Interim Assessments

iMSSA: An Overview of New Mexico's Interim Assessments

COGNIA ASSESSMENTS

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Introduction

Future Readiness: The Assessment Challenge

Educators and measurement specialists have expanded their expectations of how assessment informs learning, based in part on complex critical thinking standards, new emphases on whole child awareness and the desire for a balanced assessment system.

At the same time, the issue of testing time remains prominent in professional and public awareness. So time spent testing must be worthwhile. This means using better, more informative assessments, while spending less time testing students.

As Cognia™ explored the implications of these issues and the widely adopted college and career readiness standards similar to the Common Core State Standards (CCSS) in English language arts and mathematics, it was clear that educators seek timely, targeted instructional information at the classroom and school levels, as well as effective, meaningful data for decision making at a system level. Our goal was to create a program that could use the least amount of time to provide the most information possible. To accomplish that goal, we created test designs and test items (questions) that assess the standards with an appropriate level of rigor and complexity, use time efficiently, and deliver meaningful results.

The Cognia Solution

The iMSSA interim assessments are vertically articulated achievement tests that measure student knowledge and growth in reading, language usage, and mathematics across grades 3–8. Vertically articulated test content builds upon previous-grade content, based on the subject and grade-level content standards. This design approach ensures that both student experiences and the interpretation of the resulting outcomes are coherent and consistent.

The assessments provide information about students' current level of achievement as well as their growth toward college and career readiness. Readiness for university and careers begins with early learning. As students progress through their elementary and secondary school years, skills and knowledge build on each other. Cognia test designs reflect those learning progressions.

The assessments were developed using evidence-centered design (ECD) principles. We began development by asking the question "What do we want the results of the assessment to be able to say about students' academic progress toward readiness for college and careers?" Each decision, from how to assess each content standard, to test design and development, to score reports, was made with this question in mind. At the same time, we aimed to create test designs that deliver meaningful results to educators, while being sensitive to testing time.

The iMSSA assessments include three equivalent and interchangeable forms per year, available for beginning-of-year, mid-year, and end-of-year administrations. Scores from iMSSA provide reliable and valid information about whether students have achieved end-of-year grade-level standards as defined by Common Core State Standards (CCSS) and by extension, provide insight into college and career readiness. iMSSA items are developed to assess standards similar to the Common Core State Standards. None of the content is retrofitted or back-aligned; the test items are consistent with the instruction students experience in their classrooms. Scores from iMSSA help educators:

- Assess whether students are making progress toward academic readiness for college and careers
- Plan instruction using interim score profiles
- Measure learning and growth within a grade across grades
- Make decisions about program effectiveness

Cognia follows principled processes for test design, development, scoring, and psychometric analyses to create assessments of the strongest technical quality.

Test Design

The iMSSA assessments consist of items that measure a range of knowledge and skills related to academic success leading up to high school, in high school, and beyond. These assessments are completely machine-scored, which shortens the time between testing and reporting. Item types include multiple-choice, multiple-select, and evidence-based selected-response.

iMSSA reports provide reliable scores regarding students' learning, related to each of the reading, language usage, and mathematics claims.

iMSSA assessments measure challenging academic standards. The estimates for the duration of each test session include time for students to read longer texts, to think about questions and problems, and to generate solutions or answers before selecting a choice.

Figure 1 provides information about item types, numbers of items, and approximate testing times for iMSSA assessments. Each subject-area assessment is divided into two sections to allow ample time for students to think and respond. The two sections for each subject area can be administered sequentially or at separate times for scheduling flexibility. The number of items in each subject-area test varies by grade; depending on subject area and grade, sections take between 20 and 35 minutes.

Note that the tests are intended to be untimed to allow students to do their best work; the times listed reflect estimates of the amounts of time most students across grade levels will need to complete the tests.

Content Area	MC/MS	EBSR	Number of Items	Approximate Testing Time per Content Area
Reading	14–16	2–3	17–18	50–60 minutes
Language Usage	20	3	23	35–40 minutes
Mathematics	32–37		32–37	55–65 minutes

MC = Multiple-choice
MS = Multiple-select
EBSR = Evidence-based select-response

Figure 1: iMSSA Item Types, Numbers of Items, and Testing Time

Intended Score Interpretations and Use

Cognia worked with educators and school leaders to identify their intended interpretations and uses of scores for these assessments. We then created the test design and blueprints to gather the appropriate evidence to support those uses. For iMSSA, the intended score interpretations and uses are operationalized as claims. Activities and decisions in all aspects of the test design, development, and implementation process represent claims and are documented throughout this *Technical Bulletin*. The collection of validity evidence to support interpretation and use is ongoing and central to the design and development of iMSSA assessments. The purpose of gathering validity evidence for an assessment "is to provide an overall evaluation of the intended interpretations and uses of test scores by generating a coherent analysis of all of the evidence for and against the proposed interpretation/use, and to the extent possible, the evidence relevant to plausible alternate interpretations and decision procedures"[1].

iMSSA assessments provide a direct predictive link to the score scale of the SAT® Suite of Assessments from the College Board®. At grade 8, student results include a predicted score on the College Board's PSAT™. Total test scores and achievement levels from iMSSA enable users to determine if students are "on track" or "not on track" by grade 8 to reach the College and Career Readiness Benchmark as defined by the PSAT 8/9 link. At each grade level prior to grade 8, using a learning progressions approach, iMSSA overall scale scores and achievement levels enable users to determine if students have appropriately mastered content for the current grade of instruction. What evidence, then, is required to support this claim?

Five activities generated the needed evidence.

1. The College Board conducted a concordance study between the iMSSA and the PSAT 8/9 to establish a link between scores on the grade 8 Cognia test and PSAT 8/9. (See PSAT Linking Study, p. 20.)
2. Using these concorded scores, the iMSSA scale score associated with the PSAT 8/9 College and Career Readiness Benchmark was determined, with the result that iMSSA scale scores provide indicators of readiness for university, college and career.
3. The iMSSA grade 8 cut points corresponding to PSAT 8/9 College and Career Readiness Benchmarks were identified. These values were then cascaded backwards to determine baseline proficiency at each grade level. The Item-Descriptor Matching standard-setting method was then employed to set the final cut points, which indicate if students are "on track" to achieve college and career readiness by grade 8.
4. Estimates of ability at each achievement level were defined and were closely examined against item difficulties to validate the coherence between them, and to assure that the estimates had a logical relationship to the curriculum frameworks.
5. Impact data were examined across grades to ensure reasonable distributions of students across achievement levels.

[1] Kane, M. T. Validation. In R. L. Brennan (Ed.), Educational Measurement. Washington, DC: The National Council on Measurement in Education & the American Council on Education, 2006, pp. 17–64.

College and Career Readiness Standards, iMSSA, and Claims

iMSSA assessments are aligned to college and career readiness standards (CCR) for reading, writing and language, and mathematics, which are based on those authored by the National Governors' Association (NGA) and the Council of Chief State School Officers (CCSSO). These standards also align with many states' college and career readiness standards and are similar to the Common Core State Standards (CCSS). They reflect research on what knowledge, skills, and conceptual understanding best support students' achievement in high school and beyond. Appendix A describes the research basis for our adoption of the college and career readiness standards.

