered only 24 items.

The increased length of the current version of Star Math, combined with its increased breadth of skills coverage and enhanced technical quality, was expected to result in improved measurement precision; this showed up as slightly increased reliability, in both internal consistency reliability and alternate form reliability as shown in Table 12. For comparison, see Table 16.

Standard Error of Measurement

When interpreting the results of any test instrument, it is important to remember that the scores represent estimates of a student's true ability level. Test scores are not absolute or exact measures of performance. Nor is a single test score infallible in the information that it provides. The standard error of measurement can be thought of as a measure of how precise a given score is. The standard error of measurement describes the extent to which scores would be expected to fluctuate because of chance. If measurement errors follow a normal distribution, an SEM of 18 means that if a student were tested repeatedly, his or her scores would fluctuate within 18 points of his or her true score about 68 percent of the time, and within 36 points (twice the SEM) roughly 95 percent of the time. Since reliability can also be regarded as a measure of precision, there is a direct relationship between the reliability of a test and the standard error of measurement for the scores it produces: as reliability increases, standard error of measurement decreases.

The Star Math tests differ from traditional tests in at least two respects with regard to the standard error of measurement. First, Star Math software computes the SEM for each individual student based on his or her performance, unlike most traditional fixed tests that report the same SEM value for every examinee. Each administration of Star Math yields a unique "conditional" SEM (CSEM) that reflects the amount of information estimated to be in the specific combination of items that a student received in his or her individual test. Second, because the Star Math test is adaptive, the CSEM will tend to be lower than that of a conventional test, particularly at the highest and lowest score levels, where conventional tests' measurement precision is weakest. Because the adaptive testing process attempts to provide equally precise measurement, regardless of the student's ability level, the CSEM of scores are very similar for all students.

Table 13 and Table 14 summarize the distribution of average CSEM values for the 2018–2019 data. The average CSEM on the Unified scale was 18 scaled score units overall and quite consistent across grades, ranging from a low of 18 in grades K–10 to a high of 19 in grades 11 and 12 (Table 13). The average CSEM on the Enterprise scale was 30 scaled score units for every grade (Table 14).

Alternatively, Table 13 and Table 14 also report global SEM values, which were computed using the traditional SEM estimation method based on internal consistency reliability and the variance of test scores as follows:

$\text{SEM} = \text{SQRT}(1 - \rho)\, \sigma_x$

where

SQRT() is the square root operator

ρ is the estimated internal consistency reliability

σ_x is the standard deviation of the observed scores (in this case, Scaled Scores)

The global SEMs were almost identical to the average CSEMs on both the Unified and Enterprise scales.

Because the standard error of measurement (SEM) is scale dependent, there are differences in the reported SEMs between the Star Math Unified and Enterprise scales. Overall, the lower SEM values in Table 13 compared to those in Table 14 reflect the differences between the Unified and Enterprise scale score ranges. Neither of these is "better," as the reliability estimates are the same for both scales.

Table 13: Standard Error of Measurement for the 2018–2019 Star Math Data on the Unified Scale

Grade	Sample Size	Standard Error of Measurement—Unified Scale		
		Conditional		Global
		Average	Standard Deviation	
K	50,000	18	1.3	18
1	1,000,000	18	1.1	18
2	1,000,000	18	1.2	18
3	1,000,000	18	1.2	18
4	1,000,000	18	1.3	18
5	1,000,000	18	1.4	18
6	1,000,000	18	1.3	18
7	1,000,000	18	1.5	18
8	1,000,000	18	1.6	18
9	400,000	18	1.4	18
10	400,000	18	1.6	18
11	100,000	19	1.7	18
12	100,000	19	1.7	19
All	9,050,000	18	1.4	16

Table 14: Standard Error of Measurement for the 2018–2019 Star Math Data on the Enterprise Scale

Grade	Sample Size	Standard Error of Measurement—Enterprise Scale		
		Conditional		Global
		Average	Standard Deviation	
K	50,000	30	2.1	30
1	1,000,000	30	1.9	30
2	1,000,000	30	2.0	30
3	1,000,000	30	1.9	29
4	1,000,000	30	2.0	30
5	1,000,000	30	2.2	30
6	1,000,000	30	2.2	30
7	1,000,000	30	2.5	30
8	1,000,000	30	2.6	30
9	400,000	30	2.3	30
10	400,000	30	2.6	30
11	100,000	30	2.8	30
12	100,000	30	2.8	31
All	9,050,000	30	2.2	26

Decision Accuracy and Decision Consistency

Decision accuracy is generally defined as the degree to which observed examinee classification decisions on a single assessment would agree with true classifications for a given set of cut scores. There are multiple approaches to estimate decision accuracy. Star Math uses Rudner's index (Rudner, 2001; 2005) based on item response theory (IRT), which assumes that the maximum likelihood estimate of ability converges to a normal distribution with mean equal to θ and standard deviation equal to the conditional standard error of measurement (CSEM). Mathematically, this index can be computed as:

$$\hat{\tau} = \sum(\hat{\mathbf{P}} * \mathbf{W}) / N_e,$$

where Σ denotes the summation of all matrix elements, * denotes element-wise matrix multiplication, N_e is the number of examinees, $\hat{\mathbf{P}}$ is a $N_e \times C$ matrix of expected probabilities with C being the number of performance categories on the assessment, and $\mathbf{W}$ is a $N_e \times C$ matrix of binary weights used to indicate the observed performance categories on the assessment. The $\hat{\mathbf{P}}$ matrix is defined as:

$$\hat{\mathbf{P}} = \begin{bmatrix} \hat{p}_{11} & \hat{p}_{12} & \cdots & \hat{p}_{1C} \\ \hat{p}_{21} & \hat{p}_{22} & \cdots & \hat{p}_{2C} \\ \vdots & \vdots & \cdots & \vdots \\ \hat{p}_{N_e1} & \hat{p}_{N_e2} & \cdots & \hat{p}_{N_eC} \end{bmatrix},$$

with the expected probability $\hat{p}_{ic}$ in the above matrix estimated as:

$$\hat{p}_{ic} = \phi(\kappa_{ic}, \kappa_{i(c+1)}, \hat{\theta}_i, \hat{\sigma}_{\theta_i}),$$

where $\phi(a, b, \mu, \sigma)$ is the area from a to b under a normal curve with a mean of μ and a standard deviation of σ, $\hat{\theta}_i$ is examinee i's IRT ability estimate, $\hat{\sigma}_{\theta_i}$ is the corresponding CSEM for the ability estimate $\hat{\theta}_i$, and κ_{ic} and $\kappa_{i(c+1)}$ are cut scores with $\kappa_{i1} = -\infty$, κ_{i2} being the cut score separating performance categories 1 and 2, κ_{i3} being the cut score separating performance categories 2 and 3, and so on with the last cut score $\kappa_{i(c+1)} = \infty$. The **W** matrix of weights is defined as:

$$\mathbf{W} = \begin{bmatrix} w_{11} & w_{12} & \cdots & w_{1C} \\ w_{21} & w_{22} & \cdots & w_{2C} \\ \vdots & \vdots & \cdots & \vdots \\ w_{N_e1} & w_{N_e2} & \cdots & w_{N_eC} \end{bmatrix},$$

where the weight, w_{ic}, equals 1 if the student was classified into performance level category C based on their ability estimate and 0 otherwise.

A counterpart to decision accuracy is decision consistency, defined as the degree to which examinees would be classified into the same performance categories given parallel replications of the same assessment. The method used to estimate decision consistency is based on an extension to Rudner's decision accuracy index, which is described in Wyse and Hao (2012). This index can be estimated as:

$$\hat{\gamma} = \sum(\hat{\mathbf{P}} * \hat{\mathbf{P}})/N_e,$$

where N_e is the number of examinees and $\hat{\mathbf{P}}$ is the same $N_e \times C$ matrix of expected probabilities used when computing the decision accuracy index.

For Star Math, three different classification decisions based on benchmarks set at the 10th, 25th, and 40th percentile ranks in the student norms are available by default in the Star Math software. These cut scores are used to separate students into four different performance categories: intensive intervention, intervention, on watch, and at/above benchmark. Table 15 shows estimates of decision accuracy and consistency when identifying students based on the three individual benchmarks as well as all three benchmarks together using random samples of students that took Star Math in the 2018–2019 school year.

Results indicate that decision accuracy and consistency were quite high overall and across grades. For PR10, decision accuracy was 0.97 for every grade, while decision consistency ranged from 0.95 to 0.96. For PR25, decision accuracy ranged from a low of 0.93 to a high of 0.95, while decision consistency ranged from 0.90 to 0.93. For PR40, decision accuracy ranged from a low of 0.90 to a high of 0.93, while decision consistency ranged from 0.86 to 0.90. Decision accuracy when using all three benchmarks together ranged from a low of 0.81 to a high of 0.85, while decision consistency ranged from a low of 0.74 to a high of 0.79. These are high levels of decision accuracy and consistency when making classification decisions based on each individual benchmark or all three benchmarks together, and support using Star Math in RTI/MTSS frameworks.

Table 15: Decision Accuracy and Consistency for Different Benchmarks Based on 2018–2019 Star Math Tests

		Decision Accuracy				Decision Consistency			
Grade	N	PR10	PR25	PR40	All 3 Benchmarks	PR10	PR25	PR40	All 3 Benchmarks
K	50,000	0.97	0.93	0.91	0.83	0.95	0.91	0.88	0.79
1	1,000,000	0.97	0.94	0.91	0.83	0.96	0.91	0.87	0.78
2	1,000,000	0.97	0.93	0.90	0.81	0.95	0.90	0.86	0.75
3	1,000,000	0.97	0.93	0.91	0.82	0.96	0.90	0.87	0.76
4	1,000,000	0.97	0.93	0.91	0.82	0.96	0.90	0.87	0.76
5	1,000,000	0.97	0.93	0.91	0.82	0.95	0.91	0.88	0.76
6	1,000,000	0.97	0.94	0.92	0.83	0.96	0.91	0.88	0.77
7	1,000,000	0.97	0.94	0.92	0.83	0.96	0.92	0.89	0.78
8	1,000,000	0.97	0.94	0.92	0.83	0.96	0.92	0.89	0.78
9	400,000	0.97	0.95	0.93	0.84	0.96	0.93	0.90	0.78
10	400,000	0.97	0.95	0.92	0.84	0.96	0.93	0.89	0.78
11	100,000	0.97	0.95	0.92	0.85	0.96	0.93	0.89	0.79
12	100,000	0.97	0.95	0.92	0.85	0.96	0.93	0.89	0.79
Overall	9,050,000	0.97	0.94	0.92	0.83	0.96	0.92	0.88	0.77

24-Item Star Math Progress Monitoring Tests

Star Math is used for both universal screening and progress monitoring. The 34-item Star Math test is widely used for universal screening. A shorter version—the 24-item Star Math progress monitoring test—exists for use in progress monitoring. The following section summarizes the reliability and the standard error of measurement of the progress monitoring version of Star Math.

Reliability Coefficients

Table 16 shows the reliability estimates of the Star Math progress monitoring tests from 2017 to 2019 on both the Unified scale and the Enterprise scale.

Table 16: Reliability Estimates from the Star Math Progress Monitoring 2017–2018 and 2018–2019 Data on both the Unified Scale and the Enterprise Scale

	Progress Monitoring Reliability Estimates for Both the Unified and Enterprise Scale			
	Generic		Split-Half	
Grade	N	ρxx	N	ρxx
1	9,000	0.84	8,600	0.86
2	17,000	0.79	16,800	0.81
3	16,000	0.80	15,000	0.81
4	18,000	0.82	17,100	0.83
5	15,000	0.82	14,700	0.82
6	10,000	0.83	9,700	0.83
7	8,500	0.87	8,200	0.87
8	7,500	0.87	7,300	0.87
9	875	0.89	835	0.90
10	730	0.90	662	0.90
11	500	0.91	479	0.92
12	360	0.83	344	0.83
Overall	103,465	0.93	99,720	0.93

The progress monitoring Star Math reliability estimates are also quite high and consistent across grades 1–12, for a test composed of only 24 items.

Overall, these coefficients also compare very favorably with the reliability estimates provided for other published math achievement tests, which typically contain far more items than the 24-item Star Math progress monitoring tests. The Star Math progress monitoring test's high reliability with minimal testing time is a result of careful test item construction and an effective and efficient adaptive-branching procedure.

Standard Error of Measurement

Table 17 and Table 18 show the conditional standard error of measurement (CSEM) and the global standard error of measurement (SEM), overall and by grade level.

Table 17: Standard Error of Measurement for the 2017–2018 and 2018–2019 Star Math Progress Monitoring Data on the Unified Scale

	Progress Monitoring Standard Error of Measurement—Unified Scale				
	Conditional			Global	
Grade	Sample Size	Average	Standard Deviation	Sample Size	SEM
1	9,000	21	2.0	8,600	19
2	17,000	21	2.0	16,800	20
3	16,000	21	2.1	15,000	20
4	18,000	21	2.2	17,100	20
5	15,000	21	2.4	14,700	21
6	10,000	21	2.6	9,700	21
7	8,500	21	2.7	8,200	21
8	7,500	21	2.7	7,300	21
9	875	21	2.8	835	20
10	730	21	2.9	662	21
11	500	22	3.1	479	20
12	360	21	2.6	344	21
All	103,465	21	2.3	99,720	20

Table 18: Standard Error of Measurement for the 2017–2018 and 2018–2019 Star Math Progress Monitoring Data on the Enterprise Scale

Grade	Progress Monitoring Standard Error of Measurement—Enterprise Scale				
	Conditional			Global	
	Sample Size	Average	StandardDeviation	Sample Size	SEM
1	9,000	38	3.6	8,600	36
2	17,000	38	3.7	16,800	36
3	16,000	38	3.8	15,000	37
4	18,000	39	4.1	17,100	37
5	15,000	39	4.4	14,700	39
6	10,000	39	4.7	9,700	39
7	8,500	39	4.9	8,200	39
8	7,500	39	4.9	7,300	39
9	875	39	5.2	835	37
10	730	39	5.3	662	39
11	500	40	5.6	479	38
12	360	39	4.8	344	39
All	103,465	39	4.3	99,720	37

Comparing the estimates of reliability and measurement error of Star Math (Table 12, Table 13, and Table 14) with those of Star Math progress monitoring (Table 16, Table 17, and Table 18) confirms that Star Math is slightly superior to the shorter Star Math progress monitoring assessments in terms of reliability and measurement precision.

Decision Accuracy and Consistency

Table 19 shows the decision accuracy and consistency indices for PR10, PR25, and PR40 benchmarks for Star Math Progress Monitoring based on data collected in the 2017–2018 and 2018–2019 school years. Results suggest that the decision accuracy and consistency for the Star Math Progress Monitoring tests were high, but slightly lower than the values observed for the 34-item Star Math tests. These high levels of decision accuracy and consistency support using Star Math tests in RTI/MTSS frameworks.

Table 19: Decision Accuracy and Consistency for Different Benchmarks Based on 2017–2018 and 2018–2019 Star Math Progress Monitoring Tests

Grade	N	Decision Accuracy				Decision Consistency			
		PR10	PR25	PR40	All 3 Benchmarks	PR10	PR25	PR40	All 3 Benchmarks
1	9,000	0.97	0.93	0.90	0.81	0.95	0.90	0.86	0.76
2	17,000	0.96	0.91	0.87	0.77	0.95	0.87	0.82	0.70
3	16,000	0.94	0.88	0.86	0.71	0.92	0.83	0.81	0.63
4	18,000	0.94	0.89	0.87	0.72	0.92	0.84	0.81	0.64
5	15,000	0.95	0.88	0.87	0.72	0.93	0.83	0.82	0.64
6	10,000	0.94	0.87	0.87	0.70	0.91	0.82	0.82	0.61
7	8,500	0.94	0.88	0.89	0.72	0.91	0.84	0.84	0.64
8	7,500	0.93	0.88	0.90	0.72	0.90	0.84	0.85	0.64
9	875	0.92	0.89	0.90	0.72	0.89	0.84	0.85	0.63
10	730	0.91	0.91	0.92	0.74	0.88	0.87	0.88	0.65
11	500	0.92	0.90	0.91	0.74	0.89	0.86	0.87	0.65
12	360	0.94	0.87	0.90	0.71	0.92	0.81	0.86	0.61
Overall	103,465	0.94	0.89	0.89	0.73	0.91	0.85	0.84	0.65

Validity

Test validity was long described as the degree to which a test measures what it is intended to measure. A more current description is that a test is valid to the extent that there are evidentiary data to support specific claims as to *what* the test measures; the *interpretation* of its scores; and the uses for which it is recommended or applied. Evidence of test validity is often indirect and incremental, consisting of a variety of data that in the aggregate are consistent with the theory that the test measures the intended construct(s), or is suitable for its intended uses and interpretations of its scores. Determining the validity of a test involves the use of data and other information both internal and external to the test instrument itself.

Content Validity

One touchstone is content validity, which is the relevance of the test questions to the attributes or dimensions intended to be measured by the test. The content of the item bank and the content balancing specifications that govern the administration of each test together form the foundation for "content validity" for the Star Math assessments. These content validity issues were discussed in detail in "Content and Item Development" and were an integral part of the test items that are the basis of the current Star Math version.

Construct Validity

Construct validity, which is the overarching criterion for evaluating a test, investigates the extent to which a test measures the construct(s) that it claims to be assessing. Establishing construct validity involves the use of data and other information external to the test instrument itself. For example, Star Math claims to provide an estimate of a child's mathematics achievement level. Therefore, demonstration of Star Math construct validity rests on the evidence that the test provides such estimates. There are a number of ways to demonstrate this.

Since mathematics ability varies significantly within and across grade levels and improves as a student's grade placement increases, scores within Star Math should demonstrate these anticipated internal relationships; in fact, they do. Additionally, scores for Star Math should correlate highly with other accepted measures of mathematics achievement and competence. This section deals with both internal and external evidence of the validity of Star Math as an assessment of Mathematics achievement and competence.

Internal Evidence: Evaluation of Unidimensionality of Star Math

Star Math is a 34-item computerized-adaptive assessment that measures mathematics achievement. Its items are selected adaptively for each student, from a very large bank of mathematics test items, each of which is aligned to one of four blueprint domains:

- Numeration & Operations (NUM)
- Algebra (ALG)
- Geometry & Measurement (GEO)
- Data Analysis, Statistics & Probability (DAT)

Star Math is an application of item response theory (IRT); each test item's difficulty has been calibrated using the unidimensional Rasch model. Therefore, an important assumption is that a test measures only a single construct, specifically mathematics achievement in the case of Star Math. This assumption was tested using factor analysis, which is a statistical technique that can be used to determine the number of dimensions or constructs that a test measures. Both exploratory and confirmatory factor analyses were conducted across grade bands K to 2, 3 to 5, 6 to 8, and 9 to 12.

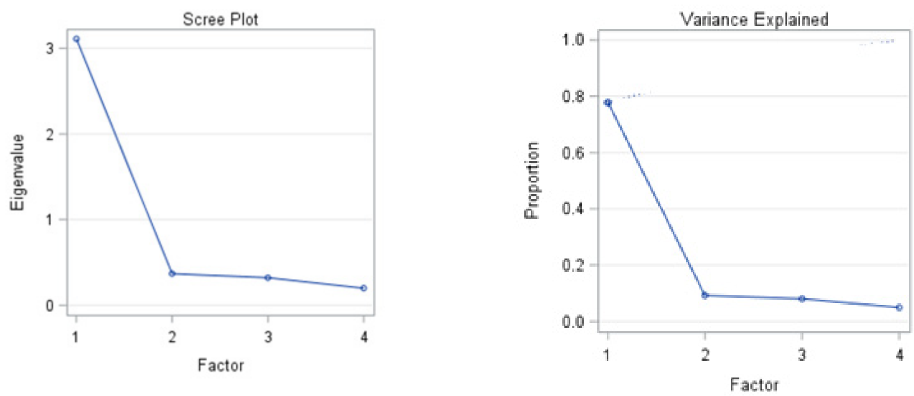
To begin, a large sample of student Star Math data was assembled. The overall sample consisted of 202,000 student records, which was investigated with confirmatory factor analysis to determine unidimensionality followed by a variety of exploratory factor analyses.

For the overall sample, each student's 34 Star Math item responses were divided into subsets of items aligned to each of the 4 blueprint domains. Tests administered in grades K–8 included items from all four domains. Tests given in grades 9–12 included items from just 3 domains with no items measuring data analysis, probability and statistics domain.

For each student, separate Rasch ability estimates (subtest scores) were calculated from each domain-specific subset of item responses. A Bayesian sequential procedure developed by Owen (1969, 1975) was used for the subtest scoring. Across all grade bands, the number of items included in each math subtest ranged from 3 to 23 items for the NUM domain, 1 to 18 items for the ALG domain, 5 to 13 items for the GEO domain, and 0 to 3 items for the DAT domain, following the Star Math test blueprints, which specify different numbers of items per domain, depending on the student's grade level.

Intercorrelations of the blueprint domain-specific Rasch subtest scores were analyzed using exploratory factor analysis (EFA) to evaluate the number of dimensions/ factors underlying Star Math domain scores. In each grade band, the EFA analyses retained a single dominant underlying dimension based on either the MINEIGEN (eigenvalue greater than 1) or the PROPORTION criterion (proportion of variance explained by the factor), as expected. An example of a scree plot from grade band K to 2 based on the PROPORTION criterion is shown in Figure 3. Similar scree plots showing a single dominant factor for the first eigenvalue and extracted factor were found at all grade bands and across grade bands. EFA analyses using both SAS and SPSS software showed one significant factor at each grade band and across all grade bands for principal components analysis, unweighted least squares factors, generalized least squares factors, maximum likelihood factors, alpha factors, image factors. Standardized factor loadings for each domain were always above 0.80 for the first extracted factor.

Figure 3: Example Scree and Variance Explained Plots from the Grade Band K to 2 Exploratory Factor Analysis in Star Math



Confirmatory factor analyses (CFA) were also conducted using the subtest scores from the CFA analysis. A separate confirmatory analysis was conducted for each grade band. The CFA models tested a single underlying model as shown in Figure 4. One CFA model with four domains was fitted for students in grade bands K to 2, 3 to 5, and 6 to 8; a second CFA model with three domains was fitted for students in grade band 9 to 12 since the test blueprint did not administer items from the domain for Data Analysis, Probability and Statistics.

Figure 4: Confirmatory Factor Analyses (CFA) in Star Math

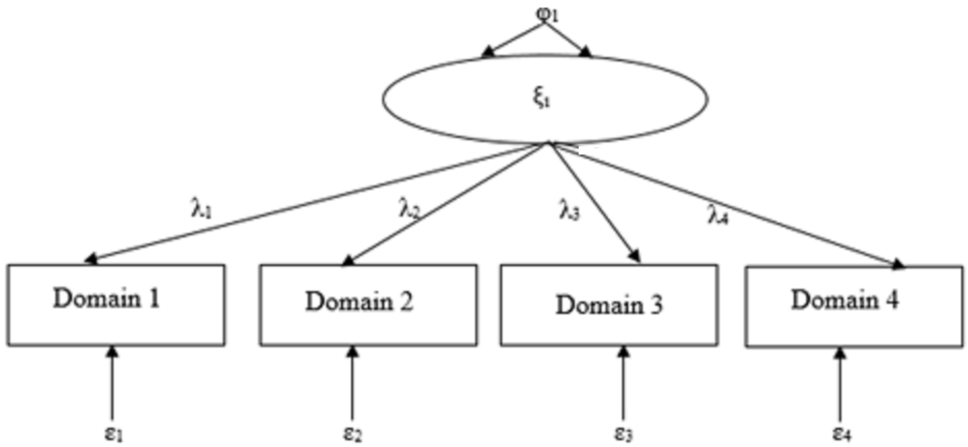


Table 20: Domain Scores Included in the CFA Models for Star Math, by Grade Band[a]

Grade Bands	Domains			
	1	**2**	**3**	**4**
K to 2	ALG	GEO	DAT	NUM
3 to 5	ALG	GEO	DAT	NUM
6 to 8	ALG	GEO	DAT	NUM
9 to 12	ALG	GEO		NUM

a. Math Domain Key:
ALG = Algebra Domain
GEO = Geometry and Measurement Domain
DAT = Data Analysis, Statistics, and Probability Domain
NUM = Numeration and Operations Domain

The results of the CFA analyses by grade band and across all grade bands are summarized in Table 21 on page 61. Grade Band ALL4 shows results across all grade bands for four math domains (ALG, GEO, DAT, and NUM); Grade Band ALL3 shows results across all grade bands for three math domains (ALG GEO and NUM). The CFA models for Grade band 9 to 12 and for Grade band ALL3 were just-identified statistical models and required fixing the expected error variance for one estimated analysis parameter. The analyst fixed the error variance for the NUM domain at its computed value for these analyses, since the NUM domain had the least number of blueprint specified items for grade band 9 to 12 which also affected estimation of grade band ALL3 at the high school level.

Table 21: Summary of the Goodness-of-Fit of the CFA Models for Star Math by Grade Band

Grade Band	N	x^2	df	CFI	GFI	NFI	RMSEA	SRMR
K to 2	35,216	95.8252	2	0.9990	0.9986	0.9990	0.0365	0.0055
3 to 5	32,095	26.0192	2	0.9997	0.9996	0.9997	0.0193	0.0025
6 to 8	47,477	165.487	2	0.9989	0.9983	0.9989	0.0415	0.0047
9 to 12	69,133	354.493	1	0.9977	0.9966	0.9977	0.0715	0.0139
ALL4	131,221	173.930	2	0.9997	0.9993	0.9997	0.0256	0.0014
ALL3	201,088	584.864	1	0.9991	0.9980	0.9869	0.0539	0.0032

As Table 21 indicates, sample sizes ranged from 32,095 to 69,133 within grade bands; because the chi-square (x^2) test is not a reliable test of model fit when sample sizes are large, a variety of fit indices are presented. The comparative fit index (CFI), goodness of fit index (GFI), and the normed fit index (NFI) are shown; for these indices, values are either 1 or very close to 1, indicating strong evidence of a single construct/dimension for Star Math. In addition, the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR) are presented. RMSEA and SRMR values less than 0.08 indicate good fit. Cutoffs for the indices are presented in Hu and Bentler, 1999. Overall, the CFA results strongly support a single underlying dimension.

Table 22 presents the CFA Factor Loadings for the four math content domains for Algebra (ALG), Geometry and Measurement (GEO), Data Analysis, Statistics and Probability (DAT) and Numeration and Operations (NUM). These results show consistently high factor loadings within grade bands across the three to four math domains, and across grade bands within each math domain cluster. The CFA factor loading range from 0.78 to 0.93 show congruence of factor loadings within domains across grade bands, and within grade bands across the math content domains. Grade Band ALL4 shows results across all grade bands for four math domains (ALG, GEO, DAT, and NUM). Grade Band ALL3 shows results across all grade bands for three math domains (ALG, GEO, and NUM).

Table 22: Summary of the CFA Factor Loadings for Star Math by Grade Band and Math Domain

Grade Band	CFA Factor Loadings			
	ALG	GEO	DAT	NUM
K to 2	0.7799	0.8581	0.7994	0.9168
3 to 5	0.8104	0.8682	0.8213	0.9321
6 to 8	0.8681	0.8652	0.8259	0.9350
9 to 12	0.9275	0.9254	NA*	0.8099
ALL4	0.9320	0.9400	0.9165	0.9690
ALL3	0.9465	0.9523	NA*	0.9356

Table 23 summarizes principal components and principal axis Exploratory Factor analysis (EFA) factor loadings for Star Math domains across all grade bands. These results show independent support of the CFA analyses' results for the unidimensionality for Star Math. Note, the component and factor loadings for the DAT math domain are estimated from grades K to 8 but were not available for grades 9 to 12 due to the test blueprint.

Table 23: Summary of Principal Components and Principal Axis EFA Factor Loadings Across All Grade Bands for Star Math Domains

Principal Components		Principal Axis
	Component	Factor
Math Domain	1	1
ALG	0.951	0.932
DAT	0.944	0.918
GEO	0.955	0.940
NUM	0.970	0.968

The EFA analyses were conducted using the factor procedure in SAS 9.4 software and in IBM SPSS version 19 software, while the CFA analysis was conducted using the calis procedure in the SAS 9.4 software (SAS Institute, Cary NC).

Relationship of Star Math Scores to Scores on Other Tests of Mathematics Achievement

The technical manual for the earliest version of Star Math listed correlations between scores on that test and those on a number of other standardized measures of math achievement, obtained in 1998 for more than 9,000 students who participated in Star Math norming for that version of the program. The standardized tests included a variety of well-established instruments, including the California Achievement Test (CAT), the Comprehensive Test of Basic Skills (CTBS), the Iowa Tests of Basic Skills (ITBS), the Metropolitan Achievement Test (MAT), the Stanford Achievement Test (SAT), and several statewide tests.

During a subsequent norming of Star Math, scores on other standardized tests were obtained for more than 30,000 additional students. All of the standardized tests listed above were included, plus others such as Northwest Evaluation Association (NWEA) and TerraNova. Scores on state assessments from the following states were also included: Arkansas, Connecticut, Delaware, Florida, Georgia, Kentucky, Idaho, Indiana, Illinois, Maryland, Michigan, Minnesota, Mississippi, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Dakota, Texas, Virginia, and Washington. The extent that the Star Math test correlates with these tests provides support for its construct validity. That is, strong and positive correlations between Star Math and these other instruments provide support for the claim that Star Math effectively measures mathematics achievement.

Table 24, Table 25, Table 26, and Table 27 (starting on page 66) summarize the correlation coefficients between the scores on the Star Math test and each of the other test instruments for which data were received. "Appendix B: Additional Evidence of Star Math Validity" on page 148 contains detailed correlational data behind the summaries in these tables.

Table 24 and Table 25 summarize "concurrent validity" data, that is, correlations between Star Math norming study test scores and other tests administered within a two-month time period.

In addition to the concurrent validity estimates summarized in Table 24 and Table 25, data concerning Star Math's predictive validity are summarized in Table 26 and Table 27. Predictive validity provides an estimate of the extent to which scores on the Star Math test predicted scores on criterion measures given at a later point in time, operationally defined as more than 2 months between the Star test (predictor) and the criterion test. It provides an estimate of the linear relationship between Star scores and scores on measures covering a similar academic domain. Predictive correlations are typically attenuated by time due to the fact that students are gaining skills in the interim between testing occasions, and also by differences between the tests' content specifications.

The following is a partial list of math assessments for which there is evidence of correlations with Star Math reported in this technical manual.

- Achievement level (RIT) Test
- ACT Aspire
- American College Testing Program
- Arkansas Augmented Benchmark Examination (AABE)
- California Achievement Test
- Canadian Achievement Test
- Cognitive Abilities Test
- Comprehensive Test of Basic Skills
- Connecticut Mastery Test
- Delaware Student Testing Program (DSTP)

- Des Moines Public School (Grade 2 pretest)
- Differential Aptitude Tests
- Educational Development Series
- Explore Tests
- Florida Comprehensive Assessment Test (FCAT)
- Florida Standards Assessments (FSA)
- Georgia Milestones
- Georgia High School Graduation Test
- Idaho Standards Achievement Test (ISAT)
- Indiana Statewide Testing for Educational Progress
- Iowa Assessment
- Iowa Test of Basic Skills (ITBS)
- Kansas State Assessment Program (KSAP)
- Kentucky Core Content Test (KCCT)
- Kentucky Core Content Test
- Key Stage 2 Standardised Attainment Tests (UK KS2 SATs)
- Maryland High School Placement Test
- McGraw Hill Mississippi/Criterion Referenced
- Metropolitan Achievement Test (MAT)
- Michigan Educational Assessment Program
- Minnesota Comprehensive Assessment (MCA)
- Mississippi Academic Assessment Program (MAAP)
- Mississippi Curriculum Test (MCT2)
- Missouri Assessment Program (MAP) Grade-Level Tests
- Multiple Assessment Series (Primary Grades)
- New Jersey Assessment of Skills and Knowledge (NJASK)
- New Standards Reference Mathematics Exam (Rhode Island)
- New York State Assessment Program
- New York State Math Assessment
- North Carolina End-of-Grade (NCEOG) Test
- Northwest Evaluation Association Levels Test
- NWEA, NALT, & MAP
- Ohio Achievement Assessment

- Ohio Proficiency Test (OPT)
- Ohio State Tests (OST)
- Oklahoma Core Curriculum Test (OCCT)
- Oklahoma School Testing Program Core Curriculum Tests
- Oregon State Assessment
- Otis Lennon School Ability Test (OLSAT)
- Palmetto Achievement Challenge Test (PACT), 2001
- Partnership for Assessment of Readiness for College and Careers (PARCC)
- Pennsylvania System of School Assessment (PSSA)
- PLAN
- Preliminary SAT/National Merit Scholarship Qualifying Test
- Smarter Balanced Assessment (SBA)
- South Dakota State Test of Educational Progress (DSTEP)
- Stanford Achievement Test
- Star Math
- State of Texas Assessments of Academic Readiness Standards Test 2
- Tennessee Comprehensive Assessment Program (TCAP)
- TerraNova
- Test of Achievement Proficiency
- Test of New York State Standards
- Texas Assessments of Academic Readiness Standards
- Texas Assessment of Academic Skills (TAAS), 2001
- Texas Assessment of Knowledge and Skills (TAKS)
- Transitional Colorado Assessment Program (TCAP)
- Virginia Standards of Learning
- Washington Assessment of Student Learning
- West Virginia Educational Standards Test 2
- Wide Range Achievement Test
- Wisconsin Forward Exam
- Wisconsin Knowledge and Concepts Examination (WKCE)

Table 24, Table 25, Table 26, and Table 27 contain summaries of some of the correlational data in support of Star Math validity. Table 24 summarizes the within-grade average concurrent validity coefficients for grades 1–6; these varied from 0.64–0.75, with an overall average of 0.73. Table 25 summarizes the concurrent validity for grades 7–12; correlations ranged from 0.56–0.74, with an overall average of 0.71.

