



A Guide to Rigor in Mathematics 2.0

In order to provide a quality mathematical education for students, instruction must be rigorous, focused, and coherent. This document provides explanations and a standards-based alignment to assist teachers in providing the first of those: a rigorous education. While this document will help teachers identify the explicit component(s) of rigor called for by each of the Louisiana Student Standards for Mathematics (LSSM), it is up to the teacher to ensure his/her instruction aligns to the expectations of the standards, allowing for the proper development of rigor in the classroom.

This rigor document is considered a “living” document as we believe that teachers and other educators will find ways to improve the document as they use it. Please send feedback to LouisianaStandards@la.gov so that we may use your input when updating this guide.

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Definitions of the Components of Rigor

Rigorous teaching in mathematics does not simply mean increasing the difficulty or complexity of practice problems. Incorporating rigor into classroom instruction and student learning means exploring at a greater depth, the standards and ideas with which students are grappling. There are **three** components of rigor that will be expanded upon in this document, and each is equally important to student mastery: **Conceptual Understanding, Procedural Skill and Fluency, and Application.**

- **Conceptual Understanding** refers to understanding mathematical concepts, operations, and relations. It is more than knowing isolated facts and methods. Students should be able to make sense of why a mathematical idea is important and the kinds of contexts in which it is useful. It also allows students to connect prior knowledge to new ideas and concepts.
- **Procedural Skill and Fluency** is the ability to apply procedures accurately, efficiently, and flexibly. It requires speed and accuracy in calculation while giving students opportunities to practice basic skills. Students' ability to solve more complex application tasks is dependent on procedural skill and fluency.
- **Application** provides valuable context for learning and the opportunity to solve problems in a relevant and a meaningful way. It is through real-world application that students learn to select an efficient method to find a solution, determine whether the solution makes sense by reasoning, and develop critical thinking skills.

A Special Note on Procedural Skill and Fluency

While speed is definitely a component of fluency, it is not necessarily speed in producing an answer; rather, fluency can be observed by watching the speed with which a student engages with a particular problem. Furthermore, fluency does not require the most efficient strategy. The standards specify grade-level appropriate strategies or types of strategies with which students should demonstrate fluency (e.g., 1.OA.C.6 allows for students to use counting on, making ten, creating equivalent but easier or known sums, etc.). It should also be noted that teachers should expect some procedures to take longer than others (e.g., fluency with the standard algorithm for division, 6.NS.B.2, as compared to fluently adding and subtracting within 10, 1.OA.C.6).

Standards identified as targeting procedural skill and fluency do not all have an expectation of automaticity and/or rote recall. Only two standards, 2.OA.B.2 and 3.OA.C.7, have explicit expectations of students knowing facts from memory. Other standards targeting procedural skill and fluency do not require students to reach automaticity. For example, in 4.G.A.2, students do not need to reach automaticity in classifying two-dimensional figures.

Recognizing the Components of Rigor

In the LSSM each standard is aligned to one or more components of rigor, meaning that each standard aims to promote student growth in conceptual understanding, procedural skill and fluency, and/or application. Key words and phrases in the standards indicate which component(s) of rigor the standard is targeting: conceptual understanding standards often use terms like *understand*, *recognize*, or *interpret*; procedural skill and fluency standards tend to use words like *fluently*, *find*, or *solve*; and application standards typically use phrases like *word problems* or *real-world problems*. Key words and phrases are underlined in each standard to help clarify the identified component(s) of rigor for each standard.

Focus in the Standards

Not all content in a given grade is emphasized equally in the standards. Some clusters require greater emphasis than others based on the depth of the ideas, the time that they take to master, and/or their importance to future mathematics or the demands of college and career readiness. More time in these areas is also necessary for students to meet the Louisiana Standards for Mathematical Practice. To say that some things have greater emphasis is not to say that anything in the standards can safely be neglected in instruction. Neglecting material will leave gaps in student skill and understanding and may leave students unprepared for the challenges of a later grade. Students should spend the large majority of their time on the major work of the grade (■). Supporting work (■) and, where appropriate, additional work (■) can engage students in the major work of the grade.

Kindergarten

LSSM – Kindergarten		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
K.CC.A.1	<u>Count</u> to 100 by ones and by tens.		✓	
K.CC.A.2	<u>Count</u> forward beginning from a given number within the known sequence (instead of having to begin at 1).		✓	
K.CC.A.3	<u>Write</u> numbers from 0 to 20. <u>Represent</u> a number of objects with a written numeral 0-20 (with 0 representing a count of no objects).	✓	✓	
K.CC.B.4	<u>Understand</u> the relationship between numbers and quantities; <u>connect</u> counting to cardinality.	✓		
K.CC.B.4a	When counting objects in standard order, say the number names as they relate to each object in the group, <u>demonstrating</u> one-to-one correspondence.	✓		
K.CC.B.4b	<u>Understand</u> that the last number name said tells the number of objects counted. The number of objects is the same regardless of their arrangement or the order in which they were counted.	✓		
K.CC.B.4c	<u>Understand</u> that each successive number name refers to a quantity that is one larger.	✓		
K.CC.B.5	<u>Count</u> to answer “How many?” questions.	✓	✓	
K.CC.B.5a	<u>Count</u> objects up to 20, arranged in a line, a rectangular array, or a circle.		✓	
K.CC.B.5b	<u>Count</u> objects up to 10 in a scattered configuration.		✓	
K.CC.B.5c	When given a number from 1-20, <u>count</u> out that many objects.		✓	
K.CC.C.6	<u>Identify</u> whether the number of objects in one group is greater than, less than, or equal to the number of objects in another group, e.g., by using matching and counting strategies.	✓		
K.CC.C.7	<u>Compare</u> two numbers between 1 and 10 presented as written numerals.	✓		
K.OA.A.1	<u>Represent</u> addition and subtraction with objects, fingers, mental images, drawings, sounds (e.g., claps), acting out situations, verbal explanations, expressions, or equations.	✓		
K.OA.A.2	Solve addition and subtraction <u>word problems</u> , and <u>add and subtract</u> within 10, e.g., by using objects or drawings to represent the problem.		✓	✓
K.OA.A.3	<u>Decompose</u> numbers less than or equal to 10 into pairs in more than one way, e.g., by using objects or drawings, and record each decomposition by a drawing or equation (e.g., $5 = 2 + 3$ and $5 = 4 + 1$).	✓		
K.OA.A.4	For any number from 1 to 9, <u>find</u> the number that makes 10 when added to the given number, e.g., by using objects or drawings, and record the answer with a drawing or equation.	✓		
K.OA.A.5	<u>Fluently</u> add and subtract within 5.		✓	
K.NBT.A.1	Gain <u>understanding</u> of place value.	✓		
K.NBT.A.1a	<u>Understand</u> that the numbers 11–19 are composed of ten ones and one, two, three, four, five, six, seven, eight, or nine ones.	✓		

LSSM – Kindergarten		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
K.NBT.A.1b	<u>Compose and decompose</u> numbers 11 to 19 using place value (e.g., by using objects or drawings).	✓		
K.NBT.A.1c	<u>Record</u> each composition or decomposition using a drawing or equation (e.g., 18 is one ten and eight ones, $18 = 1 \text{ ten} + 8 \text{ ones}$, $18 = 10 + 8$).	✓	✓	
K.MD.A.1	<u>Describe</u> measurable attributes of objects, such as length or weight. <u>Describe</u> several measurable attributes of a single object.	✓		
K.MD.A.2	Directly <u>compare</u> two objects with a measurable attribute in common, to see which object has “more of”/“less of” the attribute, and <u>describe</u> the difference. <i>For example, directly compare the heights of two children and describe one child as taller/shorter.</i>	✓		
K.MD.B.3	<u>Classify</u> objects into given categories based on their attributes; <u>count</u> the numbers of objects in each category and <u>sort</u> the categories by count.	✓	✓	
K.MD.C.4	<u>Recognize</u> pennies, nickels, dimes, and quarters by name and value (e.g., This is a nickel and it is worth 5 cents.)	✓		
K.G.A.1	<u>Describe</u> objects in the environment using names of shapes, and <u>describe</u> the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to.	✓		
K.G.A.2	Correctly <u>name</u> shapes regardless of their orientations or overall size.	✓	✓	
K.G.A.3	<u>Identify</u> shapes as two-dimensional (lying in a plane, “flat”) or three-dimensional (“solid”).	✓		
K.G.B.4	<u>Analyze and compare</u> two- and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/“corners”) and other attributes (e.g., having sides of equal length).	✓		
K.G.B.5	<u>Model</u> shapes in the world by building shapes from components (e.g., sticks and clay balls) and drawing shapes.	✓		
K.G.B.6	<u>Compose</u> simple shapes to form larger shapes. <i>For example, “Can you join these two triangles with full sides touching to make a rectangle?”</i>	✓		

1st Grade

LSSM – 1 st Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
1.OA.A.1	Use addition and subtraction within 20 to solve <u>word problems</u> involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using objects, drawings, and equations with a symbol for the unknown number to represent the problem.			✓
1.OA.A.2	Solve <u>word problems</u> that call for addition of three whole numbers whose sum is less than or equal to 20, e.g., by using objects, drawings, and equations with a symbol for the unknown number to represent the problem.			✓
1.OA.B.3	<u>Apply properties of operations</u> to add and subtract. Examples: If $8 + 3 = 11$ is known, then $3 + 8 = 11$ is also known. (Commutative property of addition.) To add $2 + 6 + 4$, the second two numbers can be added to make a ten, so $2 + 6 + 4 = 2 + 10 = 12$. (Associative property of addition.)	✓		
1.OA.B.4	<u>Understand</u> subtraction as an unknown-addend problem. <i>For example, subtract $10 - 8$ by finding the number that makes 10 when added to 8.</i>	✓		
1.OA.C.5	<u>Relate</u> counting to addition and subtraction (e.g., by counting on 2 to add 2).	✓		
1.OA.C.6	Add and subtract within 20, <u>demonstrating fluency</u> for addition and subtraction within 10. <u>Use strategies</u> such as counting on; making ten (e.g., $8 + 6 = 8 + 2 + 4 = 10 + 4 = 14$); decomposing a number leading to a ten (e.g., $13 - 4 = 13 - 3 - 1 = 10 - 1 = 9$); using the relationship between addition and subtraction (e.g., knowing that $8 + 4 = 12$, one knows $12 - 8 = 4$); and creating equivalent but easier or known sums (e.g., adding $6 + 7$ by creating the known equivalent $6 + 6 + 1 = 12 + 1 = 13$).	✓	✓	
1.OA.D.7	<u>Understand</u> the meaning of the equal sign, and <u>determine</u> if equations involving addition and subtraction are true or false. <i>For example, which of the following equations are true and which are false? $6 = 6$, $7 = 8 - 1$, $5 + 2 = 2 + 5$, $4 + 1 = 5 + 2$.</i>	✓	✓	
1.OA.D.8	<u>Determine</u> the unknown whole number in an addition or subtraction equation relating three whole numbers. <i>For example, determine the unknown number that makes the equation true in each of the equations $8 + ? = 11$, $5 = ? - 3$, $6 + 6 = ?$.</i>	✓		
1.NBT.A.1	<u>Count</u> to 120, starting at any number less than 120. In this range, <u>read and write</u> numerals and <u>represent</u> a number of objects with a written numeral.	✓	✓	
1.NBT.B.2	<u>Understand</u> that the two digits of a two-digit number represent amounts of tens and ones. <u>Understand</u> the following as special cases:	✓		
1.NBT.B.2a	10 can be thought of as a bundle of ten ones — called a “ten.”	✓		
1.NBT.B.2b	The numbers from 11 to 19 are composed of a ten and one, two, three, four, five, six, seven, eight, or nine ones.	✓		
1.NBT.B.2c	The numbers 10, 20, 30, 40, 50, 60, 70, 80, 90 refer to one, two, three, four, five, six, seven, eight, or nine tens (and 0 ones).	✓		

