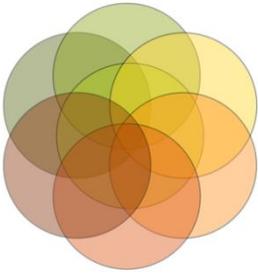# Oklahoma Academic Standards for Mathematics

Third DRAFT
September, 2015

Acknowledgements

The Oklahoma Academic Standards for Mathematics 2015 is the result of the contributions of many mathematics teachers and mathematics educators from across the state. We believe this document reflects a balanced synthesis of the work of all members of the Oklahoma Academic Standards for Mathematics Writing Committee.
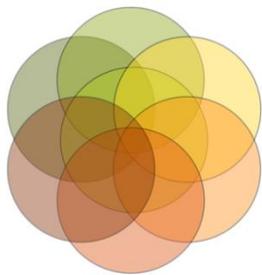
Introduction

The Oklahoma Academic Standards for Mathematics 2015 specify what students should know and be able to do as learners of mathematics at the end of each grade level or course. Students are held responsible for learning standards listed at earlier grade levels as well as their current grade level. Following each of the standards are **Sample Problems or Classroom Activities (Forthcoming)** that clarify the standards and provide possibilities for their implementation.

Throughout this document, the standards are written to allow time for study of additional material at every grade level. The order of the standards at any grade level is not meant to imply a sequence of topics and should be considered flexible for the organization of any course. The document provides standards for PK-7, Pre-Algebra, Algebra I, Geometry, Algebra II with Algebra I as the pre-requisite for both Geometry and Algebra II.

Development of the Oklahoma Academic Standards for Mathematics

The Oklahoma Academic Standards for Mathematics writing team drew on the work of the National Council of Teachers of Mathematics (NCTM) standards documents; the National Research Council's report *Adding It Up*, the Oklahoma Priority Academic Standards (PASS), and other states' standards documents and curriculum framework guides (e.g., Minnesota, Virginia, and Massachusetts). Please see the reference list at the end of this document for a more complete list of all resources consulted.

Vision and Guiding Principles

These standards envision all students in Oklahoma will become mathematically proficient and literate through a strong mathematics program that emphasizes and engages them in problem solving, communicating, reasoning and proof, making connections, and using representations. Mathematically proficient and literate students can confidently and effectively use mathematics concepts, computation skills, and numbers to problem-solve, reason and analyze information. Developing mathematical proficiency and literacy for Oklahoma students depends in large part on a clear, comprehensive, coherent, and developmentally appropriate set of standards to guide curricular decisions. The understanding and implementation of these standards throughout PK-12 mathematics experience for students is based on the following guiding principles:

Guiding Principle 1: Excellence in mathematics education requires equity--high expectations and strong support for all students.

All students must have opportunities to study—and support to learn—mathematics. Equity does not mean that every student should receive identical instruction; instead, it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students.

Guiding Principle 2: Mathematical ideas should be explored in ways that stimulate curiosity, create enjoyment of mathematics, and develop depth of understanding.

Students need to understand mathematics deeply and use it effectively. To achieve mathematical understanding, students should be actively engaged in doing meaningful mathematics, discussing mathematical ideas, and applying mathematics in interesting, thought provoking situations. Student understanding is further developed through ongoing reflection about cognitively demanding and worthwhile tasks.

Tasks should challenge and engage students in mathematics in multiple ways. Short- and long-term investigations that connect procedures and skills with conceptual understanding are integral components of an effective mathematics program. Activities should build upon curiosity and prior knowledge, and enable students to solve progressively deeper, broader, and more sophisticated problems. Mathematical tasks reflecting significant mathematics should generate active classroom talk, promote the development of conjectures, and lead to an understanding of the necessity for mathematical reasoning.

Guiding Principle 3: An effective mathematics program focuses on problem solving.

Mathematical problem solving is the hallmark of an effective mathematics program. Skill in mathematical problem solving requires practice with a variety of mathematical problems as well as a firm grasp of mathematical techniques and their underlying principles. Students who possess a deeper knowledge of mathematics can then use mathematics in a flexible way to attack various problems and devise different ways of solving any particular problem. Mathematical problem solving calls for reflective thinking, persistence, learning from the ideas of others, and going back over one's own work with a critical eye. Success in solving mathematical problems helps to create an abiding interest in mathematics.

Guiding Principle 4: Technology is essential in teaching and learning mathematics.

Technology enhances the mathematics curriculum in many ways. Technology enables students to communicate ideas within the classroom or to search for needed information. It can be especially helpful in assisting students with special needs in regular and special classrooms, at home, and in the community. Technology changes what mathematics is to be learned and when and how it is learned. Tools such as measuring instruments, manipulatives (such as base ten blocks and fraction pieces), scientific and graphing calculators, and computers with appropriate software, if properly used, contribute to a rich learning environment for developing and applying mathematical concepts. Appropriate use of calculators is essential; calculators should not be used as a replacement for basic understanding and skills. Although the use of a graphing calculator can help middle and secondary students to visualize properties of functions and their graphs, graphing calculators should be used to enhance their understanding and skills rather than replace them.

Standards Overview

The Oklahoma Academic Standards for Mathematics are developed around both content and process strands. The four main content strands, Algebraic Reasoning and Algebra, Number and Operations,

Geometry and Measurement, and Data and Probability organize the content standards throughout PK-7 and Pre-Algebra. The standards for Algebra I, Algebra II, and Geometry are fundamentally organized around these strands as well. The process standards are defined as the Mathematical Actions and Processes and are comprise of the skills and abilities students should develop and be engaged in developing throughout their PK-12 mathematics education. Among these are the ability to problem solve and communicate and reason about mathematics which will help students be ready for the mathematics expectations of college and the skills desired by many employers. The process and content standards work in concert to create clear, concise and rigorous mathematics standards and expectations for Oklahoma students with the aim of helping them be college and career ready. Both content and process strands are described below.

Algebraic Reasoning and Algebra Strand: All students should be able to reason algebraically and learn algebra. This strand provides focus for the PK-7 and Pre-Algebra standards around the notion that algebra is more than moving symbols around. It is about understanding patterns, relations and functions, representing and analyzing mathematical situations and structures using algebraic symbols, using mathematical models to represent and understanding quantitative relationships, and analyzing change in various contexts. Understanding change is fundamental to algebraic reasoning and understanding the concept of function with depth. It is also fundamental to understanding many real-world problems and ideas presented in the news.

Number and Operations Strand: A focus on number and operations is the cornerstone of a strong mathematics program. Developing students' fluency with number and operations throughout their PK-12 mathematics experience requires a balance and connection between conceptual understanding and computational proficiency. This strand provides focus on the importance of students' understanding of numbers, ways of representing numbers, relationships among numbers, relationships among number systems, and meanings of operations and how they relate to one another. Further, it requires that students should be able to compute fluently and make reasonable estimates.

Geometry and Measurement Strand: All students should gain experience using a variety of visual and coordinate representations to analyze problems and solve mathematics and learn how to use appropriate units and tools for measuring. This strand provides focus for the PK-7 and Geometry standards around the notion that geometry and measurement help students understand and represent ideas and solve problems they will encounter in their daily lives. A focus on geometry should enable students to analyze characteristics of two- and three-dimensional objects, develop arguments based on geometric relationships, describe spatial relationships using coordinate geometry and other representational systems, apply transformations and symmetry to analyze mathematical situations, and utilize visualization, spatial reasoning and geometric modeling to solve problems. A focus on measurement should enable students to understand measureable attributes of objects and the units, systems, and processes of measurement, and apply appropriate techniques, tools, and formulas to determine measurements.

