

Alabama Course of Study Mathematics



**Joseph B. Morton
State Superintendent of Education**

**STATE SUPERINTENDENT
OF EDUCATION'S MESSAGE**

Dear Educator:

The demands of our society and the workplace provide evidence of the need for all Alabama students to achieve the goal of building a strong mathematics foundation. Alabama educators must focus on the teaching of mathematics in ways that ensure students possess adequate preparation to meet future needs and function as problem solvers, decision makers, and lifelong learners. To address this goal, the content of the 2009 *Alabama Course of Study: Mathematics* sets high standards for all students by incorporating national standards for mathematics and by addressing mathematical issues affecting our state.

The 2009 *Alabama Course of Study: Mathematics*, developed by educators and business and community leaders, provides a base upon which quality mathematics programs across the state can be developed. The implementation of the content of this document through appropriate instruction will enable all Alabama students to obtain the mathematical foundations necessary to be college and career ready.

Joseph B. Morton
State Superintendent of Education

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Alabama Course of Study: Mathematics

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PREFACE

The 2009 *Alabama Course of Study: Mathematics* provides the framework for the K-12 mathematics program in Alabama's public schools. Content standards and related content included in bullets in this document are minimum and required (*Code of Alabama*, 1975, §16-35-4). They are fundamental and specific but not exhaustive. In developing local curriculum, school systems may include additional content standards to reflect local philosophies and add implementation guidelines, resources, and activities; which, by design, are not contained in this document.

The 2008-2009 Mathematics State Course of Study Committee made extensive use of the *Principles and Standards for School Mathematics*, a publication of the National Council of Teachers of Mathematics (NCTM). In addition, Committee members read articles in professional journals and other publications, including the National Assessment of Educational Progress (NAEP) standards and Achieve, Inc.'s benchmarks for mathematics; reviewed curriculum documents from other states; listened to and read statements from interested individuals and groups throughout the state; used each member's academic and experiential knowledge; and discussed issues among themselves and with colleagues. Finally, the Committee developed what they believe to be the best possible mathematics curriculum for Alabama's K-12 students.

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This document was developed by the 2008-2009 Mathematics State Course of Study Committee and Task Force composed of early childhood, intermediate school, middle school, high school, and college educators appointed by the Alabama State Board of Education and business and professional persons appointed by the Governor (*Code of Alabama*, 1975, §16-35-1). The Committee and Task Force began work in March 2008 and submitted the document to the Alabama State Board of Education for adoption at the May 2009 meeting.