LSSM – 1 st Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
1.NBT.B.3	Compare two two-digit numbers based on meanings of the tens and ones digits, <u>recording</u> the results of comparisons with the symbols $>$, $=$, and $<$.	✓		
1.NBT.C.4	Add within 100, including adding a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10.		✓	
1.NBT.C.4a	Use concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; <u>relate</u> the strategy to a number sentence; <u>justify</u> the reasoning used with a written explanation.	✓		
1.NBT.C.4b	<u>Understand</u> that in adding two-digit numbers, one adds tens and tens, ones and ones; and sometimes it is necessary to compose a ten.	✓		
1.NBT.C.5	Given a two-digit number, <u>mentally find</u> 10 more or 10 less than the number, without having to count; <u>explain</u> the reasoning used.	✓		
1.NBT.C.6	Subtract multiples of 10 in the range 10-90 from multiples of 10 in the range 10-90 (positive or zero differences), <u>using</u> concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; <u>relate</u> the strategy to a written method and <u>explain</u> the reasoning used.	✓		
1.MD.A.1	<u>Order</u> three objects by length; <u>compare</u> the lengths of two objects indirectly by using a third object.	✓	✓	
1.MD.A.2	<u>Express</u> the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end; <u>understand</u> that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. <i>Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps.</i>	✓	✓	
1.MD.B.3	<u>Tell and write</u> time in hours and half-hours using analog and digital clocks.	✓	✓	
1.MD.C.4	<u>Organize, represent, and interpret</u> data with up to three categories; <u>ask and answer</u> questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.	✓	✓	✓
1.MD.D.5	<u>Determine</u> the value of a collection of coins up to 50 cents. (Pennies, nickels, dimes, and quarters in isolation; not to include a combination of different coins.)		✓	
1.G.A.1	<u>Distinguish</u> between defining attributes (e.g., triangles are closed and three-sided) versus non-defining attributes (e.g., color, orientation, overall size); <u>build and draw</u> shapes to possess defining attributes.	✓		
1.G.A.2	<u>Compose</u> two-dimensional shapes (rectangles, squares, trapezoids, triangles, half-circles, and quarter-circles) and three-dimensional shapes (cubes, right rectangular prisms, right circular cones, and right circular cylinders) to create a composite shape, and <u>compose</u> new shapes from the composite shape.	✓		
1.G.A.3	<u>Partition</u> circles and rectangles into two and four equal shares, <u>describe</u> the shares using the words halves, fourths, and quarters, and use the phrases half of, fourth of, and quarter of. <u>Describe</u> the whole as two of, or four of the shares. <u>Understand</u> for these examples that decomposing into more equal shares creates smaller shares.	✓	✓	

2nd Grade

LSSM – 2 nd Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
2.OA.A.1	Use addition and subtraction within 100 to solve one- and two-step <u>word problems</u> involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.			✓
2.OA.B.2	<u>Fluently</u> add and subtract within 20 <u>using mental strategies</u> . By end of Grade 2, <u>know from memory</u> all sums of two one-digit numbers.		✓	
2.OA.C.3	<u>Determine</u> whether a group of objects (up to 20) has an odd or even number of members, e.g., by pairing objects or counting them by 2s; <u>write</u> an equation to express an even number as a sum of two equal addends.	✓		
2.OA.C.4	<u>Use addition</u> to <u>find</u> the total number of objects arranged in rectangular arrays with up to 5 rows and up to 5 columns; <u>write</u> an equation to express the total as a sum of equal addends.	✓		
2.NBT.A.1	<u>Understand</u> that the three digits of a three-digit number represent amounts of hundreds, tens, and ones; e.g., 706 equals 7 hundreds, 0 tens, and 6 ones. Understand the following as special cases:	✓		
2.NBT.A.1a	100 can be thought of as a bundle of ten tens — called a “hundred.”	✓		
2.NBT.A.1b	The numbers 100, 200, 300, 400, 500, 600, 700, 800, 900 refer to one, two, three, four, five, six, seven, eight, or nine hundreds (and 0 tens and 0 ones).	✓		
2.NBT.A.2	<u>Count</u> within 1000; <u>skip-count</u> by 5s, 10s, and 100s.		✓	
2.NBT.A.3	<u>Read and write</u> numbers to 1000 using base-ten numerals, number names, and expanded form.	✓	✓	
2.NBT.A.4	<u>Compare</u> two three-digit numbers based on meanings of the hundreds, tens, and ones digits, using $>$, $=$, and $<$ symbols to record the results of comparisons.	✓		
2.NBT.B.5	<u>Fluently</u> add and subtract within 100 <u>using strategies</u> based on place value, properties of operations, and/or the relationship between addition and subtraction.		✓	
2.NBT.B.6	<u>Add</u> up to four two-digit numbers <u>using strategies</u> based on place value and properties of operations.	✓	✓	
2.NBT.B.7	<u>Add and subtract</u> within 1000, <u>using</u> concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; <u>justify</u> the reasoning used with a written explanation. <u>Understand</u> that in adding or subtracting three- digit numbers, one adds or subtracts hundreds and hundreds, tens and tens, ones and ones; and sometimes it is necessary to compose or decompose tens or hundreds.	✓	✓	
2.NBT.B.8	<u>Mentally add</u> 10 or 100 to a given number 100–900, and <u>mentally subtract</u> 10 or 100 from a given number 100–900.	✓		

LSSM – 2 nd Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
2.NBT.B.9	<u>Explain</u> why addition and subtraction strategies work, using place value and the properties of operations.	✓		
2.MD.A.1	<u>Measure</u> the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.		✓	
2.MD.A.2	<u>Measure</u> the length of an object twice, using length units of different lengths for the two measurements; <u>describe</u> how the two measurements relate to the size of the unit chosen.	✓	✓	
2.MD.A.3	<u>Estimate</u> lengths using units of inches, feet, centimeters, and meters.	✓		
2.MD.A.4	<u>Measure</u> to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.		✓	
2.MD.B.5	Use addition and subtraction within 100 to solve <u>word problems</u> involving lengths that are given in the same units, e.g., by using drawings (such as drawings of rulers) and equations with a symbol for the unknown number to represent the problem.			✓
2.MD.B.6	<u>Represent</u> whole numbers as lengths from 0 on a number line diagram with equally spaced points corresponding to the numbers 0, 1, 2, ..., and <u>represent</u> whole-number sums and differences within 100 on a number line diagram.	✓		
2.MD.C.7	<u>Tell and write</u> time from analog and digital clocks to the nearest five minutes, using a.m. and p.m.	✓	✓	
2.MD.C.8	Solve <u>word problems</u> involving dollar bills, quarters, dimes, nickels, and pennies, using \$ and ¢ symbols appropriately. <i>Example: If you have 2 dimes and 3 pennies, how many cents do you have?</i>			✓
2.MD.D.9	<u>Generate</u> measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. <u>Show</u> the measurements by making a line plot, where the horizontal scale is marked off in whole-number units.		✓	
2.MD.D.10	<u>Draw</u> a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. <u>Solve</u> simple put-together, take-apart, and compare problems using information presented in a bar graph.		✓	✓
2.G.A.1	<u>Recognize and draw</u> shapes having specified attributes, such as a given number of angles or a given number of equal faces. <u>Identify</u> triangles, quadrilaterals, pentagons, hexagons, and cubes.	✓	✓	
2.G.A.2	<u>Partition</u> a rectangle into rows and columns of same-size squares and <u>count</u> to find the total number of them.	✓	✓	
2.G.A.3	<u>Partition</u> circles and rectangles into two, three, or four equal shares, <u>describe</u> the shares using the words halves, thirds, half of, a third of, etc., and <u>describe</u> the whole as two halves, three thirds, four fourths. <u>Recognize</u> that equal shares of identical wholes need not have the same shape.	✓	✓	

3rd Grade

LSSM – 3 rd Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
3.OA.A.1	<u>Interpret</u> products of whole numbers, e.g., interpret 5×7 as the total number of objects in 5 groups of 7 objects each. <i>For example, describe a context in which a total number of objects can be expressed as 5×7.</i>	✓		
3.OA.A.2	<u>Interpret</u> whole-number quotients of whole numbers, e.g., interpret $56 \div 8$ as the number of objects in each share when 56 objects are partitioned equally into 8 shares, or as a number of shares when 56 objects are partitioned into equal shares of 8 objects each. <i>For example, describe a context in which a number of shares or a number of groups can be expressed as $56 \div 8$</i>	✓		
3.OA.A.3	Use multiplication and division within 100 to solve <u>word problems</u> in situations involving equal groups, arrays, and measurement quantities, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.			✓
3.OA.A.4	<u>Determine</u> the unknown whole number in a multiplication or division equation relating three whole numbers. <i>For example, determine the unknown number that makes the equation true in each of the equations $8 \times ? = 48$, $5 = _ \div 3$, $6 \times 6 = ?$</i>	✓		
3.OA.B.5	<u>Apply properties of operations as strategies</u> to multiply and divide. ² <i>Examples: If $6 \times 4 = 24$ is known, then $4 \times 6 = 24$ is also known. (Commutative property of multiplication.) $3 \times 5 \times 2$ can be found by $3 \times 5 = 15$, then $15 \times 2 = 30$, or by $5 \times 2 = 10$, then $3 \times 10 = 30$. (Associative property of multiplication.) Knowing that $8 \times 5 = 40$ and $8 \times 2 = 16$, one can find 8×7 as $8 \times (5 + 2) = (8 \times 5) + (8 \times 2) = 40 + 16 = 56$. (Distributive property.)</i>	✓		
3.OA.B.6	<u>Understand</u> division as an unknown-factor problem. <i>For example, find $32 \div 8$ by finding the number that makes 32 when multiplied by 8.</i>	✓		
3.OA.C.7	<u>Fluently</u> multiply and divide within 100, using <u>strategies</u> such as the relationship between multiplication and division (e.g., knowing that $8 \times 5 = 40$, one knows $40 \div 5 = 8$) or properties of operations. By the end of Grade 3, <u>know from memory</u> all products of two one-digit numbers.		✓	
3.OA.D.8	Solve two-step <u>word problems</u> using the four operations. <u>Represent</u> these problems using equations with a letter standing for the unknown quantity. <u>Assess</u> the reasonableness of answers using mental computation and estimation strategies including rounding.	✓		✓
3.OA.D.9	<u>Identify</u> arithmetic patterns (including patterns in the addition table or multiplication table), and <u>explain</u> them using properties of operations. <i>For example, observe that 4 times a number is always even, and explain why 4 times a number can be decomposed into two equal addends.</i>	✓		
3.NBT.A.1	<u>Use place value understanding</u> to round whole numbers to the nearest 10 or 100.	✓		

LSSM – 3 rd Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
3.NBT.A.2	<u>Fluently</u> add and subtract within 1000 <u>using strategies and algorithms</u> based on place value, properties of operations, and/or the relationship between addition and subtraction.		✓	
3.NBT.A.3	<u>Multiply</u> one-digit whole numbers by multiples of 10 in the range 10–90 (e.g., 9×80 , 5×60) <u>using strategies</u> based on place value and properties of operations.	✓	✓	
3.NF.A.1	<u>Understand</u> a fraction $1/b$, with denominators 2, 3, 4, 6, and 8, as the quantity formed by 1 part when a whole is partitioned into b equal parts; understand a fraction a/b as the quantity formed by a parts of size $1/b$.	✓		
3.NF.A.2	<u>Understand</u> a fraction with denominators 2, 3, 4, 6, and 8 as a number on a number line diagram.	✓		
3.NF.A.2a	<u>Represent</u> a fraction $1/b$ on a number line diagram by defining the interval from 0 to 1 as the whole and partitioning it into b equal parts. <u>Recognize</u> that each part has size $1/b$ and that the endpoint of the part based at 0 locates the number $1/b$ on the number line.	✓		
3.NF.A.2b	<u>Represent</u> a fraction a/b on a number line diagram by marking off a lengths $1/b$ from 0. <u>Recognize</u> that the resulting interval has size a/b and that its endpoint locates the number a/b on the number line.	✓		
3.NF.A.3	<u>Explain</u> equivalence of fractions with denominators 2, 3, 4, 6, and 8 in special cases, and <u>compare</u> fractions by reasoning about their size.	✓		
3.NF.A.3a	<u>Understand</u> two fractions as equivalent (equal) if they are the same size, or the same point on a number line.	✓		
3.NF.A.3b	<u>Recognize and generate</u> simple equivalent fractions, e.g., $1/2 = 2/4$, $4/6 = 2/3$. <u>Explain</u> why the fractions are equivalent, e.g., by using a visual fraction model.	✓		
3.NF.A.3c	<u>Express</u> whole numbers as fractions, and <u>recognize</u> fractions that are equivalent to whole numbers. <i>Examples: Express 3 in the form $3 = 3/1$; recognize that $6/1 = 6$; locate $4/4$ and 1 at the same point of a number line diagram.</i>	✓		
3.NF.A.3d	<u>Compare</u> two fractions with the same numerator or the same denominator by reasoning about their size. <u>Recognize</u> that comparisons are valid only when the two fractions refer to the same whole. <u>Record</u> the results of comparisons with the symbols $>$, $=$, or $<$, and justify the conclusions, e.g., by using a visual fraction model.	✓		
3.MD.A.1	<u>Understand</u> time to the nearest minute.	✓		
3.MD.A.1a	<u>Tell and write</u> time to the nearest minute and <u>measure</u> time intervals in minutes, within 60 minutes, on an analog and digital clock.	✓	✓	
3.MD.A.1b	<u>Calculate</u> elapsed time greater than 60 minutes to the nearest quarter and half hour on a number line diagram.		✓	
3.MD.A.1c	Solve <u>word problems</u> involving addition and subtraction of time intervals in minutes, e.g., by representing the problem on a number line diagram.			✓