Data and Probability Strand: An increased emphasis on understanding data should span all grade levels. The idea that making sense of data and probability has become a part of our daily lives provides support for the importance of this strand throughout a students' Pk-12 mathematics experience. A focus on data and probability should enable all students to formulate questions that can be addressed with data, and collect, organize, and display relevant data to answer them, select and use appropriate statistical methods to analyze data, develop and evaluate inferences and predictions that are based on data, and understand and

apply basic concepts of probability. The study of data is also an opportunity to apply the basic skills of computing with numbers while the study of probability provides application and use of fractions in daily life.

Mathematical Actions & Processes
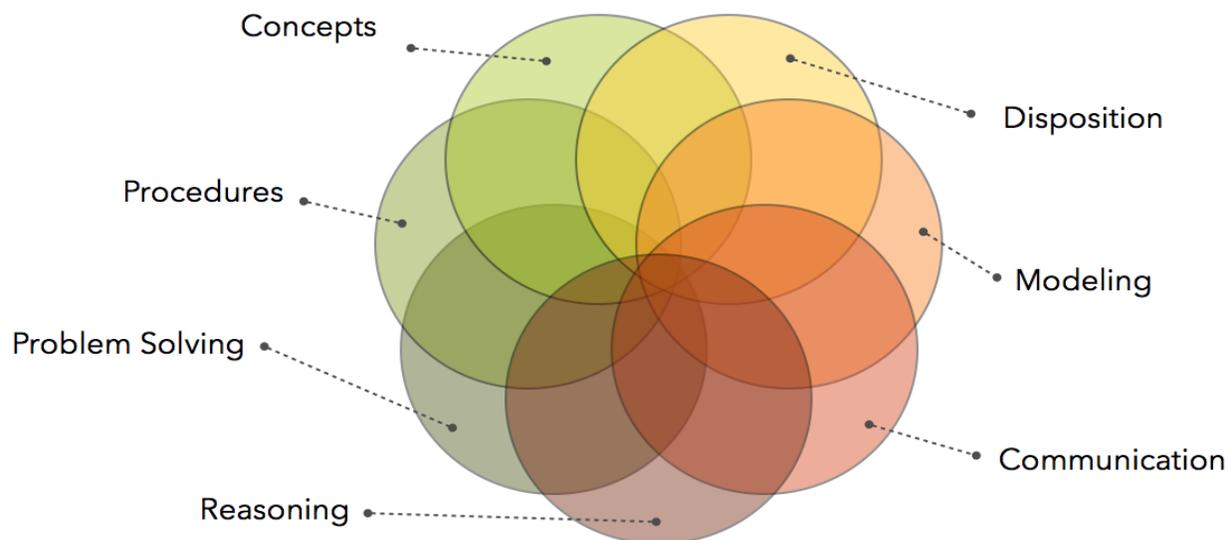
Throughout their Pk-12 education experience, mathematically literate students will:

Develop a Deep and Flexible *Conceptual* Understanding

Demonstrate a deep and flexible conceptual understanding of mathematical concepts, operations, and relations while making mathematical and real-world connections.

Develop Accurate and Appropriate *Procedural* Fluency

Pursue efficient procedures for various computations and repeated processes based on a strong sense of numbers. They will develop a sophisticated understanding of the development and application of algorithms and procedures.

Develop Strategies for *Problem Solving*

Analyze the parts of complex mathematical tasks and identify entry points to begin the search for a solution. They will select from a variety of problem solving strategies and use corresponding multiple representations (verbal, physical, symbolic, pictorial, graphical, tabular) when appropriate. They will pursue

solutions to various tasks from real-world situations and applications that are often interdisciplinary in nature. They will find methods to verify their answers in context and will always question the reasonableness of solutions.

Develop Mathematical *Reasoning*

Explore and communicate a variety of reasoning strategies to think through problems. They will apply their logic to critique the thinking and strategies of others to develop and evaluate mathematical arguments, including making arguments and counterarguments and making connections to other contexts.

Develop a Productive Mathematical *Disposition*

Hold the belief that mathematics is sensible, useful and worthwhile. They will develop the habit of looking for and making use of patterns and mathematical structures. They will persevere and become resilient, effective problem solvers.

Develop the Ability to Make Conjectures, *Model*, and Generalize

Make predictions and conjectures and draw conclusions throughout the problem solving process based on patterns and the repeated structures in mathematics. They will create, identify, and extend patterns as a strategy for solving and making sense of problems.

Develop the Ability to *Communicate* Mathematically

Develop the ability to communicate mathematically. They will discuss, write, read, interpret and translate ideas and concepts mathematically. As they progress, students' ability to communicate mathematically will include their increased use of mathematical language and terms and analysis of mathematical definitions.

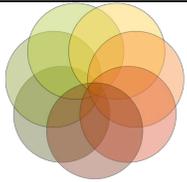# Oklahoma Academic Standards for Mathematics
5th Grade

The fifth-grade standards place emphasis on number sense with whole numbers, fractions, and decimals. This focus involves three main ideas: whole number division, the notion of decimal and their connections with fractions, and addition and subtraction of fractions. Students will develop proficiency in the use of fractions and decimals to solve problems. Solving real-world and mathematical problems is a common theme across the number and operation strand. Additionally, students will work with many foundational algebraic ideas, including exploring patterns of change using patterns, tables, graphs and rules along with evaluating expressions and solving equations involving variables when values of the variables are given. Students will describe, classify, and draw representations of three-dimensional figures. They will also determine the area of triangles and quadrilaterals. Finally, students will display and interpret data including finding the mean, median and range of a set of numbers.

Problem solving has been integrated throughout the content strands. The development of problem solving skills should be a major goal of the mathematics program at every grade level. Experience with the process of problem solving will need to be integrated early and continuously into each student's mathematics education. Students must be helped to develop a wide range of skills and strategies for solving a variety of problem types.

While learning mathematics, students should be actively engaged, using concrete materials and appropriate technologies such as calculators and computers. However, facility in the use of technology should not be regarded as a substitute for a student's understanding of quantitative concepts and relationships or for proficiency and fluency with basic computations.
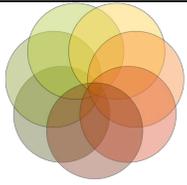
Mathematics has its own language, and the acquisition of specialized vocabulary and language patterns is crucial to a student's understanding, appreciation of, and disposition for the subject. Students should be encouraged to correctly use the concepts, skills, symbols, and vocabulary identified in the following set of standards.

Algebraic Reasoning and Algebra

5.A.1 Apply mathematical actions and processes to create and use tables, graphs and rules to describe patterns to solve real-world and mathematical problems.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**5.A.1.1** Create and use rules and tables to describe patterns of change and make predictions and generalizations about real-world and mathematical problems. **5.A.1.2** Use a rule or table to represent ordered pairs of positive integers and graph these ordered pairs on a coordinate system.

Sample Problems or Classroom Activities

FORTHCOMING

Algebraic Reasoning and Algebra

5.A.2 Apply mathematical actions and processes to understand and interpret expressions, equations, and inequalities involving variables and whole numbers, and use them to represent and solve real-world and mathematical problems.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**5.A.2.1** Generate equivalent numerical expressions and to solve problems involving whole numbers by applying the commutative, associative, and distributive properties and order of operations (no exponents). **5.A.2.2** Determine whether an equation or inequality involving a variable is true or false for a given value of the variable. **5.A.2.3** Evaluate expressions and solve equations involving variables when values for the variables are given.