Table 26 and Table 27 contain similar summaries of predictive validity coefficients. Table 26 summarizes the grades 1–6 data; coefficients ranged from 0.55–0.74, with an average of 0.72. Table 27 does the same for grade 7–12 predictive validity; obtained coefficients ranged from 0.65–0.77, with an average of 0.74.

In general, these correlation coefficients reflect very well on the validity of the Star Math test as a tool for placement in mathematics. In fact, the correlations are similar in magnitude to the validity coefficients of these measures with each other. These validity results, combined with the supporting evidence of reliability and minimization of SEM estimates for the Star Math test, provide a quantitative demonstration of how well this innovative instrument in mathematics achievement assessment performs.

Table 24: Summary of Concurrent Validity Statistics for Grades 1–6: Star Math Correlations (r) with External Tests Administered Between 2002 and 2016

Summary							
Grade(s)	**Total N**	**1**	**2**	**3**	**4**	**5**	**6**
Number of students	370,651	215	951	104,603	99,768	93,810	71,304
Number of coefficients	241	5	11	64	56	62	43
Average validity	–	0.65	0.64	0.72	0.73	0.75	0.72
Overall average	0.73						

Table 25: Summary of Concurrent Validity Statistics for Grades 7–12: Star Math Correlations (r) with External Tests Administered Between 2002 and 2016

Summary							
Grade(s)	**Total N**	**7**	**8**	**9**	**10**	**11**	**12**
Number of students	123,819	60,917	51,442	5,335	4,528	1,494	103
Number of coefficients	95	36	36	5	7	6	5
Average validity	–	0.73	0.74	0.65	0.58	0.70	0.56
Overall average	0.71						

Table 26: Summary of Predictive Validity Data, Grades 1–6: Star Fall-to-Spring Correlations (r) with External Tests Administered Between 2001 and 2016

Summary							
Grade(s)	**Total N**	**1**	**2**	**3**	**4**	**5**	**6**
Number of students	662,040	11,880	33,076	176,784	175,330	152,693	112,277
Number of coefficients	285	6	10	77	69	74	49
Average validity	–	0.55	0.63	0.72	0.74	0.73	0.74
Overall average	0.72						

Table 27: Summary of Predictive Validity Data, Grades 7–12: Star Fall-to-Spring Correlations (r) with External Tests Administered Between 2001 and 2016

Summary							
Grade(s)	**Total N**	**7**	**8**	**9**	**10**	**11**	**12**
Number of students	160,323	75,876	59,960	7,971	8,708	6,831	977
Number of coefficients	126	51	46	8	9	9	3
Average validity	–	0.75	0.74	0.75	0.77	0.72	0.65
Overall average	0.74						

Meta-Analysis of the Star Math Validity Data

Meta-analysis is a set of statistical procedures that combines results from different sources or studies. When applied to a set of correlation coefficients that estimate test validity, meta-analysis combines the observed correlations and sample sizes to yield estimates of overall validity, as well as standard errors and confidence intervals, both overall and within grades.

To conduct a meta-analysis of the Star Math validity data, the 747 correlations summarized in Table 24, Table 25, Table 26, and Table 27, observed in data from Star Math tests of more than 1.3 million students, were combined and analyzed using a fixed effects model for meta-analysis. The results are displayed in Table 28. The table lists results for the correlations within each grade, as well as results with all twelve grades' data combined. For each set of results, the table lists an estimate of the true validity, a standard error, and the lower and upper limits of a 95 percent confidence interval for the validity coefficient. Based on the 747 correlation coefficients, the overall estimate of the validity of Star Math is 0.758, with a standard error of 0.001. The probability of observing the 747 correlations reported in Table 24, Table 25, Table 26, and Table 27, if the true validity were zero, is virtually zero. Because the correlations were obtained with widely different tests, and among students from twelve different grades, these results provide strong support for the validity of Star Math as a measure of math skills.

Table 28: Results of the Meta-Analysis of Star Math Correlations with Other Tests

Grade	Effect Size		95% Confidence Interval		Total Correlations	Total N
	Validity Estimate	Standard Error	Lower Limit	Upper Limit		
1	0.558	0.009	0.545	0.570	11	12,095
2	0.627	0.005	0.620	0.633	21	34,027
3	0.755	0.002	0.753	0.756	141	281,387
4	0.760	0.002	0.759	0.762	125	275,098
5	0.765	0.002	0.764	0.767	136	246,503
6	0.777	0.002	0.775	0.779	92	183,581
7	0.770	0.003	0.768	0.772	87	136,793
8	0.754	0.003	0.751	0.756	82	111,402
9	0.708	0.009	0.699	0.716	13	13,306
10	0.751	0.009	0.744	0.759	16	13,236
11	0.740	0.011	0.730	0.750	15	8,325
12	0.731	0.030	0.702	0.758	8	1,080
All Grades	0.758	0.001	0.757	0.759	747	1,316,833

Linking Star and State Assessments: Comparing Student- and School-Level Data

With an increasingly large emphasis on end-of-the-year summative state tests, many educators seek out informative and efficient means of gauging student performance on state standards—especially those hoping to make instructional decisions before the year-end assessment date.

For many teachers, this is an informal process in which classroom assessments are used to monitor student performance on state standards. While this may be helpful, such assessments may be technically inadequate when compared to more standardized measures of student performance. Recently the assessment scale associated with Star Math has been linked to the scales used for summative mathematics tests in most states. Linking Star Math assessments to state tests allows educators to reliably predict student performance on their state assessment using Star Math scores. More specifically, it places teachers in a position to identify

- which students are on track to succeed on the year-end summative state test, and
- which students might need additional assistance to reach proficiency.

Educators using Star Math assessments can access Star Performance Reports that allow access to students' Pathway to Proficiency. These reports indicate whether individual students or groups of students (by class, grade, or demographic characteristics) are likely to be on track to meet a particular state's criteria for mathematics proficiency. In other words, these reports allow instructors to evaluate student progress toward proficiency and make data-based instructional decisions well in advance of the annual state tests. Additional reports automatically generated by Star Math help educators screen for later difficulties and progress monitor students' responsiveness to interventions.

Relationship of Star Math Scores to Scores on Multi-State Consortium Tests in Math

In recent years, the National Governors' Association, in collaboration with the Council of Chief State School Officers (CCSSO), developed a proposed set of curriculum standards in English Language Arts and Math, called the Common Core State Standards. Forty-five states voluntarily adopted those standards; subsequently, many states have dropped them, but several states continue to use them or base their own state standards on them. Two major consortia were formed to develop assessments systems that embodied those standards: the Smarter Balanced Assessment Consortium (SBAC) and Partnership for Assessment of Readiness for College and Careers (PARCC). SBAC and PARCC end-of-year assessments have been administered in numerous states in place of those states' previous annual accountability assessments. Renaissance Learning was able to obtain SBAC and PARCC scores of many students who had taken Star Math earlier in the same school years. Table 29 and Table 30 contain coefficients of correlation between Star Math and the consortium tests. The average of the concurrent correlations was approximately 0.88 for SBAC and 0.83 for PARCC. The average predictive correlation was approximately 0.89 with the SBAC assessments, and 0.85 for PARCC.

Table 29: Concurrent and Predictive Validity Data: Star Math Scaled Scores Predicting Later Performance for Grades 3–8 on Smarter Balanced Assessment Consortium Tests

Star Math Concurrent and Predictive Correlations with Smarter Balanced Assessment Scores							
Grade		**3**	**4**	**5**	**6**	**7**	**8**
Concurrent	N	10,800	10,582	9,750	7,852	6,344	5,424
	Correlation	0.86	0.88	0.89	0.87	0.88	0.87
Predictive	N	8,593	8,571	8,595	8,575	8,623	8,859
	Correlation	0.89	0.90	0.90	0.89	0.89	0.86

Table 30: Concurrent and Predictive Validity Data: Star Math Scaled Scores Correlations for Grades 3–8 with PARCC Assessment Consortium Test Scores

Star Math Concurrent and Predictive Correlations with PARCC Assessment Scores							
Grade		**3**	**4**	**5**	**6**	**7**	**8**
Concurrent	N	3,635	4,008	3,653	4,150	4,066	3,748
	Correlation	0.83	0.86	0.82	0.83	0.81	0.80
Predictive	N	4,103	4,787	4,266	5,050	4,368	4,196
	Correlation	0.83	0.82	0.78	0.79	0.80	0.77

Classification Accuracy of Star Math

Accuracy for Predicting Proficiency on a State Math Assessment

Star Math test scores have been linked statistically to numerous state Math assessment scores. The linked values have been employed to use Star Math to predict student proficiency in Math on those state tests. One example of this is a linking study conducted using a multi-state sample of students' scores on the PARCC consortium assessment.[1] Table 31 presents classification accuracy statistics for grades 3 through 8.

Table 31: Classification Diagnostics for Predicting Students' Math Proficiency on the PARCC Consortium Assessment from Earlier Star Math Scores

	Grade					
Measure	**3**	**4**	**5**	**6**	**7**	**8**
Overall classification accuracy	89%	90%	92%	91%	91%	90%
Sensitivity	71%	58%	57%	66%	59%	59%
Specificity	94%	97%	98%	97%	97%	96%
Positive predictive value (PPV)	75%	82%	83%	79%	77%	77%
Negative predictive value (NPV)	93%	91%	93%	93%	93%	92%
Observed proficiency rate (OPR)	20%	19%	15%	17%	16%	17%
Projected proficiency rate (PPR)	19%	13%	10%	14%	12%	13%
Proficiency status projection error	–1%	–6%	–5%	–3%	–4%	–4%
Area Under the ROC Curve	0.94	0.94	0.94	0.95	0.95	0.94

1. Renaissance Learning (2016). Relating Star Reading® and Star Math® to the Colorado Measure of Academic Success (CMAS) (PARCC Assessments) Performance.

As the table shows, overall classification accuracy ranged from 89% to 92%, depending on grade. Area Under the Curve (AUC) was at least 0.94 for all grades. Specificity was especially high, and the projected proficiency rates were very close to the observed proficiency rates at all grades.

Numerous other reports of linkages between Star Math and state accountability tests have been conducted. Reports are available at research.renaissance.com/.

Evidence of Technical Adequacy for Informing Screening and Progress Monitoring Decisions

Many school districts use tiered models such as Response to Intervention (RTI) or Multi-Tiered Systems of Support (MTSS) to guide instructional decision making and improve outcomes for students. These models represent a more proactive, data-driven approach for better serving students as compared with prior decision-making practices, including processes to:

- Screen all students to understand where each is in the progression of learning in reading, math, or other disciplines
- Identify at-risk students for intervention at the earliest possible moment
- Intervene early for students who are struggling or otherwise at-risk of falling behind; and
- Monitor student progress in order to make decisions as to whether they are responding adequately to the instruction/intervention

Assessment data are central to both screening and progress monitoring, and Star Math is widely used for both purposes. This chapter includes technical information about Star Math's ability to accurately screen students according to risk and to help educators make progress monitoring decisions. Much of this information has been submitted to and reviewed by the Center on Response to Intervention https://rti4success.org/ and/or the National Center on Intensive Intervention https://intensiveintervention.org/, two technical assistance groups funded by the US Department of Education.

For several years running, Star Math has enjoyed favorable technical reviews for its use in informing screening and progress monitoring decision by the CRTI and NCII, respectively. The most recent reviews by CRTI indicate that Star Math has a "convincing" level of evidence (the highest rating awarded) in the core screening categories, including classification accuracy, reliability, and validity. CRTI also notes that the extent of the technical evidence is "Broad" (again, the highest rating awarded) and notes that not only is the overall evidence compelling, but there are disaggregated data as well that shows Star Math works equally well among subgroups. The most recent reviews by NCII indicate that there is fully "convincing" evidence of Star Math's psychometric quality for progress monitoring purposes, including reliability, validity, reliability of the slope, and validity of the slope. Furthermore, they find fully "convincing" evidence that Star Math is sufficiently sensitive to student growth, has adequate alternate forms, and provides data-based guidance to educators on end-of-year benchmarks and when an intervention should be changed, among other categories. Readers may find additional information on Star Math on those sites and should note that the reviews are updated on a regular basis, as their review standards are adjusted and new technical evidence for Star Math and other assessments are evaluated.

Screening

According to the Center on Response to Intervention, "Screening is conducted to identify or predict students who may be at risk for poor learning outcomes. Universal screening assessments are typically brief, conducted with all students at a grade level, and followed by additional testing or short-term progress monitoring to corroborate students' risk status."[2]

Most commonly, screening is conducted with all students at the beginning of the year and then another two to four times throughout the school year. Star Math is widely used for this purpose. In this section, the technical evidence supporting its use to inform screening decisions is summarized.

Organizations of RTI/MTSS experts such as the Center on Response to Intervention and the RTI Action Network[3] are generally consistent in how measurement tools should be evaluated for their appropriateness as screeners. Key categories include the following:

1. **Validity and reliability**. See the "Reliability and Measurement Precision" chapter and the earlier sections of this "Validity" chapter for a summary of the available evidence supporting Star Math's reliability and validity.
2. **Practicality and efficiency.** Screening measures should not require much teacher or student time. Because most students can complete a Star Math test in 15–20 minutes or less, and because it is group administered and scored automatically, Star Math is an exceptionally efficient general outcomes measure for mathematics.

2. https://rti4success.org/essential-components-rti/universal-screening
3. http://www.rtinetwork.org/learn/research/universal-screening-within-a-rti-model

3. **Classification accuracy metrics** including sensitivity, specificity, and overall predictive accuracy. These are arguably the most important indicators, addressing the main purpose of screening: When a brief screening tool indicates a student either is or is not at risk of later difficulties in mathematics, how often is it accurate, and what types of errors are made?

It is common to use high-stakes indicators such as state summative assessments as criterion measures for classification accuracy evaluation. Star Math is linked to virtually every state summative assessment in the US as well as the United Kingdom's Key Stage 2 Standardised Attainment Tests for Maths, as well as the ACT and SAT college entrance exams. The statistical linking of the Star Math scale with these other measures' scales, combined with Star Math growth norms (discussed in the Growth Norms section, on page 81 of the Norming chapter) empowers Star Math reports, dashboards, and data extracts to make predictions throughout the school year about future student performance. These predictions inform educator screening decisions in schools using an RTI/MTSS framework. (Educators are also free to use norm-referenced scores such as Percentile Ranks to inform screening decisions.)

Star Math's classification accuracy results from several recent predictive studies are summarized in Table 32 on page 74. Each study evaluated the extent to which Star Math accurately predicted whether a student achieved a specific performance level on another mathematics measure. The specific performance level (cut point) varies by assessment and grade. Cut points are set by assessment developers and sponsors, which in the case of state summative exams usually means the state department of education and/or state board of education. State assessments generally have between three and five performance levels, and the cut point used in these analyses refers to the level the state has determined indicates meeting grade level mathematics standards. For instance, the cut point on California's CAASPP is Level 3, also known as "Standard Met." On Louisiana's LEAP 2025 the cut point is at the "Mastery" level. In the case of ACT and SAT, the cut point established by the developers (ACT and College Board, respectively) indicates an estimated level of readiness for success in college.

Table 32: Summary of Classification Accuracy Metrics from Recent Studies Linking Star Math with Summative Mathematics Measures

Assessment	Grade/s Covered	Date Study Completed	Study Sample Size	Average Result Across All Grades: Overall Classification Accuracy	Sensitivity	Specificity	Area under ROC Curve
ACT Mathematics (college readiness)	11	4/22/2016	6,328	89%	67%	98%	0.93
ACT Aspire	3–8	6/1/2017	37,581	85%	81%	80%	0.92
California Assessment of Student Performance and Progress (CAASPP) (Smarter Balanced)	3–8	10/30/2015	51,816	87%	84%	88%	0.94
Florida Standards Assessments (FSA)	3–8	6/30/2015	16,071	83%	83%	81%	0.91
Georgia Milestones	3–8	7/1/2017	44,745	89%	77%	93%	0.94
Illinois Partnership for Assessment of Readiness for College and Careers (PARCC) Assessments	3–8	7/13/2016	23,260	91%	62%	96%	0.94
Louisiana Educational Assessment Program (LEAP 2025)	3–8	1/31/2018	7,713	84%	73%	87%	0.91
Maine Educational Assessment (MEA)	3–8	7/1/2017	895	86%	78%	88%	0.91
Mississippi Academic Assessment Program (MAAP)	3–8	2/1/2017	10,954	85%	78%	88%	0.92
Missouri Assessment Program (MAP) Grade-Level Tests	3–8	3/14/2017	19,442	84%	79%	86%	0.94
North Carolina READY End-of-Grade (EOG)	3–8	2/16/2015	125,932	81%	78%	82%	0.89
Ohio State Tests	3–8	12/20/2016	19,682	83%	79%	86%	0.92
Pennsylvania's System of School Assessment (PSSA)	3–8	12/19/2016	3,436	87%	87%	86%	0.94
SAT (college entrance)	11	10/3/2018	2,126	84%	70%	87%	0.91
South Carolina College- and Career-Ready Assessments (SC READY)	3–8	12/5/2016	8,909	87%	83%	89%	0.94

Table 32: Summary of Classification Accuracy Metrics from Recent Studies Linking Star Math with Summative Mathematics Measures

Assessment	Grade/s Covered	Date Study Completed	Study Sample Size	Average Result Across All Grades			
				Overall Classification Accuracy	Sensitivity	Specificity	Area under ROC Curve
State of Texas Assessments of Academic Readiness (STAAR)	3–7	7/1/2017	642	84%	80%	85%	0.91
State of Texas Assessments of Academic Readiness (STAAR) Algebra 1 End of Course (EOC) Test	Algebra I	2/9/2017	3,292	76%	85%	60%	0.82
UK Key Stage 2 Standardised	Year 6	9/1/2017	815	89%	89%	90%	0.97
Attainment Tests (SATs) Maths							
Wisconsin Forward Exam	3–8	12/22/2016	39,812	91%	71%	96%	0.96

Notes:

- Some tests, such as the Smarter Balanced (indicated above for California) and PARCC (indicated above for Illinois) are used in multiple states, so those results may apply to other states not listed here.
- Overall classification accuracy refers to the percentage of correct classifications.
- Sensitivity refers to the rate at which Star Math identifies students as being at-risk who demonstrate a poor learning outcome at a later point in time. Sensitivity can be thought of as the true positive rate. Screening tools with high sensitivity help ensure that students who truly need intervention will be identified to receive it.
- Specificity refers to the rate at which Star Math identifies students as being not at-risk who perform satisfactorily at a later point in time. Specificity can be thought of as a true negative rate. Screening tools with high specificity help ensure that scarce resources are not invested in students who do not require extra assistance.
- Area under the ROC (Receiver Operating Characteristic) curve is a powerful indicator of overall accuracy. The ROC curve is a plot of the true positive rate (sensitivity) against the false positive rate (1-specificity) for the full range of possible screener (Star Math) cut points. The area under ROC

Curve (AUC) is an overall indication of the diagnostic accuracy of the curve. AUC values range between 0 and 1 with 0.5 indicating a chance level of accuracy. The Center for Response to Intervention considers results at or above 0.85 to be an indication of convincing evidence of classification accuracy.[4]

Note that many states tend to not use the same assessment system for more than a few consecutive years, and Renaissance endeavors to keep the Star Math classification reporting as up to date as possible. Those interested in reviewing the full technical reports for these or other state assessments are encouraged to visit http://research.renaissance.com/advancedsearch.asp and search by state name for the Star Math linking reports (e.g., "Wisconsin linking").

Progress Monitoring

According to the National Center on Intensive Intervention, "progress monitoring is used to assess a student's performance, to quantify his or her rate of improvement or responsiveness to intervention, to adjust the student's instructional program to make it more effective and suited to the student's needs, and to evaluate the effectiveness of the intervention."[5]

In an RTI/MTSS context, progress monitoring involves frequent assessment—usually occurring once every 1–4 weeks—and often involves only those students who are receiving additional instruction after been identified as at-risk via the screening process. Ultimately, educators use progress monitoring data to determine whether a student is responding adequately to the instruction, or whether adjustments need to be made to the instructional intensity or methods. The idea is to get to a decision quickly, with as little testing as possible, so that valuable time is not wasted on ineffective approaches. Educators make these decisions by comparing their performance against a goal set by the educator. Goals should be "reasonable yet ambitious"[6] as recommended by Shapiro (2008), and Star Math offers educators a variety of guidance to set normative or criterion-referenced goals that meet these criteria.

The RTI Action Network, National Center on Intensive Intervention, and other organizations offering technical assistance to schools implementing RTI/MTSS models are generally consistent in encouraging educators to select assessments for progress monitoring that have certain characteristics. A

4. https://rti4success.org/resources/tools-charts/screening-tools-chart/screening-tools-chart-rating-system
5. https://intensiveintervention.org/ncii-glossary-terms#Progress Monitoring
6. Shapiro, E. S. (2008). Best practices in setting progress-monitoring monitoring goals for academic skill improvement. In A. Thomas & J. Grimes (Eds.), Best practices in school psychology V (pp. 141–157). Bethesda, MD: National Association of School Psychologists.

summary of those characteristics and relevant information about Star Math is provided below.

1. **Evidence of psychometric quality.**

   a. **Reliability and validity.** See the "Reliability and Measurement Precision" chapter and the earlier sections of this "Validity" chapter for a summary of the available evidence supporting Star Math's reliability and validity.

   b. **Reliability of the slope.** Because progress monitoring decisions often involve the student's rate of progress over multiple test administrations, the characteristics of the student's slope of improvement, or trend line, are also important. A study was conducted in 2017 by Renaissance Learning to evaluate reliability of slope for at-risk students who were being progress monitored during the 2016–17 school year. Specifically, the sample included 96,209 students who began the school year at-risk (defined as placing below the 30th Percentile Rank in Star Math) and were assessed 10 or more times during the school year, with a minimum of 140 days between first and last test.

   Every student's Star Math test records were sorted in chronological order. Each test record was coded as either an odd- or even-numbered test. Slopes were estimated for each student's odd-number tests and also for the even-numbered tests using ordinary least squares regression. Then, the odd and even slopes were correlated. The table below summarizes the Pearson correlation coefficients by grade, indicating a consistently strong association between even and odd numbered test slopes.

Table 33: Star Math Reliability of the Slope Coefficients by Grade, 1–12

Grade	n	Coefficient
1	8,987	0.92
2	18,460	0.93
3	16,696	0.93
4	14,738	0.93
5	12,411	0.93
6	8,627	0.94
7	6,379	0.93
8	5,317	0.93
9	2,129	0.94
10	1,265	0.94
11	803	0.94
12	397	0.94

2. **Produce a sufficient number of forms.** Because Star Math is computer-adaptive with an item bank comprising more than six thousand items, there are at a minimum, several hundred alternate forms for a student at a given ability level. This should be more than sufficient for even the most aggressive progress monitoring testing schedule.

   A variety of grade-specific evidence is available to demonstrate the extent to which Star Math can reliably produce consistent scores across repeated administrations of the same or similar tests to the same individual or group. These include:

   a. Generic reliability, defined as the proportion of test score variance that is attributable to true variation in and the trait or construct the test measures. Grade-level results are summarized in Table 12 on page 43 and Table 16 on page 51.

   b. Alternate form reliability, defined as the correlation between test scores on repeated administrations to the same examinees. Grade-level results are summarized in Table 12 on page 43 and Table 16 on page 51.

   c. **Practicality and efficiency.** As mentioned above, most students complete Star Math in 15–20 minutes. It is auto-scored and can be group administered, requiring very little educator involvement, making it an efficient progress monitoring solution.

3. **Specify criteria for adequate growth and benchmarks for end-of-year performance levels.** Goal-setting decisions are handled by local educators, who know their students best and are familiar with the efficacy and intensity of the instructional supports that will be offered. That said, publishers of assessments used for progress monitoring are expected to provide empirically based guidance to educators on setting goals.

   Star Math provides guidance to inform goal setting using a number of different metrics, including the following:

   a. **Student Growth Percentile.** SGP describes a student's velocity (slope) relative to a national sample of academic peers—those students in the same grade with a similar score history. SGPs work like Percentile Ranks (1–99 scale) but once an SGP goal has been set, it is converted to a Scaled Score goal at the end date specified by the teacher. An SGP-defined goal can be converted into an average weekly increase in a Scaled Score metric if educators prefer to use that. Many teachers select either SGP 50 (indicating typical or expected growth) as minimum acceptable growth, or something indicating accelerated growth, such as 65 or 75. A helpful feature of SGP is that it can be used as a "reality check" for any goal, whether it be in an SGP metric or something else (e.g., Scaled Score, Percentile Rank). SGP estimates the likelihood that the student will achieve a level of growth or later performance. For example, a goal associated with an SGP of 75 indicates that only about 25 percent of the student's academic peers would be expected to achieve that level of growth.

b. **State test proficiency.** As described in the Screening section, the fact that Star Math is linked to virtually every state assessment enables educators to select values on the Star scale that are approximately equivalent to states' defined proficiency level cut points for each grade.

c. **Percentile Rank and Scaled Score.** Educators may also enter custom goals using Percentile Rank or Scaled Score metrics.

Additional Research on Star Math as a Progress Monitoring Tool

A 2016 study by Cormier & Bulut[7] evaluated Star Math as a progress monitoring tool, concluding:

- Although relatively little research exists on using computer adaptive measures for progress monitoring as opposed to curriculum based measurement probes, the study concluded it was possible to use Star Math for progress monitoring purposes.
- Sufficiently reliable progress monitoring slopes could be generated in as few as five Star Math administrations.
- The duration of Star Math progress monitoring (i.e., over how many weeks should be conducted) is a function of the amount of typical growth by grade in relation to measurement error. For earlier grades (when student rates of growth are greatest), that amount of time could be as little as six weeks. For middle grades, 20 weeks should be sufficient.
- These two findings challenge popular rules of thumb about progress monitoring frequency and duration (most of which are derived from CBM probe studies), which often involve weekly testing over periods of time that are selected due to popular convention rather than empirical evidence.
- Using Theil-Sen regression procedures to estimate slope as opposed to OLS could reduce the influence of outlier scores, and thus provide a more accurate picture of student growth.

7. Cormier, D. & Bulut, O. (2016). *Developing psychometrically sound decision rules for Star Math.* Report prepared for Renaissance Learning.

Differential Item Functioning

Ensuring that an assessment is not biased against different demographic subgroups that take the assessment is a fundamental aspect of showing test fairness and providing validity evidence to support the interpretations and uses of the assessment. One strategy that is often used as part of evaluating test fairness is a strategy known as differential item functioning (DIF). DIF occurs when two or more demographic subgroups perform differently on an item after controlling for performance on the test (Holland & Thayer, 1988; Zumbo, 2007). In other words, for students of similar ability, an item that displays DIF may appear to favor one group of students based on demographics such as gender and/or race/ethnicity.

There are many different methods that one can use to investigate items for DIF, including item response theory methods, observed score methods, and a variety of nonparametric approaches (Zumbo, 2007). Star Math uses the logistic regression (LR) method to evaluate items for DIF (Rogers & Swaminathan, 1993; Swaminathan & Rogers, 1990; Swaminathan, 1994). With this approach, student item responses are regressed on student ability estimates from Star Math as well as their subgroup membership and the student ability and subgroup membership interaction. To conduct a DIF analysis, a reference group and a focal group is defined. For instance, male is the reference group for gender while female is the focal group. Similarly, Caucasian is the reference group for race/ethnicity with the minority race/ethnic groups being focal groups. Separate models are run for DIF for male versus female, black versus white, Hispanic versus white, Asian versus white, and Native American versus white.

Items are flagged for DIF using a blended approach that employs a likelihood ratio test of statistical significance to determine if DIF is present, and then assessing whether any evidence of DIF is practically significant using the Nagelkerke R^2 statistic (1991). For DIF investigations using LR, a common effect size measure is defined as the difference in R^2 values between the full model (including ability, subgroup membership, and their interaction as predictors) and the base model (including ability as the sole predictor). Items are categorized as exhibiting negligible DIF if the null hypothesis is not rejected or the difference in R^2 statistics is less than 0.035, moderate DIF if the null hypothesis is rejected and the difference in R^2 statistics is greater than or equal to 0.035 and less than 0.070, or large DIF if the null hypothesis is rejected and the difference in R^2 statistics is greater than or equal to 0.070 (Jodion & Gierl, 2001).

There are a couple of points in the Star Math assessment development cycle when items are evaluated for DIF. The first time point is when an item is included as a field test item as part of Star Math's item calibration process. During item calibration, new assessment items are tried out with different groups of students to make sure that items have appropriate statistical and psychometric properties before they are used operationally and count towards a student's score. The second time point is when the full item bank of operational test items is recalibrated for scale maintenance, to check whether the statistical and psychometric properties of the items have remained similar after the items become operational.

It is important to point out that just because an item is flagged for DIF against one or more subgroups does not necessarily mean that the item is biased. There are many possible explanations why an item may be statistically flagged for DIF. All items that are statistically flagged as having non-negligible DIF are marked for a bias and sensitivity review by the Content team. This review process consists of several subject matter experts with diverse perspectives and different backgrounds looking at and reviewing each item to see if there is any content in the item that may be biased against a particular subgroup and might explain why the item was statistically flagged for DIF. Items identified as being biased for any reason are removed from the item bank and do not appear on the Star Math test. The statistical flagging of items for DIF as well as the bias and sensitivity review by the Content team helps ensure test fairness and that the items that appear on Star Math do not favor any group of students that may take the test.

As shown in Figure 5, only 1% of over 5000 items in the Star Math item bank showed any evidence of DIF when Star Math was recalibrated in 2021.

Figure 5: Summary of Star Math Items with DIF

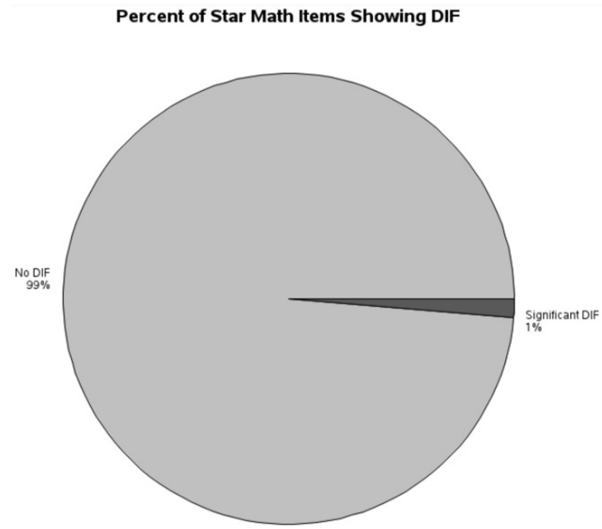


Table 34 shows the DIF results by reference and focal groups from various DIF analyses. These results suggest that of the thousands of items analyzed, very few items were flagged for DIF. There were 0.27% of items categorized with non-negligible DIF for male versus female, 0.00% of items flagged with non-negligible DIF for Asian versus white, 0.27% of items flagged with non-negligible DIF for black versus white, 0.16% of items flagged with non-negligible DIF for Hispanic versus white, and 0.00% of items flagged with non-negligible DIF for Native American versus white. These results provide evidence of the fairness of the Star Math test for different demographic subgroups that take the assessment. As previously noted, any items that show DIF are removed from operational use.

Table 34: Percentage of Items Showing DIF for Different DIF Comparisons

DIF Comparison	Percent of Items Showing DIF
Female versus Male	0.27%
Asian versus White	0.00%
Black versus White	0.27%
Hispanic versus White	0.16%
Native American versus White	0.00%

Summary of Star Math Validity Evidence

The validity data presented in this technical manual includes evidence of Star Math's concurrent, predictive, and construct validity, as well as classification accuracy statistics; strong measures of association with math achievement levels on state and multi-state accountability assessments; and extensive evidence of its technical adequacy for screening and progress monitoring. Exploratory and confirmatory factor analyses provided evidence that Star Math measures a unidimensional construct, consistent with the assumption underlying its use of the Rasch item response model. The Meta-Analysis section showed the average uncorrected correlation between Star Math and all other math tests to be 0.758. (Many meta-analyses adjust the correlations for range restriction and attenuation to less than perfect reliability; had we done that here, the average correlation would have exceeded 0.80.) Correlations with specific measures of math ability were often higher than this average. For example, correlations with PARCC assessments averaged 0.83, and those with Smarter-Balanced Assessment scores averaged 0.88. The overall pattern of hundreds of correlations between Star Math and scores on other recognized math assessments provides strong support for the claim that Star Math is a measure of math achievement.

Finally, the data showing the relationship between the current, standards-based Star Math Enterprise test and scores on specific state accountability tests and on the SBAC and PARCC Common Core consortium tests show that the correlations with these important measures are consistent with the meta-analysis findings.

Norming

Two distinct kinds of norms are described in this chapter: test score norms and growth norms. The former refers to distributions of test scores themselves. The latter refers to distributions of changes in test scores over time; such changes are generally attributed to growth in the attribute that is measured by a test. Hence distributions of score changes over time may be called "growth norms."