Cognia adopted its CCR content standards for reading, writing and language, and mathematics in 2013. Each item, all passages for reading and for language usage, and all mathematics stimuli for iMSSA were developed since then. This content is carefully designed to draw out targeted conceptual understandings and/or skills aligned to the standards. We developed the test design and each item with the end goal in mind—to paint a valid picture of students' academic progress toward readiness for high school and beyond. The assessments enable educators to make meaningful inferences about students' achievements from test scores.

iMSSA items, passages for reading and for language usage, and stimuli represent a range of task difficulty so that most students can respond successfully to some items and also experience an appropriate level of challenge. Students are given sufficient opportunity to demonstrate their knowledge and skills, ensuring that reported scores are reliable.

Reading

Reading Standards

The CCR standards for reading reflect contemporary research on the reading skills and strategies students must have in order to be prepared for high school and beyond (See Appendix A). The reading standards focus on students' abilities to comprehend, analyze, and interpret complex literary and informational texts. Young children learn to read primarily through stories and narratives; however, as students grow, more and more of what they read in school involves informational texts in social studies, science, and mathematics. To read informational texts requires complex word-attack skills, a broad academic vocabulary, and the ability to integrate ideas from graphics, timelines, images, and other media with written text.

Reading Assessments

iMSSA reading assessments use texts that represent the level of challenge and range of text complexity seen in English language arts, social studies, and science coursework. Passages are evaluated quantitatively through multiple text complexity metrics, and qualitatively for complexity and grade-level appropriateness. (The text complexity rubric we use to evaluate passages is provided in Appendix B.)

The assessments include both literary and informational texts. Assessments for grades 3–5 have a stronger focus on literary texts, and those for grades 6–8 have a stronger focus on informational texts.

Analyses and interpretations of text must be grounded in the text; therefore, iMSSA reading assessments include evidence-based items. Test items ask students to comprehend central ideas or themes and supporting details. Test items also ask students to analyze and interpret texts.

Reading Claims

iMSSA reading assessments are designed to provide reliable and valid scores for two aspects of reading: comprehension and analysis and interpretation of complex texts. Figure 2 presents the claims for the meaning of scores from iMSSA reading assessments.

Subscore	**Reading Claims** For these subscores, students who are At/Near Standard or Above Standard can:
Literary Text	• Independently and proficiently read, comprehend, analyze, and interpret grade-level appropriate literary text. Apply reading skills and strategies to enhance enjoyment and understanding of literary text, and use evidence from texts to support their analyses, interpretations, and conclusions. • Comprehend and analyze themes and important supporting details, interpret characters' motivations and actions, and analyze characters' development. • Determine the meaning of new and unfamiliar vocabulary words and evaluate an author's use of literary devices to create effects. • Analyze the structure of texts; identify and evaluate connections between events, characters, and ideas; and compare and contrast story elements and authors' treatments in two texts.
Informational Text	• Independently and proficiently read, comprehend, analyze, and interpret grade-level appropriate informational text. Apply reading skills and strategies to understand and learn from informational text, and use evidence from texts to support their analyses, interpretations, and conclusions. • Comprehend and analyze main ideas and important details and interpret an author's purpose, claims, and evidence. • Determine the meaning of new and unfamiliar vocabulary words, analyze how authors use text features and structures to communicate meaning, and interpret graphical representations of information. • Compare and contrast authors' presentations of information, arguments, and evidence in two texts.
Comprehension	• Apply reading skills and strategies to read and comprehend central ideas and themes, identify supporting details, and determine the meaning of words and phrases in grade-level appropriate literary and informational text.
Analysis and Interpretation	• Apply reading skills and strategies to grade-level appropriate literary and informational text in order to analyze how ideas, events, and characters are presented; examine relationships among elements of texts; interpret authors' themes, purposes, claims, and evidence; determine and evaluate points of view; determine the meaning of figurative and connotative language. • Analyze authors' word choice; compare and contrast the information and authors' methods in two texts; make inferences; and draw conclusions using evidence from the texts to support their interpretations and analyses.

Figure 2: Claims about the Meaning of iMSSA Reading Assessment Scores

Language Usage

Writing and Language Standards

The CCR standards for writing and language reflect current research on what students must know and be able to do to be effective writers (see Appendix A). Students must write for many purposes. These skills include the ability to select appropriate content, organize ideas, and use appropriate English language conventions. Students in grades 3–5 generally write narratives and reports. By middle school, students write in nearly all of their courses—including science and social studies—and primarily to inform. As students move into high school and college, they must develop written arguments—supporting claims with evidence, whether the evidence is from literary, historical, or scientific sources. The writing and language standards reflect the knowledge and skills necessary for students to be successful in these writing activities.

Language Usage Assessments

iMSSA language usage assessments assess whether students can evaluate and identify needed improvements for written works. Items in grades 3–5 involve analysis of narrative and expository writing; items in grades 6–8 involve analysis of expository and argument writing. Items related to writing analysis assess students' ability to identify ways to improve the content and organization of written pieces (e.g., adding/removing details, revising and reorganizing content).

Items related to English language and conventions assess their ability to improve the technical quality of writing through the improvement of language use (grammar and vocabulary) and language conventions (e.g., capitalization and punctuation).

Language Usage Claims

The iMSSA language usage assessments were designed to provide reliable and valid scores related to students' abilities to analyze writing (writing analysis) and evaluate English language usage and writing conventions (English language and conventions) in relation to written narratives, informational text, and text-based arguments.

Figure 3 presents the claims for the meaning of scores from iMSSA language usage assessments.

Subscore	**Language Usage Claims** For these subscores, students who are At/Near Standard or Above Standard can:
Narrative Writing Analysis (Grades 3–5)	Analyze the effectiveness of written narratives and identify improvements needed for sequence of events, use of transitional language, use of descriptive details, character development, use of dialogue, and consistent narrative style. (Grades 3–5)
Expository Writing Analysis (Grades 3–8)	Analyze the effectiveness of expository or informational writing and identify improvements to logical organization, supporting facts and details, clarity of purpose, cause-and-effect relationships, and consistent informational writing style and tone. (Grades 3–8)
Argument Writing Analysis (Grades 6–8)	Analyze the effectiveness of written arguments and identify improvements in the clarity of a focus or claim, supporting arguments and evidence, logical organization, maintenance of a formal writing style and tone, and use of language to convince or persuade. (Grades 6–8)
English Language and Conventions (Grades 3–8)	Evaluate written narrative, expository, and argument writing and identify improvements needed in grammar and vocabulary; and in language usage and precision, spelling, punctuation, and capitalization. (Grades 3–8)

Figure 3: Claims about the Meaning of iMSSA Language Usage Assessment Scores

Mathematics

Mathematics Standards

The CCR standards for mathematics reflect current research on the underlying cognitive skills necessary for success in mathematics. (See Appendix A.) Researchers have found that mathematical proficiency depends upon more than conceptual understanding and procedural skill. Many problem-solving and reasoning skills underpin successful mathematical learning. Readiness for high school and beyond depends on students' abilities to understand and apply mathematical concepts and procedures, as well as to use important mathematical skills such as problem solving, reasoning, and the use of mathematical models to represent and solve problems.