Sample Problems or Classroom Activities

**Example for 5.A.2.2**

MORE FORTHCOMING
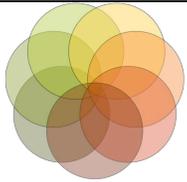
Number and Operations

5.N.1 Apply mathematical actions and processes to divide multi-digit numbers and solve real-world and mathematical problems using arithmetic.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**5.N.1.1** Estimate solutions to division problems in order to assess the reasonableness of results. **5.N.1.2** Divide multi-digit numbers, using efficient and generalizable procedures, based on knowledge of place value, including standard algorithms. Recognize that quotients can be represented in a variety of ways, including a whole number with a remainder, a fraction or mixed number, or a decimal and consider the context in which a problem is situated to select and interpret the most useful form of the quotient for the solution. **5.N.1.3** Solve real-world and mathematical problems requiring addition, subtraction, multiplication and division of multi-digit whole numbers. Use various strategies, including the inverse relationships between operations, the use of technology, and the context of the problem to assess the reasonableness of results.

**Sample Problems or Classroom Activities**

FORTHCOMING
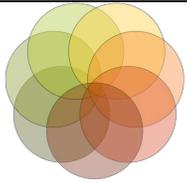
Number and Operations

5.N.2 Apply mathematical actions and processes to read, write, represent and compare fractions and decimals; recognize and write equivalent fractions; convert between fractions and decimals; use fractions and decimals in real-world and mathematical situations.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**5.N.2.1** Represent decimal fractions (e.g. 1/10, 1/100) using a variety of models (e.g, 10 by 10 grids, rational number wheel, base-ten blocks, meter stick) and make connections between fractions and decimals (e.g., the visual for 1/10 is the same as for 0.1). **5.N.2.2** Model, read and write decimals using place value to describe decimal numbers from at least millions to thousandths. **5.N.2.3** Compare and order fractions and decimals, including mixed numbers and improper fractions, and locate on a number line. **5.N.2.4** Recognize and generate equivalent decimals, fractions, mixed numbers and improper fractions in various contexts.

**Sample Problems or Classroom Activities**

FORTHCOMING
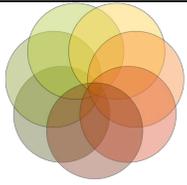
Numbers and Operations

5.N.3 Apply mathematical actions and processes to add and subtract fractions with like and unlike denominators, mixed numbers and decimals to solve real-world and mathematical problems.

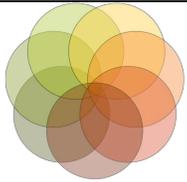| Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**5.N.3.1** Estimate sums and differences of fractions and decimals to assess the reasonableness of the results. **5.N.3.2** Using the meanings of fractions, meanings of whole number addition and subtraction, and inverse relationships to model addition and subtraction of fractions and decimals using a variety of representations (e.g., fraction strips, area models, number lines, Cuisenaire rods). **5.N.3.3** Add and subtract fractions and decimals, using efficient and generalizable procedures, including but not limited to standard algorithms in order to solve real world and mathematical problems including those involving money, measurement, geometry, and data. **5.N.3.4** Find 0.1 more than a number and 0.1 less than a number. Find 0.01 more than a number and 0.01 less than a number. Find 0.001 more than a number and 0.001 less than a number.

Sample Problems or Classroom Activities

FORTHCOMING
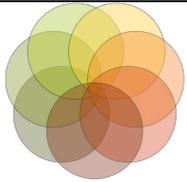
Geometry and Measurement

5.GM.1 Apply mathematical actions and processes to describe, classify, and draw representations of three-dimensional figures.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**5.GM.1.1** Describe and classify three-dimensional figures including cubes, rectangular prisms and pyramids by the number of edges, faces or vertices as well as the shapes of faces. **5.GM.1.2** Recognize and draw a net for a three-dimensional figure (e.g., cubes, rectangular prisms, pyramids).

Sample Problems or Classroom Activities

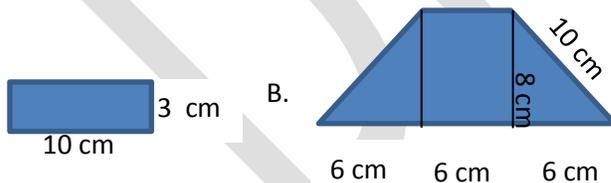FORTHCOMING

Geometry and Measurement

5.GM.2 Apply mathematical actions and processes to determine the area of triangles and parallelograms.

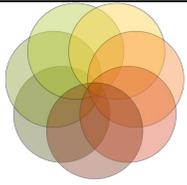| Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**5.GM.2.1** Develop and use formulas to determine the area of triangles and parallelograms. **5.GM.2.2** Find the area of polygons that can be decomposed into triangles.

Sample Problems or Classroom Activities

Example for 5.GM.2.2

Find the area of the following polygons by decomposing each into non-overlapping triangles.
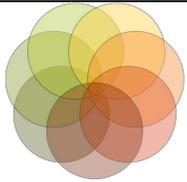

MORE FORTHCOMING

Geometry and Measurement

5.GM.3 Apply mathematical actions and processes to understand angle and length as measurable attributes of real world and mathematical objects. Use various tools to measure angles and lengths.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**5.GM.3.1** Measure and compare angles according to size. Classify angles as acute, right, and obtuse. **5.GM.3.2** Choose an appropriate instrument (e.g., ruler, yard/meter stick, tape measure) and measure the length of an object to the nearest whole centimeter or 1/16-inch.

Sample Problems or Classroom Activities

FORTHCOMING

Data and Probability

5.D.1 Apply mathematical actions and processes to display and interpret data and determine mean, median, mode, and range.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**5.D.1.1** Know and use the definitions of the mean, median, mode, and range of a set of data. Understand that the mean is a "leveling out" of data. **5.D.1.2** Using appropriate tools, create and analyze line graphs and double-bar graphs by applying understanding of whole numbers, fractions and decimals.

Sample Problems or Classroom Activities

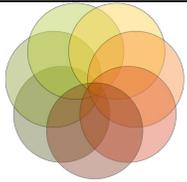FORTHCOMING

Oklahoma Academic Standards for Mathematics
6th Grade

The sixth-grade standards transition from an emphasis on whole number arithmetic in the elementary grades to an increased emphasis on algebra and geometry with some data analysis and probability. Students will read, write, represent, compare, and explore the connections between fractions, decimals, percents, and ratios. They will write positive integers as a product of factors. Students will develop mathematical proficiency with multiplication and division of fractions and solve real-world problems. Solving real-world and mathematical problems is a common theme across the number and operation strand. As a part of the algebra strand, students will recognize and represent relationships between varying quantities as well as solve real-world and mathematical problems using patterns, tables, graphs and rules. Students will model, write, solve, and graph one-step equations with one variable using number sense, the properties of operations and the properties of equality. Students will develop formulas and use them to calculate the area of quadrilaterals and be able to explain why a particular formula is used and why it works. They will begin to explore and use relationships between angles in geometric figures and choose appropriate units of measurements to solve real-world and mathematical problems. Students will display and interpret data and use probabilities to solve real-world and mathematical problems.