Background

National norms for Star Math were first developed in 2002 for Version 1 of the assessment, then updated in 2012 and 2017. The 2017 norms were used since the 2017–2018 school year until new norms were developed for introduction at the start of the 2022–2023 school year. This chapter describes the development of the 2022 norms.

The 2022 Star Math Norms

Prior to the development of the 2022 Star Math norms, a new reporting scale was developed, called the Unified scale. The Unified scale is a new linear transformation of the Star Math Rasch scores to a scale that shares features with a new scale developed for use with Star Reading and Star Early Literacy. The introduction of the Star Unified Scale provides a common scale that makes it possible for the first time to report performance on all Star assessments on the same scale.

The original Star Math scale is now referred to as the "Enterprise" score scale and will be available during the planned transition to the Unified scale as the default reporting scale. The Unified scale is the default scale in the software for the 2022–2023 school year. This chapter includes displays of normative summary data for both the Enterprise and the Unified scales

Due to testing impacts from COVID-19, the 2022 Star Math norms are based on Star Math test data collected over the course of the 2018–2019 school year. Separate early fall and late spring norms were developed for grades K through 12. Students participating in the norming study took assessments between August 1, 2018 and June 30, 2019. Students took the Star Math tests under normal test administration conditions. No specific norming test was developed and no deviations were made from the usual test administration. Thus, students in the norming sample took Star Math tests as they are administered in everyday use.

Sample Characteristics

During the norming period, a total of 4,990,729 US students in grades K–12 took Star Math tests administered using Renaissance servers hosted by Renaissance Learning. The first step in sampling was to select a representative sample of students who had tested in the fall, in the spring, or in both the fall and spring of the 2018–2019 school year. From the fall and the spring samples, stratified subsamples were randomly drawn based on student grade and ability decile. The grade and decile sampling was necessary to ensure adequate and similar numbers of students in each grade, and each decile within grade. Because these norming data were a convenience sample drawn from the Star Math customer base, steps were taken to ensure the resulting norms were nationally representative of grades K–12 US student population with regard to certain important characteristics. A post-stratification procedure was used to adjust the sample proportions to the approximate national proportions on three key variables: geographic region, district socio-economic status, and district/school size. These three variables were chosen because they had previously been used in Star Math norming studies to draw nationally representative samples, are known to be related to test scores, and were readily available for the schools in the Renaissance hosted database.

The final norming sample size, after selecting only students with test scores in either the fall or the spring or both fall and spring in the norming year and further sampling by grade and ability decile was 3,035,052 students in grades K–12. There were 2,225,100 students in the fall norming sample and 1,682,660 students in the spring norming sample; 872,708 students were included in both norming samples. These students came from 16,055 schools across 50 states and the District of Columbia.

Table 35 and Table 36 provide a breakdown of the number of students participating per grade in the fall and spring, respectively.

Table 35: Numbers of Students per Grade in the Fall Norms Sample

Grade	N	Grade	N	Grade	N
K	12,860	5	311,590	10	74,190
1	113,910	6	309,840	11	26,170
2	322,370	7	271,510	12	14,160
3	270,980	8	131,580	Total	2,225,100
4	308,380	9	57,560		

Table 36: Numbers of Students per Grade in the Spring Norms Sample

Grade	N	Grade	N	Grade	N
K	31,710	5	210,600	10	43,480
1	143,750	6	218,060	11	20,490
2	226,570	7	175,650	12	5,380
3	226,470	8	126,570	Total	1,682,660
4	213,980	9	39,950		

National estimates of US student population characteristics were obtained from two entities: the National Center for Educational Statistics (NCES) and Market Data Retrieval (MDR).

- National population estimates of students' demographics (ethnicity and gender) in grades K–12 were obtained from NCES; these estimates were from 2017–2018 for private schools and 2018–2019 for public schools, the most recent data available. National estimates of race/ethnicity were computed using the NCES data based on single race/ethnicity and also a multiple-race category. The NCES data reflect the most recent census data from the US census bureau.
- National estimates of school-related characteristics were obtained from May 2018 Market Data Retrieval (MDR) information. The MDR database contains the most recent data on schools, some of which may not be reflected in the NCES data.

Table 37 on page 88 shows national percentages of children in grades K–12 by region, school/district enrollment, district socio-economic status, location, and school type (public versus private) along with the corresponding percentages in the norming sample. MDR estimates of geographic region were based on the four broad areas identified by the National Educational Association as Northeastern, Midwestern, Southeastern, and Western regions. The specific states in each region are shown below.

Geographic Region

Using the categories established by the National Center for Education Statistics (NCES), students were grouped into four geographic regions as defined below: Northeast, Southeast, Midwest, and West.

Northeast

Connecticut, District of Columbia, Delaware, Massachusetts, Maryland, Maine, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont

Southeast

Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia

Midwest

Iowa, Illinois, Indiana, Kansas, Minnesota, Missouri, North Dakota, Nebraska, Ohio, South Dakota, Michigan, Wisconsin

West

Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, New Mexico, Nevada, Oklahoma, Oregon, Texas, Utah, Washington, Wyoming

School size

Based on total school enrollment, schools were classified into one of three school size groups: small schools had under 200 students enrolled, medium schools had 200–499 students enrolled, and large schools had 500 or more students enrolled.

Socioeconomic status as indexed by the percent of school students with free and reduced lunch

Schools were classified into one of four classifications based on the percentage of students in the school who had free or reduced student lunch. The classifications were coded as follows:

- High socioeconomic status (0%–24%)
- Above-median socioeconomic status (25%–49%)
- Below-median socioeconomic status (50%–74%)
- Low socioeconomic status (75%–100%)

No students were sampled from the schools that did not report the percent of school students with free and reduced lunch.

The norming sample also included private schools, Catholic schools, students with disabilities, and English Language Learners as described below.

Table 37: Sample Characteristics Along with National Population Estimates and Sample Estimates

		National Estimates	Fall Norming Sample	Spring Norming Sample
Region	Midwest	21.0%	22.3%	23.5%
	Northeast	18.6%	13.2%	14.0%
	Southeast	25.0%	28.2%	26.1%
	West	35.4%	36.4%	36.4%
School Enrollment	< 200	3.7%	4.2%	4.5%
	200–499	27.9%	36.6%	37.5%
	≥ 500	68.4%	59.2%	58.0%
District Socioeconomic Status	Low	20.7%	23.6%	23.9%
	Below Median	21.5%	24.0%	23.3%
	Above Median	24.4%	23.4%	23.0%
	High	33.5%	29.0%	29.8%
Location	Rural	14.4%	21.0%	20.3%
	Suburban	41.7%	36.9%	37.4%
	Town	11.4%	15.0%	14.9%
	Urban	32.5%	27.1%	27.3%
School Type	Public	91.9%	92.7%	91.6%
	Non-Public	8.1%	7.3%	8.4%

Table 38 provides information on the demographic characteristics of students in the sample and national percentages provided by NCES. No weighting was done on the basis of these demographic variables; they are provided to help describe the sample of students and the schools they attended. Because Star assessment users do not universally enter individual student demographic information such as gender and ethnicity/race, some students were missing demographic data, and the sample summaries in Table 38 are based on only those students that had gender and ethnicity information available. In addition to the student demographics shown, an estimated 6.9% of the students in the norming sample were gifted and talented (G&T) as approximated by the 2011–2012 school data collected by the Office of Civil Rights (OCR). OCR is a subsidiary of the US Department of Education.

School type was defined to be either public (including charter schools) or non-public (private, Catholic).

Table 38: Student Gender and School Information: National Estimates and Samples Percentages

			National Estimate	Fall Norming Sample	Spring Norming Sample
Gender	Public	Female	48.7%	49.5%	50.2%
		Male	51.3%	50.5%	49.8%
	Non-Public	Female	–	51.4%	52.0%
		Male	–	48.6%	48.0%
Race/Ethnicity	Public	American Indian	1.0%	1.6%	1.7%
		Asian	5.6%	5.1%	4.8%
		Black	15.1%	17.6%	18.2%
		Hispanic	27.1%	23.6%	23.9%
		White	47.1%	48.7%	48.1%
		Multiple Race[a]	4.0%	3.4%	3.4%
	Non-Public	American Indian	0.6%	0.6%	0.9%
		Asian	7.2%	10.7%	9.9%
		Black	9.2%	6.1%	7.1%
		Hispanic	11.5%	34.2%	35.0%
		White	66.7%	41.3%	40.6%
		Multiple Race[a]	4.9%	7.2%	6.6%

a. Students identified as belonging to two or more races.

Test Administration

All students took current version Star Math tests under normal administration procedures. Some students in the normative sample took the assessment two or more times within the norming windows; scores from their initial test administration in the fall and the last test administration in the spring were used for computing the norms.

Data Analysis

Student test records were compiled from the complete database of Star Math Renaissance users. Data spanned one school year from August 2018 to June 2019. Students' Unified scale Rasch scores on their first Star Math test taken during the first month of the school year based on grade placement were used to compute norms for the fall; students' Unified scale Rasch scores on the last

Star Math test taken during the 7th or 8th month of the school year were used to compute norms for the spring. Interpolation was used to estimate norms for times of the year between the first month in the fall and the last month in the spring. The norms were based on the distribution of Unified scale Rasch scores for each grade.

As noted above, a post-stratification procedure was used to approximate the national proportions on key characteristics. Post stratification weights from the regional, district socio-economic status, and school size strata were computed and applied to each student's unified Rasch ability estimate. Norms were developed based on the weighted Rasch ability estimates and then transformed to both Star Math Enterprise and Unified scaled scores. Table 39 provides descriptive statistics for each grade with respect to the normative sample performance, in the Unified scaled score units. Table 40 provides descriptive statistics for each grade with respect to the normative sample performance, in the Enterprise scaled score units.

Table 39: Descriptive Statistics for Weighted Scaled Scores by Grade for the 2018–2019 Norming Sample in the Unified Scale

	Fall Unified Scaled Scores				Spring Unified Scaled Scores			
Grade	N	Mean	Standard Deviation	Median	N	Mean	Standard Deviation	Median
K	12,860	725	50	717	31,710	797	53	799
1	113,910	774	55	771	143,750	852	55	851
2	322,370	862	53	864	226,570	919	51	919
3	270,980	915	52	917	226,470	971	56	975
4	308,380	967	57	971	213,980	1,009	59	1,013
5	311,590	1,009	61	1,012	210,600	1,044	60	1,048
6	309,840	1,049	64	1,055	218,060	1,078	66	1,083
7	271,510	1,072	69	1,080	175,650	1,094	73	1,098
8	131,580	1,092	75	1,099	126,570	1,111	77	1,116
9	57,560	1,097	74	1,105	39,950	1,114	76	1,117
10	74,190	1,099	76	1,106	43,480	1,116	78	1,118
11	26,170	1,116	76	1,118	20,490	1,124	76	1,127
12	14,160	1,124	77	1,127	5,380	1,129	76	1,133

Table 40: Descriptive Statistics for Weighted Scaled Scores by Grade for the 2018–2019 Norming Sample in the Enterprise Scale

Grade	Fall Enterprise Scaled Scores				Spring Enterprise Scaled Scores			
	N	Mean	Standard Deviation	Median	N	Mean	Standard Deviation	Median
K	12,860	192	82	179	31,710	309	86	312
1	113,910	271	90	267	143,750	398	90	397
2	322,370	415	86	418	226,570	508	83	507
3	270,980	501	85	504	226,470	592	91	598
4	308,380	586	93	593	213,980	655	95	661
5	311,590	653	99	658	210,600	711	98	717
6	309,840	719	104	728	218,060	766	107	774
7	271,510	757	112	770	175,650	792	119	799
8	131,580	789	122	801	126,570	820	125	827
9	57,560	797	120	809	39,950	824	123	829
10	74,190	800	124	811	43,480	828	127	831
11	26,170	828	123	831	20,490	840	124	845
12	14,160	841	125	846	5,380	849	124	855

Growth Norms

Student achievement typically is thought of in terms of status: a student's performance at one point in time. However, this ignores important information about a student's learning trajectory—how much students are growing over a period of time. When educators are able to consider growth information—the amount or rate of change over time—alongside current status, a richer picture of the student emerges, empowering educators to make better instructional decisions.

To facilitate deeper understanding of achievement, Renaissance Learning maintains growth norms for Star Assessments that provide insight both on growth to date and likely growth in the future. Growth norms are currently available for Star Math, Star Reading, and Star Early Literacy, and may be available for additional Star adaptive assessments in the coming years.

The growth model used by Star Assessments is Student Growth Percentile (SGP, Betebenner, 2009). SGPs were developed by Dr. Damian Betebenner, originally in partnership with several state departments of education.[1] It should be noted that the initial development of SGP involved annual state summative tests with reasonably constrained testing periods within each state. Because Star tests may be taken at multiple times throughout the year, a number of adaptations to the original model were made. For more information about Star Math SGPs, please refer to this overview: http://doc.renlearn.com/KMNet/R00571375CF86BBF.pdf

SGPs are norm-referenced estimates that compare a student's growth to that of his or her academic peers nationwide. Academic peers are defined as those students in the same grade with a similar score history. SGPs are generated via a process that uses quantile regression to provide a measure of how much a student changed from one Star testing window to the next relative to other students with similar score histories.

SGPs range from 1–99 and are interpreted similarly to Percentile Ranks, with 50 indicating typical or expected growth. For instance, an SGP score of 37 means that a student grew as much or more than 37 percent of her academic peers, and less than about 63 percent of her academic peers.

The Star Math SGP package also produces a range of future growth estimates. Those are mostly hidden from users but are presented in goal-setting and related applications to help users understand what typical or expected growth looks like for a given student. They are particularly useful for setting future goals and understanding the likelihood of reaching future benchmarks, such as likely achievement of proficient on an upcoming state summative assessment.

At present, the Star Math SGP growth norms are based on a sample of 15,216,272 matched student records from the 2016–2017, 2017–2018, and 2018–2019 school years across grades K–12. The sample included 6,140,587 unique students across all three school years. Table 41 provides a summary of the number of students and tests that were used when computing the SGP growth norms.

1. Core SGP documentation and source code are publicly available at https://cran.r-project.org/web/packages/SGP/index.html.

Table 41: Numbers of Students and Number of Tests Used in Computing SGP Growth Norms

Grade	Students	Tests	Grade	Students	Tests
K	75,312	133,011	7	602,124	1,484,164
1	554,506	1,397,878	8	571,915	1,372,359
2	678,687	1,788,294	9	309,539	643,840
3	719,905	1,879,416	10	240,530	486,311
4	730,753	1,910,923	11	164,052	313,490
5	737,422	1,913,347	12	105,295	181,071
6	679,115	1,712,168	Total	6,140,587[a]	15,216,272

a. This is the total number of unique students across *all* grades.

Score Definitions

Types of Test Scores

In a broad sense, Star Math software provides three different types of test scores that measure student performance in different ways:

- *Scaled scores.* Star Math creates a virtually unlimited number of test forms as it dynamically interacts with the students taking the test. In order to make the results of all tests comparable, and in order to provide a basis for deriving the other types of test scores described below, it is necessary to convert the results of Star Math tests to scores on a common scale. Star Math software does this in two steps. First, maximum likelihood is used to estimate each student's score on the Rasch ability scale, based on the difficulty of the items administered, and the pattern of right and wrong answers. Second, the Rasch ability scores are converted to scaled scores. Two different score scales are now available in Star assessments: the original scaled scores, which are referred to as "Enterprise" scaled scores; and a new score, expressed on the "Unified" score scale, which was introduced with the 2017–2018 school year.

  Enterprise Scale Scores

  For Star Math, the "Enterprise" scale scores are the same scores that have been reported continuously since Star Math Version 1 was introduced in 1998. The range of reported Star Math Enterprise scores extends from 0 to 1400.

  Unified Scale Scores

  Renaissance developed a single score scale that applies to all Star assessments: the Unified score scale. Development began with equating each test's underlying Rasch ability scales to a common Rasch scale; the result was the "unified Rasch scale," which is an extension of the Rasch scale used in Star Reading. The next step was to develop an integer scale based on the unified Rasch scale, with new scale scores anchored to important points on the original Enterprise score scales of both tests. The end result was a reported score scale that extends from 200 to 1400.

  Star Math and Star Reading Unified reported scale scores range from 600 to 1400. Star Early Literacy Unified reported scale scores range from 200 to 1100. One benefit of the Unified scale is an improvement in certain properties of the scale scores: scores on both tests are much less variable from grade to grade; measurement error is likewise less variable; and Unified score reliability is slightly higher than that of the Enterprise scores.

- *Criterion-referenced scores* describe what a student knows or can do, relative to a specific content domain or to a standard. Such scores may be expressed either on a continuous score scale or as a classification. An example of a criterion-referenced score on a continuous scale is a percent-correct score, which expresses what proportion of test questions the student can answer correctly in the content domain. An example of a criterion-referenced classification is a proficiency category on a standards-based assessment: the student may be said to be "proficient" or not, depending on whether his score equals, exceeds, or falls below a specific criterion (the "standard") used to define "proficiency" on the standards-based test. The domain scores and mastery classification charts in the Diagnostic Report are criterion-referenced.
- *Norm-referenced scores* compare a student's test results to the results of other students who have taken the same test. In this case, scores provide a relative measure of student achievement compared to the performance of a group of students at a given time. Percentile Ranks and Grade Equivalents are the two primary norm-referenced scores provided by Star Math software. Both of these scores are based on a comparison of a student's test results to the data collected during the development of the 2022 Star Math norms.

Grade Equivalent (GE)

A Grade Equivalent (GE) indicates the normal grade placement of students for whom a particular score is typical. If a student receives a GE of 10.0, this means that the student scored as well on Star Math as did the typical student at the beginning of grade 10. It does not necessarily mean that the student has mastered math objectives at a tenth-grade level, only that he or she obtained a Scaled Score as high as the average beginning tenth-grade student in the norms group.

GE scores are often misinterpreted as though they convey information about what a student knows or can do—that is, as if they were criterion-referenced scores. To the contrary, GE scores are norm-referenced.

GEs in Star Math range from 0 to 12.9+, where 0 represents the beginning of grade K. Because Star Math norms go no lower than grade K, the GE for a score below the minimum for GE 0 will be reported as "< 0". The scale divides the academic year into 10 monthly increments, and is expressed as a decimal with the unit denoting the grade level and the individual "months" in tenths. Because Star Math norms are based on fall and spring score data only, monthly GE scores are derived through interpolation by fitting a curve to the grade-by-grade medians. Table 44, “Scaled Score to Grade Equivalent Conversions” on page 102 in the Conversion Tables chapter, contains the Star Math Scaled Score to GE conversions for both Unified and Enterprise scaled scores.

The GE scale is not an equal-interval scale. For example, an increase of 50 Scaled Score points might represent only three or four months of GE change at the lower grades, but this same increase in Scaled Scores may signify over a year of GE change in the high school grades. This occurs because student growth in math proficiency (and other academic areas) is not linear; proficiency develops much more rapidly in the lower grades than in the middle to upper grades. Consideration of this phenomenon should be made when averaging GE scores, especially those spanning two or more grades.

Grade Equivalent Cap

For customers who are using either Star Math or Star Math Enterprise on the Renaissance hosted platform, GE scores will be capped when they exceed three grade levels above the student’s actual grade placement (seeTable 42). When a student’s Scaled Score produces a GE that is greater than the start of three grades above the student’s current grade, Star Math will report that student’s GE is greater than the cap grade but will not report the specific GE score. Because this cannot happen to students in tenth grade or above, the potential for a capped GE will only exist for K–9 students. When applicable, the GE cap will now appear on all Star Math reports—even those showing test scores from tests taken prior to this update.

For example, a fourth grade student cannot receive a GE score above 7.0 at any time of the year. If their GE score is above a 7.0, the reports will show a capped GE score of “> 7”.

Table 42: Grade Equivalents with GE Cap

Grade Placement	Grade Equivalent	Grade Equivalent Reported As
4.6	6.9	6.9
4.6	7.0	7.0
4.6	7.1	> 7

Comparing Star Math GEs with Those from Conventional Tests

Because Star Math adapts to the proficiency level of the student being tested, the GE scores that Star Math provides are more consistently accurate across the achievement spectrum than those provided by conventional paper-and-pencil test instruments. In addition, Grade Equivalent scores obtained using conventional test instruments are less accurate when a student's grade placement and GE score differ markedly. It is not uncommon for a fourth-grade student to obtain a GE score of 8.9 when using a conventional test instrument. However, this does not necessarily mean that the student is performing at a level typical of an end-of-year eighth-grader. More likely, it means that the student answered all, or nearly all, of the items correctly on the conventional test and thus performed beyond the range of the fourth-grade test.

On the other hand, Star Math GE scores are more consistently accurate, even as a student's achievement level deviates from the level of grade placement. A student may be tested on any level of material up to three grade levels above grade placement, depending upon his or her actual performance on the test. Throughout a Star Math test, students are tested on items of an appropriate level of difficulty, based on their individual level of achievement.

Percentile Rank (PR)

Percentile Rank (PR) scores indicate the percentage of students in the same grade and at the same point of time in the school year who obtained scores lower than the score of a particular student. In other words, Percentile Ranks show how an individual student's performance compares to that of his or her same-grade peers on the national level. For example, a Percentile Rank of 85 means that the student is performing at a level that exceeds 85% of other students in that grade at the same time of the year. Percentile Ranks simply indicate how a student performed compared to others who took Star Math tests as a part of the national norming study. PRs range from 1–99.

The PR scale is not an equal-interval scale. For example, at grade placement of 7.0, Star Math Unified scaled scores of 1128 and 1149 correspond to PRs of 80 and 90, respectively. Thus, a difference of 21 scaled score points represents a 10-point difference in PR. However, at the same grade placement, scaled scores of 1080 and 1096 correspond to PRs of 50 and 60, respectively. In this case, a difference of 16 scaled points also represents a 10-point difference in PR. For this reason, PR scores should not be averaged or otherwise algebraically manipulated. NCE scores, described below, are much more appropriate for these types of calculations.

Table 45 on page 106 and Table 46 on page 110 in the Conversion Tables chapter contain abridged versions of both the Unified and the Enterprise Scaled Score to Percentile Rank conversion tables used by Star Math, which only shows the fall norms based on the first month of the school year by grade. The unabridged table includes norms for all the monthly grade placement values from 0.0 to 12.9. For each grade, the fall norms (grade placement ending in ".0") and spring norms (grade placement ending in ".9") were computed directly from data, while the intermediate norms were estimated by linearly interpolating between the two end points.

Normal Curve Equivalent (NCE)

Normal Curve Equivalents (NCEs) are scores that have been scaled in such a way that they have a normal distribution, with a mean of 50 and a standard deviation of 21.06 in the normative sample for a specific grade for a given test. Because NCEs range from 1 to 99, they appear similar to Percentile Ranks, but they have the advantage of being based on an equal interval scale. That is, the difference between two successive scores on the scale has the same meaning throughout the scale. Because of this feature, NCEs are useful for purposes of statistically manipulating norm-referenced test results, such as interpolating test scores, calculating averages, and computing correlation coefficients between different tests. For example, in Star Math score reports, average Percentile Ranks are obtained by first converting the PR values to NCE values, averaging the NCE values, and then converting the average NCE back to a PR.

Table 47 on page 113 in the Conversion Tables chapter lists the NCEs corresponding to integer PR values and facilitates the conversion of PRs to NCEs. Table 48 on page 114 provides the reverse conversions from NCE to PR. The NCE values are given as a range of scores that convert to the corresponding PR value.

Student Growth Percentile (SGP)

Student Growth Percentiles (SGPs) are a norm-referenced quantification of individual student growth derived using quantile regression techniques. An SGP compares a student's growth to that of his or her academic peers nationwide with a similar achievement history on Star assessments. Academic peers are students who

- are in the same grade,

- had the same scores on the current test and (up to) two prior tests from different testing windows, and
- took the most recent test and the first prior test on the same dates.

SGPs provide a measure of how a student changed from one Star testing window[1] to the next relative to other students with similar starting Star Math scores. SGPs range from 1–99 and interpretation is similar to that of Percentile Rank scores; lower numbers indicate lower relative growth and higher numbers show higher relative growth. For example, an SGP of 70 means that the student's growth from one test window to another exceeds the growth of 70% of students nationwide in the same grade with a similar Star Math score history. All students, no matter their starting Star score, have an equal chance to demonstrate growth at any of the 99 percentiles.

SGPs are often used to indicate whether a student's growth is more or less than can be expected. For example, without an SGP, a teacher would not know if a Scaled Score increase of 100 represents good, not-so-good, or average growth. This is because students of differing achievement levels in different grades grow at different rates relative to the Star Math scale. For example, a high-achieving second-grader grows at a different rate than a low-achieving second-grader.

Similarly, a high-achieving second-grader grows at a different rate than a high-achieving eighth-grader.

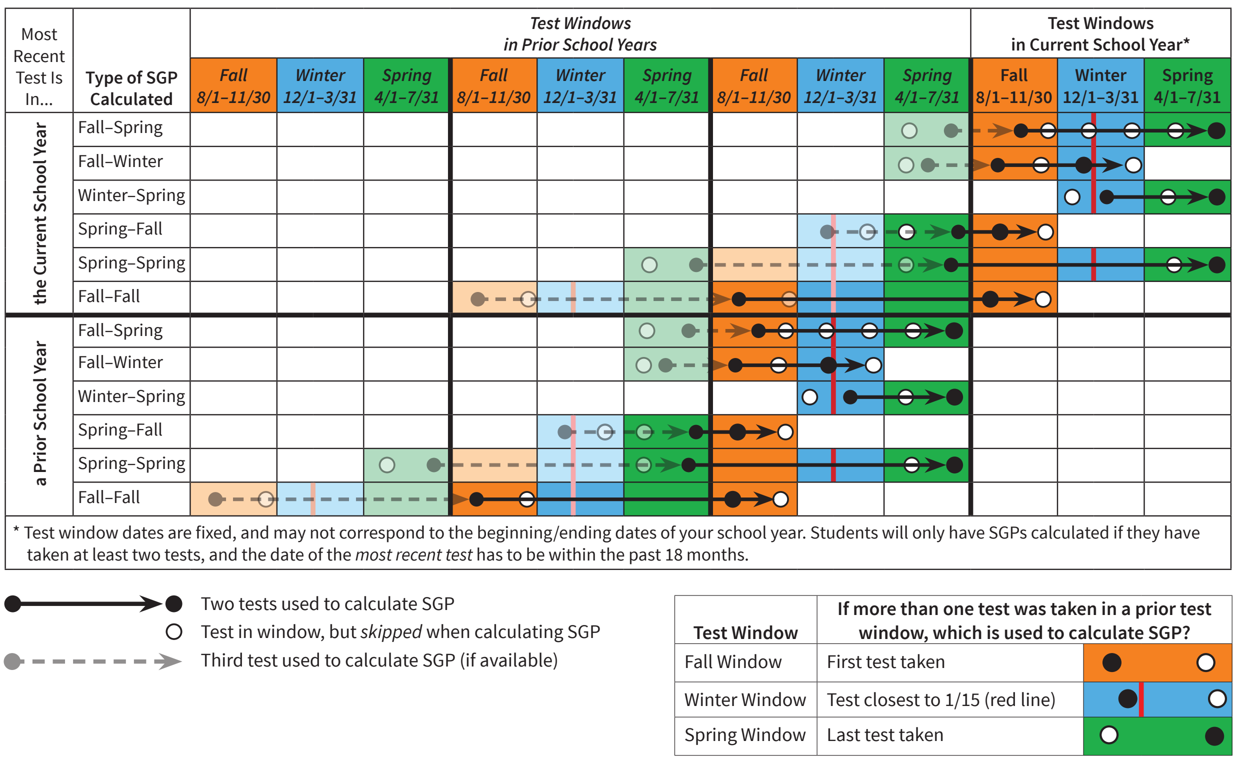
SGPs can be aggregated to describe typical growth for groups of students—for example, a class, grade, or school as a whole—by calculating the group's median, or middle, growth percentile. No matter how SGPs are aggregated, whether at the class, grade, or school level, the statistic and its interpretation remain the same. For example, if the students in one class have a median SGP of 62, that particular group of students, on average, achieved higher growth than their academic peers.

SGP is calculated for students who have taken at least two tests (a current test and a prior test) within at least two different testing windows (Fall, Winter, or Spring).

1. We collect data for our growth norms during three different time periods: fall, winter, and spring. More information about these time periods is provided on page 100..

If a student has taken more than one test in a single test window, the SGP calculation is based off the following tests:

- The current test is always the last test taken in a testing window.
- The test used as the prior test depends on what testing window it falls in:
  - Fall window: The first test taken in the Fall window is used.
  - Winter window: The test taken closest to January 15 in the Winter window is used.
  - Spring window: The last test taken in the Spring window is used.



Grade Placement

Star Math software uses students' grade placement values when determining norm-referenced scores. The values of PR (Percentile Rank) and NCE (Normal Curve Equivalent) are based not only on what Scaled Score the student achieved, but also on the grade placement of the student at the time of the test. For example, a second-grader in the first month with a Unified Scaled Score of 935 would have a PR of 92, while a third-grader in the first month with the same Unified Scaled Score would have a PR of 64.

Thus, it is crucial that student records indicate the proper grade and month within grade when students take a Star Math test, and that any testing in July or August reflects the proper understanding of how Star software deals with those months in determining grade placement.

Indicating the Appropriate Grade Placement

The numeric representation of a student's grade placement is based on the specific month in which he or she takes a test. Although teachers indicate a student's grade level or Math Instructional Level (MIL) using whole numbers, the Star Math software automatically adds fractional increments to that grade based on the month of the test. To determine the appropriate increment, Star Math considers the standard school year to run from September–June and assigns increment values of 0.0–0.9 to these months. The increment values for July and August depend on the school year setting:

- If teachers will use the July and August test scores to evaluate the student's math performance at the beginning of the year, in the Renaissance program, make sure the start date for that school year is before your testing in July and August. Grades are automatically increased by one level in each successive school year, so promoting students is not necessary. In this case, the increment value for July and August is 0.00 because these months are at the beginning of the school year.
- If teachers will use the test scores to evaluate the student's math performance at the end of the school year, make sure the end date for that school year falls after your testing in July and August. In this case, the increment value for July and August is 0.99 because these months are at the end of the school year that has passed.

Table 43 summarizes the increment values assigned to each month.

Table 43: Incremental Grade Placement Values per Month

Month	Decimal Increment	Month	Decimal Increment
July	0.0 or 0.99[a]	January	0.4
August	0.0 or 0.99[a]	February	0.5
September	0.0	March	0.6
October	0.1	April	0.7
November	0.2	May	0.8
December	0.3	June	0.9

a. Depends on the school year entered.

If your school follows the standard school calendar used in Star Math and you will not be testing in the summer, assigning the appropriate grade placements for your students is automatic.

However, if you are going to test students in July or August, whether it is for a summer program or because your normal calendar extends into these months, grade placements become an extremely important issue.

To ensure the accurate determination of norm-referenced scores when testing in the summer, you must determine whether to include the summer months in the past school year or in the next school year. Student grade levels are automatically increased in the new school year. In most cases, you can use the above guidelines.

Instructions for specifying school years and grade assignments can be found at https://help.renaissance.com/RP and https://help2.renaissance.com/setup.

Compensating for Incorrect Grade Placements

Teachers cannot make retroactive corrections to a student's grade placement by editing the grade assignments in a student's record or by adjusting the increments for the summer months after students have tested. In other words, the Star Math software cannot go back in time and correct scores resulting from erroneous grade placement information. Thus, it is extremely important for the test administrator to make sure that the proper grade placement procedures are followed.

Quantile Measures

The Quantile Measure is an auxiliary scale developed by MetaMetrics for reporting math test performance. As described by Petersen, Kolen, and Hoover (1989, p. 222) auxiliary score scales can be used to "convey additional normative information, test-content information, and information that is jointly normative and content based." One such auxiliary scale is The Quantile® Framework for Mathematics, which was developed to appropriately match students with materials at a level where the student has the background knowledge necessary to be ready for instruction on new mathematical skills and concepts. The Quantile Framework, and the Quantile scale, have been adopted by numerous states, and a number of standardized test publishers, for use as a common measure of math achievement.

In cooperation with MetaMetrics®, beginning in mid-2019, users of Star Math had the option of including Quantile measures on certain Star Math score reports, for students in grades 3 through 8. (In 2021, this was expanded to include students in grades 1–12). Quantile measures reported by Star Math will range from EM400Q to 1600Q. (The “Q” suffix identifies the score as a Quantile measure. Where it appears, the “EM” prefix (“Emerging Mathematician”) indicates a score that is below 0 on the Quantile scale; such scores are typical of beginning math students.)

The Quantile Framework is described in detail in MetaMetrics (2015); an overview of it is available in MetaMetrics (2004). Research to link Star Math scores to the Quantile scale was conducted by MetaMetrics in the 2018–2019 school year, when approximately 2 million students in grades 1 through 12 took Star Math Enterprise tests, along with grade-appropriate MetaMetrics linking items previously calibrated on the Quantile scale. Details of the research study methodology and results, including scale linking particulars, are set out in a technical report (MetaMetrics, 2019).