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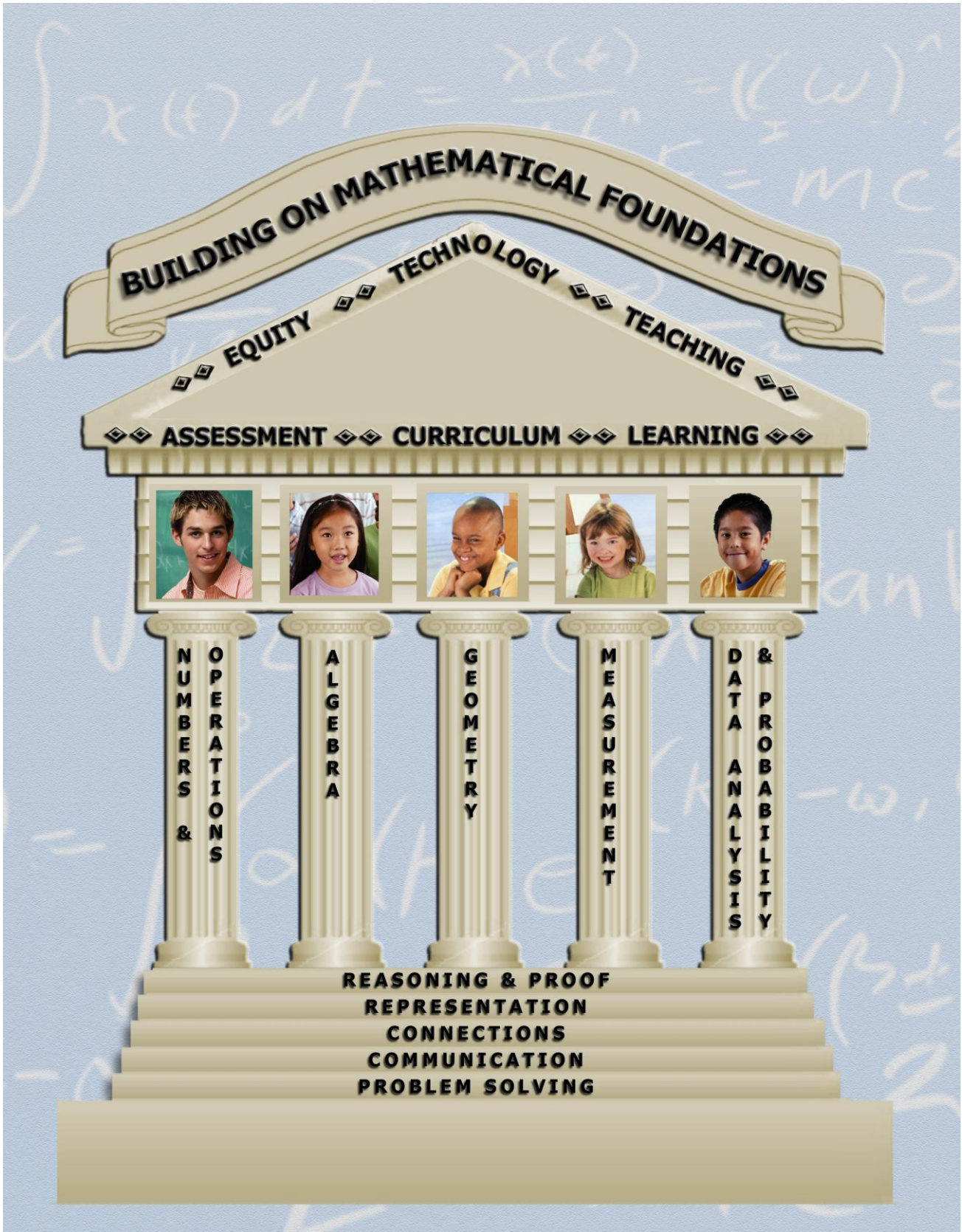
ALABAMA'S K-12 MATHEMATICS CURRICULUM

GENERAL INTRODUCTION

The goal of Alabama's K-12 mathematics program is to build mathematical foundations that enable all students to successfully live and work in an ever-changing world. Students with a solid mathematical foundation have the ability to be flexible and resourceful problem solvers. Educators, using the 2009 *Alabama Course of Study: Mathematics* as a basis for local curriculum development and instructional decision-making, are able to provide all students with the ability to use mathematics content and skills to achieve professional goals in the workplace as well as personal goals in everyday life.

Recommendations found in two documents published by the NCTM, *Principles and Standards for School Mathematics* and *Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics: A Quest for Coherence*, and the benchmarks for mathematics published by Achieve, Inc., were reviewed and used in the development of the Grades K-12 conceptual framework, position statements, content strands, content standards, and process standards for this course of study. The five broad NCTM content standards provide organization for the document and are represented as the strands around which the content standards are grouped. These five strands are Number and Operations, Algebra, Geometry, Measurement, and Data Analysis and Probability. Embedded within the content standards are the process standards of Problem Solving, Reasoning and Proof, Communication, Connections, and Representations. All content standards increase in rigor, without repetition, across the grades and address the required mathematics knowledge and skills that students must know and be able to do for each grade level or course.

Mastery of the standards enables students to build a solid foundation of knowledge, skills, and understanding in mathematics. To ensure student success, effective implementation of the 2009 *Alabama Course of Study: Mathematics* requires educators to utilize the minimum required content of this course of study to develop local curriculum guides or local courses of study.



ALABAMA'S K-12 MATHEMATICS CURRICULUM

CONCEPTUAL FRAMEWORK

The goal of Alabama's K-12 mathematics curriculum, "Building on Mathematical Foundations," is displayed across the banner at the top of the graphic on the opposite page. Student achievement of this goal enhances future opportunities and options for the workplace and for everyday life.