The standards for mathematics are built on mathematical learning progressions.

- Standards for grades 3–5 focus on understanding and applying operations with whole numbers and fractions; early algebraic reasoning skills; and basic measurement, geometric, and data analysis skills.
- Standards for grades 6–8 focus on rational numbers, algebraic thinking, proportional reasoning, and initial understanding of numeric functions.

The CCR standards for mathematics also include mathematical practices such as problem-solving, quantitative reasoning, modeling, and using mathematical patterns and structures.

Mathematics Assessments

iMSSA mathematics assessments evaluate mathematics concepts and procedures as well as mathematical practices (problem solving; logical and quantitative reasoning, including the evaluation of the arguments of others; modeling; and patterns and structure). Within concepts and procedures, the tests assess mathematical domains that reflect important learning progressions in mathematics. For grades 3–5, the tests assess operations and algebraic thinking, whole number concepts and operations, fraction concepts and operations, measurement and data, and geometry. For grades 6–8, the tests assess ratios and proportional relationships (grades 6 and 7) and functions (grade 8), the rational number system, algebraic expressions and equations, geometry, and statistics and probability.

iMSSA mathematics assessments integrate assessment of mathematical practices with that of the mathematical content domains. Many of the mathematics concepts and procedures standards were written to ensure that students will apply one or more mathematical practices to demonstrate mastery of the standard. In addition, overarching practices require integration and application of mathematical concepts and procedures in real-world and mathematical contexts. For example, mathematical modeling is applied in theoretical mathematics as well as in the social sciences, earth and space science, biology, physical science, architecture, and engineering.

The majority of the items in iMSSA mathematics assessments are designed to fully measure one mathematical practice. Most items measure a single content standard; however, where appropriate for the measurement of problem solving, reasoning, and modeling, items may require the application of more than one content standard.

Mathematics Claims

iMSSA mathematics assessments were designed to provide reliable and valid measures of students' understanding of, and ability to apply, grade-level appropriate mathematical concepts and procedures, as well as to use mathematical practices to analyze mathematical representations and solve problems. Figures 4 and 5 present claims for the meaning of scores from the iMSSA mathematics assessments.

Subscore	**Mathematics Claims—Grades 3–5** For these subscores, students who are At/Near Standard or Above Standard in grades 3–5 can:
Operations & Algebraic Thinking	• Apply mathematical operations (addition, subtraction, multiplication, and/or division) and use algebraic representations (e.g., equations) to solve problems involving whole numbers. • Identify, explain, and extend arithmetic patterns.
Number & Operations in Base Ten	• Understand and use whole number place values to represent and interpret numbers.
Number & Operations – Fractions	• Understand the concept of fractions, represent fractions and decimal fractions, and compare the sizes of whole numbers and fractions.
Measurement & Data	• Understand measurement principles and apply them to solve problems. • Represent and analyze data in simple graphs.
Geometry	• Understand geometric principles and use them to describe objects and solve problems.
Problem Solving	• Apply grade-level appropriate mathematical concepts and procedures and use quantitative and logical reasoning to solve standard and nonstandard real-world and mathematical problems.
Reasoning and Argument	• Construct viable arguments and critique the reasoning of others.
Modeling	• Use grade-level appropriate quantitative reasoning to interpret mathematical representations, represent real-world mathematical situations using mathematical models, and use mathematical models to solve real-world and mathematical problems.
Patterns and Structure	• Look for and make use of structure and repeated reasoning.

Figure 4: Claims about the Meaning of iMSSA Mathematics Assessment Scores, Grades 3–5

Subscore	**Mathematics Claims—Grades 6–8** For these subscores, students who are At/Near Standard or Above Standard in grades 6–8 can:
Ratios & Proportional Relationships (Grades 6–7)	• Understand, represent, and interpret ratios and proportional relationships between variables (e.g., the relationship between miles driven and gallons of gasoline used) to solve problems.
Functions (Grade 8)	• Understand the concept of functions and represent linear functions inequations, tables, and graphs. • Compare properties of two functions and interpret linear and nonlinear functions presented in a variety of forms.
The Number System	• In grades 6 and 7, understand, represent, and compute with rational numbers (fractions and decimal fractions). • In grade 8, understand and compare rational and irrational numbers.
Expressions & Equations	• Use expressions, equations, and inequalities to represent and solve mathematical and real-world problems.
Geometry	• Understand and apply geometric properties related to area, surface area, volume, and angles to solve real-world and mathematical problems.
Statistics & Probability	• Represent and analyze data in a variety of plots and graphs and summarize and describe distributions using multiple measures.
Problem Solving	• Apply grade-level appropriate mathematical concepts and procedures and quantitative and logical reasoning to solve standard and nonstandard real-world and mathematical problems.
Reasoning and Argument	• Construct viable arguments and critique the reasoning of others.
Modeling	• Use grade-level appropriate quantitative reasoning to interpret mathematical representations, represent real-world mathematical situations using mathematical models, and use mathematical models to solve real-world and mathematical problems.
Patterns and Structure	• Look for and make use of structure and repeated reasoning.

Figure 5: Claims about the Meaning of iMSSA Mathematics Assessment Scores, Grades 6–8

Content Development

Cognia uses Evidence-Centered Design (ECD), a principled design approach, to develop test and item specifications. ECD provides a conceptual framework for the design, development, and implementation of large-scale assessments that elicit evidence to support valid inferences about what students know and can do. ECD begins with purpose statements about what educators want scores to mean and how they are to be used.

Item, Task, and Stimulus Specifications

Cognia content specialists wrote item and task specifications for iMSSA assessments that describe in detail how each standard or cluster of standards is measured. Cognia content specialists contributed to the development of items for the PSAT 8/9 and 10. Based on their direct involvement in developing that content, they developed iMSSA items consistent with the format and level of rigor of the items on those assessments.

Item specifications identify a targeted cluster of standards and define the content limits of the cluster of standards (what can and cannot be included in items assessing that cluster), allowable vocabulary to be used in items measuring the standards, and item or task models to outline item types that are appropriate for the targeted standards. Item specifications also provide sample items. Stimulus specifications provide guidelines for passage selection and the development of graphic stimuli to support reading passages and mathematics items.

Cognia content experts delved into the mathematics practices to create detailed item specifications and "focus points" for each practice. In these item specifications, each practice is broken into two or three discrete focus points. iMSSA assessments in mathematics include items that address a range of practice focus points.

The specific mathematical practice focus points and dual coding—to both concepts and procedures and to practices—are beneficial for both teacher and student. By assessing specific practice focus points as well as concepts and procedures, iMSSA mathematics assessments yield depth and breadth of insight. For more information, see "iMSSA Mathematics Item Specifications: Practice 3 Focus Points."