Conversion Tables

Table 44: Scaled Score to Grade Equivalent Conversions

Grade Equivalent	Unified Scaled Score		Enterprise Scaled Score	
	Low	High	Low	High
0	600	722	0	187
0.1	723	729	188	198
0.2	730	735	199	208
0.3	736	742	209	220
0.4	743	749	221	231
0.5	750	756	232	242
0.6	757	763	243	254
0.7	764	770	255	265
0.8	771	777	266	277
0.9	778	784	278	288
1	785	791	289	299
1.1	792	798	300	311
1.2	799	804	312	320
1.3	805	811	321	332
1.4	812	818	333	343
1.5	819	825	344	355
1.6	826	831	356	364
1.7	832	838	365	376
1.8	839	844	377	385
1.9	845	851	386	397
2	852	857	398	407
2.1	858	864	408	418
2.2	865	870	419	428
2.3	871	877	429	439
2.4	878	883	440	449
2.5	884	889	450	459
2.6	890	895	460	468
2.7	896	901	469	478

Table 44: Scaled Score to Grade Equivalent Conversions

Grade Equivalent	Unified Scaled Score		Enterprise Scaled Score	
	Low	High	Low	High
2.8	902	907	479	488
2.9	908	913	489	498
3	914	919	499	507
3.1	920	925	508	517
3.2	926	931	518	527
3.3	932	936	528	535
3.4	937	942	536	545
3.5	943	947	546	553
3.6	948	953	554	563
3.7	954	958	564	571
3.8	959	963	572	579
3.9	964	968	580	587
4	969	973	588	595
4.1	974	978	596	603
4.2	979	983	604	611
4.3	984	988	612	620
4.4	989	992	621	626
4.5	993	997	627	634
4.6	998	1002	635	642
4.7	1003	1006	643	649
4.8	1007	1010	650	655
4.9	1011	1014	656	662
5	1015	1019	663	670
5.1	1020	1023	671	676
5.2	1024	1026	677	681
5.3	1027	1030	682	688
5.4	1031	1034	689	694
5.5	1035	1038	695	701
5.6	1039	1041	702	706
5.7	1042	1045	707	712
5.8	1046	1048	713	717
5.9	1049	1051	718	722

Table 44: Scaled Score to Grade Equivalent Conversions

Grade Equivalent	Unified Scaled Score		Enterprise Scaled Score	
	Low	High	Low	High
6	1052	1054	723	727
6.1	1055	1057	728	732
6.2	1058	1060	733	737
6.3	1061	1063	738	741
6.4	1064	1066	742	746
6.5	1067	1069	747	751
6.6	1070	1071	752	754
6.7	1072	1074	755	759
6.8	1075	1076	760	763
6.9	1077	1079	764	768
7	1080	1081	769	771
7.1	1082	1083	772	774
7.2	1084	1085	775	777
7.3	1086	1087	778	781
7.4	1088	1089	782	784
7.5	1090	1091	785	787
7.6	1092	1092	788	789
7.7	1093	1094	790	792
7.8	1095	1096	793	795
7.9	1097	1097	796	797
8	1098	1099	798	800
8.1	1100	1100	801	802
8.2	1101	1101	803	803
8.3	1102	1102	804	805
8.4	1103	1104	806	808
8.5	1105	1105	809	810
8.6	1106	1106	811	811
8.7	1107	1107	812	813
8.8	1108	1108	814	815
8.9	1109	1109	816	816
9	1110	1110	817	818
9.1	1111	1111	819	820

Table 44: Scaled Score to Grade Equivalent Conversions

Grade Equivalent	Unified Scaled Score		Enterprise Scaled Score	
	Low	High	Low	High
9.2	1112	1112	821	821
9.3	1113	1113	822	823
9.4	1114	1114	824	824
9.5	1115	1115	825	826
9.6	1116	1116	827	828
9.7	1117	1117	829	829
9.8	1118	1118	830	831
9.9	1119	1119	832	833
10	1120	1120	834	834
10.1	1121	1121	835	836
10.2	1122	1122	837	837
10.3	1123	1123	838	839
10.4	1124	1124	840	841
10.5	1125	1125	842	842
10.6	1126	1126	843	844
10.7	1127	1127	845	846
10.8	1128	1128	847	847
10.9	1129	1129	848	849
11	1130	1130	850	850
11.1	1131	1131	851	852
11.2	1132	1132	853	854
11.3	1133	1133	855	855
11.4	1134	1134	856	857
11.5	1135	1135	858	859
11.6	1136	1136	860	860
11.7	1137	1137	861	862
11.8	1138	1138	863	863
11.9	1139	1139	864	865
12	1140	1140	866	867
12.1	1141	1141	868	868
12.2	1142	1142	869	870
12.3	1143	1143	871	872

Table 44: Scaled Score to Grade Equivalent Conversions

Grade Equivalent	Unified Scaled Score		Enterprise Scaled Score	
	Low	High	Low	High
12.4	1144	1144	873	873
12.5	1145	1145	874	875
12.6	1146	1146	876	876
12.7	1147	1147	877	878
12.8	1148	1148	879	880
12.9	1149	1149	881	881
12.9+	1150	1400	882	1400

Table 45: Scaled Score to Percentile Ranks Conversion by Grade on the Unified Scale

PR	Grade (First Month of School Year)												
	K	1	2	3	4	5	6	7	8	9	10	11	12
1	600	600	600	600	600	600	600	600	600	600	600	600	600
2	644	671	743	792	825	856	896	913	923	930	929	945	946
3	652	678	756	805	840	876	916	930	942	945	943	964	965
4	655	683	764	815	852	889	928	943	953	957	954	978	980
5	660	686	771	822	863	901	938	952	963	967	964	992	996
6	662	690	776	829	871	911	946	960	972	977	973	1001	1005
7	664	693	781	835	879	917	952	968	979	987	982	1009	1014
8	668	695	785	841	885	923	958	974	986	994	989	1016	1022
9	669	698	789	846	890	929	963	981	992	999	996	1024	1029
10	670	700	793	849	895	933	968	986	997	1005	1002	1029	1036
11	672	704	797	852	900	937	972	990	1002	1009	1007	1032	1039
12	674	706	800	855	904	941	976	995	1007	1013	1011	1036	1042
13	677	708	803	858	908	944	980	998	1011	1018	1015	1039	1045
14	678	711	806	861	911	947	984	1002	1015	1022	1020	1042	1048
15	679	713	809	863	913	950	987	1005	1019	1026	1024	1045	1051
16	680	715	811	865	916	953	990	1008	1022	1030	1028	1048	1055
17	681	718	813	868	919	955	993	1012	1026	1033	1032	1051	1058
18	682	719	816	870	921	958	996	1014	1029	1037	1035	1054	1061
19	684	721	818	872	923	960	999	1017	1032	1040	1038	1058	1065
20	685	723	820	874	925	962	1001	1020	1035	1043	1042	1061	1068
21	686	725	822	876	927	965	1003	1023	1038	1045	1044	1063	1071
22	687	726	823	878	929	967	1005	1025	1041	1047	1047	1066	1074

Table 45: Scaled Score to Percentile Ranks Conversion by Grade on the Unified Scale

PR	Grade (First Month of School Year)												
	K	1	2	3	4	5	6	7	8	9	10	11	12
23	688	728	825	880	931	969	1008	1028	1044	1050	1050	1068	1076
24	690	731	827	882	933	972	1010	1030	1046	1052	1052	1070	1079
25	691	732	829	883	934	974	1012	1032	1049	1055	1055	1073	1081
26	-	734	831	885	936	976	1014	1035	1051	1058	1058	1074	1083
27	692	735	833	887	937	978	1015	1037	1054	1060	1061	1077	1085
28	693	737	834	888	939	980	1017	1039	1056	1063	1063	1079	1088
29	694	739	836	889	940	982	1019	1041	1058	1066	1066	1080	1090
30	696	740	838	891	942	984	1021	1043	1061	1068	1069	1083	1092
31	697	742	839	892	944	985	1023	1045	1063	1071	1071	1085	1094
32	698	744	841	894	945	987	1025	1047	1065	1073	1074	1088	1096
33	699	745	842	895	947	988	1027	1049	1067	1075	1076	1090	1098
34	700	747	844	897	948	990	1029	1051	1070	1077	1078	1092	1100
35	701	748	845	898	950	992	1031	1053	1072	1079	1080	1094	1102
36	702	750	846	899	951	993	1032	1055	1074	1081	1082	1095	1104
37	703	752	848	901	953	994	1034	1057	1076	1083	1084	1097	1106
38	704	753	849	902	954	996	1036	1059	1078	1085	1086	1099	1107
39	705	754	850	904	956	997	1037	1061	1080	1087	1088	1101	1109
40	706	755	852	905	957	998	1039	1062	1082	1089	1090	1103	1111
41	707	757	853	906	959	1000	1040	1064	1084	1091	1092	1104	1112
42	708	759	854	908	960	1001	1042	1066	1086	1093	1093	1106	1114
43	-	760	855	909	962	1002	1044	1068	1087	1095	1095	1107	1116
44	709	762	857	910	963	1004	1045	1070	1089	1096	1097	1109	1118
45	711	763	858	911	964	1005	1047	1072	1091	1098	1098	1111	1119
46	712	765	859	912	966	1006	1048	1073	1093	1099	1099	1112	1121
47	713	766	860	913	967	1008	1050	1075	1095	1100	1101	1114	1122
48	714	768	861	914	969	1009	1051	1077	1096	1102	1103	1115	1124
49	715	769	863	916	970	1010	1053	1079	1098	1103	1104	1117	1125
50	717	771	864	917	971	1012	1055	1080	1099	1105	1106	1118	1127
51	718	773	865	918	972	1013	1056	1082	1101	1106	1107	1120	1129
52	719	774	866	920	974	1015	1058	1084	1103	1107	1109	1121	1130
53	720	776	867	921	975	1016	1059	1085	1104	1109	1111	1123	1132
54	721	777	869	922	976	1018	1061	1087	1106	1110	1112	1124	1134
55	722	779	870	924	978	1019	1062	1088	1108	1112	1114	1125	1135

Table 45: Scaled Score to Percentile Ranks Conversion by Grade on the Unified Scale

PR	Grade (First Month of School Year)												
	K	1	2	3	4	5	6	7	8	9	10	11	12
56	724	781	871	925	979	1020	1064	1090	1110	1113	1116	1127	1136
57	725	783	872	926	980	1022	1066	1091	1111	1114	1117	1129	1138
58	726	784	873	927	982	1023	1067	1093	1113	1116	1119	1130	1140
59	727	786	875	929	983	1024	1069	1095	1115	1117	1120	1132	1141
60	728	788	876	930	984	1026	1071	1096	1117	1119	1122	1134	1144
61	729	789	877	931	986	1028	1072	1097	1118	1121	1123	1135	1145
62	731	791	879	932	987	1029	1074	1099	1120	1122	1125	1137	1147
63	732	792	880	934	989	1031	1075	1100	1122	1124	1127	1140	1149
64	733	794	881	935	990	1032	1077	1102	1123	1125	1128	1141	1151
65	734	796	882	936	991	1034	1079	1103	1125	1127	1130	1143	1153
66	735	797	883	937	992	1035	1080	1105	1127	1129	1132	1144	1154
67	737	798	885	938	994	1037	1082	1106	1128	1131	1133	1146	1156
68	738	800	886	939	995	1039	1084	1108	1130	1133	1135	1148	1158
69	739	801	888	941	996	1040	1085	1110	1132	1134	1136	1149	1159
70	741	803	889	942	997	1042	1087	1111	1134	1136	1138	1151	1161
71	743	805	891	944	999	1044	1088	1113	1135	1138	1140	1153	1163
72	745	807	892	945	1000	1045	1090	1115	1137	1140	1143	1155	1165
73	746	809	894	947	1002	1047	1092	1116	1139	1141	1144	1157	1167
74	748	810	895	948	1004	1049	1093	1118	1141	1143	1146	1159	1169
75	750	812	897	950	1005	1050	1095	1120	1143	1145	1148	1161	1171
76	752	814	899	952	1007	1052	1096	1121	1144	1146	1150	1163	1173
77	754	816	901	953	1008	1054	1097	1123	1146	1148	1152	1166	1175
78	756	818	902	955	1010	1055	1099	1124	1148	1150	1154	1169	1177
79	758	819	904	956	1012	1057	1100	1126	1149	1152	1156	1171	1181
80	760	821	906	958	1014	1059	1102	1128	1151	1154	1158	1173	1183
81	762	823	908	960	1016	1061	1104	1130	1153	1156	1159	1175	1185
82	765	825	909	962	1018	1063	1106	1132	1155	1157	1162	1177	1187
83	767	828	911	964	1020	1066	1108	1134	1157	1159	1164	1180	1190
84	770	831	913	966	1021	1068	1110	1136	1159	1161	1166	1182	1192
85	772	834	915	968	1023	1070	1112	1138	1161	1164	1169	1185	1196
86	775	837	917	970	1026	1072	1114	1141	1164	1167	1172	1189	1199
87	778	841	920	972	1028	1075	1116	1143	1167	1170	1175	1193	1203
88	781	844	922	975	1031	1078	1118	1145	1170	1174	1179	1198	1206

Table 45: Scaled Score to Percentile Ranks Conversion by Grade on the Unified Scale

PR	Grade (First Month of School Year)												
	K	1	2	3	4	5	6	7	8	9	10	11	12
89	786	847	925	977	1033	1080	1120	1147	1174	1179	1183	1203	1211
90	790	850	928	980	1036	1083	1122	1149	1176	1181	1186	1207	1218
91	795	853	931	984	1039	1087	1125	1151	1178	1183	1188	1210	1222
92	800	856	935	987	1042	1090	1127	1154	1181	1186	1191	1214	1227
93	804	859	939	991	1046	1093	1130	1156	1184	1189	1195	1220	1232
94	810	863	943	995	1050	1096	1134	1159	1188	1192	1198	1226	1238
95	818	868	948	999	1054	1100	1137	1162	1193	1196	1203	1232	1246
96	827	875	954	1003	1059	1105	1142	1167	1201	1201	1208	1239	1252
97	839	882	962	1010	1066	1112	1147	1173	1212	1207	1216	1247	1260
98	854	893	972	1018	1077	1120	1154	1184	1227	1218	1230	1261	1274
99	884	910	987	1034	1092	1134	1169	1212	1250	1237	1253	1284	1295

Table 46: Scaled Score to Percentile Ranks Conversion by Grade on the Enterprise Scale

PR	Grade (First Month of School Year)												
	K	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	60	104	221	300	354	404	469	497	513	525	523	549	551
3	73	115	242	321	378	437	502	525	544	549	546	580	582
4	78	123	255	338	398	458	521	546	562	569	564	603	606
5	86	128	266	349	416	477	538	560	578	585	580	625	632
6	89	134	274	360	429	494	551	573	593	601	595	640	647
7	92	139	282	370	442	503	560	586	604	617	609	653	661
8	99	143	289	380	451	513	570	596	616	629	621	664	674
9	100	147	295	388	460	523	578	608	625	637	632	677	686
10	102	151	302	393	468	530	586	616	634	647	642	686	697
11	105	157	308	398	476	536	593	622	642	653	650	690	702
12	108	160	313	403	482	543	599	630	650	660	656	697	707
13	113	164	318	408	489	547	606	635	656	668	663	702	712
14	115	169	323	412	494	552	612	642	663	674	671	707	716
15	117	172	328	416	497	557	617	647	669	681	677	712	721
16	118	175	331	419	502	562	622	651	674	687	684	716	728
17	120	180	334	424	507	565	627	658	681	692	690	721	733
18	121	182	339	427	510	570	632	661	686	699	695	726	738
19	125	185	343	430	513	573	637	666	690	703	700	733	744
20	126	188	346	434	517	577	640	671	695	708	707	738	749
21	128	191	349	437	520	582	643	676	700	712	710	741	754
22	130	193	351	440	523	585	647	679	705	715	715	746	759
23	131	196	354	443	526	588	651	684	710	720	720	749	762
24	134	201	357	447	530	593	655	687	713	723	723	752	767
25	136	203	360	448	531	596	658	690	718	728	728	757	770
26	-	206	364	451	534	599	661	695	721	733	733	759	773
27	138	208	367	455	536	603	663	699	726	736	738	764	777
28	139	211	369	456	539	606	666	702	729	741	741	767	782
29	141	214	372	458	541	609	669	705	733	746	746	769	785
30	144	216	375	461	544	612	673	708	738	749	751	773	788
31	146	219	377	463	547	614	676	712	741	754	754	777	791
32	147	222	380	466	549	617	679	715	744	757	759	782	795
33	149	224	382	468	552	619	682	718	747	760	762	785	798
34	151	227	385	471	554	622	686	721	752	764	765	788	801

Table 46: Scaled Score to Percentile Ranks Conversion by Grade on the Enterprise Scale

PR	Grade (First Month of School Year)												
	K	1	2	3	4	5	6	7	8	9	10	11	12
35	152	229	386	473	557	625	689	725	755	767	769	791	804
36	154	232	388	474	559	627	690	728	759	770	772	793	808
37	156	235	391	477	562	629	694	731	762	773	775	796	811
38	157	237	393	479	564	632	697	734	765	777	778	799	812
39	159	238	395	482	567	634	699	738	769	780	782	803	816
40	160	240	398	484	569	635	702	739	772	783	785	806	819
41	162	243	399	486	572	638	703	742	775	786	788	808	821
42	164	247	401	489	573	640	707	746	778	790	790	811	824
43	-	248	403	490	577	642	710	749	780	793	793	812	827
44	165	251	406	492	578	645	712	752	783	795	796	816	830
45	169	253	408	494	580	647	715	755	786	798	798	819	832
46	170	256	409	495	583	648	716	757	790	799	799	821	835
47	172	258	411	497	585	651	720	760	793	801	803	824	837
48	173	261	412	499	588	653	721	764	795	804	806	825	840
49	175	263	416	502	590	655	725	767	798	806	808	829	842
50	178	266	417	503	591	658	728	769	799	809	811	830	845
51	180	269	419	505	593	660	729	772	803	811	812	834	848
52	182	271	421	508	596	663	733	775	806	812	816	835	850
53	183	274	422	510	598	664	734	777	808	816	819	838	853
54	185	276	425	512	599	668	738	780	811	817	821	840	856
55	186	279	427	515	603	669	739	782	814	821	824	842	858
56	190	282	429	517	604	671	742	785	817	822	827	845	860
57	191	286	430	518	606	674	746	786	819	824	829	848	863
58	193	287	432	520	609	676	747	790	822	827	832	850	866
59	195	291	435	523	611	677	751	793	825	829	834	853	868
60	196	294	437	525	612	681	754	795	829	832	837	856	873
61	198	295	438	526	616	684	755	796	830	835	838	858	874
62	201	299	442	528	617	686	759	799	834	837	842	861	877
63	203	300	443	531	621	689	760	801	837	840	845	866	881
64	204	304	445	533	622	690	764	804	838	842	847	868	884
65	206	307	447	534	624	694	767	806	842	845	850	871	887
66	208	308	448	536	625	695	769	809	845	848	853	873	889
67	211	310	451	538	629	699	772	811	847	851	855	876	892
68	212	313	453	539	630	702	775	814	850	855	858	879	895

Table 46: Scaled Score to Percentile Ranks Conversion by Grade on the Enterprise Scale

PR	Grade (First Month of School Year)												
	K	1	2	3	4	5	6	7	8	9	10	11	12
69	214	315	456	543	632	703	777	817	853	856	860	881	897
70	217	318	458	544	634	707	780	819	856	860	863	884	900
71	221	321	461	547	637	710	782	822	858	863	866	887	903
72	224	325	463	549	638	712	785	825	861	866	871	890	907
73	225	328	466	552	642	715	788	827	864	868	873	894	910
74	229	330	468	554	645	718	790	830	868	871	876	897	913
75	232	333	471	557	647	720	793	834	871	874	879	900	916
76	235	336	474	560	650	723	795	835	873	876	882	903	920
77	238	339	477	562	651	726	796	838	876	879	886	908	923
78	242	343	479	565	655	728	799	840	879	882	889	913	926
79	245	344	482	567	658	731	801	843	881	886	892	916	933
80	248	347	486	570	661	734	804	847	884	889	895	920	936
81	251	351	489	573	664	738	808	850	887	892	897	923	939
82	256	354	490	577	668	741	811	853	890	894	902	926	942
83	260	359	494	580	671	746	814	856	894	897	905	931	947
84	265	364	497	583	673	749	817	860	897	900	908	934	951
85	268	369	500	586	676	752	821	863	900	905	913	939	957
86	273	373	503	590	681	755	824	868	905	910	918	946	962
87	278	380	508	593	684	760	827	871	910	915	923	952	968
88	282	385	512	598	689	765	830	874	915	921	929	960	973
89	291	390	517	601	692	769	834	877	921	929	936	968	981
90	297	395	521	606	697	773	837	881	925	933	941	975	993
91	305	399	526	612	702	780	842	884	928	936	944	980	999
92	313	404	533	617	707	785	845	889	933	941	949	986	1007
93	320	409	539	624	713	790	850	892	938	946	955	996	1016
94	330	416	546	630	720	795	856	897	944	951	960	1006	1025
95	343	424	554	637	726	801	861	902	952	957	968	1016	1038
96	357	435	564	643	734	809	869	910	965	965	977	1027	1048
97	377	447	577	655	746	821	877	920	983	975	990	1040	1061
98	401	464	593	668	764	834	889	938	1007	993	1012	1063	1084
99	450	492	617	694	788	856	913	983	1045	1024	1050	1100	1118

Table 47: Percentile Rank to Normal Curve Equivalent Conversions

PR	NCE	PR	NCE	PR	NCE	PR	NCE
1	1.0	26	36.5	51	50.5	76	64.9
2	6.7	27	37.1	52	51.1	77	65.6
3	10.4	28	37.7	53	51.6	78	66.3
4	13.1	29	38.3	54	52.1	79	67.0
5	15.4	30	39.0	55	52.6	80	67.7
6	17.3	31	39.6	56	53.2	81	68.5
7	18.9	32	40.1	57	53.7	82	69.3
8	20.4	33	40.7	58	54.2	83	70.1
9	21.8	34	41.3	59	54.8	84	70.9
10	23.0	35	41.9	60	55.3	85	71.8
11	24.2	36	42.5	61	55.9	86	72.8
12	25.3	37	43.0	62	56.4	87	73.7
13	26.3	38	43.6	63	57.0	88	74.7
14	27.2	39	44.1	64	57.5	89	75.8
15	28.2	40	44.7	65	58.1	90	77.0
16	29.1	41	45.2	66	58.7	91	78.2
17	29.9	42	45.8	67	59.3	92	79.6
18	30.7	43	46.3	68	59.9	93	81.1
19	31.5	44	46.8	69	60.4	94	82.7
20	32.3	45	47.4	70	61.0	95	84.6
21	33.0	46	47.9	71	61.7	96	86.9
22	33.7	47	48.4	72	62.3	97	89.6
23	34.4	48	48.9	73	62.9	98	93.3
24	35.1	49	49.5	74	63.5	99	99.0
25	35.8	50	50.0	75	64.2		

Table 48: Normal Curve Equivalent to Percentile Rank Conversions

NCE Range Low–High	PR	NCE Range Low–High	PR	NCE Range Low–High	PR	NCE Range Low–High	PR
1.0–4.0	1	36.1–36.7	26	50.3–50.7	51	64.6–65.1	76
4.1–8.5	2	36.8–37.3	27	50.8–51.2	52	65.2–65.8	77
8.6–11.7	3	37.4–38.0	28	51.3–51.8	53	65.9–66.5	78
11.8–14.1	4	38.1–38.6	29	51.9–52.3	54	66.6–67.3	79
14.2–16.2	5	38.7–39.2	30	52.4–52.8	55	67.4–68.0	80
16.3–18.0	6	39.3–39.8	31	52.9–53.4	56	68.1–68.6	81
18.1–19.6	7	39.9–40.4	32	53.5–53.9	57	68.7–69.6	82
19.7–21.0	8	40.5–40.9	33	54.0–54.4	58	69.7–70.4	83
21.1–22.3	9	41.0–41.5	34	54.5–55.0	59	70.5–71.3	84
22.4–23.5	10	41.6–42.1	35	55.1–55.5	60	71.4–72.2	85
23.6–24.6	11	42.2–42.7	36	55.6–56.1	61	72.3–73.1	86
24.7–25.7	12	42.8–43.2	37	56.2–56.6	62	73.2–74.1	87
25.8–26.7	13	43.3–43.8	38	56.7–57.2	63	74.2–75.2	88
26.8–27.6	14	43.9–44.3	39	57.3–57.8	64	75.3–76.3	89
27.7–28.5	15	44.4–44.9	40	57.9–58.3	65	76.4–77.5	90
28.6–29.4	16	45.0–45.4	41	58.4–58.9	66	77.6–78.8	91
29.5–30.2	17	45.5–45.9	42	59.0–59.5	67	78.9–80.2	92
30.3–31.0	18	46.0–46.5	43	59.6–60.1	68	80.3–81.7	93
31.1–31.8	19	46.6–47.0	44	60.2–60.7	69	81.8–83.5	94
31.9–32.6	20	47.1–47.5	45	60.8–61.3	70	83.6–85.5	95
32.7–33.3	21	47.6–48.1	46	61.4–61.9	71	85.6–88.0	96
33.4–34.0	22	48.2–48.6	47	62.0–62.5	72	88.1–91.0	97
34.1–34.7	23	48.7–49.1	48	62.6–63.1	73	91.1–95.4	98
34.8–35.4	24	49.2–49.7	49	63.2–63.8	74	95.5–99.0	99
35.5–36.0	25	49.8–50.2	50	63.9–64.5	75		

Appendix A: Star Math Blueprint Skills

The content blueprint is broadly categorized into four domains: 1) Numbers & Operations, 2) Algebra, 3) Geometry & Measurement, 4) Data Analysis, Statistics, and Probability. However, to ensure appropriate distribution of items within an individual test, the assessment blueprint uses six content domains by treating Numbers and Operations as two separate domains, as well as treating Geometry and Measurement as two separate domains.

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations	Count with objects and numbers	N02	Count objects grouped in tens and ones
		N04	Determine one more than or one less than a given number across decades
		N42	Count on by ones from a number less than 100
		N43	Count back by ones from a number less than 20
		N45	Complete a skip pattern starting from a multiple of 2, 5, or 10
		N46	Count on by 100s from any number
		N56	Count objects to 20
		N57	Identify a number to 20 represented by a point on a number line
		N58	Determine one more than or one less than a given number
		N59	Count by 2s to 50 starting from a multiple of 2
		N60	Count objects grouped in tens and ones
		N82	Locate a number to 20 on a number line
		N95	Determine ten more than or ten less than a given number
		N96	Count by 5s or 10s to 100 starting from a multiple of 5 or 10, respectively
		NA1	Complete a sequence of numbers to 10
		NA4	Answer a question involving an ordinal number up to “tenth”
		NFY	Complete a skip pattern of 2 or 5 starting from any number
		NFZ	Complete a skip pattern of 10 starting from any number
	Identify odd and even numbers	N97	Identify odd and even numbers less than 100
	Identify, compare, and order fractions	AJB	Compare monomial numerical expressions using the properties of powers
		E5A	Estimate fractions of a whole
		N21	Identify a fraction equivalent to a given fraction
		N27	Locate a mixed number on a number line

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Identify, compare, and order fractions (continued)	N67	Determine a pictorial model of a fraction of a set of objects
		N68	Locate a fraction on a number line
		N69	Identify equivalent fractions using models
		N77	Identify a fraction represented by a point on a number line
		N78	Compare fractions using models
		N87	Determine a pictorial model of a fraction of a whole
		N88	Order fractions using models
		N91	Compare fractions with unlike denominators
		NB3	Order fractions with unlike denominators in ascending or descending order
		NG1	Compare fractions with like denominators
	Relate a decimal number to a percent	N0W	Convert a decimal number in thousandths to a percentage
		N30	Convert a percentage to its decimal equivalent
		NFT	Convert a decimal number to a percentage
	Relate a decimal to a fraction	AJ1	Compare expressions involving unlike forms of real numbers
		N22	Convert a fraction or mixed number in hundredths or thousandths to a decimal number
		N23	Convert a decimal number in hundredths or thousandths to a fraction
		N81	Compare numbers in decimal and fractional forms
		NB1	Determine the decimal number equivalent to a fraction model
		NB2	Determine the fraction equivalent to a decimal number model
	Relate place and value to a decimal number	N24	Relate a decimal number through ten-thousandths to its word form
		N25	Identify the place of a digit in a decimal number through hundredths
		N26	Estimate a decimal number from its position on a number line
		N29	Round a decimal number to a specified place through hundredths
		N50	Read a decimal number through the hundredths place
		N51	Locate a decimal number to tenths on a number line

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Relate place and value to a decimal number (continued)	N54	Represent a decimal number in expanded form using powers of ten
		N55	Determine the decimal number represented in expanded form using powers of ten
		N71	Identify a pictorial model of tenths or hundredths of a decimal number
		N79	Compare decimal numbers through the hundredths place
		N80	Compare decimal numbers of differing places to thousandths
		N89	Order decimal numbers through the hundredths place
		N92	Order numbers in decimal and fractional forms
		NB5	Order decimal numbers of differing places to thousandths in ascending or descending order
		NB7	Convert a number less than 1 to scientific notation
		NB8	Convert a number less than 1 from scientific notation to standard form
		NB9	Determine the decimal number from a pictorial model of tenths or hundredths
		NBA	Identify a decimal number to tenths represented by a point on a number line
	Relate place and value to a whole number	N03	Relate a whole number to the word form of the number to 100
		N06	Order whole numbers to 1,000 in ascending or descending order
		N07	Relate a 3-digit whole number to its word form
		N08	Identify the place of a digit in a 3-digit number
		N09	Represent a 3-digit whole number in expanded form
		N11	Order 4-digit whole numbers in ascending or descending order
		N12	Relate a 4- or 5-digit whole number to its word form
		N14	Represent a 4-digit whole number in expanded form
		N16	Order 4- to 6-digit whole numbers in ascending or descending order
		N17	Relate a 7- to 10-digit whole number to the word form of the number
		N18	Determine the value of a digit in a 6-digit number
		N19	Represent a 5-digit whole number in expanded form

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Relate place and value to a whole number (continued)	N37	Convert a whole number greater than 10 to scientific notation
		N48	Determine the value of a digit in a 4- or 5-digit whole number
		N49	Determine which digit is in a specified place in a 4- or 5-digit whole number
		N61	Compare whole numbers to 100 using words
		N62	Order whole numbers to 100 in ascending order
		N64	Determine the 3-digit number represented as hundreds, tens, and ones
		N70	Round a 4- to 6-digit whole number to a specified place
		N74	Represent a 2-digit number as tens and ones
		N76	Compare whole numbers to 1,000 using the symbols <, >, and =
		N83	Determine the value of a digit in a 2-digit number
		N84	Represent a 3-digit number as hundreds, tens, and ones
		N86	Determine the 4-digit whole number represented in thousands, hundreds, tens, and ones
		N98	Determine the 2-digit number represented as tens and ones
		NAB	Recognize equivalent forms of a 3-digit number using hundreds, tens, and ones
		NAE	Represent a 4-digit whole number as thousands, hundreds, tens, and ones
		NAF	Determine the 4- or 5-digit whole number represented in expanded form
		NG0	Compare 4- or 5-digit whole numbers using the symbols <, >, and =
		NKE	Determine the expanded form, written in powers of ten, of a whole number to 1,000,000
	Add and subtract fractions with like denominators	C22	Add fractions with like 1-digit denominators
		C23	Subtract fractions with like 1-digit denominators
		W22	WP: Add fractions with like denominators no greater than 10 and simplify the sum
		W23	WP: Subtract fractions with like denominators no greater than 10
		WCE	WP: Subtract fractions with like denominators no greater than 10 and simplify the difference

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Add and subtract fractions with like denominators (continued)	WX2	WP: Subtract fractions with like denominators and simplify the difference
		WX3	WP: Add mixed numbers with like denominators and simplify the sum
		WX4	WP: Subtract mixed numbers with like denominators and simplify the difference
		WXZ	WP: Add fractions with like denominators and simplify the sum
	Add and subtract fractions with unlike denominators	C24	Add fractions with unlike 1-digit denominators
		C25	Subtract fractions with unlike 1-digit denominators
		C28	Add mixed numbers with unlike denominators
		C29	Subtract mixed numbers with unlike denominators
		C57	Add fractions with unlike denominators that have factors in common and simplify the sum
		C76	Add fractions with unlike denominators that have no factors in common
		C77	Subtract fractions with unlike denominators that have factors in common and simplify the difference
		C78	Subtract fractions with unlike denominators that have no factors in common
		CA7	Add fractions with unlike denominators and do not simplify the sum
		E24	Estimate the sum of fractions with unlike 1-digit denominators
		E25	Estimate the difference between fractions with unlike 1-digit denominators
		E28	Estimate the sum of mixed numbers
		E29	Estimate the difference between mixed numbers with unlike denominators
		W24	WP: Add fractions with unlike 1-digit denominators
		W25	WP: Subtract fractions with unlike 1-digit denominators
		W28	WP: Add mixed numbers with unlike denominators
		W29	WP: Subtract mixed numbers with unlike denominators