The organization of this course of study is based upon the six principles for school mathematics and the content strands and process standards found in the NCTM's *Principles and Standards for School Mathematics (PSSM)*. The six principles—Equity, Curriculum, Teaching, Learning, Assessment, and Technology—are represented on the triangle surrounding the tympanum. They reflect basic tenets that are fundamental to the design of a quality mathematics program that allows all students the opportunity to reach their mathematical potential. The content strands that describe what students should know and be able to do for each grade or course are represented on the pillars that support the tympanum. The strands are Number and Operations, Algebra, Geometry, Measurement, and Data Analysis and Probability. The five process standards—Problem Solving, Reasoning and Proof, Communication, Connections, and Representations—indicate ways students learn and apply mathematics knowledge and skills. These process standards are represented on the steps that form the foundation for the teaching and learning of the rigorous content in the mathematics strands.

Principles

The six principles on the triangle surrounding the tympanum form the framework for the design of a sound mathematics program for all students. This program provides **equity** by allowing all students access to quality instructional programs in mathematics. The **curriculum** for Grades K-12 is aligned across all grade levels and increases in rigor as students progress through the grades. It is organized around the five strands, focuses on important mathematics concepts, and provides the minimum required mathematics content for each grade and course. Effective mathematics **teaching** requires teachers to know and understand what students need to learn, know and have a deep understanding of the mathematics they teach, and know how to teach and best challenge students with multiple instructional strategies that support learning. **Learning** requires students to be actively involved in challenging activities that allow them to acquire new knowledge and skills that build upon previous learning. These activities provide students time to think and reflect upon their learning in order to deepen their conceptual knowledge of the world of mathematics. Summative and formative **assessments** provide teachers with important information to be used to direct, adjust, and improve instruction. Assessments are also a valuable tool for students to use as an indicator of their progress in meeting course objectives. Teaching students using **technology** enhances mathematics learning. Technology offers students multiple opportunities to expand and deepen their foundational knowledge and understanding of mathematics.

Strands

The content strands are the pillars that support students and the principles used to teach them. **Number and Operations** involves counting and adding whole numbers in kindergarten to defining e and modeling and solving application-based problems in the Precalculus and Probability and Statistics courses. Throughout this strand, an emphasis is placed on number sense, number systems, and the meanings of operations. The **Algebra** strand in Grades K-6 includes patterns, sequences, and properties. Students in these grades are introduced to relations, functions, and graphs. In

Grades 7-12, functions, relations, and their graphs become the primary focus while students in the Precalculus course determine limits of functions. The **Geometry** strand in Grades K-6 involves identifying polygons and their attributes, finding points on the coordinate plane, and classifying polygons. In Grades 7-12, content includes transformations of polygons on the coordinate plane, the Pythagorean Theorem, and polar coordinates. The **Measurement** strand is interwoven with the other four strands. In Grades K-4, emphasis is placed on units of measurement, time in reference to clock and calendar, and conversions within the same measurement system. In Grades 5-8, students convert between customary and metric units and find area and volume. Grades 9-12 content includes measurements between two- and three-dimensional shapes and figures. Throughout the grade levels, this strand includes an understanding of units of measure and systems, processes, tools, and formulas of measurement. The final strand in the course of study is **Data Analysis and Probability**. This strand covers a variety of concepts and includes more than calculation. It involves demonstration of conceptual understanding and decision-making skills as students select appropriate displays, formulas, and statistical methods. In Grades K-6, students summarize, categorize, and create simple data displays. In Grades 4-6, they are introduced to techniques used to determine the outcomes of simple events. Students in Grades 7-12 master measures of central tendencies and various ways data can be reported. In Grades 9-12, hypothesis testing is included in the Probability and Statistics course. Students throughout the grade levels calculate probabilities of events of varying degrees of complexity.