Item Development Process

Using the item specifications, content specialists develop or oversee the development of items that match the specifications. To develop iMSSA assessments, approximately 8,800 new items have been developed. Drafted items are internally reviewed by content specialists and professional editors for

- alignment to standards and item specifications;
- technical quality (accuracy of right answers, usefulness of wrong answer choices, and accuracy and alignment of rubrics to the demands of the items);
- consistency with Universal Design (UD) principles;
- avoidance of bias or sensitivity issues; , with consideration given to global use and
- appropriateness of vocabulary level, item contexts, and reading level.

Educator Reviews for Content, Bias, and Sensitivity

All new items are reviewed by educator committees before being selected for field testing. Content review committees scrutinize items for alignment to standards, technical quality, adherence to UD principles, and appropriateness of vocabulary, contexts, and reading level. Bias and sensitivity review committees examine items to eliminate potential sources of bias (e.g., stereotyping, negative representation of any group, preferential treatment of any group, general familiarity of item contexts) and any potentially sensitive issues (e.g., controversial topics unrelated to appropriate academic standards). Educators and other expert stakeholders from around the world participate in the review committees. In a three-year period, close to 130 professionals took part in more than 20 content reviews, and more than 85 participated in bias and

sensitivity reviews. The 10-person international review committee included members from China, Colombia, Egypt, India, Saudi Arabia, and the United States.

Cognitive Complexity (Depth of Knowledge)

Cognia content specialists have been extensively trained by WebbAlign to apply Webb's Depth of Knowledge, or DOK® classifications. These classifications are designed to describe levels of cognitive complexity associated with each content standard and test question. During item development, we meet three objectives to assure appropriate item rigor:

- Accurately evaluate the cognitive complexity level of each item
- Develop items at the appropriate cognitive complexity for the standard
- Where appropriate, develop items that assess higher cognitive complexity levels, such as strategic thinking

Operational Test Forms and Continuing Development

iMSSA assessments use multiple test forms for each grade level and content area. Additional new iMSSA forms are periodically developed. Forms are equivalent in terms of content coverage and difficulty, in order to ensure stable measurement.

Ongoing item development assures continuing scrutiny of the college and career readiness standards for accurate alignment. Regular development of new operational items assures that iMSSA assessments remain fresh and secure.

Psychometrics

Cognia documents psychometric information regarding test forms in technical and other research reports. These reports document the reliability of iMSSA test scores, accuracy and consistency classifications in proficiency levels, item statistics, item and test scaling using the 3PL and graded-response IRT models, test-form equating, and our ongoing monitoring of the iMSSA scales used for score reporting.

Setting Achievement Levels

Total Score Achievement Levels

iMSSA total scores for each content area test are reported in three achievement levels: On Target, Near Target, and Needs Support. Cognia worked with educators and content experts to create achievement level descriptors (ALDs) for each grade and content area. The ALDs describe the knowledge and skills students demonstrate at each proficiency level.

The ranges of scale scores associated with each of the achievement levels were established through a standard-setting study completed in August 2017. The standard-setting process involved panels of teachers of appropriate grade levels and subject areas, and other educators. Panelists matched items to ALDs and recommended cut scores for each achievement level. Standard setting was informed by:

- ALDs
- Learning progressions within the content areas
- Judgments of educational and content experts
- Benchmarking of grade 8 iMSSA assessments to PSAT 8/9 College and Career Readiness Benchmarks

At grade 8, the On Target achievement level represents the performance level of students who are on track for college and career readiness by grade 8. More information is available from Cognia regarding the scale scores, achievement levels, achievement level descriptors, and the standard-setting process.

Subscore Achievement Levels

We established three levels for the subscores: Below Standard, At/Near Standard, and Above Standard. The achievement level was determined for each subscore area by (a) projecting the total test On Target cut score onto each subscore scale, and (b) calculating a confidence band around that projected cut score. Subscores within the confidence band are reported as At/Near Standard. Subscores above the confidence band are reported as Above Standard; subscores below the confidence band are reported as Below Standard. Students who receive Below Standard for a subscore may need more or different instruction in order to learn the targeted knowledge and skills.

Total Content Area Scale Scores and Achievement Levels

We report two primary indicators for each content area assessment: an overall scale score on the growth scale for each subject area and an overall achievement level. These two indicators show whether students are making progress toward college and career readiness.

Total scores for reading, language usage, and mathematics are reported as scale scores on a growth scale. Educators can track students' progress on the growth scale through a school year; during the year, the scale scores show progress toward end-of-year performance expectations. This growth scale allows for the identification of students who are on track for college and career readiness in grades 3 through 8.

At grade 8, iMSSA assessment scales are linked to College Board's grade 8/9 PSAT scale. Our score reports for grade 8 provide scale scores, achievement levels, and the PSAT 8/9 College and Career Readiness Benchmarks.

Schools and school systems can provide continuous measurement of students from grade 3 through high school using iMSSA assessments and the SAT Suite of Assessments, measuring growth from grades 3–8 on the iMSSA scale and using the PSAT 8/9 beginning at grade 8 or 9. Figure 6 illustrates the progression of administration and the reporting link for iMSSA assessments and the SAT Suite in grades 3–8 and high school.

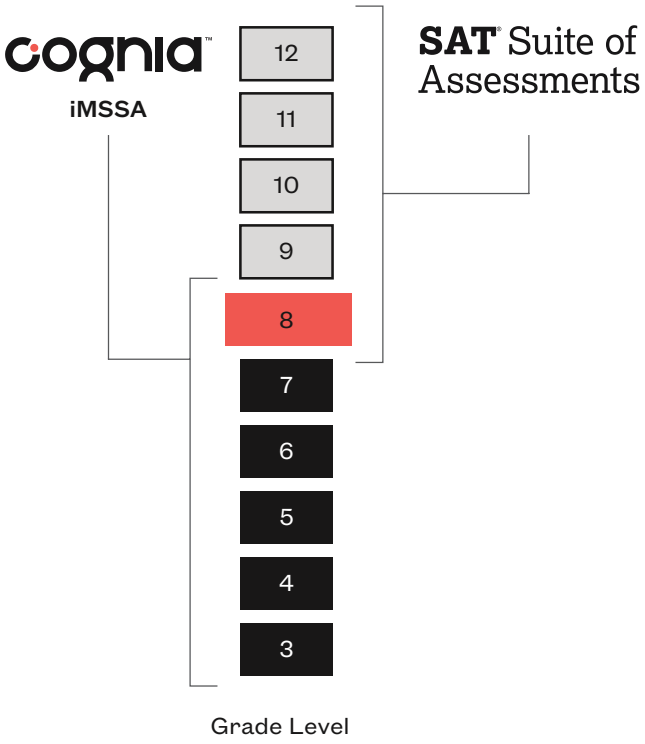

Figure 6: Grades 3–8 Reporting Link between iMSSA and the SAT Suite of Assessments

Subscore Achievement Levels

iMSSA subscore achievement levels are reliable indicators of students' strengths and needs for each claim. We report students' performance for each subscore area as Below Standard, At/Near Standard, or Above Standard. Educators can use the subscore achievement levels to group students for instruction or to plan instructional interventions for individual students.

Reading Subscore Areas

Subscore areas for reading focus on students' skills and strategies (comprehension, analysis and interpretation) as they apply to literary and informational text. The four claims areas and their reports are listed below.