Problem solving has been integrated throughout the content strands. The development of problem solving skills should be a major goal of the mathematics program at every grade level. Experience with the process of problem solving will need to be integrated early and continuously into each student's mathematics education. Students must be helped to develop a wide range of skills and strategies for solving a variety of problem types.

While learning mathematics, students should be actively engaged, using concrete materials and appropriate technologies such as calculators and computers. However, facility in the use of technology should not be regarded as a substitute for a student's understanding of quantitative concepts and relationships or for proficiency and fluency with basic computations.

Mathematics has its own language, and the acquisition of specialized vocabulary and language patterns is crucial to a student's understanding, appreciation of, and disposition for the subject. Students should be encouraged to correctly use the concepts, skills, symbols, and vocabulary identified in the following set of standards.

Algebraic Reasoning and Algebra

6.A.1 Apply mathematical actions and processes to recognize and represent relationships between varying quantities; translate from one representation to another; use patterns, tables, graphs and rules to solve real-world and mathematical problems.

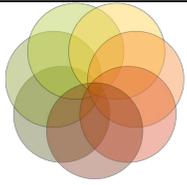| Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**6.A.1.1** Represent the relationship between two varying quantities with function rules, graphs and tables; translate between any two of these representations. **6.A.1.2** Use variables in various contexts including whether an equation or inequality involving a variable is true or false for a given value of the variable.

Sample Problems or Classroom Activities

Example for 6.A.1.3 - *Using table below, recognize and graph on the x-y coordinate plane the points (2, 3) and (1, 2).*

x	y
2	3
1	2

Use y = 2x or y = x + 2 (limit to one operation) to generate a table and then graph.

MORE FORTHCOMING

Algebraic Reasoning and Algebra

6.A.2 Apply mathematical actions and processes to use properties of arithmetic to generate equivalent numerical expressions and evaluate expressions involving positive rational numbers.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**6.A.2.1** Generate equivalent expressions and to solve problems involving positive rational numbers by applying the commutative, associative, and distributive properties and order of operations.

Sample Problems or Classroom Activities

Example for 6.A.2.1
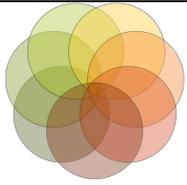
Include exponents

Which expression has 120 for the answer?

○ A. (2 x 6) x (2 x 6)

○ B. (2 x 2 x 2) x 3 x 5

○ C. 6 x 6

○ D. 6 x 5 x 3

Evaluate $4 + 5(45 - 15) + 6^2$.

○ A. 30

○ B. 46

○ C. 190

○ D. 306

MORE FORTHCOMING

Algebraic Reasoning and Algebra

6.A.3 Apply mathematical actions and processes to understand and interpret equations and inequalities involving variables and positive rational numbers. Use equations and inequalities to represent real-world and mathematical problems; use the idea of maintaining equality to solve equations. Interpret solutions in the original context.
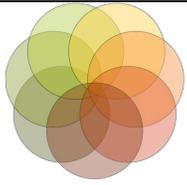
Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**6.A.3.1** Represent real-world or mathematical situations using equations and inequalities involving variables and positive rational numbers. **6.A.3.2** Solve and graph one-step equations (e.g., $1/3x = 9$) involving positive rational numbers using number sense, properties of operations and equality. Interpret a solution in the original context and assess the reasonableness of results.

Sample Problems or Classroom Activities

Resource note for 6.A.3.2: *Use a balance to model an equation and show how subtracting a number from one side requires subtracting the same amount from the other side. Hands on equations and balance tasks can help students move from the concrete to the pictorial to the abstract.*

The app "SolveMe Mobiles" for tablet and the Balance Task app found on the NCTM Illuminations website will be helpful for students working to understand solving equations.

MORE FORTHCOMING
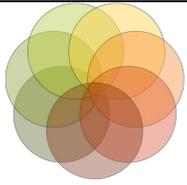
Number and Operations

6.N.1 Apply mathematical actions and processes to read, write, represent and compare integers and positive rational numbers expressed as fractions, decimals, percents and ratios; write positive integers as products of factors; use these representations in real-world and mathematical situations.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**6.N.1.1** Locate integers and rational numbers on a number line and understand the concept of opposites. **6.N.1.2** Plot coordinates in all four quadrants. Be able to identify each quadrant, the origin, the x-axis, and the y-axis. **6.N.1.3** Compare positive rational numbers represented in various forms using the symbols <, >, and =. **6.N.1.4** Explain that a percent represents parts out of 100 and ratios to 100 (e.g., 75% corresponds to the ratio 75 to 100 which is equivalent to a ratio of 3 to 4). **6.N.1.5** Determine equivalencies among fractions, decimals and percents. Select among these representations to solve problems. **6.N.1.6** Factor whole numbers and express a whole number as a product of prime factors with exponents. **6.N.1.7** Determine the greatest common factors and least common multiples. Use common factors and multiples to calculate with fractions and find equivalent fractions.

Sample Problems or Classroom Activities

FORTHCOMING

Number and Operations

6.N.2 Apply mathematical actions and processes to understand the concept of ratio and its relationship to fractions and percents and to the multiplication and division of whole numbers. Use ratios to solve real-world and mathematical problems.

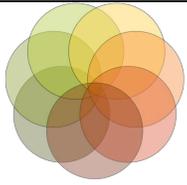| Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**6.N.2.1** Identify and use ratios to compare quantities. Recognize that comparing quantities using ratios is not the same as comparing quantities using subtraction. **6.N.2.2** Determine the unit rate for ratios of quantities with different units. **6.N.2.3** Apply the relationship between ratios, equivalent fractions and percents to solve problems in various contexts, including those involving mixture and concentrations. **6.N.2.4** Use reasoning about multiplication and division to solve ratio and rate problems.

Sample Problems or Classroom Activities

Example for 6.N.2.2

Determine the unit rate for each of the following situations:

20 miles every 5 hours   (Answer: 4 miles per hour)
12 cans of soda for $6   (Answer: 2 cans per $1)

MORE FORTHCOMING

Number and Operations

6.N.3 Apply mathematical actions and processes to multiply and divide decimals, fractions with like and unlike denominators, and mixed numbers; solve real-world and mathematical with positive rational numbers.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**6.N.3.1** Estimate solutions to problems with whole numbers, decimals, fractions, and mixed numbers and use the estimates to assess the reasonableness of results in the context of the problem. **6.N.3.2** Using the meanings of fractions, meanings of whole number multiplication and division, and inverse relationships to model multiplication and division of fractions and decimals using a variety of representations (e.g., fraction strips, area models, number lines, Cuisenaire rods). **6.N.3.3** Multiply and divide fractions and decimals, using efficient and generalizable procedures, including but not limited to standard algorithms. **6.N.3.4** Solve real-world and mathematical problems including those involving money, measurement, geometry, and data requiring arithmetic with decimals, fractions and mixed numbers.