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Add and subtract whole numbers with regrouping	C05	Add three 1-digit numbers
		C08	Add a 2-digit number and a 1- or 2-digit number with regrouping
		C09	Subtract a 1- or 2-digit number from a 2-digit number with one regrouping
		C11	Subtract a 2- or 3-digit number from a 3-digit number with two regroupings
		C18	Add four 1- to 4-digit whole numbers
		C19	Subtract two 2- to 6-digit whole numbers
		C47	Add 2- and 3-digit numbers with no more than one regrouping
		C49	Add 3- and 4-digit whole numbers with regrouping
		C50	Subtract 3- and 4-digit whole numbers with regrouping
		C69	Add two 3-digit numbers with one regrouping
		C70	Subtract a 1- or 2-digit number from a 3-digit number with one regrouping
		C71	Subtract a 3-digit number from a 3-digit number with one regrouping
		C88	Determine a number pair that totals 100
		CEL	Subtract a smaller number from a 3- or 4-digit whole number in expanded form
		W08	WP: Add a 2-digit number and a 1- or 2-digit number with regrouping
		W09	WP: Subtract a 1- or 2-digit number from a 2-digit number with one regrouping
		W18	WP: Add 3- and 4-digit whole numbers with regrouping
		W19	WP: Subtract 3- and 4-digit whole numbers with regrouping
	Add and subtract whole numbers without regrouping	A38	Determine the missing portion in a partially screened (hidden) collection of up to 10 objects
		C06	Add a 2-digit number and a 1-digit number without regrouping
		C07	Subtract a 1-digit number from a 2-digit number without regrouping
		C43	Know basic addition facts to 10 plus 10
		C44	Know basic subtraction facts to 20 minus 10
		C67	Add two 2-digit numbers without regrouping

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Add and subtract whole numbers without regrouping (continued)	C87	Subtract a 2-digit number from a 2-digit number without regrouping
		E08	Estimate the sum of two 2-digit numbers
		E09	Estimate the difference of whole numbers less than 100
		E41	Estimate a sum or difference of 2- to 4-digit whole numbers using any method
		E55	Estimate a sum or difference of whole numbers to 10,000 by rounding
		N05	Add or subtract zero to or from any number less than 100
		N99	Determine equivalent forms of a number, up to 10
		W03	WP: Use basic addition facts to solve problems
		W04	WP: Use basic subtraction facts to solve problems
		W06	WP: Add a 2-digit number and a 1-digit number without regrouping
		W7B	WP: Estimate a sum or difference of two 3- or 4-digit whole numbers using any method
		WXP	WP: Subtract a 1-digit number from a 2-digit number without regrouping
		WXQ	WP: Add two 2-digit numbers without regrouping
		WXR	WP: Subtract a 2-digit number from a 2-digit number without regrouping
		WXU	WP: Determine a basic addition-fact number sentence for a given situation
		WXV	WP: Determine a basic subtraction-fact number sentence for a given situation
		WXW	WP: Add two 3-digit numbers without regrouping
		WXY	WP: Subtract a 3-digit number from a 3-digit number without regrouping
	Add or Subtract Decimal Numbers	C33	Determine the sum of a whole number and a decimal number to hundredths
		C35	Subtract a decimal number from a whole number
		C51	Determine money amounts that total $10
		C79	Add decimal numbers and whole numbers
		C93	Subtract two decimal numbers of differing places to thousandths
		C98	Add two decimal numbers of differing places to thousandths

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Add or Subtract Decimal Numbers (continued)	CEB	Add or subtract cent amounts to or from whole dollar amounts
		CEC	Add dollars and cents to cents
		CED	Add dollars and cents to dollars
		CEE	Subtract cents from dollars and cents
		E32	Estimate the sum of two decimal numbers
		E33	Estimate the sum of a whole number and a decimal number
		E34	Estimate the difference of two decimal numbers
		E35	Estimate the difference of a whole number and a decimal number
		E44	Estimate the difference of two decimal numbers through thousandths and less than 1 by rounding to a specified place
		E45	Estimate the sum of two decimal numbers through thousandths and less than 1 by rounding to a specified place
		W33	WP: Determine the sum of a decimal number and a whole number
		W35	WP: Subtract a decimal number from a whole number
		W54	WP: Determine the amount of change from whole dollar amounts
		W94	WP: Add or subtract decimal numbers through thousandths
		W95	WP: Add or subtract a decimal number through thousandths and a whole number
		W96	WP: Estimate the sum or difference of two decimal numbers through thousandths using any method
	Convert between an improper fraction and a mixed number	N28	Convert an improper fraction to a mixed number
		N72	Convert a mixed number to an improper fraction
	Determine a square root	N31	Evaluate the positive square root of a perfect square
		N32	Determine an approximate square root of a number
		NBB	Determine the square root of a perfect-square fraction or decimal
		NBC	Determine the two closest integers to a given square root
		NBD	Approximate the location of a square root on a number line
		NFV	Determine both square roots of a perfect square

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Divide a whole number resulting in a decimal quotient	C58	Divide a whole number by a 1-digit whole number resulting in a decimal quotient through thousandths
		C59	Divide a whole number by a 2-digit whole number resulting in a decimal quotient through thousandths
		W50	WP: Divide a whole number by a 1- or 2-digit whole number resulting in a decimal quotient
	Divide whole numbers with a remainder in the quotient	C17	Divide a 2- or 3-digit whole number by a 1-digit whole number with a remainder in the quotient
		C55	Divide a multi-digit whole number by a 2-digit whole number, with a remainder and at least one zero in the quotient
		C56	Divide a multi-digit whole number by a 2-digit whole number and express the quotient as a mixed number
		W17	WP: Divide a 2- or 3-digit whole number by a 1-digit whole number with a remainder in the quotient
		W49	WP: Solve a 2-step problem involving whole numbers
		W57	WP: Divide a whole number and interpret the remainder
		W7C	WP: Divide a 3-digit whole number by a 1-digit whole number with a remainder in the quotient
	Divide Whole Numbers without a Remainder in the Quotient	AMQ	Recognize equivalent multiplication or division expressions involving basic facts
		C15	Divide a 2-digit whole number by a 1-digit whole number with no remainder in the quotient
		C21	Divide whole numbers with no remainder in the quotient
		C73	Know basic division facts to 100 ÷ 10
		CEG	Know basic division facts for 11 and 12
		CEH	Complete a multiplication and division fact family
		CEP	Divide a multi-digit whole number by 10 or 100 with no remainder
		E15	Estimate the quotient of a 2-digit whole number divided by a 1-digit whole number with no remainder in the quotient
		E21	Estimate a quotient using any method
		W15	WP: Divide a 2-digit whole number by a 1-digit whole number with no remainder in the quotient
		W21	WP: Divide whole numbers with no remainder in the quotient
		W2S	WP: Solve a 2-step whole number problem using more than one operation

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Divide Whole Numbers without a Remainder in the Quotient (continued)	W53	WP: Divide objects into equal groups by sharing
		W58	WP: Estimate a quotient using any method
		W66	WP: Divide using basic facts to 100 ÷ 10
		W90	WP: Divide a 3-digit whole number by a 1-digit whole number with no remainder in the quotient
	Evaluate a Numerical Expression	A49	Evaluate a numerical expression involving one or more exponents and multiple forms of rational numbers
		AA1	Simplify a monomial numerical expression involving the square root of a whole number
		AFM	Apply the product of powers property to a monomial numerical expression
		AFN	Apply the power of a power property to a monomial numerical expression
		AFP	Apply the quotient of powers property to monomial numerical expressions
		AG8	Multiply monomial numerical expressions involving radicals
		AG9	Divide monomial numerical expressions involving radicals
		AGT	Multiply a matrix by a scalar
		AGU	Add or subtract matrices
		AGV	Multiply matrices
		AGZ	Simplify an nth root
		AH1	Add or subtract complex numbers
		AH3	Simplify an expression involving a complex denominator
		AH9	Determine the logarithmic form of an exponential equation
		AHB	Evaluate a logarithm by converting it to exponential form
		AJ0	Evaluate a multi-step numerical expression involving absolute value
		AJE	Add and/or subtract numerical radical expressions
		AJF	Multiply a binomial numerical radical expression by a numerical radical expression
		AJG	Rationalize the denominator of a numerical radical expression
		AJR	Determine the determinant of a matrix
		AJV	Simplify an expression with a fractional exponent
		AJW	Add and subtract radical expressions

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Evaluate a Numerical Expression (continued)	AJY	Write an imaginary number in standard form
		AMT	Evaluate a numeric expression involving two operations
		AP3	Determine the inverse of a matrix
		AP4	Multiply complex numbers
		AP5	Determine the magnitude of a vector
		AP6	Add or subtract vectors component-wise
		AP7	Evaluate a linear combination of vectors
		N33	Evaluate the nth root of a whole number
		N34	Evaluate a whole number raised to a whole number power
		N35	Evaluate a whole number raised to a negative power
		N36	Evaluate a whole number raised to a fractional power
		N93	Evaluate a numerical expression of four or more operations, with parentheses, using order of operations
		N94	Evaluate a numerical expression involving integer exponents and/or integer bases
		NB6	Evaluate an integer raised to a whole number power
		NM6	Write a whole number raised to a whole number power as a product
	Find prime factors, common factors, and common multiples	N38	Identify the prime factors of a 2-digit number
		N39	Determine the greatest common factor of two whole numbers
		N40	Determine the least common multiple of two whole numbers
	Multiply and divide with decimals	C36	Multiply two decimal numbers
		C37	Divide decimal numbers
		C83	Multiply decimal numbers less than one in hundredths or thousandths
		C84	Divide a decimal number through thousandths by a 1- or 2-digit whole number where the quotient has 2–5 decimal places
		C85	Divide a 1- to 3-digit whole number by a decimal number to tenths where the quotient is a decimal number to thousandths
		C86	Divide a decimal number by a decimal number through thousandths, rounded quotient if needed

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Multiply and divide with decimals (continued)	C94	Multiply a decimal number through thousandths by 10, 100, or 1,000
		C99	Divide a decimal number by 10, 100, or 1,000
		C9A	Divide a 1- to 3-digit whole number by a decimal number to tenths where the quotient is a whole number
		C9B	Divide a 2- or 3-digit whole number by a decimal number to hundredths or thousandths, rounded quotient if needed
		C9F	Multiply a decimal number through thousandths by a whole number
		CA0	Multiply decimal numbers greater than one where the product has 2 or 3 decimal places
		W36	WP: Multiply two decimal numbers
		W37	WP: Divide a whole number by a decimal number
		W60	WP: Estimate the product of two decimals
		W80	WP: Multiply a decimal number through thousandths by a whole number
		W81	WP: Divide a decimal through thousandths by a decimal through thousandths, rounded quotient if needed
		W86	WP: Solve a multi-step problem involving decimal numbers
		W9B	WP: Divide a decimal number through thousandths by a 1- or 2-digit whole number
		W9C	WP: Divide a whole number by a decimal number through thousandths, rounded quotient if needed
		W9D	WP: Estimate the quotient of two decimals
		W9E	WP: Solve a 2-step problem involving decimals
	Multiply and divide with fractions	ABF	Determine the reciprocal of a positive whole number, a proper fraction, or an improper fraction
		AF5	Determine the reciprocal of a negative rational number
		C26	Multiply a fraction by a fraction
		C27	Divide a fraction by a fraction
		C30	Multiply mixed numbers
		C31	Divide mixed numbers
		C61	Multiply a mixed number by a fraction
		C80	Multiply a mixed number by a whole number
		C81	Divide a fraction by a whole number resulting in a fractional quotient

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Multiply and divide with fractions (continued)	C82	Divide a whole number by a fraction resulting in a fractional quotient
		W59	WP: Multiply or divide a fraction by a fraction
		W71	WP: Multiply or divide two mixed numbers or a mixed number and a fraction
		W99	WP: Solve a 2-step problem involving fractions
		WA9	WP: Solve a multi-step problem involving fractions or mixed numbers
	Multiply whole numbers	C14	Multiply a 2-digit whole number by a 1-digit whole number with no regrouping
		C16	Multiply a 2-digit whole number by a 1- or 2-digit whole number with regrouping
		C52	Multiply a 1- or 2-digit whole number by a multiple of 10, 100, or 1,000
		C53	Apply the distributive property to multiply a multi-digit number by a 1-digit number
		C54	Multiply a 3- or 4-digit whole number by a 1-digit whole number
		C72	Use a multiplication sentence to represent an area or an array model
		C74	Multiply a 2-digit whole number by a 2-digit whole number
		C91	Know basic multiplication facts to 10 × 10
		CE0	Know multiplication tables for 2, 5, and 10
		CEF	Know basic multiplication facts for 11 and 12
		CEJ	Multiply a 1-digit whole number by a multiple of 10 to 100
		CEM	Multiply a 3-digit whole number by a 2-digit whole number
		CEN	Multiply three 1- and 2-digit whole numbers
		E14	Estimate the product of a 2-digit number and a 1-digit number
		E20	Estimate the product of whole numbers using any method
		W14	WP: Multiply a 2-digit whole number by a 1-digit whole number without regrouping
		W16	WP: Multiply a 2-digit whole number by a 1- or 2-digit whole number
		W20	WP: Multiply whole numbers
		W46	WP: Multiply a multi-digit whole number by a 1-digit whole number

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Multiply whole numbers (continued)	W51	WP: Solve a multi-step problem involving whole numbers
		W65	WP: Multiply using basic facts to 10 × 10
		W8F	WP: Estimate a product of two whole numbers using any method
	Perform operations with integers	C62	Add integers
		C63	Subtract integers
		C64	WP: Add and subtract using integers
		C65	Multiply integers
		C66	Divide integers
		W87	WP: Multiply or divide integers
	Solve a problem involving percents	C97	Determine a percent of a number given a percent that is not a whole percent
		C9C	Determine the percent one number is of another number
		C9D	Determine a number given a part and a decimal percentage or a percentage more than 100%
		W38	WP: Determine the percent a whole number is of another whole number, with a result less than 100%
		W39	WP: Determine a percent of a whole number using percents less than 100
		W40	WP: Determine a whole number given a part and a percent
		W84	WP: Determine the result of applying a percent of decrease to a value
		W85	WP: Answer a question involving a fraction and a percent
		W8B	WP: Determine a given percent of a number
		W8C	WP: Determine the percent one number is of another number
		W8D	WP: Determine a number given a part and a decimal percentage or a percentage more than 100%
		WA6	WP: Determine the percent of decrease applied to a number
		WA7	WP: Determine the percent of increase applied to a number
		WA8	WP: Determine the result of applying a percent of increase to a value
		WB1	WP: Estimate a given percent of a number

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Numbers & Operations (continued)	Solve a proportion, rate, or ratio	C38	Determine the percent a whole number is of another whole number
		C39	Determine a given percent of a number
		C40	Determine a whole number given a part and a percent
		C41	Solve a proportion involving whole numbers
		C42	Determine if ratios are equivalent
		CJ2	Solve a proportion that generates a linear equation
		CJ4	Solve a proportion that generates a quadratic equation
		E38	Estimate the percent a whole number is of another whole number
		E39	Estimate a given percent of a number
		E40	Estimate a whole number given a part and a percent
		W41	WP: Solve a proportion
		W42	WP: Determine if ratios are equivalent
		W73	WP: Determine the whole, given part-to-part ratio and a part, where the whole is greater than 50
		W82	WP: Determine a unit rate with a whole number value
		W88	WP: Determine a part, given part-to-whole ratio and the whole, where the whole is greater than 50
		W89	WP: Determine a part, given part-to-whole ratio and a part, where the whole is greater than 50
		W8A	WP: Determine the whole, given part-to-whole ratio and a part, where the whole is greater than 50
		WA0	WP: Determine a part given a ratio and the whole where the whole is less than 50
		WA1	WP: Determine the whole given a ratio and a part where the whole is less than 50
		WA2	WP: Use a unit rate, with a whole number or whole cent value, to solve a problem
		WAA	WP: Determine a part, given part-to-part ratio and the whole, where the whole is greater than 50
		WAB	WP: Determine a part, given part-to-part ratio and a part, where the whole is greater than 50
		WAC	WP: Determine a unit rate
		WAD	WP: Use a unit rate to solve a problem

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Algebra	Determine a linear equation	A02	Use a 1-variable, 1-step equation to represent a verbal statement
		A06	Determine an equation for a line given a graph
		A42	Use a 2-variable equation to construct an input-output table
		A46	Use a 2-variable equation to represent a relationship expressed in a table
		A53	Determine an equation of a line in slope-intercept form given the slope and y-intercept
		A83	Determine an equation for a line given the slope of the line and a point on the line that is not the y-intercept
		A84	Determine an equation of a line in point-slope or slope-intercept form given two points on the line
		A9C	Determine the slope-intercept form or the standard form of a linear equation
		AA5	Determine the table of values that represents a linear equation with rational coefficients in two variables
		AA6	Determine a linear equation in two variables that represents a table of values
		AFD	Determine an equation for a line that goes through a given point and is parallel or perpendicular to a given line
		AKX	WP: Determine a trigonometric function that represents a situation
		AM3	Represent a proportional relationship as a linear equation
		AN4	Use a table to represent a linear function
		AP0	WP: Determine an exponential function that represents a situation such as exponential growth or decay
		APG	Determine an equation of a line in standard form given the slope and y-intercept
		APH	Determine an equation of a line in standard form given two points on the line
		GKL	Determine an equation for a line parallel or perpendicular to a given graphed line
		W83	Use a 2-variable linear equation to represent a situation
		W8E	WP: Use a 1-variable equation with rational coefficients to represent a situation involving two operations
		WA3	Use a 2-variable equation to represent a situation involving a direct proportion

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Algebra (continued)	Determine a linear equation (continued)	WAF	WP: Use a 1-variable 1-step equation to represent a situation
		WB2	WP: Use a 2-variable equation with rational coefficients to represent a situation
	Determine a system of linear equations	AP2	Represent a system of linear equations as a single matrix equation
		W74	WP: Determine a system of linear equations that represents a given situation
	Determine the operation given a situation	A30	WP: Determine the operation needed for a given situation
		ACB	Translate a verbal statement into an algebraic equation
		AMR	Determine the operation needed to make a number sentence true
		C90	Use a division sentence to represent objects divided into equal groups
		W67	WP: Determine a multiplication or division sentence for a given situation
	Evaluate an algebraic expression or function	A33	Evaluate a 2-variable expression, with two or three operations, using whole number substitution
		A36	Evaluate a 2-variable expression, with two or three operations, using integer substitution
		A50	Evaluate a function written in function notation for a given value
		AK1	Write a quadratic equation given its solutions
		ANT	Determine values of the inverse of a function using a table or a graph
		W72	WP: Evaluate a 1- or 2-variable expression or formula using whole numbers
	Graph a 1-variable inequality	A09	Relate a 1-variable inequality to its graph
	Graph on a coordinate plane	A08	Relate a graph to a 2-variable linear inequality
		A25	Relate a graph to an equation of a parabola
		A26	Relate a graph of an ellipse centered at the origin to its equation
		A48	Determine the graph of a 1-operation linear function
		A52	Determine the graph of a linear equation given in slope-intercept, point-slope, or standard form
		A91	Determine the graph of a given quadratic function
		AA0	Determine the graph of a line using given information

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Algebra (continued)	Graph on a coordinate plane (continued)	AA7	Determine the graph of a 2-operation linear function
		AA8	Determine the slope of a line given its graph or a graph of a line with a given slope
		AAC	Use a table to represent the values from a first-quadrant graph
		AFE	Determine the graph of a 2-variable absolute value equation
		AFL	Determine the graph of the solution set of a system of linear inequalities in two variables
		AHG	Determine the graph of a circle given the equation in standard form
		AHJ	Determine the graph of a hyperbola given the equation in standard form
		AHL	Determine the graph of a vertically oriented parabola
		AHM	Determine the graph of a horizontally oriented parabola
		AHV	Determine the graph of a sine, cosine or tangent function
		AJ8	Determine a 2-variable linear inequality represented by a graph
		AJA	Determine the graph of a 1-variable absolute value inequality
		AJN	Graph the inverse of a linear function
		AK4	Relate a quadratic inequality in two variables to its graph
		AKE	Graph an ellipse
		ANN	Determine the graph of a piecewise-defined function
		ANP	Determine the component form of a vector represented on a graph
		ANQ	Relate a graph to a polynomial function given in factored form
		ANR	Identify a complex number represented as a vector on a coordinate plane
		ANS	Relate a graph to a square or cube root function
		GFS	Determine the ordered pair of a point in the first quadrant
		GFV	Determine the ordered pair of a point in any quadrant
		GM3	Determine the location of an ordered pair in any quadrant
		W79	WP: Answer a question using the graph of a quadratic function

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Algebra (continued)	Identify characteristics of a linear equation or function	AMJ	Determine the slope of a line given a table of values
		A19	Determine the slope of a line given the coordinates of two points on the line
		A20	Determine the x- or y-intercept of a line given a 1-variable equation
		A9A	WP: Determine a reasonable domain or range for a function in a given situation
		A9E	Determine the slope of a line given an equation in point-slope or slope-intercept form
		AA9	Determine the x- or y-intercept of a line given its graph
		AF6	Determine if a relation is a function
		AF7	Determine if a function is linear or nonlinear
		AF8	Determine whether a graph or a table represents a linear or nonlinear function
		AJ2	Determine the independent or dependent variable in a given situation
		AJ3	Determine the domain or range of a function
		AJ4	Determine if a table or an equation represents a direct variation, an inverse variation, or neither
		AJK	Identify the domain or range of a radical function
		AJL	Determine the domain and range of a graphed function
		AKC	Determine the domain of a rational function
		AM5	Determine the effect of a change in the slope and/or y-intercept on the graph of a line
		AM8	Determine the result of a change in a or c on the graph of y=ax^2 + c
		AP8	Identify the vertex, axis of symmetry, or direction of the graph of a quadratic function
		AP9	Identify the end behavior, asymptotes, excluded values, or behavior near excluded values of a rational function
		APA	WP: Interpret an interest rate, rate of change, initial amount, frequency of compounding and other parameters of an exponential function
		APB	Determine if the inverse of a function is a function
		APC	Determine the equation of the inverse of a linear, rational root, or polynomial function

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Algebra (continued)	Identify characteristics of a linear equation or function (continued)	APD	Determine the equation of a function resulting from a translation and/or scaling of a given function
		APE	Determine the x- or y-intercept of a line given a 2-variable equation
		APF	Determine the slope of a line given the graph of the line
		GG1	Determine if lines through points with given coordinates are parallel or perpendicular
		GG2	Determine the coordinates of a point through which a line must pass in order to be parallel or perpendicular to a given line
		W76	WP: Interpret the meaning of the slope of a graphed line
		WB3	WP: Interpret the meaning of the y-intercept of a graphed line
	Relate a rule to a pattern	A21	Determine the common difference in an arithmetic sequence
		A22	Find a specified term in an arithmetic sequence
		A29	Extend a number pattern involving addition
		A31	Identify a missing term in a multiplication or a division number pattern
		A32	Determine the variable expression with one operation for a table of paired numbers
		A39	Determine the rule for an addition or subtraction number pattern
		A40	Identify a missing figure in a growing pictorial or non-numeric pattern
		A44	Generate a table of paired numbers based on a rule
		A95	Extend a number pattern involving subtraction
		AA4	Determine a rule that relates two variables
		ACA	Determine the algebraic equation that describes a pattern represented by data in a table
		AKL	Find a specified term of an arithmetic sequence given the first term and the common difference
		AKM	Find a specified term of an arithmetic sequence
		AKN	Find a specified term of an arithmetic sequence given the formula for the nth term
		AKP	WP: Solve a problem that can be represented by an arithmetic sequence

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Algebra (continued)	Relate a rule to a pattern (continued)	AKR	Find a specified term of a geometric sequence
		AKS	Find a specified term of a geometric sequence given the first three terms of the sequence
		AMS	Extend a number pattern
		ANH	Determine the explicit formula for an arithmetic sequence
		ANJ	Identify a given sequence as arithmetic, geometric, or neither
		ANK	Find a specified term of a binomial expression raised to a positive integer power
		ANL	WP: Solve a problem that can be represented by a geometric sequence
		ANM	WP: Solve a problem that can be represented by a finite geometric series
		GJZ	Use inductive reasoning to determine a rule
		W7E	WP: Generate a table of paired numbers based on a variable expression with one operation
		W97	WP: Determine the variable expression with one operation for a table of paired numbers
	Simplify an Algebraic Expression	A12	Add or subtract polynomial expressions
		A13	Multiply two binomials
		A18	Factor a common term from a binomial expression
		A55	Simplify a rational expression involving polynomial terms
		A56	Multiply rational expressions
		A57	Divide a polynomial expression by a monomial
		A58	Add or subtract two rational expressions with unlike polynomial denominators
		A61	Simplify an algebraic expression by combining like terms
		A87	Apply the product of powers property to a monomial algebraic expression
		A88	Apply the power of a power property to a monomial algebraic expression
		A89	Apply the power of a product property to a monomial algebraic expression
		A8A	Apply the quotient of powers property to monomial algebraic expressions
		A8B	Apply the power of a quotient property to monomial algebraic expressions

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Algebra (continued)	Simplify an Algebraic Expression (continued)	A8E	Multiply two binomials of the form (ax +/– b)(cx +/– d)
		A8F	Factor the GCF from a polynomial expression
		A90	Factor trinomials that result in factors of the form (ax +/– b)(cx +/– d)
		A97	Multiply two monomial algebraic expressions
		AA2	Simplify a monomial algebraic radical expression
		AAE	Apply terminology related to polynomials
		AAF	Multiply two binomials of the form (x +/– a)(x +/– b)
		AFQ	Simplify a polynomial expression by combining like terms
		AFR	Multiply a polynomial by a monomial
		AFS	Multiply two binomials of the form (ax +/– by)(cx +/– dy)
		AFV	Multiply a trinomial by a binomial
		AFW	Factor trinomials that result in factors of the form (x +/– a)(x +/– b)
		AFX	Factor a trinomial that results in factors of the form (ax +/– by)(cx +/– dy)
		AFY	Factor the difference of two squares
		AFZ	Factor a perfect-square trinomial
		AGA	Multiply monomial algebraic radical expressions
		AGB	Divide monomial algebraic radical expressions
		AGF	Divide rational expressions
		AGG	Divide a polynomial expression by a binomial
		AGJ	Add or subtract two rational expressions with like denominators
		AGK	Add or subtract two rational expressions with unlike monomial denominators
		AGP	Determine the composition of two functions
		AGY	Represent an algebraic radical expression in exponential form
		AH0	Simplify an expression with rational exponents
		AH7	Factor a polynomial using long division
		AH8	Factor a polynomial by grouping
		AHA	Convert between a simple exponential equation and its corresponding logarithmic equation

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Algebra (continued)	Simplify an Algebraic Expression (continued)	AJC	Apply properties of exponents to monomial algebraic expressions
		AJD	Factor a polynomial that has a GCF and two linear binomial factors
		AJH	Rationalize the denominator of an algebraic radical expression
		AJJ	Add or subtract algebraic radical expressions
		AK6	Factor a difference of squares
		AK7	Factor the sum or difference of 2 cubes
		AK8	Factor a polynomial into a binomial and trinomial
		ANU	Simplify a monomial algebraic expression that includes fractional exponents and/or nth roots
		ANV	Multiply or divide functions
		AP1	Identify equivalent logarithmic expressions using the properties of logarithms
	Solve a linear equation	A01	Determine a missing addend in a number sentence involving 2-digit numbers
		A04	Determine a solution to a 2-variable linear equation
		A28	Determine a missing addend in a basic addition-fact number sentence
		A37	Solve a proportion involving decimals
		A43	Solve a 2-step linear equation involving integers
		A45	Solve a 1-step equation involving whole numbers
		A47	Solve a 1-step linear equation involving integers
		A51	Solve a 1-variable linear equation with the variable on both sides
		A81	Determine a missing subtrahend in a basic subtraction-fact number sentence
		A98	Solve a 1-step equation involving rational numbers
		A99	Solve a 2-step equation involving rational numbers
		AAB	Rewrite an equation to solve for a specified variable
		AF9	Solve a 1-variable linear equation that requires simplification and has the variable on one side
		AFA	Solve a direct or inverse variation problem
		AMN	Determine the missing subtrahend in a number sentence involving 3-digit numbers

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Algebra (continued)	Solve a linear equation (continued)	AMP	Determine the missing dividend or divisor in a number sentence involving basic facts
		W75	WP: Solve a problem involving a 1-variable, 2-step equation
		WXS	WP: Determine a missing addend in a basic addition-fact number sentence
		WXT	WP: Determine a missing subtrahend in a basic subtraction-fact number sentence
	Solve a Linear Inequality	A07	Determine the solution set of a 1-variable linear inequality
		A62	Determine the graph of the solutions to a 2-step linear inequality in one variable
		A9B	Solve a 1-variable linear inequality with the variable on both sides
		AAA	Solve a 2-step linear inequality in one variable
		ADC	Solve a 1-variable linear inequality with the variable on one side
		AFB	Solve a 1-variable compound inequality
		AJ6	Solve a 2-variable linear inequality for the dependent variable
		AJ7	Determine if an ordered pair is a solution to a 2-variable linear inequality
		WB4	WP: Solve a problem involving a 2-step linear inequality in one variable
	Solve a Nonlinear Equation	A15	Solve a quadratic equation using the square root rule
		A16	Solve a quadratic equation by factoring
		A17	Determine the term needed to complete the square in a quadratic equation
		A54	Solve a radical equation that leads to a quadratic equation
		A59	Solve a rational equation involving terms with monomial denominators
		A60	Solve a rational equation involving terms with polynomial denominators
		A85	Solve a 1-variable absolute value inequality
		A93	Solve a quadratic equation using the quadratic formula
		AA3	Solve a radical equation that leads to a linear equation
		AG1	Solve a quadratic equation by taking the square root
		AG2	Determine the solution(s) of an equation given in factored form

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Algebra (continued)	Solve a Nonlinear Equation (continued)	AG3	Use the discriminant to determine the number of real solutions
		AH5	Solve a quadratic equation with complex solutions
		AHC	Solve a logarithmic equation
		AJ5	Solve a 1-variable absolute value equation
		AK2	Solve a cubic equation
		AKD	Write the equation of a circle given its center and radius
		ANZ	Solve a problem involving the Pythagorean identity sin^2(theta) + cos^2(theta) = 1
		GGQ	Determine an equation of a circle
		GGR	Determine the radius, center, or diameter of a circle given an equation
	Solve a system of linear equations	A14	Solve a system of linear equations in two variables using any method
		AF1	Solve a number problem that can be represented by a linear system of equations
		AFJ	Determine the number of solutions to a system of linear equations
		AGX	Solve a problem involving matrices
		AJQ	Solve a system of three equations
Geometry & Measurement	Determine a missing figure in a pattern	A96	Identify a missing figure in a repeating pictorial or non-numeric pattern
		G01	Identify a missing figure in a geometric pattern
	Determine a missing measure or dimension of a shape	G02	Relate the radius to the diameter in a circle
		G22	Determine a missing angle measure in a triangle
		G23	Use the Pythagorean theorem to determine a length
		G27	Determine a missing dimension given two similar shapes
		GE4	Determine the midpoint of a line segment given the coordinates of the endpoints
		GE6	Determine the measure of an angle formed by parallel lines and one or more transversals given an angle measure
		GF6	Determine the measure of an angle or the sum of the angles in a polygon
		GF9	Determine a length using parallel lines and proportional parts

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Geometry & Measurement (continued)	Determine a missing measure or dimension of a shape (continued)	GFA	Determine a length using the properties of a 45-45-90 degree triangle or a 30-60-90 degree triangle
		GFB	Solve a problem involving the length of an arc
		GFC	Determine the length of a line segment, the measure of an angle, or the measure of an arc using a tangent to a circle
		GFD	Determine a length using a line segment tangent to a circle and the radius that intersects the tangent
		GFE	Determine the measure of an arc or an angle using the relationship between an inscribed angle and its intercepted arc
		GFG	Solve a problem involving the distance formula
		GFH	Solve a problem using inequalities in a triangle
		GFJ	Determine a length in a complex figure using the Pythagorean theorem
		GG3	Solve for the length of a side of a triangle using the Pythagorean theorem
		GG4	WP: Determine a length or an angle measure using triangle relationships
		GG5	Determine the length of a side or the measure of an angle in congruent triangles
		GG6	WP: Solve a problem using the properties of angles and/or sides of polygons
		GG8	Determine the length of a side in one of two similar polygons
		GG9	Determine the length of a side or the measure of an angle in similar triangles
		GGA	Determine a length given the perimeters of similar triangles or the lengths of corresponding interior line segments
		GGB	Determine a length in a triangle using a midsegment
		GGE	WP: Determine a length using similarity
		GGP	Determine the measure of an arc or a central angle using the relationship between the arc and the central angle
		GHC	Solve a problem involving the midpoint formula
		GHE	Determine a length or an angle measure using the segment addition postulate or the angle addition postulate
		GHF	Solve a problem involving a bisected angle or a bisected segment

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Geometry & Measurement (continued)	Determine a missing measure or dimension of a shape (continued)	GHJ	Determine the measure of an angle in a figure involving parallel and/or perpendicular lines
		GHL	Determine the measure of an angle using angle relationships and the sum of the interior angles in a triangle
		GHM	Determine a length in a triangle using a median
		GHP	Solve a problem involving a point on the bisector of an angle
		GHQ	Determine a length or an angle measure using general properties of parallelograms
		GHR	Determine a length or an angle measure using properties of squares, rectangles, or rhombi
		GHS	Determine a length or an angle measure using properties of kites
		GHT	Determine a length or an angle measure using properties of trapezoids
		GHU	Determine a length or an angle measure in a complex figure using properties of polygons
		GKA	Determine the effect of a change in dimensions on the perimeter or area of a shape
		GMY	Determine the distance between two points on a coordinate plane
		GN0	Determine the measure of an angle formed by parallel lines and one or more transversals given algebraic expressions
		GN1	Use triangle inequalities to determine a possible side length given the length of two sides
		GN2	Determine the measure of an angle or an arc using a tangent to a circle
		WB0	WP: Solve a problem involving similar shapes
		WB5	WP: Use the Pythagorean theorem to find a length or a distance
	Identify congruence and similarity of geometric shapes	GA3	Identify figures that are the same size and shape
		GA4	Compare common objects to basic shapes
		GA8	Determine lines of symmetry
		GB0	Determine the result of a reflection, rotation, or translation
		GE7	Identify a triangle congruence postulate that justifies a congruence statement
		GF7	Identify a triangle similarity postulate that justifies a similarity statement