- Comprehension: Indicates how well students comprehend main ideas and important details in both literary and informational texts.
- Analysis and Interpretation: Indicates how well students apply higher-order thinking skills to both literary and informational text.
- Literary Text: Indicates how well students comprehend, analyze, and interpret literary text.
- Informational Text: Indicates how well students comprehend, analyze, and interpret informational text.

Figure 7 presents reporting information for iMSSA interim reading assessments.

Language Usage Subscore Areas

iMSSA language usage subscore areas focus on students' abilities to analyze the effectiveness of written works and apply English language conventions. Writing analysis subscore achievement levels indicate how well students can evaluate written works for improvement in content, organization, mood, and tone. Subscore achievement levels for English language and conventions indicate how well students can improve writing conventions, language usage, and vocabulary in written works.

- Subscore areas for grades 3–5 include Narrative Writing Analysis, Expository Writing Analysis, and English Language and Conventions.
- Subscore areas for grades 6–8 include Expository Writing Analysis, Argument Writing Analysis, and English Language and Conventions.

Figures 8 and 9 present the reporting information for iMSSA language usage assessments for grades 3–5 and 6–8, respectively.

Score	Scaled Score	Achievement Level
Total Reading	✓	✓
Literary Text		✓
Informational Text		✓
Comprehension		✓
Analysis and Interpretation		✓

Figure 7: Reported Total Scores and Subscore Areas for iMSSA Reading Assessments

Score	Scaled Score	Achievement Level
Total Language Usage	✓	✓
Narrative Writing Analysis		✓
Expository Writing Analysis		✓
English Language and Conventions		✓

Figure 8: Grades 3–5 Reported Total Scores and Subscore Areas for iMSSA Language Usage Assessments

Score	Scaled Score	Achievement Level
Total Language Usage	✓	✓
Expository Writing Analysis		✓
Argument Writing Analysis		✓
English Language and Conventions		✓

Figure 9: Grades 6–8 Reported Total Scores and Subscore Areas for iMSSA Language Usage Assessments

Mathematics Subscore Areas

In addition to providing information on students' understanding and application of grade-level mathematics concepts and procedures, iMSSA mathematics subscores include information on students' use of mathematical practices.

- The mathematics concepts and procedures category is divided into several mathematics domains based on grade level, as shown in the figures below.
- Subscores within mathematical practices include problem-solving, logical and quantitative reasoning, using mathematical models to represent and solve problems, and understanding the patterns and structures within mathematics.

Figure 10 presents the reporting information for iMSSA mathematics assessments for grades 3–5. Figure 11 presents the reporting information for grades 6–8 iMSSA mathematics assessments.

Score	Scaled Score	Achievement Level
Total Mathematics	✓	✓
Operations and Algebraic Thinking		✓
Number & Operations in Base Ten		✓
Number & Operations—Fractions		✓
Measurement & Data		✓
Geometry		✓
Problem Solving		✓
Reasoning and Argument		✓
Modeling		✓
Patterns and Structure		✓

Figure 10: Grades 3–5 Reported Total Scores and Subscore Areas for iMSSA Mathematics Assessments

Score	Scaled Score	Achievement Level
Total Mathematics	✓	✓
Ratios & Proportional Relationships (Grades 6–7)		✓
Functions (Grade 8)		✓
The Number System		✓
Expressions & Equations		✓
Geometry		✓
Statistics & Probability		✓
Problem Solving		✓
Reasoning and Argument		✓
Modeling		✓
Patterns and Structure		✓

Figure 11: Grades 6–8 Reported Total Scores and Subscore Areas for iMSSA Mathematics Assessments

PSAT Linking Study

These assessments were developed with cooperation from the College Board and with the expectation that Cognia results for 8th graders would include a direct link to the PSAT 8/9 scores and benchmarks. To establish this link, the College Board conducted a concordance study, using a regression-based method to predict the PSAT 8/9 evidence-based reading and writing (ERW) scores given iMSSA reading and language usage scale scores; and PSAT 8/9 math scores given iMSSA math scale scores.

College Board's PSAT 8/9 comprises two sections: ERW and math. The PSAT 8/9 is designed to be administered to 8th and 9th graders and is administered in either fall or spring. Test scores for reading, writing, and math range from 6 to 36, and section scores for ERW and math range from 120 to 720. Each section has a benchmark to indicate if students are on track to be college-ready in that area. The benchmarks for 8th-grade students are 430 for ERW and 390 for math.

A concordance study can be used to determine the relationship between two measures that are similar but not strictly parallel in terms of content and specifications. AERA/APA/NCME Standard 5.18 states that "when linking procedures are used to relate scores on tests or test forms that are not closely parallel, the construction, intended interpretation, and limitations of those linkings should be described clearly"[1].

Figure 12 shows a portion of the table showing the concordance of iMSSA language usage scores with the PSAT 8/9 evidence-based reading and writing (ERW) scores (College Board, p. 15–16)[2].

iMSSA Scale Score	PSAT 8/9 Scale Score
760-775	310
776-790	320
791-802	330
803-812	340
813-820	350
821-828	360
829-835	370
836-842	380
843-848	390
849-854	400
855-860*	410
861-865	420
866-870	430**
871-875	440
876-880	450
881-884	460
885-889	470
890-893	480
894-897	490
898-902	500

* iMSSA On Target cut point

** PSAT 8/9 Benchmark

Figure 12: Partial Concordance Table for iMSSA Language Usage and PSAT 8/9 ERW

1 AERA, APA, & NCME. Standards for Educational and Psychological Testing, 2014, p. 106.

2 The College Board. Concordance: PSAT and eMPower Assessments*, October 2017.

* iMSSA assessments, also known as the Cognia Interim Assessments, were formerly called eMPower™ Assessments.

A regression-based method was used to establish the link between Cognia and PSAT 8/9 results obtained from a concordance study. This study was conducted in 2016 with approximately 700 grade 8 students who were assessed with Cognia Interim Assessments in the spring and PSAT 8/9 in the following fall.

This projection approach is useful to estimate the expected PSAT 8/9 scale scores given Cognia scale scores. The concordance reports moderately high correlations between the corresponding PSAT 8/9 and iMSSA scale scores.

As presented in Figure 12, if a student scored 860 on iMSSA language usage, which is On Target in grade 8 and on track to be college ready, that student is predicted to obtain a score of 410 on the PSAT 8/9 ERW section. This predicted score is lower than the PSAT benchmark of 430. Similar information is available for Cognia reading and math assessments.

Lexile and Quantile Linking Studies

MetaMetrics® developed its Lexile® Framework for Reading and Quantile® Framework for Mathematics as auxiliary scales—score scales associated with a primary reporting scale, such as these interim assessments, to appropriately match students' developmentally appropriate content frameworks. The Lexile Framework for Reading was "developed to appropriately match readers with text at a level that provides challenge but not frustration"[1]. The Quantile Framework for Mathematics "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"[2].

MetaMetrics conducted a series of concordance studies to link the Lexile and Quantile Measures to the interim assessment scale scores. The Lexile and Quantile frameworks for Reading and Math respectively are often used as an auxiliary scale score to convey additional information about test performance beyond the primary score scale. When the two score scales are linked, the linkage can be used to enhance the results of the primary assessment.