Processes

The PSSM process standards are the foundation upon which the content standards, categorized by the strands, are mastered. **Problem-solving** skills are utilized to extend students' mathematical knowledge and skills in all strands. Application-based problems are incorporated within every grade level. Multiple representations, including algebraic, numerical, graphical, and verbal, are used to enhance students' understanding of a standard. Through mathematical **reasoning and proof**, students use higher-order thinking skills to formulate and justify understanding of mathematical concepts. Multiple forms of **communication** are stressed throughout the course of study. Students communicate through written, verbal, graphical, or pictorial representations to justify results and strategies. They develop a sense of the interconnectedness of mathematics concepts and learn to view mathematics as an integrated field of study. They become aware of the **connections** among mathematics-to-mathematics topics, mathematics-to-other content area topics, and mathematics-to-life application topics. Students use multiple **representations** such as concrete objects, charts and graphs, and symbols to facilitate mastery of the content standards. As students progress in their understanding of mathematics, their capacity to make representations of mathematical ideas expands.

POSITION STATEMENTS

Equity

All Alabama students, with no exception, must have the opportunity to learn relevant and challenging mathematics. The individual needs, interests, and abilities of all students should be considered in planning for instruction. This course of study is written to support differentiated instruction that enables and motivates students in the learning of meaningful mathematics. Teachers who have high expectations for all students structure their classrooms, plan lessons, and provide reasonable accommodations with the goal of meeting the needs of all Alabama students.

Curriculum

The 2009 *Alabama Course of Study: Mathematics* is intended to serve as a guide for curriculum development in local school systems. This course of study presents the framework that provides Alabama's students with content that is coherent, rigorous, and well-articulated across the grades and that focuses on and makes connections between important mathematical ideas. Educators should select or develop resources that help students make these connections and recognize and apply mathematics concepts in contexts outside the area of mathematics. Mathematical investigations that lead students from facts and skills to conceptual understanding and problem-solving techniques enable students to understand how mathematical ideas interconnect and build on one another to produce a coherent whole.

Teaching

The quality and effectiveness of mathematics education in Alabama is influenced by choices made by local school systems and teachers. Effective mathematics teachers develop and maintain their mathematical and pedagogical knowledge, collaborate with colleagues, and seek high-quality professional development opportunities. Effective mathematics teachers use this course of study to plan lessons that engage all students in learning. In elementary grades, it is important to develop students' interest in and enjoyment of mathematics. In the middle grades and high school, teachers should plan relevant classroom activities that actively involve all students. Projects and problems that make connections between mathematics and students' lives are important at this level. Effective teachers make it a regular practice to reflect on lessons and classroom interactions, including making adjustments as needed.

Learning

Students learn mathematics best when they understand what they are learning. To build upon prior knowledge and experiences, they must be actively engaged in the learning process with meaningful, worthwhile tasks. This engagement affords students opportunities to become confident in their learning and to develop a genuine interest in pursuing ways to solve increasingly difficult problems. Learning mathematics through the use of multiple representations, including algebraic, numerical, graphical, and verbal methods, increases students' abilities to make mathematical connections and become effective communicators of mathematics.

Assessment

Assessment provides teachers and students with information to guide and improve instruction and learning. Effective assessment is planned concurrently with instructional goals. Teachers must plan to use formative assessments during the instructional process and summative assessments at the conclusion of a unit of instruction. Formative assessment is considered a hallmark of effective mathematics instruction and involves the ongoing monitoring of student learning to inform instruction. Information gained from formative assessment is useful to teachers in providing differentiated instruction and to students in the provision of frequent feedback. Varied types of formative assessment should be an integral component of instructional practice in Alabama's mathematics classrooms. Assessment includes, but is not limited to, open-ended problems, constructed-response tasks, selected-response tasks, performance assessments, observations, discussions, journals, and portfolios.

Technology

Technology is an essential component in the teaching and learning of mathematics. Teachers must take advantage of opportunities to heighten student understanding by planning lessons using available technology and making sound instructional decisions about meaningful projects and tasks in which learning is enhanced through the appropriate use of technology. Technology, when used effectively, increases students' understanding of fundamental mathematics concepts, helps them develop an appreciation of mathematics, and inspires them to pursue the study of mathematics for a lifetime.

Directions for Interpreting the Minimum Required Content

1. **CONTENT STANDARDS** are statements that define what students should know and be able to do at the conclusion of a course or grade. Content standards in this document contain minimum required content. The order in which standards are listed within a course or grade is not intended to convey a sequence for instruction. Each content standard completes the phrase “*Students will.*”

Students will:

Determine the inverse of a function and a relation.