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Geometry & Measurement (continued)	Identify congruence and similarity of geometric shapes (continued)	GF8	Identify similar triangles using triangle similarity postulates or theorems
		GFF	Identify congruent triangles using triangle congruence postulates or theorems
		GH8	Determine the coordinates of a preimage or an image given a reflection across a horizontal line, a vertical line, the line y = x, or the line y = −x
		GHA	Determine the coordinates of the image of a figure after two transformations of the same type
		GL0	Identify congruent shapes
		GL1	Identify mirror images
	Solve a problem involving the area of a shape	G06	Determine the area of a square
		G07	Determine the area of a rectangle given the length and width
		G08	Determine the area of a right triangle
		G09	Determine the area of a circle
		G24	Use a formula to determine the area of a triangle
		G25	Determine the area of a complex shape
		G33	Solve a problem given the area of a circle
		GAD	Determine the area of a polygon on a grid
		GAF	Determine the missing side length of a rectangle given a side length and the area
		GE5	Determine the area of a right triangle or a rectangle given the coordinates of the vertices of the figure
		GGS	Determine the area of a quadrilateral
		GGT	Determine a length given the area of a parallelogram
		GGU	Determine the area of a sector of a circle
		GGV	Determine the length of the radius or the diameter of a circle given the area of a sector
		GGW	WP: Determine a length or an area involving a sector of a circle
		GGX	Determine the measure of an arc or an angle given the area of a sector of a circle
		GJ3	Determine the area or circumference of a circle given an equation of the circle
		GKT	Determine the area of a shape composed of rectangles given a picture on a grid

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Geometry & Measurement (continued)	Solve a problem involving the area of a shape (continued)	GN3	Determine a length given the area of a kite or rhombus
		GN4	Determine a length given the area of a trapezoid
		W56	WP: Determine the area of a rectangle
		W69	WP: Determine the area of a triangle
		W70	WP: Determine a missing dimension given the area and another dimension
		W98	WP: Determine the area of a square or rectangle
	Solve a problem involving the perimeter of a shape	G03	Determine the perimeter of a square
		G04	WP: Determine the perimeter of a rectangle
		G05	Determine the perimeter of a triangle
		G26	Solve a problem involving the circumference of a circle
		GAB	Determine the perimeter of a rectangle given a picture showing length and width
		GAC	Determine the missing side length of a rectangle given a side length and the perimeter
		WA4	WP: Determine the perimeter or the area of a complex shape
	Solve a problem involving the surface area or volume of a solid	G10	Determine the volume of a rectangular prism
		G31	Determine the surface area of a rectangular prism
		G32	WP: Find the surface area of a rectangular prism
		G34	Determine the volume of a rectangular or a triangular prism
		GGY	Determine a length given the surface area of a right cylinder or a right prism that has a rectangle or a right triangle as a base
		GH0	Solve a problem involving the volume of a right pyramid or a right cone
		GH1	Determine the surface area of a sphere
		GH2	Determine the volume of a sphere or hemisphere
		GJP	Solve a problem involving the surface areas of similar solid figures
		W61	WP: Solve a problem involving the volume of a geometric solid
		W62	WP: Determine the surface area of a geometric solid
		W7F	WP: Determine the volume of a rectangular prism

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Geometry & Measurement (continued)	Use the vocabulary of geometry and measurement	G12	Identify rays
		G13	Identify line segments
		G14	Identify parallel lines
		G15	Identify intersecting line segments
		G16	Identify perpendicular lines
		G19	Identify perpendicular or parallel lines when given a transversal
		G21	Classify an obtuse angle or an acute angle given a picture
		G30	Classify an angle given its measure
		G37	Determine the common attributes in a set of geometric shapes
		GA1	Use basic terms to describe position
		GA2	Identify a circle, a triangle, a square, or a rectangle
		GA5	Identify a line of symmetry
		GA6	Identify a shape with given attributes
		GA7	Identify a common solid shape
		GFZ	Classify a right angle or a straight angle given a picture
		GH7	Relate the coordinates of a preimage or an image to a translation described using mapping notation
		GH9	Relate the coordinates of a preimage or an image to a dilation centered at the origin
		GHD	Identify a relationship between points, lines, and/or planes
		GHG	Identify angle relationships formed by multiple lines and transversals
		GHH	Identify parallel lines using angle relationships
		GJS	Determine the angle of rotational symmetry of a figure
		GK0	Use deductive reasoning to draw a valid conclusion from conditional statements
		GK1	Identify a statement or an example that disproves a conjecture
		GK2	Identify a valid biconditional statement
		GKE	Determine the number of faces, edges, or vertices in a 3-dimensional figure
		GKH	Identify a cross section of a 3-dimensional shape
		GKJ	Relate a net to a 3-dimensional shape

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Geometry & Measurement (continued)	Use the vocabulary of geometry and measurement (continued)	GKN	Identify the converse, inverse, or contrapositive of a statement
		GKV	Determine attributes of a triangle or a quadrilateral from a model
		GKW	Relate a model of a triangle or a quadrilateral to a list of attributes
		GKX	Identify a picture of a 3-dimensional shape
		GKY	Name a 3-dimensional shape from a picture
		GMZ	Identify a geometric construction given an illustration
		MA1	Compare objects using the vocabulary of measurement
	Calculate elapsed time	M17	Calculate elapsed time exceeding an hour with regrouping
		MDB	Calculate elapsed time within an hour, given two clocks, with regrouping
		W68	WP: Calculate elapsed time exceeding an hour with regrouping hours
	Determine a measurement	AKV	Convert between degree measure and radian measure
		AKY	Determine the value of an inverse sine, cosine, or tangent expression
		G17	Identify angle relationships formed by parallel lines cut by a transversal
		G18	Identify angle relationships formed by intersecting lines
		G20	Determine the measure of a vertical angle or a supplementary angle
		GGJ	Determine a sine, cosine, or tangent ratio in a right triangle
		M01	Convert between inches, feet, and yards
		M02	Estimate the height or length of a common object in customary units
		M04	Convert between customary units of capacity
		M05	Convert within metric units of mass, length, and capacity
		M06	Determine the approximate value of a unit converted between customary and metric measures
		M07	Identify an angle given its measure
		M08	Estimate the height of a common object in metric units
		M09	Measure length in centimeters
		M11	Convert a rate from one unit to another with a change in one unit

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Geometry & Measurement (continued)	Determine a measurement (continued)	M12	Convert a rate from one unit to another with a change in both units
		M18	WP: Determine a measure of length, weight or mass, or capacity or volume using proportional relationships
		MA9	Measure length in inches
		MAA	Read a thermometer in degrees Fahrenheit or Celsius
	Relate money to symbols, words, and amounts	C89	Determine cent amounts that total a dollar
		MA2	Identify a coin or the value of a coin
		MA4	Determine the value of groups of coins to $1.00
		N75	Translate between a dollar sign and a cent sign
		NAC	Convert money amounts in words to amounts in symbols
	Tell time	M10	Tell time to the minute
		M15	Tell time to the quarter hour
		M16	Tell time to 5-minute intervals
		MA5	Tell time to the hour and half hour
		MD9	Convert hours to minutes or minutes to seconds
Data Analysis, Statistics, and Probability	Determine a measure of central tendency	S07	Determine the mean of a set of whole number data
		S08	Determine the median of a set of data given a frequency table
		S14	Determine the median of an odd number of data values
		SD3	Determine the median of an even number of data values
	Determine the probability of one or more events	S11	Determine the probability of a single event
		S12	Determine the probability of independent events
	Read or answer a question about charts, tables, or graphs	AME	Determine if a scatter plot shows a positive relationship, a negative relationship, or no relationship between the variables
		AMF	Make a prediction based on a scatter plot
		S00	Read a simple pictograph
		S01	Read a table
		S02	Read a bar graph
		S03	Read a circle graph
		S04	Answer a question using information from a table
		S05	Answer a question using information from a bar graph
		S06	Answer a question using information from a circle graph

Table 49: Star Math Blueprint Skills

Blueprint Domain	Blueprint Skillset	Skill Code	Star Math US Blueprint Skill
Data Analysis, Statistics, and Probability (continued)	Read or answer a question about charts, tables, or graphs (continued)	S13	Answer a question using information from a line graph
		S18	Answer a question using information from a pictograph (1 symbol = more than 1 object)
		S19	Answer a question using information from a bar graph with a y-axis scale by 2s
		S21	Read a double-bar graph
		S22	Answer a question using information from a double-bar graph
		S23	Answer a question using information from a circle graph using percentage calculations
		S24	Answer a question using information from a histogram
		SA1	Read a tally chart
		SA2	Read a line graph
		SD7	Read a 2-category tally chart
		SD9	Answer a question using information from a 2-category tally chart
		SDC	Read a line plot
		SDD	Answer a question using information from a line plot
		SE6	Answer a question using information from a scatter plot
	Use a chart, table, or graph to represent data	S15	Use a circle graph to represent percentage data
		S16	Use a histogram to represent data
		S17	Use a pictograph to represent data (1 symbol = more than 1 object)
		S20	Use a line graph to represent data
		S26	Use a bar graph with a y-axis scale by 2s to represent data
		SA3	Use a double-bar graph to represent data
		SD1	Use a line plot to represent data
		SD5	Use a scatter plot to organize data
		SD8	Use a 2-category tally chart to represent groups of objects (1 symbol = 1 object)
	Use a proportion to make an estimate	S25	Use a proportion to make an estimate, related to a population, based on a sample

Appendix B: Additional Evidence of Star Math Validity

The Validity chapter of this technical manual places its emphasis on summaries of Star Math validity evidence, and on recent evidence which comes primarily from the 34-item, standards-based version of the assessment introduced in 2011. However, the abundance of earlier evidence, and evidence related to the 24-item Star Math versions, is all part of the accumulation of technical support for the validity and usefulness of Star Math. Much of that cumulative evidence is presented in this appendix to ensure that the historical continuity of research in support of Star Math validity is not lost. The material that follows touches on the following list of topics:

- Relationship of Star Math Scores to Scores on Other Tests of Math Achievement
- Relationship of Star Math Scores to Teacher Ratings
- Linking Star and State Assessments: Comparing Student- and School-Level Data
- Classification Accuracy and Screening Data Reported to The National Center on Response to Intervention (NCRTI)

Relationship of Star Math Scores to Scores on Other Tests of Math Achievement

The technical manual for the earliest version of Star Math listed correlations between scores on that test and those on a number of other standardized measures of math achievement, obtained in 1998 for more than 9,000 students who participated in Star Math norming for that version of the program. The standardized tests included a variety of well-established instruments, including the California Achievement Test (CAT), the Comprehensive Test of Basic Skills (CTBS), the Iowa Tests of Basic Skills (ITBS), the Metropolitan Achievement Test (MAT), the Stanford Achievement Test (SAT), and several statewide tests. During the development of Star Math Version 2, additional correlations with external tests were obtained from a total of more than 8,000 tests administered in 2000 and 2001.

During the 2014 norming of Star Math, scores on other standardized tests were obtained for more than 30,000 additional students. All of the standardized tests listed above were included, plus others such as

Northwest Evaluation Association (NWEA) and TerraNova. Scores on state assessments from the following states were also included: Arkansas, Connecticut, Delaware, Florida, Georgia, Kentucky, Idaho, Indiana, Illinois, Maryland, Michigan, Minnesota, Mississippi, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Dakota, Texas, Virginia, and Washington. The extent that the Star Math test correlates with these tests provides support for its construct validity. That is, strong and positive correlations between Star Math and these other instruments provide support for the claim that Star Math effectively measures mathematics achievement.

Table 50 and Table 51 present the correlational data from the 2000–2001 development of Star Math 2. Table 50 lists the correlational details for 4,996 students in grades 1–6; Table 51 lists counterpart data for 3,066 students in grades 7–12.

Table 52 through Table 55 present the correlation coefficients between the scores on the Star Math test and other test instruments subsequent to the Star Math 2 development in years ranging from 2002 through 2016. Table 52 and Table 53 display "concurrent validity" data, that is, correlations between Star Math norming study test scores and other tests administered within a two-month time period. Tests listed in Table 52 and Table 53 were administered between the fall of 2001 and the spring of 2013.

Table 54 and Table 55 display predictive validity data from the same period. Predictive validity provides an estimate of the extent to which scores on the Star Math test predicted scores on criterion measures given at a later point in time, operationally defined as more than 2 months between the Star test (predictor) and the criterion test. It provides an estimate of the linear relationship between Star scores and scores on measures covering a similar academic domain.

Table 50: External Validity Data—Star Math 2.0 Correlation Coefficients (r) with External Tests Administered Prior to Spring 2002, Grades 1–6[a]

Test	Version	Date	Score	1		2		3		4		5		6	
				n	r	n	r	n	r	n	r	n	r	n	r
Achievement Level (RIT) Test															
RIT		F 01	SS	–	–	–	–	–	–	–	–	–	–	150	0.69*
California Achievement Test															
CAT	5th Ed.	S 01	SS	–	–	–	–	46	0.52*	–	–	–	–	–	–
Cognitive Abilities Test															
CogAT		F 00	SS	–	–	–	–	41	0.61*	–	–	–	–	–	–
CogAT		F 01	SS	–	–	45	0.73*	–	–	–	–	–	–	–	–

Table 50: External Validity Data—Star Math 2.0 Correlation Coefficients (r) with External Tests Administered Prior to Spring 2002, Grades 1–6[a]

Test	Version	Date	Score	1		2		3		4		5		6	
				n	r	n	r	n	r	n	r	n	r	n	r
Comprehensive Test of Basic Skills															
CTBS	4th Ed.	S 01	GE	–	–	–	–	–	–	43	0.67*	–	–	–	–
CTBS	A-13	S 00	NCE	–	–	–	–	–	–	65	0.60*	–	–	–	–
CTBS	A-13	S 00	SS	–	–	–	–	–	–	–	–	44	0.70*	–	–
CTBS	A-13	S 01	GE	–	–	–	–	–	–	–	–	–	–	56	0.69*
CTBS	A-13	S 01	NCE	–	–	–	–	–	–	–	–	67	0.72*	–	–
CTBS	A-13	S 01	SS	–	–	–	–	–	–	42	0.61*	–	–	–	–
Connecticut Mastery Test															
Conn	2nd	F 00	SS	–	–	–	–	–	–	–	–	35	0.51*	–	–
Conn	3rd	F 01	SS	–	–	–	–	–	–	42	0.64*	–	–	27	0.52*
Des Moines Public School (Grade 2 pretest)															
DMPS		F 01	NCE	–	–	25	0.76*	–	–	–	–	–	–	–	–
Educational Development Series															
EDS	13C	S 01	GE	–	–	–	–	30	0.69*	–	–	–	–	–	–
EDS	14C	S 00	GE	–	–	–	–	–	–	32	0.44*	–	–	–	–
EDS	15C	F 01	GE	–	–	–	–	–	–	–	–	37	0.68*	–	–
Florida Comprehensive Assessment Test															
FCAT		S 01	NCE	–	–	–	–	–	–	–	–	73	0.65*	–	–
Iowa Tests of Basic Skills															
ITBS	Form A	S 01	NCE	–	–	–	–	73	0.45*	78	0.65*	–	–	–	–
ITBS	Form A	F 01	NCE	–	–	–	–	25	0.41*	25	0.35	23	0.33	86	0.81*
ITBS	Form A	F 01	SS	–	–	–	–	–	–	–	–	–	–	73	0.64*
ITBS	Form K	F 00	SS	–	–	–	–	–	–	–	–	–	–	20	0.92*
ITBS	Form K	S 01	NCE	–	–	101	0.67*	74	0.64*	31	0.25	11	0.58	31	0.62*
ITBS	Form K	F 01	NCE	–	–	–	–	10	0.78*	16	0.78*	9	0.54	18	0.63*
ITBS	Form K	F 01	SS	–	–	–	–	–	–	–	–	75	0.77*	68	0.71*
ITBS	Form L	S 01	NCE	–	–	–	–	13	0.5	46	0.81*	13	0.73*	–	–
ITBS	Form L	S 01	SS	–	–	–	–	–	–	11	0.81*	–	–	–	–
ITBS	Form L	F 01	NCE	–	–	–	–	–	–	–	–	69	0.66*	–	–
ITBS	Form M	S 99	NCE	–	–	–	–	–	–	–	–	–	–	19	0.68*
ITBS	Form M	S 00	NCE	–	–	–	–	–	–	–	–	28	0.65*	–	–

Table 50: External Validity Data—Star Math 2.0 Correlation Coefficients (r) with External Tests Administered Prior to Spring 2002, Grades 1–6[a]

Test	Version	Date	Score	1		2		3		4		5		6	
				n	r	n	r	n	r	n	r	n	r	n	r
Iowa Tests of Basic Skills (continued)															
ITBS	Form M	S 01	NCE	–	–	19	0.81*	–	–	43	0.78*	–	–	–	–
ITBS	Form M	S 01	SS	–	–	–	–	47	0.39*	32	0.55*	–	–	–	–
ITBS	Form M	F 01	NCE	5	0.88*	–	–	–	–	15	0.82*	–	–	–	–
McGraw Hill Mississippi/Criterion Referenced															
McGraw		S 01	SS	–	–	–	–	–	–	–	–	121	0.52*	–	–
Metropolitan Achievement Test															
MAT	7th Ed.	F 01	NCE	–	–	–	–	–	–	–	–	–	–	15	0.84*
Michigan Education Assessment Program															
MEAP		S 01	SS	–	–	–	–	–	–	–	–	88	0.72*	–	–
Multiple Assessment Series (Primary Grades)															
Multiple		S 01	NCE	–	–	14	0.52	19	0.54*	–	–	–	–	–	–
New York State Math Assessment															
NYSMA		S 01	SS	–	–	–	–	–	–	–	–	50	0.79*	–	–
North Carolina End of Grade															
NCEOG		F 01	SS	–	–	–	–	85	0.57*	–	–	–	–	–	–
Northwest Evaluation Association Levels Test															
NWEA		S 01	NCE	–	–	–	–	–	–	–	–	83	0.81*	64	0.78*
NWEA		F 01	NCE	–	–	–	–	50	0.56*	49	0.54*	99	0.70*	–	–
Ohio Proficiency Test															
Ohio		S 01	SS	–	–	–	–	113	0.65*	–	–	–	–	–	–
Stanford Achievement Test															
SAT9		S 99	SS	–	–	–	–	–	–	–	–	55	0.65*	–	–
SAT9		S 00	SS	–	–	–	–	–	–	–	–	–	–	15	0.5
SAT9		F 00	NCE	–	–	–	–	17	0.84*	20	0.83*	–	–	–	–
SAT9		F 00	SS	–	–	–	–	–	–	–	–	–	–	46	0.58*
SAT9		S 01	NCE	–	–	–	–	43	0.69*	–	–	50	0.38*	–	–
SAT9		S 01	SS	64	0.52*	–	–	–	–	58	0.41*	52	0.58*	51	0.65*
SAT9		F 01	SS	–	–	–	–	–	–	90	0.54*	32	0.67*	24	0.57*
Tennessee Comprehensive Assessment Program, 2001															
TCAP	2001	S 01	SS	–	–	–	–	–	–	–	–	48	0.56*	–	–

Table 50: External Validity Data—Star Math 2.0 Correlation Coefficients (r) with External Tests Administered Prior to Spring 2002, Grades 1–6[a]

				1		2		3		4		5		6	
Test	**Version**	**Date**	**Score**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**
TerraNova															
TerraNova		S 00	NCE	–	–	–	–	–	–	–	–	–	–	43	0.60*
TerraNova		S 00	SS	–	–	–	–	–	–	–	–	11	0.61*	–	–
TerraNova		F 00	SS	–	–	–	–	–	–	–	–	108	0.62*	–	–
TerraNova		S 01	NCE	–	–	–	–	–	–	–	–	69	0.40*	85	0.62*
TerraNova		S 01	SS	–	–	–	–	–	–	104	0.50*	62	0.59*	131	0.71*
TerraNova		F 01	NCE	–	–	58	0.38*	63	0.56*	70	0.74*	85	0.61*	–	–
Test of New York State Standards															
TONYSS		S 01	SS	–	–	–	–	55	0.75*	68	0.47*	–	–	–	–
Texas Assessment of Academic Skills															
TAAS	2001	S 01	SS	–	–	–	–	–	–	78	0.52*	–	–	–	–
TAAS	2001	S 01	TLI	–	–	–	–	–	–	–	–	–	–	82	0.42*
Virginia Standards of Learning															
Virginia		S 00	SS	–	–	–	–	–	–	–	–	24	0.73*	–	–
Washington Assessment of Student Learning															
Wash		S 00	SS	–	–	–	–	–	–	–	–	–	–	90	0.54*
Wide Range Achievement Test															
WRAT III		F 01	NCE	–	–	–	–	–	–	44	0.32*	44	0.66*	–	–

Summary							
Grade(s)	**All**	**1**	**2**	**3**	**4**	**5**	**6**
Number of students	4,996	69	262	804	1,102	1,565	1,194
Number of coefficients	98	2	6	17	23	29	21
Average validity	–	0.7	0.65	0.6	0.59	0.62	0.65
Overall average	0.62						

a. n = Sample size.
* Denote correlation coefficients that are statistically significant at the 0.05 level.

Table 51: External Validity Data—Star Math 2.0 Correlation Coefficients (r) with External Tests Administered Prior to Spring 2002, Grades 7–12[a]

				7		8		9		10		11		12	
Test	**Version**	**Date**	**Score**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**
American College Testing Program															
ACT		F 01	NCE	–	–	–	–	–	–	–	–	–	–	26	0.87*
California Achievement Tests															
CAT	5th Ed.	F 01	NCE	–	–	–	–	64	0.73*	–	–	–	–	–	–
CAT	5th Ed.	F 01	SS	170	0.54*	–	–	–	–	–	–	–	–	–	–
Comprehensive Test of Basic Skills															
CTBS	4th Ed.	S 00	SS	67	0.67*	75	0.73*	–	–	–	–	–	–	–	–
CTBS	A-13	S 00	SS	–	–	31	0.65*	–	–	–	–	–	–	–	–
CTBS	A-13	S 01	SS	23	0.82*	–	–	–	–	48	0.63*	–	–	–	–
Delaware Student Testing Program															
DSTP		S 01	SS	–	–	–	–	94	0.27*	–	–	–	–	–	–
Differential Aptitude Tests															
DAT	Level 1	F 01	NCE	–	–	–	–	41	0.70*	–	–	–	–	–	–
Explore Tests															
Explore		F 01	NCE	–	–	64	0.54*	–	–	–	–	–	–	–	–
Georgia High School Graduation Test															
Georgia		S 01	NCE	–	–	–	–	–	–	–	–	–	–	23	0.71*
Indiana Statewide Testing for Educational Progress															
ISTEP		F01	NCE	–	–	–	–	51	0.57*	22	0.58*	–	–	–	–
Iowa Tests of Basic Skills															
ITBS	Form A	F 01	SS	66	0.71*	–	–	–	–	–	–	–	–	–	–
ITBS	Form K	S 01	NCE	73	0.80*	18	0.52*	–	–	–	–	–	–	–	–
ITBS	Form K	F 01	NCE	6	0.72	14	0.69*	–	–	–	–	–	–	–	–
ITBS	Form L	S 01	NCE	36	0.74*	32	0.53*	–	–	19	0.67*	32	0.84*	–	–
ITBS	Form M	S 99	NCE	–	–	5	0.89*	–	–	–	–	11	0.80*	–	–
ITBS	Form M	S 00	NCE	–	–	–	–	–	–	9	0.94*	–	–	–	–
ITBS	Form M	S 01	NCE	49	0.52*	48	0.51*	–	–	–	–	–	–	–	–
Kentucky Core Content Test															
KCCT		S 01	NCE	–	–	–	–	45	0.43*	–	–	–	–	–	–
Maryland High School Placement Test															
Maryland		S 01	NCE	–	–	–	–	47	0.60*	–	–	–	–	–	–

Table 51: External Validity Data—Star Math 2.0 Correlation Coefficients (r) with External Tests Administered Prior to Spring 2002, Grades 7–12[a]

				7		8		9		10		11		12	
Test	**Version**	**Date**	**Score**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**
McGraw Hill Mississippi/Criterion Referenced															
McGraw		S 01	SS	–	–	–	–	73	0.56*	–	–	–	–	–	–
Metropolitan Achievement Test															
MAT	7th Ed.	F 01	NCE	5	0.8	11	0.82*	–	–	–	–	–	–	–	–
North Carolina End of Grade Tests															
NCEOG		S 01	SS	–	–	177	0.59*	–	–	–	–	–	–	–	–
Oklahoma School Testing Program Core Curriculum Tests															
Oklahoma		S 01	SS	–	–	–	–	26	0.67*	–	–	–	–	–	–
Oregon State Assessment															
Oregon		S 01	NCE	–	–	45	0.53*	–	–	–	–	–	–	–	–
PLAN															
PLAN		F 99	SS	–	–	–	–	–	–	–	–	–	–	–	0.42
PLAN		F 00	SS	–	–	–	–	–	–	–	–	40	0.28	–	–
PLAN		F 01	NCE	–	–	–	–	–	–	63	0.61*	–	–	–	–
Preliminary SAT/National Merit Scholarship Qualifying Test															
PSAT/NMSQT	NMSQT	F 00	NCE	–	–	–	–	–	–	–	–	–	–	–	0.63*
PSAT/NMSQT	NMSQT	F 01	NCE	–	–	–	–	–	–	–	–	72	0.64*	–	–
Stanford Achievement Test															
SAT9		S 98	NCE	11	0.84*	–	–	–	–	–	–	–	–	–	–
SAT9		S 99	NCE	14	0.71*	–	–	–	–	–	–	–	–	–	–
SAT9		F 00	SS	–	–	45	0.85*	–	–	–	–	–	–	–	–
SAT9		S 01	NCE	45	0.71*	105	0.81*	11	0.69*	–	–	–	–	–	–
SAT9		S 01	SS	54	0.76*	109	0.69*	19	0.27	77	0.59*	67	0.76*	71	0.65*
SAT9		F 01	SS	104	0.84*	–	–	–	–	–	–	–	–	–	–
TerraNova															
TerraNova		S 99	NCE	35	0.61*	47	0.62*	–	–	–	–	–	–	–	–
TerraNova		S 00	SS	18	0.73*	–	–	–	–	–	–	–	–	–	–
TerraNova		S 01	NCE	17	0.29	17	0.52*	–	–	–	–	–	–	–	–
TerraNova		S 01	SS	–	–	99	0.74*	–	–	–	–	–	–	–	–
TerraNova		F 01	SS	–	–	38	0.74*	–	–	–	–	–	–	–	–
Test of Achievement Proficiency															
TAP		F 01	NCE	–	–	–	–	8	0.7	7	0.7	–	–	–	–

Table 51: External Validity Data—Star Math 2.0 Correlation Coefficients (r) with External Tests Administered Prior to Spring 2002, Grades 7–12[a]

Test	Version	Date	Score	7		8		9		10		11		12	
				n	r	n	r	n	r	n	r	n	r	n	r
Texas Assessment of Academic Skills, 2001															
TAAS	2001	S 01	SS	66	0.44*	69	0.33*	–	–	–	–	–	–	–	–
Virginia Standards of Learning															
Virginia		S 00	SS	25	0.71*	–	–	–	–	–	–	–	–	–	–

Summary							
Grade(s)	**All**	**7**	**8**	**9**	**10**	**11**	**12**
Number of students	3,066	930	1,049	479	245	222	141
Number of coefficients	66	20	19	11	7	5	4
Average validity	–	0.67	0.65	0.56	0.67	0.66	0.6
Overall average	0.64						

a. n = Sample size.
* Denotes correlation coefficients that are statistically significant at the 0.05 level.

Table 52: Concurrent Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 1–6[a]

Test Form	Date	Score	1		2		3		4		5		6	
			n	r	n	r	n	r	n	r	n	r	n	r
Arkansas Augmented Benchmark Examination (AABE)														
AABE	S 08	SS	–	–	–	–	725	0.68*	686	0.70*	634	0.70*	297	0.66*
ACT Aspire														
ACT Aspire – Mathematics	S 14–16	SS	–	–	–	–	5212	0.78*	5005	0.76*	4796	0.78*	4311	0.77*
California Achievement Test (CAT) 5th Edition														
CAT	S 02	NCE	–	–	–	–	17	0.50*	–	–	–	–	–	–
CAT/5	F 10–11	SS	105	0.74*	166	0.64*	209	0.65*	242	0.54*	202	0.71*	186	0.66*
Canadian Achievement Test														
CAT/2	F 10–11	SS	–	–	–	–	–	–	24	0.74*	21	0.63*	–	–
Comprehensive Test of Basic Skills (CTBS)														
CTBS–A13	S 02	SS	–	–	–	–	–	–	–	–	21	0.66*	–	–
CTBS	S 02	NCE	–	–	–	–	–	–	–	–	–	–	32	0.65*

Table 52: Concurrent Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 1–6[a]

			1		2		3		4		5		6	
Test Form	**Date**	**Score**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**
Delaware Student Testing Program (DSTP)														
DSTP	S 03	SS	–	–	–	–	258	0.72*	–	–	296	0.73*	–	–
DSTP	S 05	SS	–	–	–	–	66	0.67*	–	–	–	–	–	–
DSTP	S 06	SS	–	–	140	0.66*	58	0.85*	40	0.63*	151	0.75*	44	0.77*
Florida Comprehensive Assessment Test (FCAT)														
FCAT	S 06	SS	–	–	–	–	58	0.85*	40	0.63*	–	–	–	–
FCAT	S 06–08	SS	–	–	–	–	2,338	0.74*	2,211	0.74*	2,078	0.74*	279	0.65*
Florida Standards Assessments (FSA)														
FSA	S 15	SS	–	–	–	–	1,508	0.78*	1,944	0.79*	2,637	0.82*	1,434	0.84*
Georgia Milestones														
Mile-stones – Mathe-matics	S 15	SS	–	–	–	–	11262	0.79*	10434	0.79*	10925	0.79	6732	0.79*
Idaho Standards Achievement Test (ISAT)														
ISAT	F 02	SS	–	–	–	–	192	0.68*	188	0.75*	194	0.75*	221	0.74*
ISAT	S 03	SS	–	–	–	–	224	0.74*	209	0.83*	222	0.78*	231	0.82*
ISAT	S 07–09	SS	–	–	–	–	798	0.70*	699	0.60*	727	0.62*	217	0.69*
Iowa Test of Basic Skills (ITBS)														
ITBS–A	S 02	NCE	–	–	–	–	–	–	50	0.66*	79	0.72*	–	–
ITBS–K	S 02	SS	–	–	–	–	–	–	–	–	–	–	70	0.69*
ITBS–L	S 02	NCE	–	–	7	0.78*	23	0.57*	17	0.70*	21	0.66*	–	–
ITBS–M	S 02	NCE	14	0.56*	11	0.58*	–	–	–	–	–	–	–	–
ITBS–M	S 02	SS	–	–	–	–	17	0.72*	–	–	–	–	–	–
Kansas State Assessment Program (KSAP)														
KSAP	S 06–08	SS	–	–	–	–	915	0.59*	947	0.67*	752	0.66*	402	0.67*
Kentucky Core Content Test (KCCT)														
KCCT	S 08–10	SS	–	–	–	–	3,777	0.69*	3,115	0.70*	2,228	0.66*	1,785	0.66*
Key Stage 2 Standardised Attainment Tests (KS2 SATs)														
Maths	S 16	SS	–	–	–	–	–	–	–	–	815	0.84*	–	–
Maths	S 16	Raw	–	–	–	–	–	–	–	–	815	0.83*	–	–
McGraw Hill Mississippi/Criterion Referenced														
	S 02	SS	–	–	–	–	–	–	–	–	44	0.73*	–	–

Table 52: Concurrent Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 1–6[a]