## Sample Problems or Classroom Activities

Examples for 6.N.3.3

Example 1. *Solve the following multiplication 2-way. For each row or column the first two numbers are multiplied to produce the last number.*

Teacher Note: *This problem is self-checking, encourages students to use their number sense to decide where to start, encourages mental arithmetic, and helps students see the reciprocal relationship between multiplication and division.*

Example 2. *Solve the multiplication problem $6 \times \frac{2}{3}$ using at least 3 different strategies. Explain your thinking process for each.*

Possible solutions:
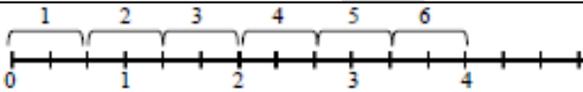
After drawing a number line and marking it off in thirds, I made 6 hops of $\frac{2}{3}$ and ended on 4. Thus, my answer is 4.
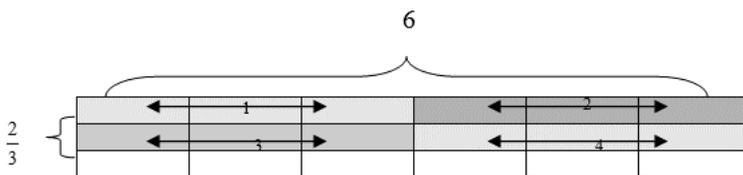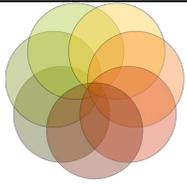

I drew a 1 by 6 array and then cut my side of 1 into 3 equal parts. Then I shaded $\frac{2}{3}$ of each of my 6 columns.

I found that I had 4 wholes shaded. Therefore, $6 \times \frac{2}{3} = 4$.

I know that $\frac{1}{3}$ of 6 is 2. So, $\frac{2}{3}$ of 6 is double that – 4.

MORE FORTHCOMING

97

Geometry and Measurement

6.GM.1 Apply mathematical actions and processes to calculate perimeter and area of two- dimensional figures to solve real-world and mathematical problems.

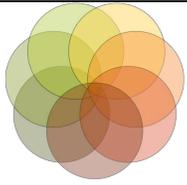| Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**6.GM.1.1** Develop and use formulas for the area of quadrilaterals (e.g., squares, rectangles, rhombi, parallelograms, trapezoids) using a variety of methods including but not limited to the standard algorithm. **6.GM.1.2** Find the perimeter of polygons to solve real-world and mathematical problems.

Sample Problems or Classroom Activities

FORTHCOMING
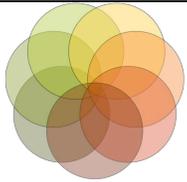
Geometry and Measurement

6.GM.2 Apply mathematical actions and processes to understand and use relationships between angles in geometric figures.
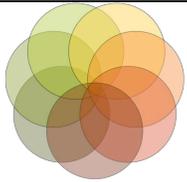
Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**6.GM.2.1** Solve problems using the relationships between the angles (e.g. vertical, complementary, and supplementary) formed by intersecting lines. **6.GM.2.2** Determine missing angle measures in a triangle using the fact that the sum of the interior angles of a triangle is 180˚.

Sample Problems or Classroom Activities

FORTHCOMING

Geometry and Measurement

6.GM.3 Apply mathematical actions and processes to choose appropriate units of measurement and use ratios to convert within measurement systems to solve real-world and mathematical problems.
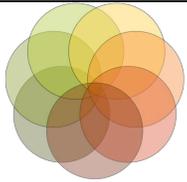
Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**6.GM.3.1** Solve problems in various contexts involving conversion of weights, capacities, geometric measurements and times within the same measurement systems using appropriate units.

Sample Problems or Classroom Activities

FORTHCOMING

Data and Probability

6.D.1 Apply mathematical actions and processes to display and interpret data, including box and whisker plots.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**6.D.1.1** For a given set of data, explain and defend which measure of central tendency (mean, median, and mode) would provide the most descriptive information. **6.D.1.2** Create and analyze box and whisker plots exploring how each segment contains ¼ of the data.

Sample Problems or Classroom Activities

FORTHCOMING

Data and Probability

6.D.2 Apply mathematical actions and processes to use probability to solve real-world and mathematical problems: represent probabilities using fractions, decimals, and percents.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**6.D.2.1** Determine the sample space (set of possible outcomes) for a given experiment and determine which members of the sample space are related to certain events. Sample space may be determined by the use of tree diagrams, tables or pictorial representations. **6.D.2.2** Identify dependent and independent events. **6.D.2.3** Model situations in which the probabilities are known, compare the resulting relative frequencies with the known probabilities; know that there may be differences.

Sample Problems or Classroom Activities

Example 6.D.2.2

Repeatedly draw colored chips with replacement from a bag with an unknown mixture of chips, record relative frequencies, and use the results to make predictions about the contents of the bag.

MORE FORTHCOMING

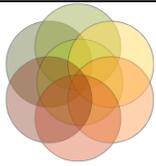# Oklahoma Academic Standards for Mathematics
7th Grade

The seventh-grade standards continue the transition from an emphasis placed on whole number arithmetic in the elementary grades to an increased emphasis on algebra and geometry with some data analysis and probability. Students who complete seventh grade are prepared to study pre-algebra in eighth grade. Topics in grade seven include integer concepts and computation, proportional reasoning, and two-step linear equations. Students will apply the properties of real numbers to solve both equations and inequalities. Students will display and interpret meaningful data in a variety of ways. They will also begin to use proportional reasoning to draw conclusions and make predictions about relative frequencies of outcomes based on probability.

Problem solving has been integrated throughout the content strands. The development of problem solving skills should be a major goal of the mathematics program at every grade level. Experience with the process of problem solving will need to be integrated early and continuously into each student's mathematics education. Students must be helped to develop a wide range of skills and strategies for solving a variety of problem types.

While learning mathematics, students should be actively engaged, using concrete materials and appropriate technologies such as calculators and computers. However, facility in the use of technology should not be regarded as a substitute for a student's understanding of quantitative concepts and relationships or for proficiency and fluency with basic computations.

Mathematics has its own language, and the acquisition of specialized vocabulary and language patterns is crucial to a student's understanding, appreciation of, and disposition for the subject. Students should be encouraged to correctly use the concepts, skills, symbols, and vocabulary identified in the following set of standards.
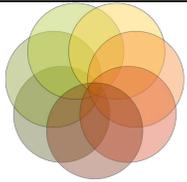
Algebraic Reasoning and Algebra

7.A.1 Apply mathematical actions and processes to understand the concept of proportionality in real-world and mathematical situations, and distinguish between proportional and other relationships.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**7.A.1.1** Recognize that a relationship between two variables, *x* and *y,* is proportional if it can be expressed in the form $\frac{y}{x}=k$ or $y=kx$. Distinguish proportional relationships from other relationships, including inversely proportional relationships ($xy=k$ or $y=\frac{k}{x}$). **7.A.1.2** Recognize that the graph of a proportional relationship is a line through the origin whose slope is the unit rate (constant of proportionality). Know how to use graphing technology to examine what happens to a line when the unit rate is changed.

**Sample Problems or Classroom Activities**

FORTHCOMING

Algebraic Reasoning and Algebra

7.A.2 Apply mathematical actions and processes to recognize proportional relationships in real-world and mathematical situations; represent these and other relationships with tables, verbal descriptions, symbols and graphs; solve problems involving proportional relationships and explain results in the original context.

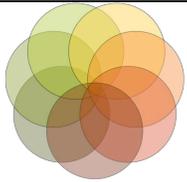| Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**7.A.2.1** Represent proportional relationships with tables, verbal descriptions, symbols, equations and graphs; translate from one representation to another. Determine the unit rate (constant of proportionality or slope) given any of these representations. **7.A.2.2** Solve multi-step problems involving proportional relationships in numerous contexts. **7.A.2.3** Use knowledge of proportions to assess the reasonableness of solutions. **7.A.2.4** Represent real-world or mathematical situations using equations and inequalities involving variables and positive and negative rational numbers.