(Precalculus – Content Standard 6)

2. **BULLETS** denote content related to the standards and required for instruction. Bulleted content is listed under a standard and identifies additional minimum required content.

Students will:

Identify the center, radius, and diameter of a circle.

- Identifying a chord and an arc of a circle

(Fifth Grade – Content Standard 10)

3. **EXAMPLES** clarify certain components of content standards or bullets. They are illustrative but not exhaustive.

Students will:

Describe a pattern in a number sequence.

Examples: 3, 8, 13, 18, 23,...

50, 46, 42, 38, 34,...

(Second Grade – Content Standard 7)

KINDERGARTEN – SECOND GRADE OVERVIEW

Students in Grades K-2 are developing a sense of themselves as they grow in their ability to communicate and work with others. They display a natural curiosity about participating in their surroundings. As their language and communicative abilities develop, they make sense of their world through active involvement in reasoning and problem-solving situations. At these grade levels, students begin to construct, modify, and integrate ideas by interacting with the physical world as well as with peers and adults.

Students in Grades K-2 come to school with diverse mathematical and technological backgrounds. Some have been exposed to numerous opportunities to make mathematical connections and to use technology in daily life, while others lack these experiences. Utilization of flexible groupings where students share discoveries and teachers communicate strategies helps students build upon prior mathematical experiences. The ideal early childhood classroom environment encourages students' natural mathematical inquisitiveness and provides opportunities for them to construct mathematical understanding in authentic and relevant experiences using hands-on materials. Early experiences with technology reinforce mathematical thinking and provide contextual understanding for students in Grades K-2.

The Grades K-2 mathematics program provides a challenging curriculum designed to deepen and expand mathematics understanding through a gradual building of knowledge and skills leading students to realize the interconnectedness of mathematics topics. This K-2 curriculum is well-articulated across the grades, takes into account prior learning as well as learning to be addressed in future grades and courses, and focuses on the learning of relevant mathematics knowledge and skills to prepare students for solving problems encountered in daily life as well as for continued study in mathematics.

Content standards within this document are designed to help students reason, communicate, reflect, and make sense of their world. This curriculum empowers students to explore the ideas of pattern, shape, number, and space to help them establish a solid foundation for further study in mathematics. The Grades K-2 content standards are organized into the five content strands described in the General Introduction of this document. The Number and Operations and Geometry strands are the cornerstones of mathematics at these grade levels. Students gain conceptual knowledge of number and place value through counting, composing and decomposing numbers, and grouping quantities. Computational fluency in addition and subtraction is achieved through a strong mathematics foundation that includes a thorough understanding of the concepts of addition and subtraction. Essential principles of the Geometry strand include understanding spatial relationships and describing plane and solid figures. In the Algebra strand, foundations are established through patterns, relationships, and functions. Standards in the Data Analysis and Probability strand are introduced through the collection and analysis of a variety of information. Knowledge in the Measurement strand is achieved through the development of nonstandard and standard measurement skills. All five content strands are interconnected in these grades in order to build a strong foundation for future success in mathematics.

KINDERGARTEN

Young students learn through exploration and problem-solving and begin to apply their knowledge of the world and to use representations for conveying ideas. Beginning connections are made between their informal knowledge of quantity, shape, size, and pattern and the formal language of mathematics. During the kindergarten year, communication and cooperation are enhanced through numerous opportunities for independent and group activities that allow students to utilize the skills of reasoning and proof.

Mathematics is introduced through activities that develop and deepen students' conceptual understanding. The physical arrangement of the kindergarten classroom allows for exploration, manipulation of objects, and active involvement. Manipulative materials enable students to engage in their own learning and broaden simple mathematical concepts. They benefit from well-planned, thought-provoking experiences that include hands-on activities as they formally begin their study of the world of mathematics.

In kindergarten, mathematical concepts include recognizing patterns and shapes, demonstrating one-to-one correspondence, making comparisons, using classification skills, and ordering sets of objects. By the end of kindergarten, students are able to recognize numbers and shapes, replicate simple patterns, and communicate using mathematical vocabulary.