			1		2		3		4		5		6	
Test Form	**Date**	**Score**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**
Metropolitan Achievement Test (MAT)														
MAT–6th Ed.	S 02	NCE	69	0.55*	–	–	–	–	–	–	–	–	–	–
MAT–8th Ed.	S 02	SS	–	–	–	–	–	–	38	0.83*	–	–	–	–
Michigan Educational Assessment Program (MEAP) – Mathematics														
MEAP	F 04	SS	–	–	–	–	–	–	154	0.81*	–	–	–	–
MEAP	F 05	SS	–	–	–	–	71	0.75*	69	0.78*	77	0.83*	89	0.77*
MEAP	F 06	SS	–	–	–	–	162	0.72*	–	–	53	0.67*	123	0.69*
Minnesota Comprehensive Assessment (MCA)														
MCA	S 03	SS	–	–	–	–	85	0.71*	–	–	81	0.76*	–	–
MCA	S 04	SS	–	–	–	–	91	0.74*	–	–	83	0.73*	–	–
Mississippi Academic Assessment Program (MAAP)														
MAAP – Mathematics	S 16	SS	–	–	–	–	2058	0.78*	1633	0.79*	2045	0.72*	2145	0.74*
Mississippi Curriculum Test (MCT2)														
CTB	S 02	SS	–	–	–	–	–	–	10	0.62*	–	–	–	–
CTB	S 03	SS	–	–	–	–	117	0.71*	154	0.77*	119	0.78*	52	0.43*
MCT	S 03	SS	–	–	–	–	117	0.71*	154	0.77*	110	0.78*	52	0.43*
MCT2	S 08	SS	–	–	–	–	1,786	0.72*	1,757	0.72*	1,531	0.73*	1,180	0.78*
Missouri Assessment Program (MAP) Grade-Level Tests														
MAP – Mathematics	S 16	SS	–	–	–	–	4403	0.84*	4276	0.83*	4239	0.83*	2266	0.84*
New Jersey Assessment of Skills and Knowledge (NJASK)														
NJASK	S 13	SS	–	–	–	–	1,589	0.82*	1,715	0.82*	1,485	0.85*	389	0.76*
New York State Assessment Program														
NYSTP	S 13	SS	–	–	–	–	122	0.73*	–	–	–	–	–	–
North Carolina End-of-Grade (NCEOG) Test														
NCEOG	S 02	NCE	–	–	–	–	70	0.60*						
NCEOG	S 02	SS					62	0.73*						
NCEOG	S 06–08	SS	–	–	–	–	1,100	0.72*	751	0.72*	482	0.65*	202	0.77*
NCEOG	S 14	SS	–	–	–	–	9,235	0.76*	8,324	0.76*	7,866	0.77*	4,618	0.78*

Table 52: Concurrent Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 1–6[a]

Test Form	Date	Score	1		2		3		4		5		6	
			n	r	n	r	n	r	n	r	n	r	n	r
NWEA, NALT, & MAP														
	F 02	SS	–	–	–	–	81	0.75*	–	–	77	0.86*	–	–
	S 03	SS	–	–	–	–	85	0.82*	–	–	80	0.85*	–	–
	F 03	SS	–	–	77	0.69*	92	0.73*	75	0.82*	79	0.86*	–	–
	S 04	SS	–	–	80	0.72*	92	0.84*	65	0.84*	82	0.86*	–	–
	F 04	SS	–	–	–	–	63	0.53*	77	0.78*	86	0.84*	–	–
	S 05	SS	–	–	–	–	63	0.74*	80	0.87*	96	0.87*	–	–
Ohio Achievement Assessment														
OAA	S 13	SS	–	–	–	–	1,725	0.76*	1,594	0.75*	1,605	0.76*	1,601	0.69*
Ohio State Tests (OST)														
OST – Mathematics	S 16	SS	–	–	–	–	4397	0.82*	3870	0.83*	3514	0.80*	3752	0.77*
Oklahoma Core Curriculum Test (OCCT)														
OCCT	S 06	SS	–	–	–	–	77	0.71*	92	0.61*	66	0.68*	60	0.63*
Partnership for Assessment of Readiness for College and Careers (PARCC)														
PARCC	S 15	SS	–	–	–	–	4,103	0.8	4,787	0.83*	4,266	0.79*	5,050	0.8*
Pennsylvania System of School Assessment (PSSA)														
PSSA	S 02	SS	–	–	–	–	–	–	–	–	–	–	62	0.76*
PSSA	S 13	SS	–	–	–	–	87	0.76*	76	0.86*	70	0.64*	–	–
South Dakota State Test of Educational Progress (DSTEP)														
DSTEP	S 08–10	SS	–	–	–	–	2,092	0.74*	1,555	0.74*	1,309	0.72*	837	0.74*
Stanford Achievement Test (SAT9)														
SAT9	S 02	NCE	–	–	113	0.56*	39	0.83*	46	0.54*	103	0.70*	49	0.65*
SAT9	S 02	SS	20	0.76*	16	0.68*	18	0.59*	19	0.57*	71	0.49*	84	0.62*
Smarter Balanced Assessment (SBA)														
SBA	S 15	SS	–	–	–	–	608	0.85*	640	0.87*	513	0.85*	561	0.86*
SBA	S 15	SS	–	–	–	–	10,800	0.84*	10,582	0.86*	9,750	0.86*	7,852	0.86*
State of Texas Assessments of Academic Readiness Standards Test 2														
STAAR	S 12–13	SS	–	–	–	–	5,794	0.73*	6,141	0.75*	5,538	0.71*	4,437	0.75*
STAAR	S 11–14	SS	–	–	–	–	6,424	0.77*	6,138	0.76*	1,833	0.78*	5,331	0.73*

Table 52: Concurrent Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 1–6[a]

			1		2		3		4		5		6	
Test Form	**Date**	**Score**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**
Tennessee Comprehensive Assessment Program (TCAP)														
TCAP	S 11	SS	–	–	–	–	35	0.78*	–	–	–	–	–	–
TCAP	S 12	SS	–	–	–	–	72	0.76*	98	0.69*	74	0.85*	–	–
TCAP	S 13	SS	–	–	–	–	172	0.74*	232	0.63*	286	0.68*	–	–
TerraNova														
TerraNova	S 02	NCE	7	0.66*	14	0.46*	125	0.68*	18	0.67*	17	0.79*	15	0.64*
TerraNova	F 03	SS	–	–	177	0.55*	172	0.45*	119	0.67*	160	0.78*	–	–
TerraNova	S 04	SS	–	–	150	0.75*	205	0.71*	149	0.71*	182	0.78*	–	–
Texas Assessment of Academic Achievement (TAAS)														
TAAS	S 01	SS	–	–	–	–	1,036	0.56*	1,047	0.50*	1,006	0.65*	991	0.61*
TAAS	S 02	SS	–	–	–	–	674	0.65*	669	0.63*	677	0.64*	885	0.64*
Texas Assessment of Knowledge and Skills (TAKS)														
TAKS	S 03	SS	–	–	–	–	1,134	0.63*	1,129	0.62*	1,086	0.70*	–	–
Transitional Colorado Assessment Program (TCAP)														
TCAP	S 12–13	SS	–	–	–	–	3,185	0.84*	3,211	0.88*	3,183	0.89*	3,111	0.90*
West Virginia Educational Standards Test 2														
WESTEST 2	S 12	SS	–	–	–	–	2,386	0.74*	2,725	0.75*	2,324	0.75*	1,153	0.73*
Wisconsin Forward Exam														
WI Forward – Mathematics	S 16	SS	–	–	–	–	8720	0.79*	8255	0.76*	8047	0.73*	6941	0.82*
Wisconsin Knowledge and Concepts Examination (WKCE)														
WKCE	F 06–10	SS	–	–	–	–	1,322	0.71*	1,393	0.72*	1,801	0.73*	1,175	0.75*

Summary

Grade(s)	**All**	**1**	**2**	**3**	**4**	**5**	**6**
Number of students	370,651	215	951	104,603	99,768	93,810	71,304
Number of coefficients	241	5	11	64	56	62	43
Average validity	–	0.65	0.64	0.72	0.73	0.75	0.72
Overall average	0.73						

a. n = Sample size.
* Denotes correlation coefficients that are statistically significant at the 0.05 level.

Table 53: Concurrent Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 7–12[a]

Test Form	Date	Score	7		8		9		10		11		12	
			n	r	n	r	n	r	n	r	n	r	n	r
Arkansas Augmented Benchmark Examination (AABE)														
AABE	S 08	SS	99	0.56*	74	0.77*	–	–	–	–	–	–	–	–
ACT														
ACT – Mathematics	S 08– 15	SS	–	–	–	–	14	0.54*	177	0.47*	1278	0.66*	26	–0.04
ACT Aspire														
ACT Aspire – Mathematics	S 14–16	SS	3351	0.81*	3377	0.82*	5083	0.65*	3981	0.76*	–	–	–	–
California Achievement Test (CAT) 5th Edition														
CAT/5	F 10–11	SS	166	0.73*	129	0.64*	52	0.71*	33	0.68*	–	–	–	–
Delaware Student Testing Program (DSTP)														
DSTP	S 03	SS	–	–	254	0.78*	–	–	–	–	–	–	–	–
Florida Comprehensive Assessment Test (FCAT)														
FCAT	S 02	SS	–	–	–	–	–	–	51	0.64*	57	0.66*	38	0.75*
FCAT	S 06–08	SS	195	0.65*	89	0.60*	–	–	–	–	–	–	–	–
Florida Standards Assessments (FSA)														
FSA	S 15	SS	1,211	0.82*	936	0.71*	–	–	–	–	–	–	–	–
Georgia Milestones														
Milestones – Mathematics	S 15	SS	5877	0.77*	6049	0.74*	–	–	–	–	–	–	–	–
Idaho Standards Achievement Test (ISAT)														
ISAT	F 02	SS	206	0.81*	170	0.81*	–	–	–	–	–	–	–	–
ISAT	S 03	SS	227	0.85*	174	0.82*	–	–	–	–	–	–	–	–
ISAT	S 06–08	SS	289	0.71*	328	0.77*	–	–	–	–	–	–	–	–
Iowa Test of Basic Skills (ITBS)														
ITBS–M	S 02	SS	37	0.40*	–	–	–	–	–	–	–	–	–	–
Kansas State Assessment Program (KSAP)														
KSAP	S 06–08	SS	271	0.74*	137	0.75*	–	–	–	–	–	–	–	–
Kentucky Core Content Test (KCCT)														
KCCT	S 08–10	SS	788	0.68*	362	0.64*	–	–	–	–	–	–	–	–
Measures of Academic Progress (MAP)														
MAP	S 15	SS	413	0.82	646	0.82	–	–	–	–	–	–	–	–

Table 53: Concurrent Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 7–12[a]

Test Form	Date	Score	7		8		9		10		11		12	
			n	r	n	r	n	r	n	r	n	r	n	r
Michigan Educational Assessment Program (MEAP) – Mathematics														
MEAP	F 05	SS	65	0.72*	71	0.80*	–	–	–	–	–	–	–	–
MEAP	F 06	SS	122	0.84*	123	0.58*	–	–	–	–	–	–	–	–
Mississippi Academic Assessment Program (MAAP)														
MAAP – Mathematics	S 16	SS	1417	0.73*	1185	0.70*	–	–	–	–	–	–	–	–
Mississippi Curriculum Test (MCT2)														
MCT2	S 08	SS	721	0.66*	549	0.71*	–	–	–	–	–	–	–	–
Missouri Assessment Program (MAP) Grade-Level Tests														
MAP – Mathematics	S 16	SS	1874	0.76*	1294	0.73*	–	–	–	–	–	–	–	–
New Standards Reference Mathematics Exam (Rhode Island)														
NRSME	S 02	SS	–	–	–	–	–	–	–	–	67	0.67*	9	0.66*
North Carolina End-of-Grade (NCEOG) Test														
NCEOG	S 06–08	SS	216	0.70*	39	0.81*	–	–	–	–	–	–	–	–
NCEOG	S 14	SS	3,947	0.73*	3,302	0.72*	–	–	–	–	–	–	–	–
New Jersey Assessment of Skills and Knowledge (NJASK)														
NJASK	S 13	SS	620	0.79*	611	0.78*	–	–	–	–	–	–	–	–
Ohio Achievement Assessment														
OAA	S 13	SS	1,412	0.65*	1,380	0.65*	–	–	–	–	–	–	–	–
Ohio State Tests (OST)														
OST – Mathematics	S 16	SS	3412	0.77*	2883	0.73*	–	–	–	–	–	–	–	–
Ohio Proficiency Test (OPT)														
OPT	S 02	SS	–	–	–	–	23	0.67*	26	0.40*	24	0.77*	24	0.69*
Oklahoma Core Curriculum Test (OCCT)														
OCCT	S 06	SS	55	0.63*	68	0.70*	–	–	–	–	–	–	–	–
Otis Lennon School Ability Test (OLSAT)														
OLSAT	S 02	NCE	–	–	–	–	–	–	12	0.36	13	0.91*	6	0.72*
Palmetto Achievement Challenge Test (PACT), 2001														
PACT	S 02	SS	–	–	161	0.72*	–	–	–	–	–	–	–	–
Partnership for Assessment of Readiness for College and Careers (PARCC)														
PARCC	S 15	SS	4,368	0.77*	4,196	0.75*	–	–	–	–	–	–	–	–

Table 53: Concurrent Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 7–12[a]

Test Form	Date	Score	7		8		9		10		11		12	
			n	r	n	r	n	r	n	r	n	r	n	r
South Dakota State Test of Educational Progress (DSTEP)														
DSTEP	S 08–10	SS	525	0.73*	535	0.73*	–	–	–	–	–	–	–	–
Smarter Balanced Assessment (SBA)														
SBA	S 15	SS	569	0.82*	432	0.79*	–	–	–	–	55	0.52	–	–
SBA	S 15	SS	6,344	0.86*	5,424	0.83*	–	–	–	–	–	–	–	–
State of Texas Assessments of Academic Readiness Standards Test 2														
STAAR	S 12–13	SS	4,171	0.71*	3,379	0.68*	–	–	–	–	–	–	–	–
STAAR	S 11–14	SS	4,437	0.74*	–	–	–	–	–	–	–	–	–	–
Texas Assessment of Academic Achievement (TAAS)														
TAAS	S 01	SS	892	0.60*	825	0.67*	–	–	–	–	–	–	–	–
TAAS	S 02	SS	768	0.62*	809	0.68*	–	–	–	–	–	–	–	–
Texas Assessment of Academic Skills (TAAS), 2001														
TAAS	S 02	TLI	–	–	–	–	163	0.69*	–	–	–	–	–	–
Transitional Colorado Assessment Program (TCAP)														
TCAP	S 12–13	SS	3,173	0.90*	3,114	0.88*	–	–	–	–	–	–	–	–
West Virginia Educational Standards Test 2														
WESTEST 2	S 12	SS	1,184	0.76*	1,215	0.69*	–	–	–	–	–	–	–	–
Wisconsin Forward Exam														
WI Forward – Mathematics	S 16	SS	6855	0.74	6355	0.7	–	–	–	–	–	–	–	–
Wisconsin Knowledge and Concepts Examination (WKCE)														
WKCE	F 06–10	SS	640	0.79*	767	0.76*	–	–	248	0.73*	–	–	–	–

Summary

Grade(s)	All	7	8	9	10	11	12
Number of students	123,819	60,917	51,442	5,335	4,528	1,494	103
Number of coefficients	95	36	36	5	7	6	5
Average validity	–	0.73	0.74	0.65	0.58	0.7	0.56
Overall average	0.71						

a. n = Sample size.
* Denotes correlation coefficients that are statistically significant at the 0.05 level.

Table 54: Predictive Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 1–6[a]

Test Form	Date	Score	1		2		3		4		5		6	
			n	r	n	r	n	r	n	r	n	r	n	r
Arkansas Augmented Benchmark Examination (AABE)														
AABE	F 07	SS	–	–	–	–	1,196	0.69*	1,128	0.67*	994	0.73*	638	0.71*
ACT Aspire														
ACT Aspire	S 14	SS	–	–	–	–	373	0.77*	392	0.67*	380	0.61*	359	0.70*
ACT Aspire – Mathematics	F 13–S 16	SS	–	–	–	–	5117	0.80*	4994	0.78*	5096	0.78*	4090	0.78*
Delaware Student Testing Program (DSTP)														
DSTP	F 02	SS	–	–	–	–	191	0.70*	–	–	228	0.70*	–	–
DSTP	F 04	SS	–	–	–	–	171	0.67*	–	–	–	–	–	–
DSTP	W 05	SS	–	–	–	–	149	0.76*	–	–	–	–	–	–
DSTP	S 05	SS	–	–	–	–	132	0.64*	172	0.63*	185	0.62*	–	–
DSTP	F 05	SS	–	–	206	0.64*	219	0.66*	249	0.67*	265	0.68*	–	–
DSTP	W 05	SS	–	–	242	0.61*	226	0.61*	269	0.62*	277	0.68*		
Florida Comprehensive Assessment Test (FCAT)														
FCAT	F 05	SS	–	–	–	–	54	0.79*	42	0.69*	–	–	–	–
FCAT	F 05–07	SS	–	–	–	–	5,292	0.74*	5,020	0.73*	4,895	0.77*	1,015	0.66*
Florida Standards Assessments (FSA)														
FSA	S 15	SS	–	–	–	–	4,188	0.81*	4,133	0.82*	4,107	0.81*	1,398	0.84*
Georgia Milestones														
Milestones – Mathematics	F 14–S 15	SS	–	–	–	–	8279	0.82*	7868	0.81*	7802	0.82*	6965	0.80*
Idaho Standards Achievement Test (ISAT)														
ISAT	F 08–10	SS	–	–	–	–	1,875	0.67*	1,908	0.63*	2,312	0.69*	1,809	0.73*
Iowa Assessment														
IA	F 12	SS	–	–	–	–	770	0.67*	885	0.65*	896	0.56*	732	0.48*
IA	W 12	SS	–	–	–	–	1,299	0.61*	997	0.62*	923	0.58*	918	0.64*
IA	S 12	SS	–	–	–	–	299	0.66*	301	0.67*	268	0.62*	204	0.62*
Kentucky Core Content Test (KCCT)														
KCCT	F 07–09	SS	–	–	–	–	5,821	0.68*	5,325	0.67*	4,199	0.66*	3,172	0.63*
Kentucky Performance Rating for Educational Progress (K-PREP)														
K-PREP	S 12	SS	–	–	–	–	557	0.82*	556	0.87*	537	0.85*	43	0.66*
Louisiana Educational Assessment Program (LEAP 2025)														
LEAP 2025 – Mathematics	F 15–S 16	SS	–	–	–	–	1965	0.80*	1964	0.80*	1653	0.77*	703	0.80*

Table 54: Predictive Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 1–6[a]

			1		2		3		4		5		6	
Test Form	**Date**	**Score**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**
Maine Educational Assessment (MEA)														
MEA – Mathematics	F 15–S 16	SS	–	–	–	–	139	0.81*	142	0.77*	157	0.72*	158	0.74*
Michigan Educational Assessment Program (MEAP)														
MEAP	F 04	SS	–	–	–	–	–	–	64	0.70*	74	0.85*	81	0.74*
MEAP	W 05	SS	–	–	–	–	–	–	65	0.80*	75	0.87*	42	0.72*
MEAP	S 05	SS	–	–	–	–	66	0.63*	65	0.73*	76	0.83*	84	0.71*
Michigan Student Test of Educational Progress (M-STEP)														
M-STEP	S 15	SS	–	–	–	–	783	0.85*	758	0.85*	345	0.84*	644	0.84*
Georgia Milestones – English Language Arts														
Milestones	S 15	SS	–	–	–	–	814	0.86*	721	0.84*	845	0.83*	471	0.8*
Minnesota Comprehensive Assessment (MCA)														
MCA	F 02	SS	–	–	–	–	81	0.64*	–	–	78	0.72*	–	–
MCA	W 03	SS	–	–	–	–	86	0.66*	–	–	81	0.77*	–	–
MCA	F 03	SS	–	–	–	–	87	0.53*	–	–	79	0.69*	–	–
MCA	W 04	SS	–	–	–	–	93	0.60*	–	–	82	0.75*	–	–
Mississippi Academic Assessment Program (MAAP)														
MAAP – Mathematics	F 15–S 16	SS	–	–	–	–	2390	0.79*	1937	0.70*	1686	0.69*	1662	0.78*
Mississippi Curriculum Test (MCT2)														
MCT	F 02	SS	–	–	–	–	48	0.64*	33	0.82*	73	0.80*	–	–
MCT	F 03	SS	–	–	–	–	109	0.51*	164	0.72*	156	0.69*	–	–
MCT2	F 07	SS	–	–	–	–	2,989	0.69*	3,022	0.70*	2,796	0.72*	2,741	0.74*
Missouri Assessment Program (MAP) Grade-Level Tests														
MAP – Mathematics	F 15–S 16	SS	–	–	–	–	3846	0.86*	3836	0.84*	3872	0.84*	2930	0.84*
New York State Assessment Program														
NYSTP	F 12	SS	–	–	–	–	290	0.60*	–	–	–	–	–	–
North Carolina End-of-Grade (NCEOG) Test														
NCEOG	F 05–07	SS	–	–	–	–	2,494	0.73*	2,008	0.70*	1,096	0.69*	830	0.70*
NCEOG	S 14	SS	–	–	–	–	29,878	0.71*	28,659	0.73*	27,366	0.73*	15,420	0.74*
NWEA NALT & MAP														
	F 02	–	–	–	–	–	80	0.65*	–	–	77	0.86*	–	–
	W 03	–	–	–	–	–	85	0.78*	–	–	80	0.90*	–	–
	F 03	–	–	–	–	–	86	0.68*	69	0.81*	78	0.87*	–	–
	W 04	–	–	–	–	–	92	0.80*	68	0.80*	81	0.93*	–	–

Table 54: Predictive Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 1–6[a]

Test Form	Date	Score	1		2		3		4		5		6	
			n	r	n	r	n	r	n	r	n	r	n	r
Oklahoma Core Curriculum Test (OCCT)														
OCCT	F 05	SS	–	–	–	–	87	0.71*	88	0.61*	77	0.55*	83	0.56*
Ohio Achievement Assessment														
OAA	F 12	SS	–	–	–	–	47	0.82*	43	0.76*	34	0.71*	32	0.61*
Ohio State Tests (OST)														
OST – Mathematics	F 15–S 16	SS	–	–	–	–	3846	0.83*	3588	0.84*	3255	0.81*	3371	0.80*
Partnership for Assessment of Readiness for College and Careers (PARCC)														
PARCC	S 15	SS	–	–	–	–	3,635	0.83*	4,008	0.83*	3,653	0.8*	4,150	0.82*
Pennsylvania System of School Assessment (PSSA)														
PSSA	S 12	SS	–	–	–	–	92	0.82*	84	0.88*	74	0.7*	–	–
PSSA	F 12	SS	–	–	–	–	87	0.79*	74	0.81*	72	0.59*	–	–
PSSA	F 12	SS	–	–	–	–	84	0.82*	70	0.79*	73	0.65*	–	–
PSSA	W 13	SS	–	–	–	–	86	0.78*	74	0.81*	72	0.66*	–	–
PSSA	W 13	SS	–	–	–	–	86	0.8*	75	0.85*	75	0.61*	–	–
PSSA	S 13	SS	–	–	–	–	85	0.76*	74	0.84*	73	0.65*	–	–
PSSA	S 13	SS	–	–	–	–	85	0.78*	69	0.84*	71	0.71*	–	–
PSSA	S 15	SS	–	–	–	–	580	0.85*	717	0.84*	606	0.82*	575	0.85*
South Carolina College-and Career-Ready Assessments (SC READY)														
SC READY – Mathematics	F 15–S 16	SS	–	–	–	–	2224	0.82*	2047	0.79*	1428	0.82*	1092	0.79*
South Dakota State Test of Educational Progress (DSTEP)														
DSTEP	F 07–09	SS	–	–	–	–	3,886	0.73*	3,665	0.75*	3,084	0.72*	2,328	0.75*
Smarter Balanced Assessment (SBA)														
SBA	F 14	SS	–	–	–	–	608	0.82*	640	0.81*	513	0.83*	561	0.82*
SBA	W 14	SS	–	–	–	–	608	0.83*	640	0.84*	513	0.83*	561	0.84*
SBA	S 15	SS	–	–	–	–	8,593	0.87*	8,571	0.88*	8,595	0.88*	8,575	0.88*
STAR Math														
STAR–M	F 01	SS	–	–	–	–	1,036	0.61*	1,047	0.63*	1,006	0.65*	991	0.65*
STAR–M	F 05	SS	2,605	0.50*	7,195	0.63*	11,716	0.67*	13,295	0.69*	10,343	0.70*	6,823	0.75*
STAR–M	F 06	SS	4,687	0.58*	12,464	0.62*	16,474	0.66*	17,161	0.70*	16,181	0.71*	12,026	0.73*
STAR–M	F 05	SS	1,147	0.51*	3,181	0.62*	4,894	0.67*	5,254	0.70*	2,164	0.69*	1,474	0.74*
STAR–M	F 05	SS	1,147	0.42*	3,181	0.57*	4,894	0.62*	5,254	0.64*	2,164	0.73*	1,474	0.80*
STAR–M	S 06	SS	1,147	0.66*	3,181	0.69*	4,894	0.73*	5,254	0.74*	2,164	0.73*	1,474	0.80*
STAR–M	S 06	SS	1,147	0.62*	3,181	0.63*	4,894	0.69*	5,254	0.70*	2,164	0.71*	1,474	0.78*

Table 54: Predictive Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 1–6[a]

Test Form	Date	Score	1		2		3		4		5		6	
			n	r	n	r	n	r	n	r	n	r	n	r
State of Texas Assessments of Academic Readiness Standards Test 2														
STAAR	F 11–12	SS	–	–	–	–	4,788	0.75*	4,945	0.76*	4,740	0.76*	4,353	0.74*
STAAR	S 14–15	SS	–	–	–	–	4,744	0.8*	4,613	0.77*	3,878	0.77*	4,878	0.74*
Tennessee Comprehensive Assessment Program (TCAP)														
TCAP	F 10	SS	–	–	–	–	329	0.51*	305	0.58*	307	0.63*	–	–
TCAP	F 11	SS	–	–	–	–	328	0.58*	229	0.60*	406	0.64*	–	–
TCAP	F 12	SS	–	–	–	–	591	0.62*	522	0.65*	649	0.67*	290	0.75*
TCAP	S 14	SS	–	–	–	–	127	0.82*	122	0.87*	–	–	–	–
Texas Assessment of Academic Achievement (TAAS)														
TAAS	F 01	SS	–	–	–	–	1,036	0.51*	1,047	0.42*	1,006	0.60*	991	0.61*
Texas Assessment of Knowledge and Skills (TAKS)														
TAKS	F 02	SS	–	–	–	–	262	0.64*	135	0.49*	228	0.70*	646	0.69*
TerraNova														
TerraNova	F 03	–	–	–	117	0.69*	165	0.58*	116	0.75*	154	0.54*	–	–
TerraNova	W 04	–	–	–	128	0.58*	197	0.47*	120	0.71*	173	0.77*	–	–
West Virginia Educational Standards Test 2														
WESTEST 2	F 11	SS	–	–	–	–	2,447	0.75*	2,536	0.77*	2,298	0.78*	1,533	0.77*
Wisconsin Forward Exam														
WI Forward – Mathematics	F 15–S 16	SS	–	–	–	–	895	0.81*	800	0.79*	785	0.73*	711	0.84*
Wisconsin Knowledge and Concepts Examination (WKCE)														
WKCE	S 05–09	SS	–	–	–	–	4,645	0.66*	4,980	0.68*	5,345	0.74*	4,702	0.75*
Summary														
Grade(s)		**All**	**1**		**2**		**3**		**4**		**5**		**6**	
Number of students		662,040	11,880		33,076		176,784		175,330		152,693		112,277	
Number of coefficients		285	6		10		77		69		74		49	
Average validity		–	0.55		0.63		0.72		0.74		0.73		0.74	
Overall average		0.72												

a. n = Sample size.
* Denotes correlation coefficients that are statistically significant at the 0.05 level.

Table 55: Predictive Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 7–12[a]

Test Form	Date	Score	7		8		9		10		11		12	
			n	r	n	r	n	r	n	r	n	r	n	r
Arkansas Augmented Benchmark Examination (AABE)														
AABE	F 07	SS	369	0.67*	296	0.76*	–	–	–	–	–	–	–	–
ACT														
ACT – Mathematics	F 07–S 15	SS	–	–	–	–	68	0.59*	1368	0.53*	4800	0.74*	92	0.43*
ACT Aspire														
ACT Aspire	S 14	SS	376	0.67*	349	0.79*	–	–	–	–	–	–	–	–
ACT Aspire – Mathematics	F 13–S 16	SS	4065	0.80*	4046	0.82*	5358	0.72*	4815	0.78*	–	–	–	–
Delaware Student Testing Program (DSTP)														
DSTP	F 02	SS	242	0.74*	–	–	–	–	–	–	–	–	–	–
DSTP	S 05	SS	227	0.71*	175	0.75*	–	–	–	–	–	–	–	–
Florida Comprehensive Assessment Test (FCAT)														
FCAT	F 05–07	SS	783	0.72*	336	0.70*	–	–	–	–	–	–	–	–
Florida Standards Assessments (FSA)														
FSA	S 15	SS	1,267	0.83*	978	0.73*	–	–	–	–	–	–	–	–
Georgia Milestones														
Milestones – Mathematics	F 14–S 15	SS	6743	0.79*	7088	0.76*	–	–	–	–	–	–	–	–
Idaho Standards Achievement Test (ISAT)														
ISAT	F 05–07	SS	588	0.75*	484	0.75*	–	–	–	–	–	–	–	–
Iowa Assessment														
IA	F 12	SS	809	0.61*	787	0.65*	–	–	–	–	–	–	–	–
IA	W 12	SS	620	0.66*	470	0.73*	–	–	–	–	–	–	–	–
IA	S 12	SS	172	0.67*	164	0.67*	–	–	–	–	–	–	–	–
Kentucky Core Content Test (KCCT)														
KCCT	F 07–09	SS	1,789	0.65*	1,153	0.59*	–	–	–	–	–	–	–	–
Kentucky Performance Rating for Educational Progress (K-PREP)														
K-PREP	S 12	SS	46	0.68*	323	0.78*	–	–	–	–	–	–	–	–
Louisiana Educational Assessment Program (LEAP 2025)														
LEAP 2025 – Mathematics	F 15–S 16	SS	865	0.82*	563	0.74*	–	–	–	–	–	–	–	–

Table 55: Predictive Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 7–12[a]

			7		8		9		10		11		12	
Test Form	**Date**	**Score**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**	**n**	**r**
Maine Educational Assessment (MEA)														
MEA – Mathematics	F 15–S 16	SS	138	0.70*	161	0.61*	–	–	–	–	–	–	–	–
Michigan Educational Assessment Program (MEAP)														
MEAP	F 04	SS	56	0.78*	–	–	–	–	–	–	–	–	–	–
MEAP	W 05	SS	56	0.78*	–	–	–	–	–	–	–	–	–	–
MEAP	S 05	SS	37	0.86*	–	–	–	–	–	–	–	–	–	–
Michigan Student Test of Educational Progress (M-STEP)														
M-STEP	S 15	SS	1053	0.84*	677	0.8*	–	–	–	–	–	–	–	–
Georgia Milestones – English Language Arts														
Milestones	S 15	SS	453	0.8*	463	0.77*	–	–	–	–	–	–	–	–
Mississippi Academic Assessment Program (MAAP)														
MAAP – Mathematics	F 15–S 16	SS	1644	0.77*	1635	0.75*	–	–	–	–	–	–	–	–
Mississippi Curriculum Test (MCT2)														
MCT2	F 07	SS	2,127	0.71*	2,190	0.70*	–	–	–	–	–	–	–	–
Missouri Assessment Program (MAP) Grade-Level Tests														
MAP – Mathematics	F 15–S 16	SS	2734	0.74*	2224	0.73*	–	–	–	–	–	–	–	–
North Carolina End-of-Grade (NCEOG) Test														
NCEOG	F 05–07	SS	443	0.78*	397	0.71*	–	–	–	–	–	–	–	–
NCEOG	S 14	SS	1,267	0.83*	978	0.73*	–	–	–	–	–	–	–	–
Oklahoma Core Curriculum Test (OCCT)														
OCCT	F 05	SS	74	0.57*	70	0.67*	–	–	–	–	–	–	–	–
Ohio Achievement Assessment														
OAA	F 12	SS	60	0.63*	45	0.49*	–	–	–	–	–	–	–	–
Ohio State Tests (OST)														
OST – Mathematics	F 15–S 16	SS	3029	0.80*	2593	0.76*	–	–	–	–	–	–	–	–
Partnership for Assessment of Readiness for College and Careers (PARCC)														
PARCC	S 15	SS	4,066	0.8*	3,748	0.76*	–	–	–	–	–	–	–	–

Table 55: Predictive Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 7–12[a]

Test Form	Date	Score	7		8		9		10		11		12	
			n	r	n	r	n	r	n	r	n	r	n	r
Pennsylvania System School Assessment (PSSA)														
PSSA – Mathematics	F 14–S 15	SS	532	0.83*	426	0.80*	–	–	–	–	–	–	–	–
South Carolina College-and Career-Ready Assessments (SC READY)														
SC READY – Mathematics	F 15–S 16	SS	1077	0.78*	1041	0.76*	–	–	–	–	–	–	–	–
South Dakota State Test of Educational Progress (DSTEP)														
DSTEP	F 07–09	SS	1,851	0.74*	1,522	0.75*	–	–	–	–	–	–	–	–
Smarter Balanced Assessment (SBA)														
SBA	F 14	SS	569	0.81*	432	0.79*	–	–	–	–	55	0.5	–	–
SBA	W 14	SS	569	0.81*	432	0.77*	–	–	–	–	55	0.59	–	–
SBA	S 15	SS	4,066	0.8*	3,748	0.76*	–	–	–	–	–	–	–	–
STAR Math														
STAR–M	F 01	–	892	0.72*	825	0.78*	–	–	–	–	–	–	–	–
STAR–M	F 05	–	3,551	0.75*	2,693	0.76*	668	0.79*	508	0.79*	572	0.79*	378	0.76*
STAR–M	F 06	–	7,564	0.76*	7,122	0.77*	1,017	0.78*	876	0.76*	693	0.83*	507	0.77*
STAR–M	F 05	–	1,191	0.75*	127	0.84*	215	0.78*	213	0.83*	164	0.75*	–	–
STAR–M	F 05	–	1,191	0.71*	127	0.77*	215	0.78*	213	0.81*	164	0.75*	–	–
STAR–M	S 06	–	1,191	0.79*	127	0.82*	215	0.80*	213	0.85*	164	0.79*	–	–
STAR–M	S 06	–	1,191	0.77*	127	0.82*	215	0.76*	213	0.82*	164	0.77*	–	–
State of Texas Assessments of Academic Readiness Standards Test 2														
STAAR	F 11–12	SS	4,177	0.72*	3,508	0.72*	–	–	–	–	–	–	–	–
STAAR	S 14–15	SS	4,350	0.76*	–	–	–	–	–	–	–	–	–	–
Tennessee Comprehensive Assessment Program (TCAP)														
TCAP	F 12	SS	273	0.80*	169	0.59*	–	–	–	–	–	–	–	–
Texas Assessment of Academic Achievement (TAAS)														
TAAS	F 01	SS	892	0.59*	825	0.67*	–	–	–	–	–	–	–	–
Texas Assessment of Knowledge and Skills (TAKS)														
TAKS	F 02	SS	564	0.74*	562	0.74*	–	–	–	–	–	–	–	–
West Virginia Educational Standards Test 2														
WESTEST 2	F 11	SS	1,437	0.78*	1,377	0.72*	–	–	–	–	–	–	–	–

Table 55: Predictive Validity Data—Star Math Correlation Coefficients (r) with External Tests Administered Between 2002 and 2016, Grades 7–12[a]

Test Form	Date	Score	7		8		9		10		11		12	
			n	r	n	r	n	r	n	r	n	r	n	r
Wisconsin Forward Exam														
WI Forward – Mathematics	F 15–S 16	SS	667	0.74*	635	0.73*	–	–	–	–	–	–	–	–
Wisconsin Knowledge and Concepts Examination (WKCE)														
WKCE	S 05–09	SS	1,883	0.79*	1,742	0.76*	–	–	289	0.76*	–	–	–	–
Summary														
Grade(s)		**All**	**7**		**8**		**9**		**10**		**11**		**12**	
Number of students		160,323	75,876		59,960		7,971		8,708		6,831		977	
Number of coefficients		126	51		46		8		9		9		3	
Average validity		–	0.75		0.74		0.75		0.77		0.72		0.65	
Overall average		0.74												

a. n = Sample size.
* Denotes correlation coefficients that are statistically significant at the 0.05 level.