Sample Problems or Classroom Activities

FORTHCOMING
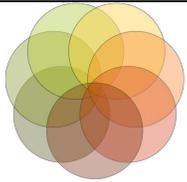
Algebraic Reasoning and Algebra

7.A.3 Apply mathematical actions and processes to use number sense, the properties of operations, and algebraic reasoning to identify, simplify, and solve simple linear equations and inequalities.
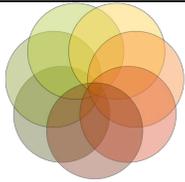
Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**7.A.3.1** Write and solve two-step linear equations with one variable using number sense, the properties of operations, and the properties of equality. **7.A.3.2** Model, write, solve, and graph one-step linear inequalities with one variable.

Sample Problems or Classroom Activities

FORTHCOMING

Algebraic Reasoning and Algebra

7.A.4 Apply mathematical actions and processes to use ratios to solve real-world and mathematical problems.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**7.A.4.1** Use reasoning about multiplication and division to solve ratio and rate problems. **7.A.4.2** Use proportional reasoning to solve problems involving ratios in various contexts. **7.A.4.3** Use knowledge of proportions to assess the reasonableness of solutions.

**Sample Problems or Classroom Activities**

FORTHCOMING

Algebraic Reasoning and Algebra

7.A.5 Apply mathematical actions and processes to use order of operations and algebraic properties to generate equivalent numerical and algebraic expressions containing positive and negative rational numbers and grouping symbols; evaluate such expressions.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**7.A.5.1** Use properties of algebra to generate equivalent numerical and algebraic expressions containing positive and negative rational numbers, grouping symbols and whole number exponents. Properties of algebra include associative, commutative and distributive laws. **7.A.5.2** Apply understanding of order of operations and grouping symbols when using calculators and other technologies.

**Sample Problems or Classroom Activities**

FORTHCOMING
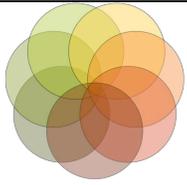
Algebraic Reasoning and Algebra

7.A.6 Apply mathematical actions and processes to represent real-world and mathematical situations using equations with variables. Solve equations algebraically, using the properties of equality. Interpret solutions in the original context.

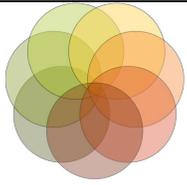| Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**7.A.6.1** Represent relationships in various contexts with equations involving variables and positive and negative rational numbers. **7.A.6.2** Use properties of operations and equality to solve for the value of a variable and interpret solutions in the original context. **7.A.6.3**. Solve equations resulting from proportional relationships in various contexts.

Sample Problems or Classroom Activities

FORTHCOMING
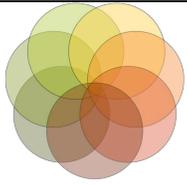
Number and Operations

7.N.1 Apply mathematical actions and processes to read, write, represent and compare positive and negative rational numbers, expressed as integers, fractions and decimals.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**7.N.1.1** Know that every rational number can be written as the ratio of two integers or as a terminating or repeating decimal. Recognize that π is not rational, but that it can be approximated by rational numbers such as $\frac{22}{7}$ and 3.14. **7.N.1.2** Compare and order positive and negative rational numbers expressed in various forms using the symbols <, >, =, ≤, and ≥. **7.N.1.3** Recognize and generate equivalent representations of positive and negative rational numbers, including equivalent fractions.

Sample Problems or Classroom Activities

FORTHCOMING

Number and Operations

7.N.2 Apply mathematical actions and processes to calculate with positive and negative rational numbers, and rational numbers with natural number exponents, to solve real-world and mathematical problems.
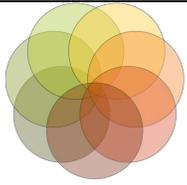
Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**7.N.2.1** Use real-world contexts and the inverse relationship between addition and subtraction to explain why the procedures of arithmetic with negative rational numbers make sense. **7.N.2.2** Model addition, subtraction, multiplication and division of positive and negative integers using a variety of representations (e.g., two-color counters, number lines). **7.N.2.3** Add, subtract, multiply and divide positive and negative rational numbers including integers, fractions and terminating decimals; use efficient and generalizable procedures including but not limited to standard algorithms. **7.N.2.4** Raise integers to whole number exponents. **7.N.2.5** Solve real-world and mathematical problems involving calculations with positive and negative rational numbers and positive integer exponents. **7.N.2.6** Demonstrate an understanding of the relationship between the absolute value of a rational number and distance on a number line. Use the symbol for absolute value. **7.N.2.7** Calculate the percent of a number and determine what percent one number is of another number to solve problems in various contexts (e.g., sales tax, markup, discount, percent error, tip). **7.N.2.8** Use proportional reasoning to solve

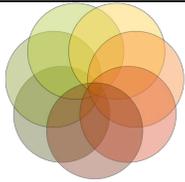|	problems involving ratios in various contexts.

Sample Problems or Classroom Activities

FORTHCOMING

Geometry and Measurement

7.GM.1 Apply mathematical actions and processes to analyze the effect of change of scale, translations and reflections on the attributes of two-dimensional figures.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**7.GM.1.1** Describe the properties of similarity, compare geometric figures for similarity, and determine scale factors. **7.GM.1.2** Apply scale factors, length ratios and area ratios to determine side lengths and areas of similar geometric figures limited to triangles and rectangles. **7.GM.1.3** Use proportions and ratios to solve problems involving scale drawings and conversions of measurement units.

**Sample Problems or Classroom Activities**

FORTHCOMING

Geometry and Measurement

7.GM.2 Apply mathematical actions and processes to use reasoning with proportions and ratios to determine measurements, justify formulas, and solve real-world and mathematical problems involving circles and related geometric figures.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**7.GM.2.1** Demonstrate an understanding of the proportional relationship between the diameter and circumference of a circle and that the unit rate (constant of proportionality) is π and can be approximated by rational numbers such as $\frac{22}{7}$ and 3.14. **7.GM.2.2** Calculate the circumference and area of circles to solve problems in various contexts, as approximate values and in terms of π.

**Sample Problems or Classroom Activities**

FORTHCOMING
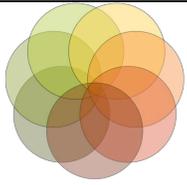
Geometry and Measurement

7.GM.3 Apply mathematical actions and processes to develop and understand the concept of surface area and volume of rectangular prisms.

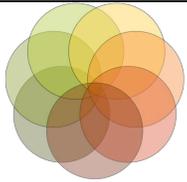| Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**7.GM.3.1** Using a variety of tools and strategies, develop the concept that surface area of a rectangular prism can be found by wrapping the figure with same-sized square units without gaps or overlap. Use appropriate measurements such as cm^2. **7.GM.3.2** Using a variety of tools and strategies, develop the concept that the volume rectangular prisms can be found by counting the total number of same-sized cubic units that fill a shape without gaps or overlaps. Use appropriate measurements such as cm^3.