A single-group study design was chosen to link the interim assessment reading to the Lexile framework and the interim assessment math to the Quantile framework. MetaMetrics selected items from the Lexile and Quantile item pools that most closely approximated these interim assessment reading and math items. The Lexile and Quantile linking items were administered as part of a Cognia Interim Assessments administration during a large-scale state testing window in March and April, 2016. More than 75,000 students in grades 3–8 took both Cognia assessments and the Lexile and Quantile items.

Since responses were available from the same students who had taken both Cognia items and Lexile and Quantile items, a direct link was created between Cognia score scales and Lexile and Quantile score scales, using these data to appropriately account for student performance on these items. For this study, a linear linking approach was adopted that resulted in transformation constants or linking equations between the Cognia scale scores and the Lexile and Quantile measures, where any given Cognia reading score can be converted to a Lexile score, and a math score to a Quantile score.

Cognia has adapted the MetaMetrics data to align with the iMSSA's three achievement levels. Figure 13 shows the Lexile and Quantile ranges as they are associated with the achievement levels Cognia uses for its own interim assessment reports.
For New Mexico's iMSSA, those levels correspond as follows: Proficient and Advanced map to On Target, Basic maps to Near Target, and Below Basic maps to Needs Support.

[1] MetaMetrics. Linking the eMPower* Reading Assessments with The Lexile® Framework for Reading, April 2017, p. 1.
[2] MetaMetrics. Linking the eMPower* Reading Assessments with The Lexile® Framework for Reading, April 2017, p. 1.

* Cognia Interim Assessments were formerly called eMPower™ Assessments.

Cognia Achievement Level

Grade	Below Basic	Basic	Proficient	Advanced*
Lexile Range (Reading)				
3	BR170L–505L	515L–580L	590L–790L	800L–1200L
4	BR95L–560L	570L–695L	705L–915L	920L–1300L
5	BR40L–600L	610L–805L	820L–1065L	1075L–1400L
6	BR10L–700L	710L–885L	895L–1115L	1125L–1500L
7	BR70L–755L	765L–960L	975L–1250L	1260L–1600L
8	20L–830L	840L–1060L	1070L–1270L	1280L–1700L
Quantile Range (Math)				
3	EM285Q–455Q	465Q–665Q	675Q–960Q	975Q**
4	EM155Q–585Q	595Q–775Q	780Q–960Q	970Q–1075Q
5	EM10Q–680Q	690Q–845Q	850Q–1025Q	1035Q–1125Q
6	0Q–710Q	720Q–880Q	890Q–1140Q	1150Q–1200Q
7	5Q–760Q	770Q–955Q	965Q–1145Q	1155Q–1325Q
8	25Q–785Q	795Q–980Q	990Q–1195Q	1205Q–1450Q

*Maximum values here indicate the highest reported Lexile or Quantile measure for each grade.

**All students achieving Advanced in grade 3 mathematics have an associated maximum reported Quantile score of 975Q.

Figure 13: Concordance of MetaMetrics Lexile and Quantile Ranges with Cognia Achievement Levels

Appendix A: Research Basis for Standards for Progress toward College and Career Readiness

Cognia Interim Assessments are designed to measure college and career readiness content standards similar to Common Core State Standards (CCSS). These standards target knowledge, skills, and abilities—in reading, vocabulary, writing, language, and mathematics—that students need to make progress in school toward college and career readiness (CCR) and critical thinking skills. These standards compare favorably to content standards in many U.S. states (e.g., California, Florida, Indiana, Louisiana, Maine, Maryland, Massachusetts, Missouri, New Hampshire, New York, Oregon, Pennsylvania, South Carolina, Washington, and Wisconsin) as well as the standards proposed by the National Governors' Association (NGA) and the Council of Chief State School Officers (CCSSO), which are used globally by a number of institutions. The standards are also aligned with the content focuses in the College Board's SAT Suite of Assessments. The PSAT/SAT assessments are grounded in extensive research conducted by the College Board on what is required for success in college and workforce training. The Cognia Interim Assessments alignment with PSAT and SAT further ensures that the upper levels of Cognia Interim Assessments measure growth toward success in high school and beyond.

Reading and Vocabulary Standards

The college and career readiness standards for reading and vocabulary reflect contemporary research on the skills and knowledge students must have in order to be prepared for high school and beyond.

The reading standards are grounded in research about the reading skills and strategies, types of text, and complexity of text students will encounter throughout school and in the work place[1]. An essential aspect of this research is that students must be able to comprehend, analyze, and interpret text that increases in complexity and vocabulary demands as students move from one year to the next.

Research also shows that the types of text students read changes over time. Young children learn to read primarily through stories and narratives. However, as students grow, more and more of what they read in school involves informational texts in social studies, science, and mathematics (Achieve, 2007). Reading informational text requires complex word attack skills, a broad academic vocabulary, and the ability to integrate ideas from graphics, timelines, images, and other media with written text[2].

Effective reading in school also requires students to comprehend the wide array of academic language necessary for comprehending texts in science and social studies[3]. In fact, students' vocabulary level is a key factor in their overall achievement[4]. However, vocabulary alone is not sufficient for academic success. Research suggests that most word learning occurs indirectly and unconsciously through normal reading, writing, listening, and speaking[5]. Students must have the skills to interpret unfamiliar vocabulary in order to develop vocabulary and make sense of what they read.

The reading and vocabulary standards focus on students' abilities to apply reading skills as well as vocabulary knowledge and skills to comprehend, analyze, and interpret complex literary and informational text.

Writing and Language Standards

The college and career readiness standards for writing and language reflect current research on what students must know and be able to do to be effective writers. Effective writing requires focus, organization of ideas, integration and elaboration of information, and application of writing conventions.

1 Achieve, Inc., 2007; Afflerbach, Pearson, & Paris, 2008; Bowen, Roth, & McGinn, 1999, 2002; Erickson & Strommer, 1991; Hayes, Wolfer, & Wolfe, 1996; Heller & Greenleaf, 2007; Kintsch, 1998, 2009; Kutner, Greenberg, Jin, Boyle, Hsu, & Dunleavy, 2007; McNamara, Graesser, & Louwerse, 2010; Milewski, Johnson, Glazer, & Kubota, 2005; Perfetti, Landi, & Oakhill, 2005; Pritchard, Wilson, & Yamnitz, 2007; Shanahan & Shanahan, 2008; van den Broek, Lorch, Linderholm, & Gustafson, 2001.

2 Hayes, Wolfer, & Wolfe, 1996.

3 Betts, 1946; Carver, 1994; Laufer, 1988.

4 Baumann & Kameenui, 1991; Becker, 1977; Daneman & Green, 1986; Hayes & Ahrens, 1988; Herman, Anderson, Pearson, & Nagy, 1987; National Institute of Child Health and Human Development, 2000.