3.MD.A.2	Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.	✓	✓	✓
3.MD.B.3	Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step “how many more” and “how many less” problems using information presented in scaled bar graphs. For example, draw a bar graph in which each square in the bar graph might represent 5 pets.		✓	✓
3.MD.B.4	Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units— whole numbers, halves, or quarters.	✓	✓	
3.MD.C.5	Recognize area as an attribute of plane figures and understand concepts of area measurement.	✓		
3.MD.C.5a	A square with side length 1 unit, called “a unit square,” is said to have “one square unit” of area, and can be used to measure area.	✓		
3.MD.C.5b	A plane figure which can be covered without gaps or overlaps by n unit squares is said to have an area of n square units.	✓		
3.MD.C.6	Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).		✓	
3.MD.C.7	Relate area to the operations of multiplication and addition.	✓		
3.MD.C.7a	Find the area of a rectangle with whole-number side lengths by tiling it, and show that the area is the same as would be found by multiplying the side lengths.	✓	✓	
3.MD.C.7b	Multiply side lengths to find areas of rectangles with whole- number side lengths in the context of solving real-world and mathematical problems, and represent whole-number products as rectangular areas in mathematical reasoning.	✓	✓	✓
3.MD.C.7c	Use tiling to show in a concrete case that the area of a rectangle with whole-number side lengths a and $b + c$ is the sum of $a \times b$ and $a \times c$. Use area models to represent the distributive property in mathematical reasoning.	✓		
3.MD.D.8	Solve real-world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.		✓	✓
3.MD.E.9	Solve word problems involving pennies, nickels, dimes, quarters, and bills greater than one dollar, using the dollar and cent symbols appropriately.			✓

3.G.A.1	<p><u>Understand</u> that shapes in different categories (e.g., rhombuses, rectangles, and others) may share attributes (e.g., having four sides), and that the shared attributes can define a larger category (e.g., quadrilaterals). <u>Recognize</u> rhombuses, rectangles, and squares as examples of quadrilaterals, and <u>draw</u> examples of quadrilaterals that do not belong to any of these subcategories.</p>	✓	✓	
3.G.A.2	<p><u>Partition</u> shapes into parts with equal areas. <u>Express</u> the area of each part as a unit fraction of the whole. <i>For example, partition a shape into 4 parts with equal area, and describe the area of each part as 1/4 of the area of the shape.</i></p>	✓	✓	

4th Grade

LSSM – 4 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
4.OA.A.1	<u>Interpret</u> a multiplication equation as a comparison and <u>represent</u> verbal statements of multiplicative comparisons as multiplication equations, e.g., interpret $35 = 5 \times 7$ as a statement that 35 is 5 times as many as 7, and 7 times as many as 5.	✓		
4.OA.A.2	Multiply or divide to solve <u>word problems</u> involving multiplicative comparison, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem, distinguishing multiplicative comparison from additive comparison (Example: 6 times as many vs. 6 more than).			✓
4.OA.A.3	Solve multi-step <u>word problems</u> posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. <u>Represent</u> these problems using equations with a letter standing for the unknown quantity. <u>Assess</u> the reasonableness of answers using mental computation and estimation strategies including rounding. <i>Example: Twenty-five people are going to the movies. Four people fit in each car. How many cars are needed to get all 25 people to the theater at the same time?</i>	✓		✓
4.OA.B.4	Using whole numbers in the range 1–100,			
4.OA.B.4a	<u>Find</u> all factor pairs for a given whole number.		✓	
4.OA.B.4b	<u>Recognize</u> that a given whole number is a multiple of each of its factors.	✓		
4.OA.B.4c	<u>Determine</u> whether a given whole number is a multiple of a given one-digit number.	✓		
4.OA.B.4d	<u>Determine</u> whether a given whole number is prime or composite.	✓		
4.OA.C.5	<u>Generate</u> a number or shape pattern that follows a given rule. <u>Identify</u> apparent features of the pattern that were not explicit in the rule itself. <i>For example, given the rule "Add 3" and the starting number 1, generate terms in the resulting sequence and observe that the terms appear to alternate between odd and even numbers. Explain informally why the numbers will continue to alternate in this way.</i>	✓	✓	
4.NBT.A.1	<u>Recognize</u> that in a multi-digit whole number less than or equal to 1,000,000, a digit in one place represents ten times what it represents in the place to its right. <i>Examples: (1) recognize that $700 \div 70 = 10$; (2) in the number 7,246, the 2 represents 200, but in the number 7,426 the 2 represents 20, recognizing that 200 is ten times as large as 20, by applying concepts of place value and division.</i>	✓		
4.NBT.A.2	<u>Read and write</u> multi-digit whole numbers less than or equal to 1,000,000 using base-ten numerals, number names, and expanded form. <u>Compare</u> two multi-digit numbers based on meanings of the digits in each place, using $>$, $=$, and $<$ symbols to record the results of comparisons.	✓	✓	
4.NBT.A.3	<u>Use place value understanding</u> to round multi-digit whole numbers, less than or equal to 1,000,000, to any place.	✓		
4.NBT.B.4	<u>Fluently</u> add and subtract multi-digit whole numbers, with sums less than or equal to 1,000,000, <u>using</u> the standard algorithm.		✓	

LSSM – 4 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
4.NBT.B.5	Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.	✓	✓	
4.NBT.B.6	Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.	✓	✓	
4.NF.A.1	Explain why a fraction a/b is equivalent to a fraction $(n \times a)/(n \times b)$ by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions. (Denominators are limited to 2, 3, 4, 5, 6, 8, 10, 12, and 100.)	✓	✓	
4.NF.A.2	Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as $1/2$. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols $>$, $=$, or $<$, and justify the conclusions, e.g., by using a visual fraction model. (Denominators are limited to 2, 3, 4, 5, 6, 8, 10, 12, and 100.)	✓		
4.NF.B.3	Understand a fraction a/b with $a > 1$ as a sum of fractions $1/b$. (Denominators are limited to 2, 3, 4, 5, 6, 8, 10, 12, and 100.)	✓		
4.NF.B.3a	Understand addition and subtraction of fractions as joining and separating parts referring to the same whole. Example: $3/4 = 1/4 + 1/4 + 1/4$.	✓		
4.NF.B.3b	Decompose a fraction into a sum of fractions with the same denominator in more than one way, recording each decomposition by an equation. Justify decompositions, e.g., by using a visual fraction model. Examples: $3/8 = 1/8 + 1/8 + 1/8$; $3/8 = 1/8 + 2/8$; $2 \frac{1}{8} = 1 + 1 + 1/8 = 8/8 + 8/8 + 1/8$.	✓		
4.NF.B.3c	Add and subtract mixed numbers with like denominators, e.g., by replacing each mixed number with an equivalent fraction, and/or by using properties of operations and the relationship between addition and subtraction.		✓	
4.NF.B.3d	Solve word problems involving addition and subtraction of fractions referring to the same whole and having like denominators, e.g., by using visual fraction models and equations to represent the problem.			✓
4.NF.B.4	Multiply a fraction by a whole number. (Denominators are limited to 2, 3, 4, 5, 6, 8, 10, 12, and 100.)		✓	
4.NF.B.4a	Understand a fraction a/b as a multiple of $1/b$. For example, use a visual fraction model to represent $5/4$ as the product $5 \times (1/4)$, recording the conclusion by the equation $5/4 = 5 \times (1/4)$.	✓		
4.NF.B.4b	Understand a multiple of a/b as a multiple of $1/b$, and use this understanding to multiply a fraction by a whole number. For example, use a visual fraction model to express $3 \times (2/5)$ as $6 \times (1/5)$, recognizing this product as $6/5$. (In general, $n \times (a/b) = (n \times a)/b$.)	✓	✓	

4.NF.B.4c	Solve <u>word problems</u> involving multiplication of a fraction by a whole number, e.g., by using visual fraction models and equations to represent the problem. <i>For example, if each person at a party will eat $\frac{3}{8}$ of a pound of roast beef, and there will be 5 people at the party, how many pounds of roast beef will be needed? Between what two whole numbers does your answer lie?</i>			✓
4.NF.C.5	<u>Express</u> a fraction with denominator 10 as an equivalent fraction with denominator 100, and use this technique to <u>add</u> two fractions with respective denominators 10 and 100. <i>For example, express $\frac{3}{10}$ as $\frac{30}{100}$, and add $\frac{3}{10} + \frac{4}{100} = \frac{34}{100}$.</i>	✓	✓	
4.NF.C.6	Use <u>decimal notation</u> for fractions with denominators 10 or 100. <i>For example, rewrite 0.62 as $\frac{62}{100}$; describe a length as 0.62 meters; locate 0.62 on a number line diagram; represent $\frac{62}{100}$ of a dollar as \$0.62.</i>		✓	
4.NF.C.7	<u>Compare</u> two decimals to hundredths by reasoning about their size. <u>Recognize</u> that comparisons are valid only when the two decimals refer to the same whole. <u>Record</u> the results of comparisons with the symbols $>$, $=$, or $<$, and justify the conclusions, e.g., by using a visual model.	✓		
4.MD.A.1	<u>Know</u> relative sizes of measurement units within one system of units including: ft, in; km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, <u>express</u> measurements in a larger unit in terms of a smaller unit. (Conversions are limited to one-step conversions.) <u>Record</u> measurement equivalents in a two-column table. <i>For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...</i>	✓	✓	
4.MD.A.2	Use the four operations to solve <u>word problems</u> involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving whole numbers and/or simple fractions (addition and subtraction of fractions with like denominators and multiplying a fraction times a fraction or a whole number), and problems that require expressing measurements given in a larger unit in terms of a smaller unit. <u>Represent</u> measurement quantities using diagrams such as number line diagrams that feature a measurement scale.	✓		✓
4.MD.A.3	Apply the area and perimeter formulas for rectangles in <u>real-world and mathematical problems</u> . <i>For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor.</i>		✓	✓
4.MD.B.4	<u>Make</u> a line plot to display a data set of measurements in fractions of a unit ($\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$). <u>Solve problems</u> involving addition and subtraction of fractions by using information presented in line plots. <i>For example, from a line plot find and interpret the difference in length between the longest and shortest specimens in an insect collection.</i>		✓	✓
4.MD.C.5	<u>Recognize</u> angles as geometric shapes that are formed wherever two rays share a common endpoint, and <u>understand</u> concepts of angle measurement.	✓		
4.MD.C.5a	An angle is measured with reference to a circle with its center at the common endpoint of the rays, by considering the fraction of the circular arc between the points where the two rays intersect the circle	✓		