Sample Problems or Classroom Activities

FORTHCOMING
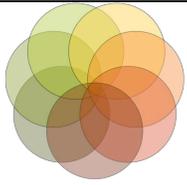
Data and Probability

7.D.1 Apply mathematical actions and processes to display and interpret data in a variety of ways, including circle graphs and histograms.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**7.D.1.1** Design simple experiments, collect data and calculate measures of central tendency (mean, median, and mode) and spread (range). Use these quantities to draw conclusions about the data collected and make predictions. **7.D.1.2** Use reasoning with proportions to display and interpret data in circle graphs (pie charts) and histograms. Choose the appropriate data display and know how to create the display using a spreadsheet or other graphing technology.

Sample Problems or Classroom Activities

FORTHCOMING

Data and Probability

7.D.2 Apply mathematical actions and processes to calculate probabilities and reason about probabilities using proportions to solve real-world and mathematical problems.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Conceptual Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**7.D.2.1** Determine the theoretical probability of an event using the ratio between the size of the event and the size of the sample space; represent probabilities as percents, fractions and decimals between 0 and 1 inclusive. Understand that probabilities measure likelihood. **7.D.2.2** Use proportional reasoning to draw conclusions about and predict relative frequencies of outcomes based on probabilities.

Sample Problems or Classroom Activities

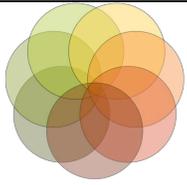FORTHCOMING

Oklahoma Academic Standards for Mathematics
Pre-Algebra

The Pre-Algebra standards prepare students for success in Algebra I. The Pre-Algebra standards are divided into four strands: Number and Operations, Algebraic Reasoning and Algebra, Geometry and Measurement, and Data and Probability. In Number and Operations, irrational numbers will be introduced. In Algebraic Reasoning and Algebra, students will use their computation skills with rational numbers to solve multi-step linear equations, extend solving to include two step linear inequalities, and begin working with functions. Students will recognize and interpret linear functions in real-world and mathematical situations and represent relations and functions in multiple ways including tables, graphs, and rules. In the Geometry and Measurement strand, students will apply the Pythagorean Theorem, as well as calculate the surface area and volume of rectangular prisms and right cylinders. In Data and Probability, students will explain effects of outliers on measures of central tendency, interpret data using scatterplots, and calculate experimental probabilities.

Problem solving has been integrated throughout the content strands. The development of problem solving skills should be a major goal of the mathematics program at every grade level. Experience with the process of problem solving will need to be integrated early and continuously into each student's mathematics education. Students must be helped to develop a wide range of skills and strategies for solving a variety of problem types.

While learning mathematics, students should be actively engaged, using concrete materials and appropriate technologies such as calculators and computers. However, facility in the use of technology should not be regarded as a substitute for a student's understanding of quantitative concepts and relationships or for proficiency and fluency with basic computations.

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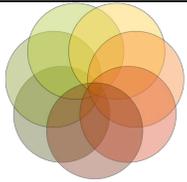
Algebraic Reasoning and Algebra

PA.A.1 Apply mathematical actions and processes to understand the concept of function in real-world and mathematical situations, and distinguish between linear and nonlinear functions.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Problem Solving Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**PA.A.1.1** Recognize that a function is a relationship between an independent variable and a dependent variable in which the value of the independent variable determines the value of the dependent variable. Use functional notation, such as $f(x)$, to represent such relationships. **PA.A.1.2** Use linear functions to represent relationships in which changing the input variable by some amount leads to a change in the output variable that is a product of a constant and that amount. **PA.A.1.3** Identify a function as linear if it can be expressed in the form $f(x)=mx+b$ or if its graph is a straight line.

Sample Problems or Classroom Activities

FORTHCOMING

Algebraic Reasoning and Algebra

PA.A.2 Apply mathematical actions and processes to recognize linear functions in real-world and mathematical situations; represent linear functions and other functions with tables, verbal descriptions, symbols and graphs; solve problems involving these functions and explain results in the original context.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Solving Diverse Problems Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**PA.A.2.1** Represent linear functions with tables, verbal descriptions, symbols, equations and graphs; translate from one representation to another. **PA.A.2.2** Identify, describe, and analyze linear relationships between two variables (e.g., as the value of x increases on a table, do the values of y increase or decrease, identify a positive rate of change on a graph and compare it to a negative rate of change). **PA.A.2.3** Identify graphical properties of linear functions including slopes and intercepts. Know that the slope equals the rate of change, and that the y-intercept is zero when the function represents a proportional relationship. **PA.A.2.4** Predict the effect on the graph of a linear equation when the slope or y-intercept changes (e.g., make predictions from graphs, identify the slope or y-intercept in the equation y = mx + b and relate to a graph). Use appropriate tools to examine these effects.

Sample Problems or Classroom Activities

Example for PA.A.2.4

*One example solved in two ways – Desmos and graphing calculator.*

Desmos: $m = \frac{2}{3}$; b = - 2; Teacher Note: students can drag the line to different locations to see the changes in slope and y-intercept; they can also change the values for m and/or b on the left for specific examples. Multiple representations can be illustrated.
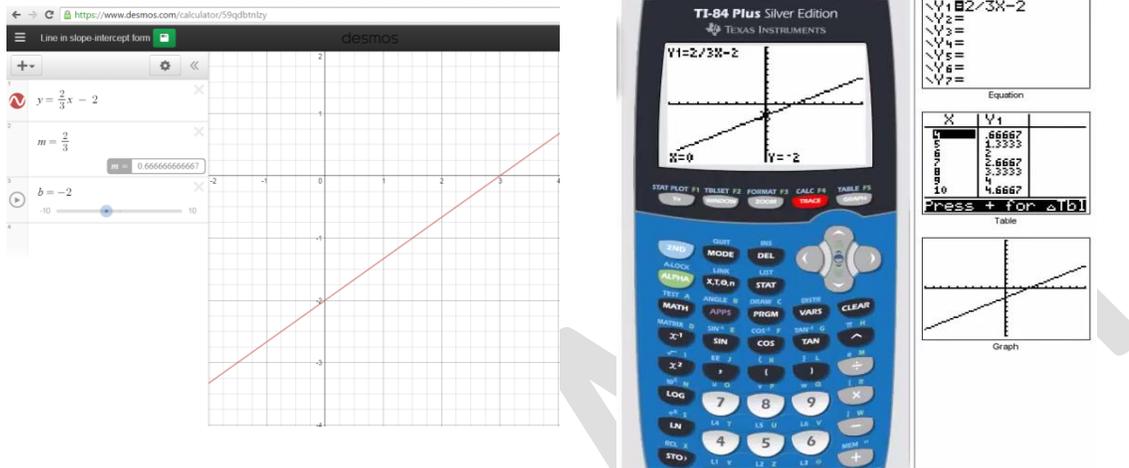
TI 84+: m = 2/3; b = - 2;

Teacher Note: *students can change use graph of table to find the values for slope and/or y-intercept. They can also enter additional equations to see the effect on m and/or b.*
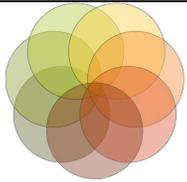
MORE FORTHCOMING
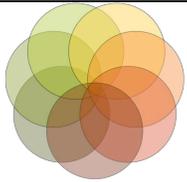
Algebraic Reasoning and Algebra

PA.A.3 Apply mathematical actions and processes to generate equivalent numerical and algebraic expressions and use algebraic properties to evaluate expressions.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Solving Diverse Problems Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**PA.A.3.1** Evaluate algebraic expressions using a variety of methods. **PA.A.3.2** Justify steps in generating equivalent expressions by identifying the properties used, including the properties of operation and equality. Properties include the associative, commutative and distributive laws, and the order of operations, including grouping symbols.