5 Miller, 1999; Nagy, Anderson, & Herman, 1987.

Students must write for many purposes. Children in grades 3–5 generally write narratives and reports. By middle school, students write in nearly all of their courses—including science and social studies—and primarily to inform. As students move into high school and college, they must develop written arguments—supporting claims with evidence, whether the evidence is from literary, historical, or scientific sources[1]. Research is very clear that effective writing requires understanding and application of standard English language conventions[2]. Research also suggests that students' understanding of the language conventions of disciplinary texts improves their ability to comprehend complex social studies and science texts[3].

The standards focus on students' abilities to write and to evaluate the writing of others. Standards address three primary writing purposes:

- narrative writing, writing to inform, and developing written arguments.
- The standards also focus on effective and accurate use of English language structures and conventions.

Mathematics Standards

The college and career readiness standards for mathematics are grounded in research on mathematics learning and cognition. This research showed that successful curricula focused on a few key concepts and procedures each year—with each year building on the skill and understanding of previous years—rather than covering the same material year after year.

Mathematical Practices—The Thinking behind Mathematics Achievement

Investigation of what it takes for students to be successful in mathematics is a fairly new area of research. Challenged by the low performance of students on international assessments and the difficulty students have in learning higher levels of mathematics in school, researchers[4] have begun to examine the underlying cognitive skills necessary for success in mathematics. Researchers have found that mathematical proficiency depends upon more than conceptual understanding and procedural skill; many problem-solving and reasoning skills underpin successful mathematical learning.

Several researchers' work[5] has opened this field to close examination. Research on mathematical learning can be classified into several categories: problem-solving processes, metacognitive processes, comprehension in mathematics, representations, analogic thinking, and research on specific cognitive processes within areas of mathematics (e.g., number sense, proportional reasoning, statistical reasoning).

Problem Solving

Shoenfeld (1985) defined problem solving as a cognitive process directed at achieving a goal when no solution is obvious to the problem solver. Many researchers refer to the work of Polya (1945) to describe mathematical problem solving. Polya identified four stages of problem solving: understanding the problem, developing a plan, carrying out the plan, and looking back. For example, Kilpatrick et al (2001) equate strategic mathematical competence with the ability to solve problems. They define strategic competence as the ability to interpret a problem, represent it to oneself (and possibly to others), and execute a plan to solve the problem[6].

Metacognitive processes are those that allow the problem solver to stand back from her or his processes to make judgments about efficacy of those processes in solving the specific problem at hand and to alter strategies as needed to solve the problem[7].

Modeling and Argument

Others have enhanced Polya's simple four-stage model by elaborating on different stages in problem-solving processes such as divergent thinking to get beyond algorithms (Imai, 2000), creating and using representations or models[8], accessing prior mathematical knowledge, setting sub-goals, verifying whether procedures are working; arguing, justifying, and/or modifying choices[9]. Graf (2009) claimed that arguing and justifying are central aspects of problem solving. Arguing and justifying involve selecting or providing examples that represent a statement or claim, providing counterexamples, making conjectures, making deductive arguments (such as proofs), evaluating the reasonableness of results through substitution, estimation, and approximation, and connecting problems and results to real-world knowledge.

Quantitative Reasoning

A critical aspect of mathematics is the fact that most mathematical behaviors involve connecting some real phenomena to an abstract, symbolic system[10]. According to Duval (2006), in order to solve problems, students must be able to comprehend mathematical information. Duval defines comprehension in mathematics as the ability to understand and use signs, symbols, and other representations that stand for concrete or abstract objects, events, or phenomena. The connections among representations and objects, events, and phenomena are established by rules. To comprehend or present mathematical information, students must be able to read and understand the meaning of signs, symbols, and other representations and to write or construct representations by applying the appropriate rules.

1 ACT, Inc., 2009; Milewski, Johnson, Glazer, & Kubota, 2005; National Assessment Governing Board, 2006.
2 Biber, 1991; Krauthamer, 1999; Lefstein, 2009; Schleppegrell, 2001.
3 Achugar, Schleppegrell, & Oteiza, 2007; Gargani, 2006.
4 e.g., Dossey, Mullis, Lindquist, & Chambers, 1988; National Center for Educational Statistics, 2009a, 2009b, 2009c.
5 Carpenter, et al (1999), Scheoenfeld (1980, 1985), Schoenfeld & Herrmann (1980), Greeno and colleagues (1979, 1984, 1986, 1991, 1997 (and others).
6 Kilpatrick et al, 2001.
7 Flavel, 1976; Greeno, 1979, 1984, 1997; Greeno, Greeno, & Perfetti, 1979; Greeno, Riley, & Gelman, 1984; Greeno, et al, 1985; Greeno, et al, 1986.
8 Goldin, 1998; Greeno & Hall, 1997; Lehrer & Schauble, 2000.
9 Graf, 2009.
10 Hudson, 1983; Resnick, 1991.

According to Furinghetti & Morselli (2009), reading a problem or statement does not automatically imply that the individual understands the problem or statement. Reformulating a problem into mathematical representations is the beginning of developing a plan. Representations used to clarify a problem may be unsuccessful and rejected or they may move the problem solver forward in solving the problem or developing the proof[1].

Representations are the ways in which problem solvers take observations and organize them into mathematical models. Models can be created with concrete objects (such as manipulatives), symbols (such as equations and inequalities), figures, graphs, tables, diagrams, pictures, and verbal language. Research suggests that mathematical models allow students to understand patterns in mathematical information and that facility in creating models allows students to see and evaluate different mathematical representations of mathematical phenomena[2].

Patterns and Structure

White, Alexander, & Daugherty (1998) highlight four aspects of analogical reasoning that are critical to mathematical thinking and problem solving: encoding, inferring, mapping, and applying. Problem solving depends on students' abilities to determine the attributes of an object or symbol (encoding), connect the object or symbol to abstract concepts and representations (inferring and mapping) and then to recognize or use the patterns among objects and symbols (applying). This is important given that research has linked analogical reasoning to problem solving[3], algebraic understanding[4], and interpretations of mathematical representations[5].

This body of research has contributed significantly to our understanding of what practices proficient students use when approaching and solving abstract and real-world mathematical problems.

Concepts and Procedures—The Tools of Mathematical Problem Solving

Research on mathematical understanding in specific domains of mathematics is growing. Research primarily has focused on students' understanding of number, proportional reasoning, statistical reasoning, and algebraic reasoning.

Number Sense

Very young children recognize numbers up to three and recognize differences in amounts for numbers greater than four without counting[6]. This latter skill is related to estimation[7]. Very young children can also do nonverbal computations with small numbers using manipulatives[8].

By age 5, young children can count objects and most can label objects during counting[9]. Most 5 year-olds understand one-to-one correspondence, order, and the fact that the last number in a count indicates the number of objects in a set[10].

Students begin to struggle with mathematical learning as they begin to work with rational numbers. Rational numbers are used in most careers—making understanding of fractions and decimal fractions critical to success in school and beyond.

Proportional Reasoning

Proportional reasoning is the gateway to understanding functional relationships. Several researchers have examined understanding of proportional reasoning[11] and its impact on students' ability to solve problems[12]. Researchers have found that individuals may have strong proportional reasoning skills whether or not they have studied proportions in school and that if students do not apply proportional reasoning, they have difficulty computing with rational numbers.