4.MD.C.5b	An angle that turns through $1/360$ of a circle is called a "one-degree angle," and can be used to measure angles.	✓		
4.MD.C.5c	An angle that turns through n one-degree angles is said to have an angle measure of n degrees.	✓		
4.MD.C.6	<u>Measure</u> angles in whole-number degrees using a protractor. <u>Sketch</u> angles of specified measure.		✓	
4.MD.C.7	<u>Recognize</u> angle measure as additive. When an angle is decomposed into non-overlapping parts, the angle measure of the whole is the sum of the angle measures of the parts. Solve addition and subtraction problems to find unknown angles on a diagram in <u>real-world and mathematical problems</u> , e.g., by using an equation with a letter for the unknown angle measure.	✓	✓	✓
4.MD.D.8	<u>Recognize</u> area as additive. <u>Find</u> areas of rectilinear figures <u>by decomposing</u> them into non-overlapping rectangles <u>and adding</u> the areas of the non-overlapping parts, applying this technique to solve <u>real-world problems</u> .	✓	✓	✓
4.G.A.1	<u>Draw</u> points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. <u>Identify</u> these in two-dimensional figures.	✓	✓	
4.G.A.2	<u>Classify</u> two-dimensional figures based on the presence or absence of parallel or perpendicular lines, or the presence or absence of angles of a specified size. <u>Recognize</u> right triangles as a category, and <u>identify</u> right triangles		✓	
4.G.A.3	<u>Recognize</u> a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. <u>Identify</u> line-symmetric figures and <u>draw</u> lines of symmetry.	✓	✓	

5th Grade

LSSM – 5 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
5.OA.A.1	Use parentheses or brackets in numerical expressions, and <u>evaluate</u> expressions with these symbols.	✓	✓	
5.OA.A.2	<u>Write</u> simple expressions that record calculations with whole numbers, fractions and decimals, and <u>interpret</u> numerical expressions without evaluating them. <i>For example, express the calculation "add 8 and 7, then multiply by 2" as $2 \times (8 + 7)$. Recognize that $3 \times (18,932 + 9.21)$ is three times as large as $18,932 + 9.21$, without having to calculate the indicated sum or product.</i>	✓		
5.OA.B.3	<u>Generate</u> two numerical patterns using two given rules. <u>Identify</u> apparent relationships between corresponding terms. <u>Form</u> ordered pairs consisting of corresponding terms from the two patterns, and <u>graph</u> the ordered pairs on a coordinate plane. <i>For example, given the rule "Add 3" and the starting number 0, and given the rule "Add 6" and the starting number 0, generate terms in the resulting sequences, and observe that the terms in one sequence are twice the corresponding terms in the other sequence. Explain informally why this is so.</i>	✓	✓	
5.NBT.A.1	<u>Recognize</u> that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left.	✓		
5.NBT.A.2	<u>Explain and apply</u> patterns in the number of zeros of the product when multiplying a number by powers of 10. <u>Explain and apply</u> patterns in the values of the digits in the product or the quotient, when a decimal is multiplied or divided by a power of 10. <u>Use</u> whole-number exponents to denote powers of 10. <i>For example, $10^0 = 1$, $10^1 = 10$... and $2.1 \times 10^2 = 210$.</i>	✓	✓	
5.NBT.A.3	<u>Read, write, and compare</u> decimals to thousandths.	✓	✓	
5.NBT.A.3a	<u>Read and write</u> decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., $347.392 = 3 \times 100 + 4 \times 10 + 7 \times 1 + 3 \times (1/10) + 9 \times (1/100) + 2 \times (1/1000)$.	✓	✓	
5.NBT.A.3b	<u>Compare</u> two decimals to thousandths based on meanings of the digits in each place, using $>$, $=$, and $<$ symbols to record the results of comparisons.	✓		
5.NBT.A.4	<u>Use place value understanding to round</u> decimals to any place.	✓	✓	
5.NBT.B.5	Fluently multiply multi-digit whole numbers <u>using the standard algorithm</u> .		✓	
5.NBT.B.6	<u>Find</u> whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, <u>using strategies</u> based on place value, the properties of operations, subtracting multiples of the divisor, and/or the relationship between multiplication and division. <u>Illustrate and/or explain</u> the calculation by using equations, rectangular arrays, area models, or other strategies based on place value.	✓	✓	

LSSM – 5 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
5.NBT.B.7	Add, subtract, multiply, and divide decimals to hundredths, <u>using</u> concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; <u>justify</u> the reasoning used with a written explanation.	✓	✓	
5.NF.A.1	<u>Add and subtract</u> fractions with unlike denominators (including mixed numbers) <u>by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators</u> . For example, $2/3 + 5/4 = 8/12 + 15/12 = 23/12$. (In general, $a/b + c/d = (ad + bc)/bd$.)	✓	✓	
5.NF.A.2	Solve <u>word problems</u> involving addition and subtraction of fractions.			✓
5.NF.A.2a	Solve <u>word problems</u> involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem.			✓
5.NF.A.2b	Use benchmark fractions and number sense of fractions to <u>estimate mentally and justify</u> the reasonableness of answers. For example, recognize an incorrect result $2/5 + 1/2 = 3/7$, by observing that $3/7 < 1/2$.	✓		
5.NF.B.3	<u>Interpret</u> a fraction as division of the numerator by the denominator ($a/b = a \div b$). Solve <u>word problems</u> involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. For example, interpret $3/4$ as the result of dividing 3 by 4, noting that $3/4$ multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size $3/4$. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?	✓		✓
5.NF.B.4	<u>Apply and extend previous understandings</u> of multiplication to <u>multiply</u> a fraction or whole number by a fraction.	✓	✓	
5.NF.B.4a	<u>Interpret</u> the product $(m/n) \times q$ as m parts of a partition of q into n equal parts; equivalently, as the result of a sequence of operations, $m \times q \div n$. For example, use a visual fraction model to show understanding, and create a story context for $(m/n) \times q$.	✓		
5.NF.B.4b	<u>Construct</u> a model to develop understanding of the concept of multiplying two fractions and <u>create</u> a story context for the equation. [In general, $(m/n) \times (c/d) = (mc)/(nd)$.]	✓		
5.NF.B.4c	<u>Find</u> the area of a rectangle with fractional side lengths <u>by tiling</u> it with unit squares of the appropriate unit fraction side lengths, and <u>show</u> that the area is the same as would be found by multiplying the side lengths.	✓	✓	
5.NF.B.4d	<u>Multiply</u> fractional side lengths to find areas of rectangles, and <u>represent</u> fraction products as rectangular areas.	✓	✓	

LSSM – 5 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
5.NF.B.5	<u>Interpret</u> multiplication as scaling (resizing)	✓		
5.NF.B.5a	<u>Comparing</u> the size of a product to the size of one factor on the basis of the size of the other factor, without performing the indicated multiplication.	✓		
5.NF.B.5b	<u>Explaining</u> why multiplying a given number by a fraction greater than 1 results in a product greater than the given number (recognizing multiplication by whole numbers greater than 1 as a familiar case).	✓		
5.NF.B.5c	<u>Explaining</u> why multiplying a given number by a fraction less than 1 results in a product smaller than the given number.	✓		
5.NF.B.5d	<u>Relating</u> the principle of fraction equivalence $a/b = (n \times a)/(n \times b)$ to the effect of multiplying a/b by 1.	✓		
5.NF.B.6	Solve <u>real-world problems</u> involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem.			✓
5.NF.B.7	<u>Apply and extend previous understandings</u> of division to <u>divide</u> unit fractions by whole numbers and whole numbers by unit fractions.	✓	✓	
5.NF.B.7a	<u>Interpret</u> division of a unit fraction by a non-zero whole number, and <u>compute</u> such quotients. For example, create a story context for $(1/3) \div 4$, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that $(1/3) \div 4 = 1/12$ because $(1/12) \times 4 = 1/3$.	✓	✓	
5.NF.B.7b	<u>Interpret</u> division of a whole number by a unit fraction, and <u>compute</u> such quotients. For example, create a story context for $4 \div (1/5)$, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that $4 \div (1/5) = 20$ because $20 \times (1/5) = 4$.	✓	✓	
5.NF.B.7c	Solve <u>real-world problems</u> involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions, e.g., by using visual fraction models and equations to represent the problem. For example, how much chocolate will each person get if 3 people share $1/2$ lb of chocolate equally? How many $1/3$ -cup servings are in 2 cups of raisins?			✓
5.MD.A.1	<u>Convert</u> among different-sized standard measurement units within a given measurement and use these conversions in solving <u>multi-step, real-world problems</u> (e.g., convert 5 cm to 0.05 m; 9 ft to 108 in).		✓	✓
5.MD.B.2	<u>Make</u> a line plot to display a data set of measurements in fractions of a unit ($1/2, 1/4, 1/8$). Use operations on fractions for this grade to <u>solve problems</u> involving information presented in line plots. For example, given different measurements of liquid in identical beakers, find the amount of liquid each beaker would contain if the total amount in all the beakers were redistributed equally.		✓	✓
5.MD.C.3	<u>Recognize</u> volume as an attribute of solid figures and <u>understand</u> concepts of volume measurement.	✓		
5.MD.C.3a	A cube with side length 1 unit, called a "unit cube," is said to have "one cubic unit" of volume, and can be used to measure volume.	✓		

LSSM – 5 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
5.MD.C.3b	A solid figure which can be packed without gaps or overlaps using n unit cubes is said to have a volume of n cubic units.	✓		
5.MD.C.4	<u>Measure</u> volumes <u>by counting</u> unit cubes, using cubic cm, cubic in, cubic ft, and improvised units.		✓	
5.MD.C.5	<u>Relate</u> volume to the operations of multiplication and addition and solve <u>real-world and mathematical problems</u> involving volume.	✓	✓	✓
5.MD.C.5a	<u>Find</u> the volume of a right rectangular prism with whole-number side lengths <u>by packing</u> it with unit cubes, and <u>show</u> that the volume is the same as would be found by multiplying the edge lengths, equivalently by multiplying the height by the area of the base. <u>Represent</u> threefold whole-number products as volumes, e.g., to represent the associative property of multiplication.	✓	✓	
5.MD.C.5b	Apply the formulas $V = l \times w \times h$ and $V = b \times h$ for rectangular prisms to find volumes of right rectangular prisms with whole-number edge lengths in the context of solving <u>real-world and mathematical problems</u> .		✓	✓
5.MD.C.5c	<u>Recognize</u> volume as additive. <u>Find</u> volumes of solid figures composed of two non-overlapping right rectangular prisms <u>by adding</u> the volumes of the non-overlapping parts, applying this technique to solve <u>real-world problems</u> .	✓	✓	✓
5.G.A.1	Use a pair of perpendicular number lines, called axes, to <u>define</u> a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. <u>Understand</u> that the first number in the ordered pair indicates how far to travel from the origin in the direction of one axis, and the second number in the ordered pair indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., x -axis and x -coordinate, y -axis and y -coordinate).	✓		
5.G.A.2	<u>Represent</u> real-world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and <u>interpret</u> coordinate values of points in the context of the situation.	✓	✓	
5.G.B.3	<u>Understand</u> that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. <i>For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.</i>	✓		
5.G.B.4	<u>Classify</u> quadrilaterals in a hierarchy based on properties. (Students will define a trapezoid as a quadrilateral with at least one pair of parallel sides.)		✓	

6th Grade

LSSM – 6 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
6.RP.A.1	Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."	✓		
6.RP.A.2	Understand the concept of a unit rate a/b associated with a ratio $a:b$ with $b \neq 0$, and use rate language in the context of a ratio relationship. For example, "This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is $3/4$ cup of flour for each cup of sugar." "We paid \$75 for 15 hamburgers, which is a rate of \$5 per hamburger."	✓		
6.RP.A.3	Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.		✓	✓
6.RP.A.3a	Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.	✓	✓	
6.RP.A.3b	Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what unit rate were lawns being mowed?			✓
6.RP.A.3c	Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent.		✓	✓
6.RP.A.3d	Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.	✓	✓	
6.NS.A.1	Interpret and compute quotients of fractions, and solve word problems involving division of fractions by fractions, e.g., by using visual fraction models and equations to represent the problem. For example, create a story context for $(2/3) \div (3/4)$ and use a visual fraction model to show the quotient; use the relationship between multiplication and division to explain that $(2/3) \div (3/4) = 8/9$ because $3/4$ of $8/9$ is $2/3$. (In general, $(a/b) \div (c/d) = ad/bc$.) How much chocolate will each person get if 3 people share $1/2$ lb of chocolate equally? How many $3/4$ -cup servings are in $2/3$ of a cup of yogurt? How wide is a rectangular strip of land with length $3/4$ mi and area $1/2$ square mi?.	✓	✓	✓
6.NS.B.2	Fluently divide multi-digit numbers using the standard algorithm.		✓	
6.NS.B.3	Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.		✓	
6.NS.B.4	Find the greatest common factor of two whole numbers less than or equal to 100 and the least common multiple of two whole numbers less than or equal to 12. Use the distributive property to express a sum of two whole numbers 1-100 with a common factor as a multiple of a sum of two whole numbers with no common factor. For example, express $36 + 8$ as $4(9 + 2)$.		✓	