Relationship of Star Math Scores to Teacher Ratings

In order to have a common measure of each student's math skills independent of Star Math, Renaissance Learning constructed two 12-item checklists for teachers to use during the 2014 norming study.

On this worksheet, teachers were asked to rate each student's ability to complete a wide range of tasks related to developing math skills. The intent of this checklist was to provide teachers with a single, brief instrument they could use to rate any student.

For simplicity, two rating forms were developed: one for grades 1–5, and another for grades 6–12. This section presents the skills rating instrument itself, its psychometric properties as observed in the norming study, and the relationship between student skills ratings on the instrument and their Scaled Scores on Star Math.

The Rating Instruments

To gather ratings of math skills from teachers, these instruments were intended to specify a sequence of skills that the teacher could quickly assess for each student. The skills were ordered such that a student who could correctly perform the nth skill in the list could almost certainly perform all of the preceding skills correctly as well. Such a list, even though quite short, provided a reliable method for sorting students from first through twelfth grade into an ordered set of math skill categories.

To construct the two ratings instruments, nineteen skill-related items were written, ranked from easiest to hardest, and assembled into two rating instruments. The first twelve items—the twelve easiest skills—formed the rating instrument used for grades 1–5. The eighth through nineteenth items—the twelve hardest skills—made up the instrument used for grades 6–12.

Each teacher was asked to dichotomously rate his or her students participating in the Star Math norming study on each skill using the rating form appropriate to the student's grade. To assist with this process, the norming study software incorporated a feature enabling it to print a ratings worksheet for each participating grade. The printed ratings worksheet consisted of a checklist of the twelve skill-related performance tasks, pre-printed with the names of the participating students. To complete the instrument, the teacher had to simply mark, for each student, any task he or she believed the student could perform. The items forming both rating forms are shown on the following page.

Grade 1–5 Math Skills Rating Worksheet

In the table below, please identify which of the following tasks each of your students can probably do correctly.

1. Identify the longest pencil among 3 pencils of different lengths.
2. Add 2 to 4.
3. State how many cents a dime is worth.
4. Determine the number that shows “ones” in 162.
5. Subtract 7 from 35.
6. Determine the number that follows in the sequence 2, 6, 10, 14, _____.
7. Divide 18 by 3.
8. Write 78,318 in expanded form.
9. Read aloud the word name for 0.914.
10. Solve the problem 4/9 + 8/9.
11. Translate the statement “36 divided by a number is 12” into an equation.
12. Divide 11,540 by 577.

Grade 6–12 Math Skills Rating Worksheet

In the table below, please identify which of the following tasks each of your students can probably do correctly.

1. Write 78,318 in expanded form.
2. Read aloud the word name for 0.914.
3. Solve the problem 4/9 + 8/9.
4. Translate the statement “36 divided by a number is 12” into an equation.
5. Divide 11,540 by 577.
6. Solve a word problem requiring the calculation of proportions.
7. Solve the problem “14 is 50% of what number?”
8. Solve a word problem requiring the calculation of 80% of 112.
9. Simplify the expression (x + 1)(x + 4).
10. Solve the equation $x^2 = 16x$.
11. Calculate vertical and supplementary angles.
12. Determine 6^{-2}.

Participating teachers were asked to complete the following rating checklist for all students in their math class:

Student No.	Student Name	Mark an "X" for the tasks that each student probably can do correctly and an "O" for the tasks that each student probably cannot do correctly:												
		1	2	3	4	5	6	7	8	9	10	11	12	Not Rated
1	Bartles, Amanda													
2	Bowers, Erica													
3	Driggon, Haley													
4	Edmond, Mason													
5	Edwards, Robert													
6	Halstead, Matthew													
7	Jackson, Wesley													
8	Kendricks, Marcy													
9	Lyons, Freda													

Psychometric Properties of the Skills Ratings

Teachers completed skills ratings for 17,326 of the 29,185 students in the US norms group. The skills rating items were calibrated on an IRT scale using the Rasch model, with item parameters from both levels placed on a common scale. This allowed the skills ratings for students at both levels to be assigned a score on the same Rasch metric.

The resulting Rasch scores ranged from –14.47 to 11.1. The lower value corresponds to students in grades 1 to 5 rated as possessing none of the math skills, and the higher value corresponds to students in grades 6–12 rated as possessing all of them. Table 56 lists data about the psychometric properties of the rating scale, overall and by grade, including the correlations between skills ratings and Star Math Scaled Scores. The internal consistency reliability of the rating scale was estimated as 0.93, using Cronbach's alpha.

Table 56: Psychometric Characteristics of the Skills Rating Scale and its Relationship to Scaled Scores, by Grade

Grade	N	Skills Rating		STAR Math Scaled Score		Correlation of Skills Ratings and Scaled Scores[a]
		Mean	S.D.	Mean	S.D.	
1	1,916	–6.60	2.95	385	89	0.40*
2	2,043	–3.67	2.41	503	84	0.47*
3	1,817	0.04	3.06	589	87	0.52*
4	1,820	1.26	2.83	651	90	0.58*
5	2,072	2.97	2.84	713	97	0.50*
6	1,637	5.5	2.07	763	100	0.44*
7	1,465	5.57	2.18	785	109	0.50*
8	1,639	6.96	2.5	811	117	0.54*
9	1,036	6.88	2.87	798	110	0.52*
10	688	8.78	2.38	824	119	0.38*
11	737	9.81	2.3	847	123	0.39*
12	456	10.03	2.05	876	127	0.42*
Overall	17,326	2.42	5.6	672	177	0.85*

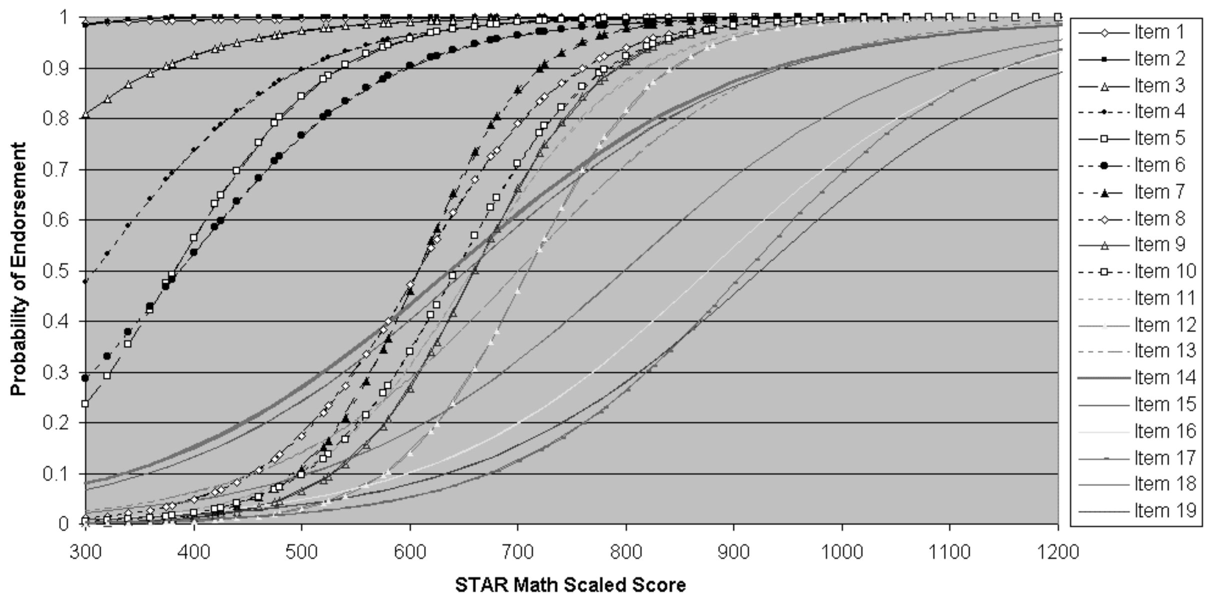
a. Asterisks denote correlation coefficients that are statistically significant at the 0.05 level.

Relationship of Star Math Scaled Scores to Math Skills Ratings

As the data in Table 56 show, the mean ratings increased directly with grade, from 6.6 at grade 1 to 10.03 at grade 12. The correlation between the skills ratings and Star Math Scaled Scores was significant at every grade level. The overall correlation was 0.85, indicating a substantial degree of relationship between the computer-adaptive Star Math test and teachers' ratings of their students' math skills.

Figure 6 displays the relationships of each of the nineteen rating scale items to Star Math Scaled Scores. These relationships were obtained by fitting mathematical models to the response data for each of the rating items. Each of the curves in the figure is a graphical depiction of the respective model. As the curves show, the proportion of students rated as possessing each of the 19 rated skills increases with the Star Math Scaled Score.

Figure 6: The Relationship of Teachers' Ratings of Student Math Skills to Star Math Scaled Scores



The relative positions of the curves provide one indication of the relative difficulty of the 19 rated skills. The rating items' Rasch difficulty parameters, displayed in Table 57, provide a somewhat different indication; the skills rating items are listed in the table from easiest to most difficult, by Rasch difficulty. The first column of Table 57 indicates the relative difficulty of the nineteen rating items, where relative difficulty 1 is the easiest and 19 is most difficult. The second and third columns list the item numbers and text of the skills rating items. The fourth column lists the Rasch difficulty scale value for each item.

The fifth column lists the correlations between students' ratings and their Star Math Scaled Scores.

Table 57: The Nineteen Rating Scale Items Listed in Order of Difficulty with Rasch Difficulty Parameters

Relative Difficulty	Item	Rating Scale Item	Rasch Difficulty	Correlation with Scaled Score[a]
Easiest	1	Identify the longest pencil among 3 pencils of different lengths.	–14.58	0.06*
↓	2	Add 2 to 4.	–14.30	0.09*
	3	State how many cents a dime is worth.	–10.28	0.26*
	4	Determine the number that shows "ones" in 162.	–7.26	0.43*
	5	Subtract 7 from 35.	–6.12	0.55*
	6	Determine the number that follows in the sequence 2, 6, 10, 14, _____.	–5.42	0.49*
	7	Divide 18 by 3.	–1.85	0.71*
	8	Write 78,318 in expanded form.	1.22	0.67*
	10	Solve the problem 4/9 + 8/9.	2.09	0.70*
	9	Read aloud the word name for 0.914.	2.51	0.70*
	11	Translate the statement "36 divided by a number is 12" into an equation.	2.59	0.67*
	12	Divide 11,540 by 577.	3.89	0.68*
	14	Solve the problem "14 is 50% of what number?"	4.54	0.40*
	15	Solve a word problem requiring the calculation of 80% of 112.	4.75	0.34*
	13	Solve a word problem requiring the calculation of proportions.	5.12	0.35*
	18	Calculate vertical and supplementary angles.	6.85	0.35*
	16	Simplify the expression (x + 1)(x + 4).	8.1	0.37*
↓	19	Determine 6^{-2}	9.03	0.36*
Most Difficult	17	Solve the equation $x^2 = 16x$.	9.12	0.33*

a. Asterisks denote correlation coefficients that are statistically significant at the 0.05 level.

Notice that the first two rating scale items ("Identify the longest pencil among 3 pencils of different lengths" and "Add 2 to 4") had extremely low Rasch difficulty indices, and correlations with Scaled Scores that were near zero. As can be seen in Figure 6, these items were endorsed for nearly 100% of the students, regardless of their Star Math Scaled Scores.

As a result, they did not discriminate among students with high and low levels of developed math ability, as measured by the Star Math test.

Although teachers endorsed items 3–6 somewhat less often than items 1 and 2, they still considered these math tasks relatively easy for their students to complete. The correlations with Star Math Scaled Scores for items 3–6 were higher than those for the first two items, but still only moderate. This may have occurred because the skills associated with items 3–6 are almost completely mastered (defined as 80% proficiency) by a student obtaining a Star Math Scaled Score of 500.

Teachers' responses to items 7–12 suggest that their corresponding math tasks are considerably more difficult for their students to complete. This is reflected both in their Rasch difficulty parameters in Table 57 and in Figure 6. The figure suggests that mastery of these skills occurs between 700 and 800 on the Star Math Score Scale. The slopes of the curves for these are all steep relative to other skills items, suggesting that these skills develop rapidly, compared to the others. The correlations between these items and Scaled Scores support this hypothesis, as items 7–12 show the highest correlations with Star Math Scaled Scores.

Items 13–19 measure the most difficult of the skills. This is indicated by their Rasch difficulty parameters in Table 57 and is also confirmed by the locations at which 80% mastery occurs, illustrated in Figure 6, which suggests that these skills develop much later than all others. In fact, all students may not master these skills. Moreover, all of these items have only moderate correlations with Star Math Scaled Scores, suggesting that growth of these skills is relatively gradual.

Linking Star and State Assessments: Comparing Student- and School-Level Data

With an increasingly large emphasis on end-of-the-year summative state tests, many educators seek out informative and efficient means of gauging student performance on state standards—especially those hoping to make instructional decisions before the year-end assessment date.

For many teachers, this is an informal process in which classroom assessments are used to monitor student performance on state standards. While this may be helpful, such assessments may be technically inadequate when compared to more standardized measures of student performance. Recently the assessment scale associated with Star Math has been linked to the scales used for summative mathematics tests in nearly every state in the US. Linking Star Math assessments to state tests allows educators to reliably predict student performance on their state assessment using Star Math scores. More specifically, it places teachers in a position to identify

- which students are on track to succeed on the year-end summative state test, and
- which students might need additional assistance to reach proficiency.

Educators using Star Math assessments can access Star Performance Reports that allow access to students' Pathway to Proficiency. These reports indicate whether individual students or groups of students (by class, grade, or demographic characteristics) are likely to be on track to meet a particular state's criteria for mathematics proficiency. In other words, these reports allow instructors to evaluate student progress toward proficiency and make data-based instructional decisions well in advance of the annual state tests. Additional reports automatically generated by Star Math help educators screen for later difficulties and progress monitor students' responsiveness to interventions.

An overview of two methodologies used for linking Star Math to state assessments is provided in the following sections.

Methodology Comparison

Renaissance Learning has developed linkages between Star Math Scaled Scores and scores on the accountability tests of most states. Depending on the kind of data available for such linking, these linkages have been accomplished using one of two different methods. One method used student-level data, where both Star and state test scores were available for the same students. The other method used school-level data; this method was applied when approximately 100% of students in a school had taken Star Math, but individual students' state test scores were not available.

Student-Level Data

Using individual data to link scores between distinct assessments is commonly used when student-level data are readily available for both assessments. In this case, the distribution of standardized scores on one test (e.g. percentile ranks) may be compared to the distribution of standardized scores on another test in an effort to establish concordance. When available, individual state test data for linking purposes allowed for the comparison of Star assessments to state test scores. Star test comparison scores were obtained within an eight-week window around the median state test date (+/–4 weeks).

Typically, states classify students into one of three, four, or five performance levels on the basis of cut scores (e.g. Below Basic, Basic, Proficient, or

Advanced). After each testing period, a distribution of students falling into each of these categories will always exist (e.g. 30% in Basic, 25% in Proficient, etc.). Because Star data were available for the same students who completed the state test, the distributions could be linked via equipercentile linking analysis (see Kolen & Brennan, 2004) to scores on the state test. This process creates tables of approximately equivalent scores on each assessment, allowing for the lookup of Star scale scores that correspond to the cut scores for different performance levels on the state test. For example, if 20% of students were "Below Basic" on the state test, the lowest Star cut score would be set at a score that partitioned only the lowest 20% of scores.

School-Level Data

While using student-level data is still common, obstacles associated with individual data often lead to a difficult and time-consuming process of obtaining and analyzing data. In light of the time-sensitive needs of schools, obtaining student-level data is not always an option. As an alternative, school-level data may be used in a similar manner. These data are publicly available, thus making the linking process more efficient.

School-level data were analyzed for some of the states included in the student-level linking analysis. In an effort to increase sample size, the school-level data presented here represent "projected" Scaled Scores. Each Star score was projected to the mid-point of the state test administrations window using decile-based growth norms. The growth norms are both grade- and subject-specific and are based on the growth patterns of more than one million students using Star assessments over a three-year period. Again, the linking process used for school-level data is very similar to the previously described process—the distribution of state test scores is compared to projected Star scores and using the observed distribution of state-test scores, equivalent cut scores are created for the Star assessments (the key difference being that these comparisons are made at the group level).

Accuracy Comparisons

Accuracy comparisons between student- and school-level data are particularly important given the marked resource differences between the two methods. These comparisons are presented for three states[1] in Table 58, Table 59, and Table 60. With few exceptions, results of linking using school-level data were

1. Data were available for Arkansas, Florida, Idaho, Kansas, Kentucky, Mississippi, North Carolina, South Dakota, and Wisconsin; however, only North Carolina, Mississippi, and Kentucky are included in the current analysis.

nearly identical to student-level data on measures of specificity, sensitivity, and overall accuracy. McLaughlin and Bandeira de Mello (2002) employed similar methods in their comparison of NAEP scores and state assessment results, and this method has been used several times since then (McLaughlin & Bandeira de Mello, 2003; Bandeira de Mello, Blankenship, & McLaughlin, 2009; Bandeira et al., 2008).

In a similar comparison study using group-level data, Cronin et al. (2007) observed cut score estimates comparable to those requiring student-level data.

Table 58: Number of Students Included in Student-Level and School-Level Linking Analyses by State, Grade, and Subject

State	Grade	Math	
		Student	School
NC	3	1,100	524
	4	751	890
	5	482	551
	6	202	515
	7	216	67
	8	39	372
MS	3	1,786	4,309
	4	1,757	4,584
	5	1,531	5,294
	6	1,180	5,190
	7	721	3,390
	8	549	1,896
KY	3	3,777	935
	4	3,155	1,797
	5	2,228	1,430
	6	1,785	1,497
	7	788	984
	8	362	1,036

Table 59: Comparison of School Level and Student Level Classification Diagnostics for Mathematics

State	Grade	Sensitivity[a]		Specificity[b]		False + Rate[c]		False – Rate[d]		Overall Rate	
		Student	School	Student	School	Student	School	Student	School	Student	School
NC	3	92%	81%	53%	73%	47%	27%	8%	19%	80%	78%
	4	90%	78%	52%	73%	48%	27%	10%	22%	80%	78%
	5	83%	83%	62%	57%	38%	43%	17%	17%	75%	74%
	6	94%	87%	42%	65%	58%	35%	6%	13%	74%	83%
	7	91%	88%	61%	69%	39%	31%	9%	12%	81%	84%
	8	89%	77%	58%	76%	42%	24%	11%	23%	77%	77%
MS	3	78%	70%	77%	83%	23%	17%	22%	30%	77%	76%
	4	73%	73%	81%	81%	19%	19%	27%	27%	77%	77%
	5	71%	68%	83%	84%	17%	16%	29%	32%	77%	76%
	6	71%	66%	81%	85%	19%	15%	29%	34%	76%	76%
	7	83%	84%	82%	81%	18%	19%	17%	16%	83%	83%
	8	56%	66%	89%	83%	11%	17%	44%	34%	76%	76%
KY	3	95%	92%	45%	54%	55%	46%	5%	8%	83%	83%
	4	92%	87%	47%	60%	53%	40%	8%	13%	80%	80%
	5	90%	90%	51%	50%	49%	50%	10%	10%	77%	77%
	6	82%	80%	64%	68%	36%	32%	18%	20%	75%	75%
	7	72%	68%	81%	85%	19%	15%	28%	32%	76%	76%
	8	59%	66%	89%	85%	11%	15%	41%	34%	74%	76%

a. Sensitivity refers to the proportion of correct positive predictions.
b. Specificity refers to the proportion of negatives that are correctly identified (e.g. student will not meet a particular cut score)
c. False + rate refers to the proportion of students incorrectly identified as “at-risk.”
d. False – rate refers to the proportion of students incorrectly identified as not “at-risk.”

Table 60: Comparison of Differences Between Achieved ad Forecasted Performance Levels in Math (Forecast % – Achieved %)

State	Grade	Student	School	Student	School	Student	School	Student	School
NC		Level I		Level II		Level III		Level IV	
	3	−2.6%	−1.6%	−2.8%	0.80%	15.60%	2.10%	−10.2%	−1.3%
	4	−4.0%	−0.4%	−2.5%	1.20%	14.70%	1.50%	−8.2%	−2.3%
	5	−2.7%	−0.9%	1.60%	−3.9%	10.00%	11.60%	−8.9%	−6.7%
	6	−7.3%	−5.3%	−8.2%	−4.5%	18.60%	7.10%	−3.1%	2.70%
	7	−1.3%	−0.6%	−5.0%	−1.1%	15.10%	1.10%	−8.8%	0.60%
	8	−4.2%	−4.4%	−5.6%	−2.9%	2.50%	−1.2%	7.40%	8.60%
MS		Minimal		Basic		Proficient		Advanced	
	3	2.70%	10.10%	0.00%	0.20%	1.10%	−15.0%	−3.9%	4.60%
	4	1.50%	9.90%	4.40%	−3.4%	−3.7%	−10.7%	−2.1%	4.20%
	5	0.80%	9.40%	5.30%	−1.0%	−3.5%	−11.3%	−2.7%	2.80%
	6	4.70%	12.60%	−0.8%	−4.3%	−1.8%	−11.6%	−2.1%	3.30%
	7	0.70%	2.80%	−0.5%	−3.7%	0.00%	−1.8%	−0.2%	2.80%
	8	5.80%	7.00%	4.60%	−4.4%	−9.9%	−4.1%	−0.5%	1.50%
KY		Novice		Apprentice		Proficient		Distinguished	
	3	−3.2%	−2.0%	−4.8%	−2.6%	12.10%	3.30%	−4.0%	1.40%
	4	−4.1%	−2.7%	−3.9%	1.00%	5.60%	1.60%	2.40%	0.10%
	5	−3.7%	−0.2%	−5.4%	−9.7%	11.40%	8.40%	−2.3%	1.60%
	6	−3.9%	−0.4%	0.10%	−0.5%	5.80%	0.50%	−2.1%	0.20%
	7	−1.9%	7.10%	10.50%	3.60%	1.20%	−3.0%	−9.6%	−7.5%
	8	1.50%	4.30%	13.80%	4.90%	−5.0%	−1.9%	−10.2%	−7.3%

References

Allington, R., & McGill-Franzen, A. (2003). Use students' summer-setback months to raise minority achievement. *Education Digest,* 69(3), 19–24.

Alonzo, A. C., & Gearhart, M. (2006). Considering learning progressions from a classroom assessment perspective. *Measurement, 14*(1 & 2), 99–104.

Bandeira de Mello, V., Blankenship, C., & McLaughlin, D. H. (2009). *Mapping state proficiency standards onto NAEP Scales: 2005–2007* (NCES 2010-456). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Betebenner, D. W. (2009). Norm- and criterion-referenced student growth. *Educational Measurement: Issues and Practice, 28*(4), 42–51.

Betebenner, D. W. (2010). New directions for student growth models. Retrieved from the National Network of State Teachers of the Year (NNSTOY) website: https://www.nnstoy.org/download/evalution/LinkClick%20Betebenner.pdf

Betebenner, D. W., & Iwaarden, A. V. (2011a). SGP: An R package for the calculation and visualization of student growth percentiles [Computer Software manual]. (R package version 0.4-0.0 available at http://cran.r-project.org/web/packages/SGP/)

Betebenner, D. W. (2011b). A technical overview of the student growth percentile methodology: Student growth percentiles and percentile growth trajectories/projections. The National Center for the Improvement of Educational Assessment. Retrieved from http://www.nj.gov/education/njsmart/performance/SGP_Technical_Overview.pdf

Bock, R. D., Thissen, D., & Zimowski, M. F. (1997). IRT estimation of domain scores. *Journal of Educational Measurement, 34,* 197–211.

Bracey, G. (2002). Summer loss: The phenomenon no one wants to deal with. *Phi Delta Kappan, 84*(1), 12–13.

Corcoran, T., Mosher, F. A., & Rogat, A. (2009). *Learning progressions in science: An evidence-based approach to reform of teaching.* (CPRE Research Report # RR-63). New York: Consortium for Policy Research.

Cormier, D. & Bulut, O. (Manuscript under review.) Using computer-adaptive tests to monitor student progress: optimal slope estimates, administration frequency, and data points.

Cronin, J., Kingsbury, G. G., Dahlin, M., & Bowe, B. (2007). *Alternate methodologies for estimating state standards on a widely used computer adaptive test.* Paper presented at the American Educational Research Association, Chicago, IL.

Deno, S. (2003). Developments in curriculum-based measurement. *Journal of Special Education, 37*(3), 184–192.

Fuchs, D., & Fuchs, L. S. (2006). Introduction to Response to Intervention: What, why, and how valid is it? *Reading Research Quarterly, 41*(1), 93–99.

Hedges, L. V., & Olkin, I. (1985). *Statistical methods for meta-analysis.* Orlando, FL: Academic Press.

Heritage, M. (2008). *Learning progressions: Supporting instruction and formative assessment.* Washington, DC: Chief Council of State School Officers.

Holland, P. W., & Thayer, D. T. (1988). Differential item functioning and the Mantel-Haenszel procedure. In H. Wainer & H. I. Braun (Eds.), *Test validity* (pp. 129–145). Hillsdale, NJ: Lawrence Erlbaum.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling,* 6, 1–55.

Jodoin, M. G., & Gierl, M. J. (2001). Evaluating Type I Error and Power Rates Using an Effect Size Measure with the Logistic Regression Procedure for DIF Detection. *Applied Measurement in Education,* 14, 329–349.

Kolen, M., & Brennan, R. (2004). *Test equating, scaling, and linking* (2nd ed.). New York: Springer.

Leahy, S., & Wiliam, D. (2011). *Devising learning progressions assessment.* Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA.

McLaughlin, D. H., & Bandeira de Mello, V. (2002). *Comparison of state elementary school mathematics achievement standards using NAEP 2000.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

McLaughlin, D. H., & Bandeira de Mello, V. (2003). *Comparing state reading and math performance standards using NAEP.* Paper presented at the National Conference on Large-Scale Assessment, San Antonio, TX.

McLaughlin, D. H., Bandeira de Mello, V., Blankenship, C., Chaney, K., Esra, P., Hikawa, H., et al. (2008). *Comparison between NAEP and state reading* *assessment results: 2003* (NCES 2008-474). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics.

Market Data Retrieval. (2001). A D&B Company: Shelton, CT.

MetaMetrics, Inc. (2004). *The Quantile Framework for Mathematics: Overview*. Durham, NC: Author.

MetaMetrics, Inc. (2019). *Linking the Renaissance Star Assessments™ for Math with the Quantile Framework® for Mathematics.* Durham, NC: Author, February 2019.

MetaMetrics, Inc. (2015). *The Quantile Framework for Mathematics: Quantile Development and Validation.* Durham, NC: Author.

Monaghan, W. (2006). The facts about subscores (ETS R&D Connections No. 4). Princeton, NJ: Educational Testing Services. Available online: http://www.ets.org/Media/Research/pdf/RD_Connections4.pdf.

Nagelkerke, N. J. D. (1991). A note on a general definition of the coefficient of determination. *Biometrika,* 78, 691–692.

National Council of Teachers of Mathematics. (2006). *Curriculum focal points for prekindergarten through grade 8 mathematics.* Reston, VA.

National Mathematics Advisory Panel. (2008). *Foundations for success: The final report of the National Mathematics Advisory Panel.* Washington, DC: U.S. Department of Education. Available online: http://www.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf.

Neter, J., Kutner, M., Nachtsheim, C., & Wasserman, W. (1996). *Applied linear statistical models* (4th ed.). New York: WCB McGraw-Hill.

Owen, R. J. (1969) A Bayesian approach to tailored testing. *Research Bulletin 69-92*. Princeton, N. J.: Educational Testing Service.

Owen, R. J. (1975) A Bayesian sequential procedure for quantal response in the context of adaptive mental testing. *Journal of the American Statistical Association,* 70, 351–356.

Pepe M. S., Janes, H., Longton, G. Leisenring, W., & Newcomb, P. (2004). Limitations of the odds ratio in gauging the performance of a diagnostic, prognostic, or screening marker. *American Journal of Epidemiology, 159,* 882–890.

Petersen, N.S., Kolen, M.J., & Hoover, H.D. (1989). Scaling, Norming, and Equating. In R.L. Linn (Ed.), *Educational Measurement* (3rd ed. pp. 221–

262). New York: American Council on Education and Macmillan Publishing Company.

Popham, W. J. (2007). The lowdown on learning progressions. *Educational Leadership, 64*(7), 83–84.

Rogers, H. J., & Swaminathan, H. (1993). A comparison of the logistic regression and Mantel-Haenszel procedures for detecting differential item functioning. *Applied Psychological Measurement,* 17, 105–116.

Rudner, L. M. (2001). Computing the expected proportions of misclassified examinees. *Practical Assessment Research & Evaluation, 7(14)*.

Rudner, L. M. (2005). Expected classification accuracy. *Practical Assessment Research & Evaluation, 10(13)*.

Skoupski, W.P., & Carvajal, J. (2010). A comparison of approaches for improving the reliability of objective scores. *Educational and Psychological Measurement, 70*(3), 357–375.

Swaminathan, H., & Rogers, H. J. (1990). Detecting differential item functioning using logistic regression procedures. Journal of Educational Measurement, 27, 361–370.

Swaminathan, H. (1994). Differential item functioning: A discussion. In Dany Laveault, Bruno D. Zumbo, Marc E. Gessaroli, and Marvin W. Boss (Eds.), *Modern Theories of Measurement: Problems and Issues.* Ottawa, Canada: University of Ottawa.

Urry, V. W. (1975). *The effects of guessing on parameters of item discriminatory power.* TN 75-2. Washington DC: Personnel Research and Development Center, US Civil Service Commission, May.

VanDerHeyden, A., & Burns, M. (2008). Examination of the Utility of Various Measures of Mathematics Proficiency. *Assessment for Effective Intervention, 33*(4), 215–224.

Wyse, A. E., & Hao, S. (2012). An evaluation of item response theory classification accuracy and consistency indices. *Applied Psychological Measurement, 36(7)*, 602–624.

Zhou, X. H., Obuchowski, N. A., & Obushcowski, D. M. (2002). *Statistical methods in diagnostic medicine.* Wiley & Sons: New York.

Zumbo, B. (2007). Three generations of differential item functioning (DIF) analyses: Considering where it has been, where it is now, and where it is going. *Language Assessment Quarterly, 4,* 223–233.

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About Renaissance

Renaissance® transforms data about how students learn into instruments of empowerment for classroom teachers, enabling them to guide all students to achieve their full potentials. Through smart, data-driven educational technology solutions that amplify teachers' effectiveness, Renaissance helps teachers teach better, students learn better, and school administrators lead better. By supporting teachers in the classroom but not supplanting them, Renaissance solutions deliver tight learning feedback loops: between teachers and students, between assessment of skills mastery and the resources to spur progress, and between each student's current skills and future academic growth.

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