**Sample Problems or Classroom Activities**

FORTHCOMING

Algebraic Reasoning and Algebra

PA.A.4 Apply mathematical actions and processes to represent real-world and mathematical problems using equations and inequalities involving linear expressions. Solve and graph equations and inequalities algebraically and graphically. Interpret solutions in the original context.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Solving Diverse Problems Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**PA.A.4.1** Model, write, and solve multi-step linear equations with one variable to solve mathematical and real-world problems. Interpret solutions in the original context. **PA.A.4.2** Express linear equations in slope-intercept form. Graph and interpret linear equations on an x-y coordinate plane. **PA.A.4.3** Model, write, and solve one- and two-step linear inequalities with one variable using the properties of inequality. Graph the solutions on a number line. **PA.A.4.4** Represent real-world situations using equations and inequalities involving one variable.

Sample Problems or Classroom Activities

FORTHCOMING
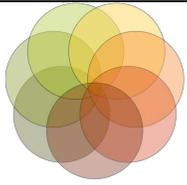
Number and Operations

PA.N.1 Apply mathematical actions and processes to read, write, compare, classify and represent real numbers, and use them to solve problems in various contexts.
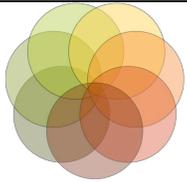
Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Solving Diverse Problems Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**PA.N.1.1** Develop and apply the properties of positive and negative integer exponents to generate equivalent numerical expressions, including $a^0 = 1$, **a** not equal to zero. **PA.N.1.2** Express approximations of very large and very small numbers using scientific notation; understand how scientific calculators display numbers in scientific notation. Multiply and divide numbers expressed in scientific notation, express the answer in scientific notation, using the correct number of significant digits when physical measurements are involved. **PA.N.1.3** Classify real numbers as rational or irrational. Recognize that when a square root of a positive integer is not an integer, then it is irrational. Recognize that the sum of a rational number and an irrational number is irrational, and the product of a non-zero rational number and an irrational number is irrational. **PA.N.1.4** Compare real numbers; locate real numbers on a number line. Identify the square root of a perfect square to 400 or, if it is not a perfect square root, locate it as a real number between two consecutive positive integers. **PA.N.1.5** Express approximations of very large and very small numbers using scientific notation; understand how calculators display numbers in scientific notation. Multiply and divide numbers expressed in scientific notation, express the answer in scientific notation, using the correct number of significant digits when physical measurements are

	involved.

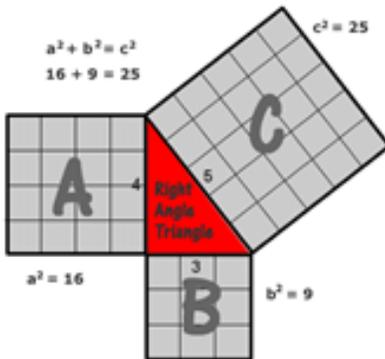**Sample Problems or Classroom Activities**

FORTHCOMING

Geometry and Measurement

PA.GM.1 Apply mathematical actions and processes to solve problems involving right triangles using the Pythagorean Theorem.
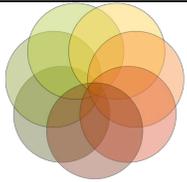
Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Solving Diverse Problems Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**PA.GM.1.1** Informally justify the Pythagorean Theorem using measurements, diagrams or dynamic software and use the Pythagorean Theorem to solve problems involving right triangles. **PA.GM.1.2** Determine the distance between two points on a horizontal or vertical line in a coordinate system. Use the Pythagorean Theorem to find the distance between any two points in a coordinate system.

Sample Problems or Classroom Activities
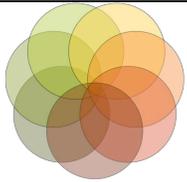
Example for PA.GM.1.1

MORE FORTHCOMING

Geometry and Measurement

PA.GM.2 Apply mathematical actions and processes to solve problems involving parallel and perpendicular lines on a coordinate system.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Solving Diverse Problems Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**PA.GM.2.1** Use the relationships between the slopes of parallel lines and between the slopes of perpendicular lines graphically and algebraically to determine whether sets of lines are parallel, perpendicular, or neither. Dynamic graphing software may be used to examine these relationships.

**Sample Problems or Classroom Activities**

FORTHCOMING

Geometry and Measurement

PA.GM.3 Apply mathematical actions and processes to calculate surface area and volume of three-dimensional figures.

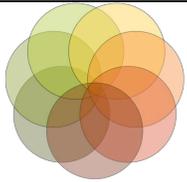| Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Solving Diverse Problems Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**PA.GM.3.1** Calculate the surface area of a rectangular prism using decomposition or nets. Use appropriate measurements such as cm^2. **PA.GM.3.2** Calculate the surface area of a cylinder, as approximate values and in terms of π, using decomposition or nets. Use appropriate measurements such as cm^2. **PA.GM.3.3** Develop and use the formulas $V = \ell wh$ and $V = Bh$ to determine the volume of rectangular prisms. Justify why base area (B) and height (h) are multiplied to find the volume of a rectangular prism by breaking the prism into layers of rectangles. Use appropriate measurements such as cm^3. **PA.GM.3.4** Develop and use the formulas $V = \pi r^2 h$ and $V = Bh$ to determine the volume of right cylinders, as approximate values and in terms of π. Justify why base area B and height h are multiplied to find the volume of a right cylinder by breaking the cylinder into layers of circles with radius (r). Use appropriate measurements such as cm^3.

Sample Problems or Classroom Activities

FORTHCOMING
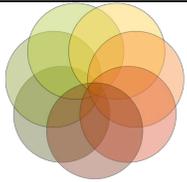
Data and Probability

PA.D.1 Apply mathematical actions and processes to display and interpret data in a variety of ways, including using scatterplots and approximate lines of best fit. Use lines of best fit to draw conclusions about data.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Solving Diverse Problems Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**PA.D.1.1** Describe the impact that inserting or deleting a data point has on the mean and the median of a data set. Know how to create data displays using a spreadsheet and use a calculator to examine this impact. **PA.D.1.2** Explain how outliers affect measures of central tendency. **PA.D.1.3** Collect, display and interpret data using scatterplots. Use the shape of the scatterplot to informally estimate a line of best fit and determine an equation for the line. Use appropriate titles, labels and units. Know how to use graphing technology to display scatterplots and corresponding lines of best fit. **PA.D.1.4** Use a line of best fit to estimate rate of change and to make predictions about values not in the original data set and assess the reasonableness of predictions using scatterplots by interpreting them in the original context.

Sample Problems or Classroom Activities

FORTHCOMING

Data and Probability

PA.D.2 Apply mathematical actions and processes to calculate experimental probabilities and reason about probabilities to solve real-world and mathematical problems.

Mathematical Actions and Processes	Mathematical Benchmark
Develop a Deep and Flexible Understanding Develop Accurate and Appropriate Procedural Fluency Develop Strategies for Solving Diverse Problems Develop Mathematical Reasoning Develop a Productive Mathematical Disposition Develop the Ability to Make Conjectures, Model, and Generalize Develop the Ability to Communicate Mathematically	**PA.D.2.1** Calculate experimental probabilities and represent them as percents, fractions and decimals between 0 and 1 inclusive. Use experimental probabilities to make predictions when actual probabilities are unknown.

Sample Problems or Classroom Activities

FORTHCOMING