LSSM – 6 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
6.NS.C.5	<u>Understand</u> that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to <u>represent</u> quantities in real-world contexts, <u>explaining</u> the meaning of 0 in each situation.	✓		
6.NS.C.6	<u>Understand</u> a rational number as a point on the number line. Extend number line diagrams and coordinate axes familiar from previous grades to <u>represent</u> points on the line and in the plane with negative number coordinates.	✓		
6.NS.C.6a	<u>Recognize</u> opposite signs of numbers as indicating locations on opposite sides of 0 on the number line; <u>recognize</u> that the opposite of the opposite of a number is the number itself, e.g., $-(-3) = 3$, and that 0 is its own opposite.	✓		
6.NS.C.6b	<u>Understand</u> signs of numbers in ordered pairs as indicating locations in quadrants of the coordinate plane; <u>recognize</u> that when two ordered pairs differ only by signs, the locations of the points are related by reflections across one or both axes.	✓		
6.NS.C.6c	<u>Find and position</u> integers and other rational numbers on a horizontal or vertical number line diagram; <u>find and position</u> pairs of integers and other rational numbers on a coordinate plane.	✓	✓	
6.NS.C.7	<u>Understand</u> ordering and absolute value of rational numbers.	✓		
6.NS.C.7a	<u>Interpret</u> statements of inequality as statements about the relative position of two numbers on a number line diagram. <i>For example, interpret $-3 > -7$ as a statement that -3 is located to the right of -7 on a number line oriented from left to right.</i>	✓		
6.NS.C.7b	<u>Write, interpret, and explain</u> statements of order for rational numbers in real-world contexts. <i>For example, write $-3^{\circ}\text{C} > -7^{\circ}\text{C}$ to express the fact that -3°C is warmer than -7°C.</i>	✓		
6.NS.C.7c	<u>Understand</u> the absolute value of a rational number as its distance from 0 on the number line; <u>interpret</u> absolute value as magnitude for a positive or negative quantity in a real-world situation. <i>For example, for an account balance of -30 dollars, write $-30 = 30$ to describe the size of the debt in dollars.</i>	✓		
6.NS.C.7d	<u>Distinguish</u> comparisons of absolute value from statements about order. <i>For example, recognize that an account balance less than -30 dollars represents a debt greater than 30 dollars.</i>	✓		
6.NS.C.8	Solve <u>real-world and mathematical problems</u> by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.		✓	✓
6.EE.A.1	<u>Write and evaluate</u> numerical expressions involving whole-number exponents.	✓	✓	
6.EE.A.2	<u>Write, read, and evaluate</u> expressions in which letters stand for numbers.	✓	✓	

LSSM – 6 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
6.EE.A.2a	<u>Write</u> expressions that record operations with numbers and with letters standing for numbers. For example, express the calculation "Subtract y from 5" as $5 - y$.	✓		
6.EE.A.2b	<u>Identify</u> parts of an expression using mathematical terms (sum, term, product, factor, quotient, coefficient); <u>view</u> one or more parts of an expression as a single entity. For example, describe the expression $2(8 + 7)$ as a product of two factors; view $(8 + 7)$ as both a single entity and a sum of two terms.	✓	✓	
6.EE.A.2c	<u>Evaluate</u> expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. <u>Perform</u> arithmetic operations, including those involving whole-number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). For example, use the formulas $V = s^3$ and $A = 6s^2$ to find the volume and surface area of a cube with sides of length $s = 1/2$.		✓	
6.EE.A.3	<u>Apply the properties of operations</u> to <u>generate</u> equivalent expressions. For example, apply the distributive property to the expression $3(2 + x)$ to produce the equivalent expression $6 + 3x$; apply the distributive property to the expression $24x + 18y$ to produce the equivalent expression $6(4x + 3y)$; apply properties of operations to $y + y + y$ to produce the equivalent expression $3y$.	✓	✓	
6.EE.A.4	<u>Identify</u> when two expressions are equivalent (i.e., when the two expressions name the same number regardless of which value is substituted into them). For example, the expressions $y + y + y$ and $3y$ are equivalent because they name the same number regardless of which number y stands for.	✓		
6.EE.B.5	<u>Understand</u> solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? <u>Use substitution</u> to determine whether a given number in a specified set makes an equation or inequality true.	✓	✓	
6.EE.B.6	Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; <u>understand</u> that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.	✓	✓	✓
6.EE.B.7	Solve <u>real-world and mathematical problems</u> by writing and solving equations and inequalities of the form $x + p = q$ and $px = q$ for cases in which p , q and x are all nonnegative rational numbers. Inequalities will include $<$, $>$, \leq , and \geq .		✓	✓
6.EE.B.8	<u>Write</u> an inequality of the form $x > c$ or $x < c$ to represent a constraint or condition in a real-world or mathematical problem. <u>Recognize</u> that inequalities of the form $x > c$ or $x < c$ have infinitely many solutions; <u>represent</u> solutions of such inequalities on number line diagrams.	✓	✓	
6.EE.C.9	<u>Use variables</u> to represent two quantities in a real-world problem that change in relationship to one another; <u>write</u> an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. <u>Analyze</u> the relationship between the dependent and independent variables using graphs and tables, and <u>relate</u> these to the equation. For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation $d = 65t$ to represent the relationship between distance and time.	✓	✓	

6.G.A.1	Find the area of right triangles, other triangles, special quadrilaterals, and polygons <u>by composing</u> into rectangles or <u>decomposing</u> into triangles and other shapes; apply these techniques in the context of solving <u>real-world and mathematical problems</u> .	✓	✓	✓
6.G.A.2	Find the volume of a right rectangular prism with fractional edge lengths <u>by packing</u> it with unit cubes of the appropriate unit fraction edge lengths, and <u>show</u> that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas $V = lwh$ and $V = bh$ to find volumes of right rectangular prisms with fractional edge lengths in the context of solving <u>real-world and mathematical problems</u> .	✓	✓	✓
6.G.A.3	<u>Draw</u> polygons in the coordinate plane given coordinates for the vertices; <u>use coordinates</u> to <u>find</u> the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving <u>real-world and mathematical problems</u> .	✓	✓	✓
6.G.A.4	<u>Represent</u> three-dimensional figures using nets made up of rectangles and triangles, and <u>use the nets</u> to <u>find</u> the surface area of these figures. Apply these techniques in the context of solving <u>real-world and mathematical problems</u> .	✓	✓	✓
6.SP.A.1	<u>Recognize</u> a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. <i>For example, "How old am I?" is not a statistical question, but "How old are the students in my school?" is a statistical question because one anticipates variability in students' ages.</i>	✓		
6.SP.A.2	<u>Understand</u> that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.	✓		
6.SP.A.3	<u>Recognize</u> that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.	✓		
6.SP.B.4	<u>Display</u> numerical data in plots on a number line, including dot plots, histograms, and box plots.		✓	
6.SP.B.5	<u>Summarize</u> numerical data sets in relation to their context, such as by:	✓	✓	
6.SP.B.5a	<u>Reporting</u> the number of observations.	✓		
6.SP.B.5b	<u>Describing</u> the nature of the attribute under investigation, including how it was measured and its units of measurement.	✓		
6.SP.B.5c	<u>Giving</u> quantitative measures of center (median and/or mean) and variability (interquartile range), as well as <u>describing</u> any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.	✓	✓	
6.SP.B.5d	<u>Relating</u> the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.	✓		

7th Grade

LSSM – 7 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
7.RP.A.1	<u>Compute</u> unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. <i>For example, if a person walks 1/2 mile in each 1/4 hour, compute the unit rate as the complex fraction $\frac{1/2}{1/4}$ miles per hour, equivalently 2 miles per hour.</i>		✓	
7.RP.A.2	<u>Recognize and represent</u> proportional relationships between quantities.	✓	✓	
7.RP.A.2a	<u>Decide</u> whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.	✓	✓	
7.RP.A.2b	<u>Identify</u> the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.	✓		
7.RP.A.2c	<u>Represent</u> proportional relationships by equations. <i>For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as $t = pn$.</i>	✓	✓	
7.RP.A.2d	<u>Explain</u> what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points $(0, 0)$ and $(1, r)$ where r is the unit rate.	✓		
7.RP.A.3	Use proportional relationships to solve <u>multi-step ratio and percent problems</u> of simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, and percent error.		✓	✓
7.NS.A.1	<u>Apply and extend previous understandings</u> of addition and subtraction to <u>add and subtract</u> rational numbers; <u>represent</u> addition and subtraction on a horizontal or vertical number line diagram.	✓	✓	
7.NS.A.1a	<u>Describe</u> situations in which opposite quantities combine to make 0. <i>For example, a hydrogen atom has 0 charge because its two constituents are oppositely charged.</i>	✓		
7.NS.A.1b	<u>Understand</u> $p + q$ as the number located a distance $ q $ from p , in the positive or negative direction depending on whether q is positive or negative. <u>Show</u> that a number and its opposite have a sum of 0 (are additive inverses). <u>Interpret</u> sums of rational numbers by describing real-world contexts.	✓		
7.NS.A.1c	<u>Understand</u> subtraction of rational numbers as adding the additive inverse, $p - q = p + (-q)$. <u>Show</u> that the distance between two rational numbers on the number line is the absolute value of their difference, and apply this principle in real-world contexts.	✓		
7.NS.A.1d	<u>Apply properties of operations</u> as strategies to <u>add and subtract</u> rational numbers.	✓	✓	

7.NS.A.2	Apply and extend previous understandings of multiplication and division and of fractions to <u>multiply and divide</u> rational numbers.	✓	✓	
7.NS.A.2a	<u>Understand</u> that multiplication is extended from fractions to rational numbers by requiring that operations continue to satisfy the properties of operations, particularly the distributive property, leading to products such as $(-1)(-1) = 1$ and the rules for multiplying signed numbers. <u>Interpret</u> products of rational numbers by describing real-world contexts.	✓		
7.NS.A.2b	<u>Understand</u> that integers can be divided, provided that the divisor is not zero, and every quotient of integers (with non-zero divisor) is a rational number. If p and q are integers, then $-(p/q) = (-p)/q = p/(-q)$. <u>Interpret</u> quotients of rational numbers by describing real-world contexts.	✓		
7.NS.A.2c	Apply properties of operations as strategies to <u>multiply and divide</u> rational numbers.	✓	✓	
7.NS.A.2d	<u>Convert</u> a rational number to a decimal using long division; <u>know</u> that the decimal form of a rational number terminates in 0s or eventually repeats.	✓	✓	
7.NS.A.3	Solve <u>real-world and mathematical problems</u> involving the four operations with rational numbers.		✓	✓
7.EE.A.1	Apply properties of operations as strategies to <u>add, subtract, factor, and expand</u> linear expressions with rational coefficients to include multiple grouping symbols (e.g., parentheses, brackets, and braces).	✓	✓	
7.EE.A.2	<u>Understand</u> that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. For example, $a + 0.05a = 1.05a$ means that "increase by 5%" is the same as "multiply by 1.05."	✓		
7.EE.B.3	Solve multi-step <u>real-life and mathematical problems</u> posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. <u>Apply properties of operations</u> to <u>calculate</u> with numbers in any form; <u>convert</u> between forms as appropriate; and <u>assess</u> the reasonableness of answers using mental computation and estimation strategies. For example: If a woman making \$25 an hour gets a 10% raise, she will make an additional $1/10$ of her salary an hour, or \$2.50, for a new salary of \$27.50. If you want to place a towel bar $9\frac{3}{4}$ inches long in the center of a door that is $27\frac{1}{2}$ inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.	✓	✓	✓
7.EE.B.4	Use variables to <u>represent</u> quantities in a real-world or mathematical problem, and <u>construct</u> simple equations and inequalities to <u>solve problems</u> by reasoning about the quantities.	✓	✓	✓
7.EE.B.4a	Solve <u>word problems</u> leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p , q , and r are specific rational numbers. Solve equations of these forms <u>fluently</u> . <u>Compare</u> an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?	✓	✓	✓
7.EE.B.4b	Solve <u>word problems</u> leading to inequalities of the form $px + q > r$, $px + q \geq r$, $px + q < r$ or $px + q \leq r$, where p , q , and r are specific rational numbers. <u>Graph</u> the solution set of the inequality and <u>interpret</u> it in the context of the problem. For example: As a salesperson, you are paid \$50 per week plus \$3 per sale. This week you want your pay to be at least \$100. Write an inequality for the number of sales you need to make, and describe the solutions.	✓	✓	✓