Statistics and Probability

Researchers have also looked at statistical reasoning. Statistical representations require two-dimensional thinking and understanding of central tendencies. Leher and Schauble (2000) found that primary-level students naturally organized their data into graphical displays and began to discuss central tendency when asked to organize the data to make it more readable by others.

Some of what is known about statistical reasoning comes from judgment and decision-making literature. In making statistical interpretations, research suggests that people ignore sample size, base rate, regression, and logic[13]. If given sufficient time to understand the sampling process and if reminded to consider the role of chance in producing events, people can think statistically[14]. For example, if students know that the population is very heterogeneous (e.g., racial and ethnic characteristics of students in different schools), they are more likely to take sample size into account when drawing conclusions from data.

Another finding about statistical reasoning is that, because statistics are generally used to describe and/or predict data in situations that are familiar, students may insert their own biases into interpretations of data[15].

Algebraic Thinking

Several researchers have found that students see arithmetic and algebra as distinct areas of mathematics, leading them to use arithmetic solutions when algebraic solutions will be more effective[16]. Lawler (1981) called these "islands of knowledge" (p. 179). Greeno, et al (1986) indicated that there are cognitive explanations for this confusion. Algebraic thinking involves not only equations, inequalities and expressions, but also diagrams, tables, and graphs. Making connections among different algebraic representations deepens understanding of algebra and functions[17].

1 Furinghetti & Morselli, 2009.
2 Goldin, 1998; Lehrer & Schauble, 2000.
3 English, 1997; Novick 1988.
4 English & Sharry, 1996.
5 English & Halford, 1995.
6 Carey, 2004; Le Corre and Carey, 2007; Mix, Huttenlocher, & Levine, 2002; Mix, Sandhofer, & Baroody 2005; Wynn, 1990.
7 Siegler and Booth, 2004.
8 Klein and Bisanz, 2000.
9 Baroody, 1987; Baroody Lai, & Mix, 2006.
10 Gelman & Gallistel, 1978; Siegler and Booth, 2004.
11 Carraher, Carraher, & Schliemann, 1985; Hart, 1984; Schliemann and Nunes, 1990; Tounaire, 1986.
12 Kishimoto, 2000).
13 Kahneman & Tversky, 1972, 1973, 1982.
14 Nisbett, Krantz, Jepson, & Kunda, 1993.
15 Kahneman & Tversky, 1982.
16 Lee and Wheeler, 1989; Resnick, Cauzinille-Marmeche, & Mathieu, 1987.
17 National Research Council, 2000.

Learning Progressions

A key to mathematical learning is the ways in which students organize and process their knowledge[1]. New knowledge builds on previous understanding. Although not always the case, later learning may be fully dependent on students' mastery of prerequisite knowledge. Graf (2009) outlines several efforts that have been made to define learning progressions. Much of the work on young children's learning progressions comes from Piagetian research and is based on learning that takes place before formal schooling.

Children in grades 3–5 develop number sense as well as the ability to add, subtract, multiply, and divide with whole numbers and fractions. Young children learn basic rules for measurement, the characteristics of simple geometric figures, and how to read and interpret simple graphs. By middle school, the focus of number sense shifts to decimal fractions or rational numbers.

To be ready for high school, students must be able to handle more abstract mathematical information and to apply algorithms, to use ratios and proportional relationships, and to use algebra and functions to solve mathematical problems. In middle school, students begin to solve nonstandard problems that require integration of concepts and procedures to new situations. Students begin to represent mathematical information using models such as equations and graphs beginning in elementary school. Over time, students develop the ability to reason quantitatively and logically—skills that are prerequisite to learning how to do proofs in high school and beyond.

In summary, current research shows that critical thinking and readiness for high school, college, and careers depends on students' abilities to understand and apply mathematical concepts and procedures, as well as their use of important mathematical skills such as problem solving, reasoning, the use of mathematical models to represent and solve problems, and their abilities to abstract mathematical patterns and structures.

The college and career readiness standards for mathematics focus on students' deep understanding of number and number systems; their ability to apply mathematical operations to solve real-world and mathematical problems; their ability to use expressions, equations, and models to represent mathematical situations and solve problems; and their ability to reason logically about mathematical phenomena.

[1] Pellegrino, Chudowsky, & Glaser, 2001, p. 650.

Appendix B: Qualitative Rubric for Text Complexity

	Exceedingly Complex	Very Complex	Moderately Complex	Slightly Complex
Text Structure	**Organization**: Is intricate with regard to such elements as point of view, time shifts, multiple characters, storylines, and detail **Use of Graphics**: If used, illustrations or graphics are essential for understanding the meaning of the text	**Organization**: May include subplots, time shifts, and more complex characters **Use of Graphics**: If used, illustrations or graphics support or extend the meaning of the text	**Organization**: May have two or more storylines and occasionally be difficult to predict **Organization**: May have two or more storylines and occasionally be difficult to predict	**Organization**: May have two or more storylines and occasionally be difficult to predict **Organization**: May have two or more storylines and occasionally be difficult to predict
Language Features	**Organization**: May have two or more storylines and occasionally be difficult to predict **Organization**: May have two or more storylines and occasionally be difficult to predict **Organization**: May have two or more storylines and occasionally be difficult to predict	**Organization**: May have two or more storylines and occasionally be difficult to predict **Organization**: May have two or more storylines and occasionally be difficult to predict **Organization**: May have two or more storylines and occasionally be difficult to predict	**Organization**: May have two or more storylines and occasionally be difficult to predict **Organization**: May have two or more storylines and occasionally be difficult to predict **Sentence Structure**: Primarily simple and compound sentences, with some complex constructions	**Sentence Structure**: Primarily simple and compound sentences, with some complex constructions **Vocabulary**: Contemporary, familiar, conversational language **Sentence Structure**: Mainly simple sentences
Meaning	Multiple competing levels of meaning that are difficult to identify, separate, and interpret; theme is implicit or subtle, often ambiguous, and revealed over the entirety of the text	Multiple levels of meaning that may be difficult to identify or separate; theme is implicit or subtle and may be revealed over the entirety of the text	Multiple levels of meaning clearly distinguished from each other; theme is clear but may be conveyed with some subtlety	One level of meaning; theme is obvious and revealed early in the text
Knowledge Demands	**Life Experiences**: Explores complex, sophisticated, or abstract themes; experiences portrayed are distinctly different from those of the common reader **Intertextuality and Cultural Knowledge**: Many references or allusions to other texts or cultural elements	**Life Experiences**: Explores themes of varying levels of complexity or abstraction; experiences portrayed are uncommon to most readers **Intertextuality and Cultural Knowledge**: Some references or allusions to other texts or cultural elements	**Life Experiences**: Explores several themes; experiences portrayed are common to many readers **Intertextuality and Cultural Knowledge**: Few references or allusions to other texts or cultural elements	**Life Experiences**: Explores a single theme; experiences portrayed are everyday and common to most readers **Intertextuality and Cultural Knowledge**: No references or allusions to other texts or cultural elements

Figure 14: Adapted from Research Supporting Key Elements of the Standards, Common Core State Standards for English Language Arts and Literacy in History/Social Studies and Science and Technical Subjects (2010).