7.G.A.1	Solve <u>problems</u> involving scale drawings of geometric figures, including <u>computing</u> actual lengths and areas from a scale drawing and <u>reproducing</u> a scale drawing at a different scale.		✓	✓
7.G.A.2	<u>Draw</u> (freehand, with ruler and protractor, or with technology) geometric shapes with given conditions. (Focus is on triangles from three measures of angles or sides, <u>noticing</u> when the conditions determine one and only one triangle, more than one triangle, or no triangle.)	✓	✓	
7.G.A.3	<u>Describe</u> the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.	✓		
7.G.B.4	<u>Know</u> the formulas for the area and circumference of a circle and use them to <u>solve problems</u> ; <u>give</u> an informal derivation of the relationship between the circumference and area of a circle.	✓	✓	✓
7.G.B.5	<u>Use facts</u> about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to <u>write and solve</u> simple equations for an unknown angle in a figure.	✓	✓	
7.G.B.6	Solve <u>real-world and mathematical problems</u> involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms. (Pyramids limited to surface area only.)		✓	✓
7.SP.A.1	<u>Understand</u> that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. <u>Understand</u> that random sampling tends to produce representative samples and support valid inferences.	✓		
7.SP.A.2	<u>Use data</u> from a random sample to <u>draw inferences</u> about a population with an unknown characteristic of interest. <u>Generate</u> multiple samples (or simulated samples) of the same size <u>to gauge the variation</u> in estimates or predictions. <i>For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.</i>	✓	✓	✓
7.SP.B.3	<u>Informally assess</u> the degree of visual overlap of two numerical data distributions with similar variabilities <u>using quantitative measures</u> of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as <u>describing</u> any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.	✓	✓	
7.SP.B.4	<u>Use measures of center and measures of variability</u> for numerical data from random samples to <u>draw informal comparative inferences</u> about two populations. <i>For example, decide whether the words in a chapter of a seventh-grade science book are generally longer than the words in a chapter of a fourth-grade science book.</i>	✓	✓	✓
7.SP.C.5	<u>Understand</u> that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.	✓		
7.SP.C.6	<u>Approximate</u> the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and <u>predict</u> the approximate relative frequency given the probability. <i>For example, when rolling a number cube 600 times, predict that a 3 or 6 would be rolled roughly 200 times, but probably not exactly 200 times.</i>	✓	✓	

7.SP.C.7	<u>Develop</u> a probability model and <u>use it</u> to find probabilities of events. <u>Compare</u> probabilities from a model to observed frequencies; if the agreement is not good, <u>explain</u> possible sources of the discrepancy.	✓	✓	
7.SP.C.7a	<u>Develop</u> a uniform probability model by assigning equal probability to all outcomes, and <u>use the model</u> to determine probabilities of events. <i>For example, if a student is selected at random from a class, find the probability that Jane will be selected and the probability that a girl will be selected.</i>	✓	✓	
7.SP.C.7b	<u>Develop</u> a probability model (which may not be uniform) by observing frequencies in data generated from a chance process. <i>For example, find the approximate probability that a spinning penny will land heads up or that a tossed paper cup will land open-end down. Do the outcomes for the spinning penny appear to be equally likely based on the observed frequencies?</i>	✓	✓	
7.SP.C.8	<u>Find</u> probabilities of compound events <u>using</u> organized lists, tables, tree diagrams, and simulation.	✓	✓	✓
7.SP.C.8a	<u>Understand</u> that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.	✓		
7.SP.C.8b	<u>Represent</u> sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language (e.g., "rolling double sixes"), <u>identify</u> the outcomes in the sample space which compose the event.	✓	✓	
7.SP.C.8c	<u>Design and use</u> a simulation to generate frequencies for compound events. <i>For example, use random digits as a simulation tool to approximate the answer to the question: If 40% of donors have type A blood, what is the probability that it will take at least 4 donors to find one with type A blood?</i>	✓	✓	✓

8th Grade

LSSM – 8 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
8.NS.A.1	<u>Know</u> that numbers that are not rational are called irrational. <u>Understand</u> informally that every number has a decimal expansion; for rational numbers <u>show</u> that the decimal expansion repeats eventually. <u>Convert</u> a decimal expansion which repeats eventually into a rational number by analyzing repeating patterns.	✓	✓	
8.NS.A.2	<u>Use rational approximations</u> of irrational numbers to <u>compare</u> the size of irrational numbers, <u>locate</u> them approximately on a number line diagram, and <u>estimate</u> the value of expressions (e.g., π^2). <i>For example, by truncating the decimal expansion of $\sqrt{2}$, show that $\sqrt{2}$ is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations to the hundredths place.</i>	✓	✓	
8.EE.A.1	<u>Know and apply</u> the properties of integer exponents to <u>generate</u> equivalent numerical expressions. <i>For example, $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$.</i>	✓	✓	
8.EE.A.2	<u>Use square root and cube root symbols</u> to <u>represent</u> solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. <u>Evaluate</u> square roots of small perfect squares and cube roots of small perfect cubes. <u>Know</u> that $\sqrt{2}$ is irrational.	✓	✓	
8.EE.A.3	<u>Use numbers expressed in the form of a single digit times an integer power of 10</u> to <u>estimate</u> very large or very small quantities, and to <u>express</u> how many times as much one is than the other. <i>For example, estimate the population of the United States as 3 times 10^8 and the population of the world as 7 times 10^9, and determine that the world population is more than 20 times larger.</i>	✓	✓	
8.EE.A.4	<u>Perform operations</u> with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. <u>Use scientific notation and choose units</u> of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). <u>Interpret</u> scientific notation that has been generated by technology.	✓	✓	
8.EE.B.5	<u>Graph</u> proportional relationships, <u>interpreting</u> the unit rate as the slope of the graph. <u>Compare</u> two different proportional relationships represented in different ways. <i>For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.</i>	✓	✓	✓
8.EE.B.6	<u>Use similar triangles</u> to <u>explain</u> why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; <u>derive</u> the equation $y = mx$ for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at b .	✓		
8.EE.C.7	<u>Solve</u> linear equations in one variable.		✓	

LSSM – 8 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
8.EE.C.7a	Give <u>examples</u> of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case <u>by successively transforming</u> the given equation into simpler forms, until an equivalent equation of the form $x = a$, $a = a$, or $a = b$ results (where a and b are different numbers).	✓	✓	
8.EE.C.7b	<u>Solve</u> linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.		✓	
8.EE.C.8	<u>Analyze and solve</u> pairs of simultaneous linear equations.	✓	✓	
8.EE.C.8a	<u>Understand</u> that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.	✓		
8.EE.C.8b	<u>Solve</u> systems of two linear equations in two variables algebraically, and <u>estimate</u> solutions by graphing the equations. Solve simple cases <u>by inspection</u> . For example, $3x + 2y = 5$ and $3x + 2y = 6$ have no solution because $3x + 2y$ cannot simultaneously be 5 and 6.	✓	✓	
8.EE.C.8c	Solve <u>real-world and mathematical problems</u> leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.		✓	✓
8.F.A.1	<u>Understand</u> that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. (Function notation is not required in this grade level.)	✓		
8.F.A.2	<u>Compare</u> properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.	✓		✓
8.F.A.3	<u>Interpret</u> the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; <u>categorize</u> functions as linear or nonlinear when given equations, graphs, or tables. For example, the function $A = s^2$ giving the area of a square as a function of its side length is not linear because its graph contains the points $(1, 1)$, $(2, 4)$ and $(3, 9)$, which are not on a straight line.	✓	✓	
8.F.B.4	<u>Construct</u> a function to model a linear relationship between two quantities. <u>Determine</u> the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. <u>Interpret</u> the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.	✓	✓	
8.F.B.5	<u>Describe qualitatively</u> the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). <u>Sketch</u> a graph that exhibits the qualitative features of a function that has been described verbally.	✓		
8.G.A.1	<u>Verify experimentally</u> the properties of rotations, reflections, and translations:	✓		
8.G.A.1a	Lines are taken to lines, and line segments to line segments of the same length.	✓		

LSSM – 8 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
8.G.A.1b	Angles are taken to angles of the same measure.	✓		
8.G.A.1c	Parallel lines are taken to parallel lines.	✓		
8.G.A.2	<u>Explain</u> that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, <u>describe</u> a sequence that exhibits the congruence between them. (Rotations are only about the origin and reflections are only over the <i>y</i> -axis and <i>x</i> -axis in Grade 8.)	✓	✓	
8.G.A.3	<u>Describe</u> the effect of dilations, translations, rotations, and reflections on two-dimensional figures <u>using coordinates</u> . (Rotations are only about the origin, dilations only use the origin as the center of dilation, and reflections are only over the <i>y</i> -axis and <i>x</i> -axis in Grade 8.)	✓		
8.G.A.4	<u>Explain</u> that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, <u>describe</u> a sequence that exhibits the similarity between them. (Rotations are only about the origin, dilations only use the origin as the center of dilation, and reflections are only over the <i>y</i> -axis and <i>x</i> -axis in Grade 8.)	✓	✓	
8.G.A.5	<u>Use informal arguments</u> to <u>establish facts</u> about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. <i>For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.</i>	✓		
8.G.B.6	<u>Explain</u> a proof of the Pythagorean Theorem and its converse using the area of squares.	✓		
8.G.B.7	Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in <u>real-world and mathematical problems</u> in two and three dimensions.		✓	✓
8.G.B.8	<u>Apply the Pythagorean Theorem</u> to <u>find</u> the distance between two points in a coordinate system.		✓	
8.G.C.9	<u>Know</u> the formulas for the volumes of cones, cylinders, and spheres and use them to solve <u>real-world and mathematical problems</u> .	✓	✓	✓
8.SP.A.1	<u>Construct and interpret</u> scatter plots for bivariate measurement data to investigate patterns of association between two quantities. <u>Describe</u> patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.	✓	✓	
8.SP.A.2	<u>Know</u> that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, <u>informally fit</u> a straight line, and <u>informally assess</u> the model fit by judging the closeness of the data points to the line.	✓		

LSSM – 8 th Grade		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
8.SP.A.3	<u>Use the equation of a linear model to solve problems</u> in the context of bivariate measurement data, <u>interpreting</u> the slope and intercept. <i>For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.</i>	✓		✓
8.SP.A.4	<u>Understand</u> that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. <u>Construct and interpret</u> a two-way table summarizing data on two categorical variables collected from the same subjects. <u>Use relative frequencies</u> calculated for rows or columns to <u>describe</u> possible association between the two variables. <i>For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?</i>	✓	✓	✓

Algebra I

LSSM – Algebra I		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
A1: N-RN.B.3	Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.	✓		
A1: N-Q.A.1	Use <u>units</u> as a way to <u>understand</u> problems and to guide the solution of multi-step problems; <u>choose and interpret</u> units consistently in formulas; <u>choose and interpret</u> the scale and the origin in graphs and data displays. *	✓		
A1: N-Q.A.2	<u>Define</u> appropriate quantities for the purpose of descriptive modeling. *	✓		
A1: N-Q.A.3	<u>Choose</u> a level of accuracy appropriate to limitations on measurement when reporting quantities. *	✓		
A1: A-SSE.A.1	<u>Interpret</u> expressions that represent a quantity in terms of its context. *	✓		
A1: A-SSE.A.1a	<u>Interpret</u> parts of an expression, such as terms, factors, and coefficients. *	✓		
A1: A-SSE.A.1b	<u>Interpret</u> complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)^n$ as the product of P and a factor not depending on P . *	✓		
A1: A-SSE.A.2	Use the structure of an expression to <u>identify</u> ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, or see $2x^2 + 8x$ as $(2x)(x) + 2x(4)$, thus recognizing it as a polynomial whose terms are products of monomials and the polynomial can be factored as $2x(x+4)$.	✓	✓	
A1: A-SSE.B.3	<u>Choose and produce</u> an equivalent form of an expression to <u>reveal and explain</u> properties of the quantity represented by the expression. *	✓	✓	
A1: A-SSE.B.3a	<u>Factor</u> a quadratic expression to <u>reveal</u> the zeros of the function it defines. *	✓	✓	
A1: A-SSE.B.3b	<u>Complete the square</u> in a quadratic expression to <u>reveal</u> the maximum or minimum value of the function it defines. *	✓	✓	
A1: A-SSE.B.3c	<u>Use the properties of exponents</u> to <u>transform</u> expressions for exponential functions emphasizing integer exponents. For example, the growth of bacteria can be modeled by either $f(t) = 3^{(t+2)}$ or $g(t) = 9(3^t)$ because the expression $3^{(t+2)}$ can be rewritten as $(3^t)(3^2) = 9(3^t)$. *		✓	
A1: A-APR.A.1	<u>Understand</u> that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; <u>add, subtract, and multiply</u> polynomials.	✓	✓	
A1: A-APR.B.3	<u>Identify</u> zeros of quadratic functions, and <u>use the zeros</u> to <u>sketch</u> a graph of the function defined by the polynomial.	✓	✓	

LSSM – Algebra I		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
A1: A-CED.A.1	<u>Create</u> equations and inequalities in one variable and <u>use them to solve problems</u> . <i>Include equations arising from linear, quadratic, and exponential functions.</i> *	✓	✓	✓
A1: A-CED.A.2	<u>Create</u> equations in two or more variables to <u>represent</u> relationships between quantities; <u>graph</u> equations on coordinate axes with labels and scales. *	✓	✓	
A1: A-CED.A.3	<u>Represent</u> constraints by equations or inequalities, and by systems of equations and/or inequalities, and <u>interpret</u> solutions as viable or nonviable options in a modeling context. <i>For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.</i> *	✓		✓
A1: A-CED.A.4	<u>Rearrange</u> formulas to highlight a quantity of interest, using the same reasoning as in solving equations. <i>For example, rearrange Ohm's law $V = IR$ to highlight resistance R.</i> *		✓	
A1: A-REI.A.1	<u>Explain</u> each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. <u>Construct</u> a viable argument to justify a solution method.	✓		
A1: A-REI.B.3	<u>Solve</u> linear equations and inequalities in one variable, including equations with coefficients represented by letters.		✓	
A1: A-REI.B.4	<u>Solve</u> quadratic equations in one variable.		✓	
A1: A-REI.B.4a	<u>Use the method of completing the square</u> to <u>transform</u> any quadratic equation in x into an equation of the form $(x - p)^2 = q$ that has the same solutions. <u>Derive</u> the quadratic formula from this form.		✓	
A1: A-REI.B.4b	<u>Solve</u> quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. <u>Recognize</u> when the quadratic formula gives complex solutions and write them as "no real solution."	✓	✓	
A1: A-REI.C.5	<u>Prove</u> that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.	✓		
A1: A-REI.C.6	<u>Solve</u> systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.		✓	
A1: A-REI.D.10	<u>Understand</u> that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).	✓		
A1: A-REI.D.11	<u>Explain</u> why the x -coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; <u>find</u> the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, piecewise linear (to include absolute value), and exponential functions. *	✓	✓	

LSSM – Algebra I		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
A1: A-REI.D.12	<u>Graph</u> the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and <u>graph</u> the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.		✓	
A1: F-IF.A.1	<u>Understand</u> that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x . The graph of f is the graph of the equation $y = f(x)$.	✓		
A1: F-IF.A.2	<u>Use</u> function notation, <u>evaluate</u> functions for inputs in their domains, and <u>interpret</u> statements that use function notation in terms of a context.	✓	✓	
A1: F-IF.A.3	<u>Recognize</u> that sequences are functions whose domain is a subset of the integers. <u>Relate</u> arithmetic sequences to linear functions and geometric sequences to exponential functions.	✓		
A1: F-IF.B.4	For linear, piecewise linear (to include absolute value), quadratic, and exponential functions that model a relationship between two quantities, <u>interpret</u> key features of graphs and tables in terms of the quantities, and <u>sketch</u> graphs showing key features given a verbal description of the relationship. <i>Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.</i> *	✓		
A1: F-IF.B.5	<u>Relate</u> the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. <i>For example, if the function $h(n)$ gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.</i> *	✓		
A1: F-IF.B.6	<u>Calculate and interpret</u> the average rate of change of a linear, quadratic, piecewise linear (to include absolute value), and exponential function (presented symbolically or as a table) over a specified interval. <u>Estimate</u> the rate of change from a graph. *	✓	✓	
A1: F-IF.C.7	<u>Graph</u> functions expressed symbolically and <u>show</u> key features of the graph, by hand in simple cases and using technology for more complicated cases. *	✓	✓	
A1: F-IF.C.7a	<u>Graph</u> linear and quadratic functions and <u>show</u> intercepts, maxima, and minima. *	✓	✓	
A1: F-IF.C.7b	<u>Graph</u> piecewise linear (to include absolute value) and exponential functions. *		✓	
A1: F-IF.C.8	<u>Write</u> a function defined by an expression in different but equivalent forms to <u>reveal and explain</u> different properties of the function.	✓	✓	
A1: F-IF.C.8a	<u>Use the process of factoring and completing the square</u> in a quadratic function to <u>show</u> zeros, extreme values, and symmetry of the graph, and <u>interpret</u> these in terms of a context.	✓	✓	
A1: F-IF.C.9	<u>Compare</u> properties of two functions (linear, quadratic, piecewise linear [to include absolute value] or exponential) each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). <i>For example, given a graph of one quadratic function and an algebraic expression for another, determine which has the larger maximum.</i>	✓	✓	

LSSM – Algebra I		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
A1: F-BF.A.1	<u>Write</u> a linear, quadratic, or exponential function that describes a relationship between two quantities. *	✓	✓	
A1: F-BF.A.1a	<u>Determine</u> an explicit expression, a recursive process, or steps for calculation from a context. *	✓	✓	
A1: F-BF.B.3	<u>Identify</u> the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative). Without technology, <u>find</u> the value of k given the graphs of linear and quadratic functions. With technology, <u>experiment</u> with cases and <u>illustrate an explanation</u> of the effects on the graph that include cases where $f(x)$ is a linear, quadratic, piecewise linear (to include absolute value) or exponential function.	✓	✓	
A1: F-LE.A.1	<u>Distinguish</u> between situations that can be modeled with linear functions and with exponential functions. *	✓		
A1: F-LE.A.1a	<u>Prove</u> that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. *	✓		
A1: F-LE.A.1b	<u>Recognize</u> situations in which one quantity changes at a constant rate per unit interval relative to another. *	✓		
A1: F-LE.A.1c	<u>Recognize</u> situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. *	✓		
A1: F-LE.A.2	<u>Construct</u> linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table). *	✓	✓	
A1: F-LE.A.3	<u>Observe</u> using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. *	✓		
A1: F-LE.B.5	<u>Interpret</u> the parameters in a linear or exponential function in terms of a context. *	✓		
A1: S-ID.A.2	<u>Use statistics</u> appropriate to the shape of the data distribution to <u>compare</u> center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. *	✓	✓	
A1: S-ID.A.3	<u>Interpret</u> differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). *	✓		
A1: S-ID.B.5	<u>Summarize</u> categorical data for two categories in two-way frequency tables. <u>Interpret</u> relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). <u>Recognize</u> possible associations and trends in the data. *	✓	✓	
A1: S-ID.B.6	<u>Represent</u> data on two quantitative variables on a scatter plot, and <u>describe</u> how the variables are related. *	✓	✓	

LSSM – Algebra I		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
A1: S-ID.B.6a	<u>Fit</u> a function to the data; <u>use functions</u> fitted to data to <u>solve problems</u> in the context of the data. <u>Use given functions</u> or choose a function suggested by the context. Emphasize linear and quadratic models. *	✓	✓	✓
A1: S-ID.B.6b	<u>Informally assess</u> the fit of a function <u>by plotting and analyzing</u> residuals. *	✓	✓	
A1: S-ID.B.6c	<u>Fit</u> a linear function for a scatter plot that suggests a linear association. *		✓	
A1: S-ID.C.7	<u>Interpret</u> the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. *	✓		
A1: S-ID.C.8	<u>Compute</u> (using technology) and <u>interpret</u> the correlation coefficient of a linear fit. *	✓	✓	
A1: S-ID.C.9	<u>Distinguish</u> between correlation and causation. *	✓		

*Modeling standard

Geometry

LSSM – Geometry		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
GM: G-CO.A.1	<u>Know</u> precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.	✓		
GM: G-CO.A.2	<u>Represent</u> transformations in the plane using, e.g., transparencies, tracing paper, or geometry software; <u>describe</u> transformations as functions that take points in the plane as inputs and give other points as outputs. <u>Compare</u> transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).	✓		
GM: G-CO.A.3	Given a rectangle, parallelogram, trapezoid, or regular polygon, <u>describe</u> the rotations and reflections that carry it onto itself.	✓	✓	
GM: G-CO.A.4	<u>Develop</u> definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.	✓		
GM: G-CO.A.5	Given a geometric figure and a rotation, reflection, or translation, <u>draw</u> the transformed figure using, e.g., graph paper, tracing paper, or geometry software. <u>Specify</u> a sequence of transformations that will carry a given figure onto another.	✓	✓	
GM: G-CO.B.6	<u>Use geometric descriptions of rigid motions to transform</u> figures and to <u>predict</u> the effect of a given rigid motion on a given figure; given two figures, <u>use</u> the definition of congruence in terms of rigid motions to <u>decide</u> if they are congruent.	✓	✓	
GM: G-CO.B.7	<u>Use</u> the definition of congruence in terms of rigid motions to <u>show</u> that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.	✓		
GM: G-CO.B.8	<u>Explain</u> how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.	✓		
GM: G-CO.C.9	<u>Prove and apply</u> theorems about lines and angles. <i>Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.</i>	✓	✓	
GM: G-CO.C.10	<u>Prove and apply</u> theorems about triangles. <i>Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.</i>	✓	✓	

GM: G-CO.C.11	Prove and <u>apply</u> theorems about parallelograms. <i>Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.</i>	✓	✓	
GM: G-CO.D.12	<u>Make</u> formal geometric constructions with a variety of tools and methods, e.g., compass and straightedge, string, reflective devices, paper folding, or dynamic geometric software. Examples: <i>Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.</i>		✓	
GM: G-CO.D.13	<u>Construct</u> an equilateral triangle, a square, and a regular hexagon inscribed in a circle.		✓	
GM: G-SRT.A.1	<u>Verify experimentally</u> the properties of dilations given by a center and a scale factor:	✓		
GM: G-SRT.A.1a	A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.	✓		
GM: G-SRT.A.1b	The dilation of a line segment is longer or shorter in the ratio given by the scale factor.	✓		
GM: G-SRT.A.2	Given two figures, <u>use</u> the definition of similarity in terms of similarity transformations to <u>decide</u> if they are similar; <u>explain using similarity transformations</u> the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.	✓	✓	
GM: G-SRT.A.3	<u>Use the properties of similarity transformations to establish</u> the AA criterion for two triangles to be similar.	✓		
GM: G-SRT.B.4	<u>Prove and apply</u> theorems about triangles. <i>Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity; SAS similarity criteria, SSS similarity criteria, ASA similarity.</i>	✓	✓	
GM: G-SRT.B.5	<u>Use congruence and similarity criteria for triangles to solve problems</u> and to <u>prove relationships</u> in geometric figures.	✓	✓	✓
GM: G-SRT.C.6	<u>Understand</u> that by similarity, side ratios in right triangles, including special right triangles (30-60-90 and 45-45-90), are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.	✓		
GM: G-SRT.C.7	<u>Explain and use</u> the relationship between the sine and cosine of complementary angles.	✓	✓	
GM: G-SRT.C.8	<u>Use</u> trigonometric ratios and the Pythagorean Theorem to <u>solve</u> right triangles in <u>applied problems</u> . *			✓
GM: G-C.A.1	<u>Prove</u> that all circles are similar.	✓		
GM: G-C.A.2	<u>Identify and describe</u> relationships among inscribed angles, radii, and chords, including the following: <i>the relationship that exists between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; and a radius of a circle is perpendicular to the tangent where the radius intersects the circle.</i>	✓		

GM: G-C.A.3	<u>Construct</u> the inscribed and circumscribed circles of a triangle, and <u>prove</u> properties of angles for a quadrilateral inscribed in a circle.	✓	✓	
GM: G-C.B.5	<u>Use similarity</u> to <u>determine</u> that the length of the arc intercepted by an angle is proportional to the radius, and <u>define</u> the radian measure of the angle as the constant of proportionality; <u>derive</u> the formula for the area of a sector.	✓	✓	
GM: G-GPE.A.1	<u>Derive</u> the equation of a circle of given center and radius <u>using</u> the Pythagorean Theorem; <u>complete the square</u> to <u>find</u> the center and radius of a circle given by an equation.		✓	
GM: G-GPE.B.4	<u>Use coordinates</u> to <u>prove</u> simple geometric theorems <u>algebraically</u> . <i>For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point $(0, 2)$.</i>		✓	
GM: G-GPE.B.5	<u>Prove</u> the slope criteria for parallel and perpendicular lines and <u>use them</u> to <u>solve geometric problems</u> (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).	✓	✓	
GM: G-GPE.B.6	<u>Find</u> the point on a directed line segment between two given points that partitions the segment in a given ratio.	✓	✓	
GM: G-GPE.B.7	<u>Use coordinates</u> to <u>compute</u> perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula. *		✓	
GM: G-GMD.A.1	<u>Give an informal argument</u> , e.g., dissection arguments, Cavalieri's principle, and informal limit arguments, for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone.	✓		
GM: G-GMD.A.3	<u>Use volume formulas</u> for cylinders, pyramids, cones, and spheres to <u>solve problems</u> . *		✓	✓
GM: G-GMD.B.4	<u>Identify</u> the shapes of two-dimensional cross-sections of three-dimensional objects, and <u>identify</u> three-dimensional objects generated by rotations of two-dimensional objects.	✓		
GM: G-MG.A.1	<u>Use</u> geometric shapes, their measures, and their properties to <u>describe</u> objects (e.g., modeling a tree trunk or a human torso as a cylinder). *	✓		
GM: G-MG.A.2	<u>Apply concepts of density</u> based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot). *			✓
GM: G-MG.A.3	Apply geometric methods to <u>solve design problems</u> (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios). *			✓
GM: S-CP.A.1	<u>Describe</u> events as subsets of a sample space (the set of outcomes) <u>using characteristics</u> (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not"). *	✓		
GM: S-CP.A.2	<u>Understand</u> that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and <u>use this characterization</u> to <u>determine</u> if they are independent. *	✓	✓	

GM: S-CP.A.3	<u>Understand</u> the conditional probability of A given B as $P(A \text{ and } B)/P(B)$, and <u>interpret</u> independence of A and B as saying that the conditional probability of A given B is the same as the probability of A , and the conditional probability of B given A is the same as the probability of B . *	✓		
GM: S-CP.A.4	<u>Construct and interpret</u> two-way frequency tables of data when two categories are associated with each object being classified. <u>Use</u> the two-way table as a sample space to <u>decide</u> if events are independent and to <u>approximate</u> conditional probabilities. <i>For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.</i> *	✓	✓	✓
GM: S-CP.A.5	<u>Recognize and explain</u> the concepts of conditional probability and independence in everyday language and everyday situations. <i>For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.</i> *	✓		
GM: S-CP.B.6	<u>Find</u> the conditional probability of A given B as the fraction of B 's outcomes that also belong to A , and <u>interpret</u> the answer in terms of the model. *	✓	✓	✓
GM: S-CP.B.7	<u>Apply the Addition Rule</u> , $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$, and <u>interpret</u> the answer in terms of the model. *	✓	✓	✓

*Modeling standard

Algebra II

LSSM – Algebra II		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
A2: N-RN.A.1	<u>Explain</u> how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. <i>For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.</i>	✓		
A2: N-RN.A.2	<u>Rewrite</u> expressions involving radicals and rational exponents <u>using the properties of exponents</u> .	✓	✓	
A2: N-Q.A.2	<u>Define</u> appropriate quantities for the purpose of descriptive modeling. *	✓		
A2: N-CN.A.1	<u>Know</u> there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real.	✓		
A2: N-CN.A.2	Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to <u>add, subtract, and multiply</u> complex numbers.		✓	
A2: N-CN.C.7	<u>Solve</u> quadratic equations with real coefficients that have complex solutions.		✓	
A2: A-SSE.A.2	<u>Use the structure of an expression</u> to <u>identify</u> ways to rewrite it. <i>For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.</i>	✓	✓	
A2: A-SSE.B.3	<u>Choose and produce</u> an equivalent form of an expression to <u>reveal and explain</u> properties of the quantity represented by the expression. *	✓	✓	
A2: A-SSE.B.3c	<u>Use the properties of exponents</u> to <u>transform</u> expressions for exponential functions. <i>For example the expression 1.15^t can be rewritten as $(1.15^{1/12})^{12t} \approx 1.012^{12t}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.</i> *		✓	
A2: A-SSE.B.4	<u>Apply</u> the formula for the sum of a finite geometric series (when the common ratio is not 1), and <u>use the formula to solve problems</u> . <i>For example, calculate mortgage payments.</i> *		✓	✓
A2: A-APR.B.2	<u>Know and apply</u> the Remainder Theorem: For a polynomial $p(x)$ and a number a , the remainder on division by $x - a$ is $p(a)$, so $p(a) = 0$ if and only if $(x - a)$ is a factor of $p(x)$.	✓	✓	
A2: A-APR.B.3	<u>Identify</u> zeros of polynomials when suitable factorizations are available, and <u>use the zeros</u> to <u>construct</u> a rough graph of the function defined by the polynomial.	✓	✓	
A2: A-APR.C.4	<u>Use</u> polynomial identities and <u>use them</u> to <u>describe</u> numerical relationships. <i>For example, the polynomial identity $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.</i>	✓	✓	

LSSM – Algebra II		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
A2: A-APR.D.6	<u>Rewrite</u> simple rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, where $a(x)$, $b(x)$, $q(x)$, and $r(x)$ are polynomials with the degree of $r(x)$ less than the degree of $b(x)$, using inspection, long division, or, for the more complicated examples, a computer algebra system.	✓	✓	
A2: A-CED.A.1	<u>Create</u> equations and inequalities in one variable and <u>use them to solve problems</u> . <i>Include equations arising from linear and quadratic functions, and simple rational and exponential functions.</i> *	✓	✓	✓
A2: A-REI.A.1	<u>Explain</u> each step in solving an equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. <u>Construct</u> a viable argument to justify a solution method.	✓		
A2: A-REI.A.2	<u>Solve</u> simple rational and radical equations in one variable, and <u>give</u> examples showing how extraneous solutions may arise.	✓	✓	
A2: A-REI.B.4	<u>Solve</u> quadratic equations in one variable.		✓	
A2: A-REI.B.4b	<u>Solve</u> quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. <u>Recognize</u> when the quadratic formula gives complex solutions and <u>write</u> them as $a \pm bi$ for real numbers a and b .	✓	✓	
A2: A-REI.C.6	<u>Solve</u> systems of linear equations exactly and approximately (e.g., with graphs), limited to systems of at most three equations and three variables. With graphic solutions, systems are limited to two variables.		✓	
A2: A-REI.C.7	<u>Solve</u> a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. <i>For example, find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$.</i>		✓	
A2: A-REI.D.11	<u>Explain</u> why the x -coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; <u>find</u> the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. *	✓	✓	
A2: F-IF.B.4	For a function that models a relationship between two quantities, <u>interpret</u> key features of graphs and tables in terms of the quantities, and <u>sketch</u> graphs showing key features given a verbal description of the relationship. <i>Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.</i> *	✓		

LSSM – Algebra II		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
A2: F-IF.B.6	Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. *	✓	✓	
A2: F-IF.C.7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. *	✓	✓	
A2: F-IF.C.7b	Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. *		✓	
A2: F-IF.C.7c	Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. *	✓	✓	
A2: F-IF.C.7e	Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. *	✓	✓	
A2: F-IF.C.8	Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.	✓	✓	
A2: F-IF.C.8b	Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)12^t$, $y = (1.2)^t/10$, and classify them as representing exponential growth or decay.	✓		
A2: F-IF.C.9	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, determine which has the larger maximum	✓	✓	
A2: F-BF.A.1	Write a function that describes a relationship between two quantities. *	✓	✓	
A2: F-BF.A.1a	Determine an explicit expression, a recursive process, or steps for calculation from a context. *	✓	✓	
A2: F-BF.A.1b	Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model. *	✓	✓	✓
A2: F-BF.A.2	Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms. *	✓	✓	✓
A2: F-BF.B.3	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.	✓	✓	
A2: F-BF.B.4	Find inverse functions.		✓	
A2: F-BF.B.4a	Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse. For example, $f(x) = 2x^3$ or $f(x) = (x+1)/(x-1)$ for $x \neq 1$.		✓	

LSSM – Algebra II		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
A2: F-LE.A.2	Given a graph, a description of a relationship, or two input-output pairs (include reading these from a table), <u>construct</u> linear and exponential functions, including arithmetic and geometric sequences to <u>solve multistep problems</u> . *	✓	✓	✓
A2: F-LE.A.4	For exponential models, <u>express</u> as a logarithm the solution to $ab^{ct} = d$ where a , c , and d are numbers and the base b is 2, 10, or e ; <u>evaluate</u> the logarithm using technology. *	✓	✓	
A2: F-LE.B.5	<u>Interpret</u> the parameters in a linear or exponential function in terms of a context. *	✓		
A2: F-TF.A.1	<u>Understand</u> radian measure of an angle as the length of the arc on the unit circle subtended by the angle.	✓		
A2: F-TF.A.2	<u>Explain</u> how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.	✓		
A2: F-TF.B.5	<u>Choose trigonometric functions</u> to <u>model</u> periodic phenomena with specified amplitude, frequency, and midline. *	✓	✓	
A2: F-TF.C.8	<u>Prove</u> the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to <u>find</u> $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.	✓	✓	
A2: S-ID.A.4	<u>Use the mean and standard deviation</u> of a data set to <u>fit</u> it to a normal distribution and to <u>estimate</u> population percentages. <u>Recognize</u> that there are data sets for which such a procedure is not appropriate. <u>Use</u> calculators, spreadsheets, and tables to <u>estimate</u> areas under the normal curve. *	✓	✓	✓
A2: S-ID.B.6	<u>Represent</u> data on two quantitative variables on a scatter plot, and <u>describe</u> how the variables are related. *	✓	✓	
A2: S-ID.B.6a	<u>Fit</u> a function to the data; <u>use functions</u> fitted to data to <u>solve problems</u> in the context of the data. <u>Use given functions or choose a function</u> suggested by the context. Emphasize exponential models. *	✓	✓	✓
A2: S-IC.A.1	<u>Understand</u> statistics as a process for making inferences about population parameters based on a random sample from that population. *	✓		
A2: S-IC.A.2	<u>Decide</u> if a specified model is consistent with results from a given data-generating process, e.g., using simulation. <i>For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?</i> *	✓	✓	✓
A2: S-IC.B.3	<u>Recognize</u> the purposes of and differences among sample surveys, experiments, and observational studies; <u>explain</u> how randomization relates to each. *	✓		
A2: S-IC.B.4	<u>Use data from a sample survey</u> to <u>estimate</u> a population mean or proportion; <u>develop</u> a margin of error through the <u>use</u> of simulation models for random sampling. *		✓	✓

LSSM – Algebra II		Explicit Component(s) of Rigor		
Code	Standard	Conceptual Understanding	Procedural Skill and Fluency	Application
A2: S-IC.B.5	<u>Use data from a randomized experiment to compare</u> two treatments; <u>use simulations to decide</u> if differences between parameters are significant. *	✓	✓	✓
A2: S-IC.B.6	<u>Evaluate</u> reports based on data. *	✓		

*Modeling standard