Number and Operations

Students will:

- Count in sequence by ones from 1 to 30 and backwards from 10 to 0.
 - Identifying the quantity of a given set of objects from 0 to 20
 - Identifying the numeral that represents a given set of objects
 - Identifying numerals 0 through 20 in sequential and nonsequential order
- Demonstrate concepts of number sense by using one-to-one correspondence; comparing sets of objects up to 10 using vocabulary terms, including *more than*, *less than*, *most*, or *least*; and recognizing that the quantity remains the same when the spatial arrangement changes.
 - Composing numbers 1 through 10
Example: recognizing that 4 and 1 is equal to 5
 - Decomposing numbers 1 through 10
Example: recognizing 5 as being represented by 2 and 3
 - Estimating the number of objects in sets that contain up to 20 objects
- Demonstrate addition and subtraction processes needed to solve single-digit problems using authentic situations.
 - Examples: *There are 2 girls and 3 boys sitting at the blue table. What is the total number of children sitting at the blue table? Answer: There are 5 children sitting at the blue table.*
There are 6 birds on a tree. A squirrel chases 2 birds away. How many birds are left? Answer: There are 4 birds left on the tree.
 - Illustrating conceptual understanding of joining and separating sets using a variety of materials
- Identify coins by name, including penny, nickel, dime, and quarter.

5. Recognize that a whole object can be divided into parts.
 - Distinguishing parts of a whole as equal or not equal

Algebra

6. Explain criteria used to sort objects.
Examples: shape, size, color
7. Create a repeating pattern using multiple representations.
Examples: movement patterns—clap, stomp, stomp; clap, stomp, stomp
color patterns—blue, red, red; blue, red, red
shape patterns—□, △, △; □, △, △

Geometry

8. Identify two-dimensional (plane) shapes, including rectangle, square, circle, triangle, hexagon, trapezoid, and rhombus, and three-dimensional (solid) figures, including sphere, cone, and cylinder.
 - Locating shapes in the environment
 - Combining shapes to fill in the area of a given shape
Example: covering a rectangle with two triangles
9. Describe spatial relationships of objects using positional terms.
Examples: *inside, outside, above, below, between, on, over, under, near, far, beside, touching*

Measurement

10. Use vocabulary to compare length, volume, or weight of objects.
Examples: length—*longer than, as long as, shorter than, as short as, taller than, as tall as*
volume—*holds more, holds less*
weight—*as light as, as heavy as, heavier than, lighter than*
11. Use vocabulary associated with the sequence of time, including words related to clocks and calendars.
Examples: sequence of time—*before, after, first, last, next*
clocks—*hour, afternoon, evening*
calendars—*day, week, month, year, yesterday, today, tomorrow*

Data Analysis and Probability

12. Categorize data on Venn diagrams, pictographs, and “yes-no” charts using real objects, symbolic representations, or pictorial representations.
 - Describing collected data
Examples: “We have more boys in our class than girls.”
“Yellow is our least favorite color.”

FIRST GRADE

Students enter first grade as curious, active learners with a wide range of mathematical abilities and experiences. Although most students have mastered the oral counting sequence, actual counting abilities may vary greatly. Students possess mathematical knowledge based on their experiences, yet lack the communication skills needed to share this knowledge. In order to grow mathematically, first graders need time to develop conceptual knowledge, connect mathematical concepts with their own experiences, reflect on their learning, and communicate their understanding of mathematics to others.

An effective instructional environment incorporates the use of hands-on materials, in-depth reasoning activities, verbal communication skills, and visual representations of mathematics concepts. Morning calendar, daily data analysis activities, and other routines also provide opportunities for instruction in mathematics. Students work independently, with partners, in small groups, and in large groups as they solve problems, make choices regarding materials and strategies, and reflect on their processes. The integration of literature, use of cooperative learning strategies, and active participation in the classroom help students make strong connections necessary for viewing mathematics as an important way of interpreting the world around them.

Content standards for first grade are designed to allow students to learn mathematics concepts with understanding. Learning with understanding makes subsequent learning easier as students are better able to connect new knowledge to existing knowledge. Learning with understanding also allows students to enhance problem-solving skills and become more adept in computational skills. According to the NCTM, development of a balance of and a connection between conceptual understanding and computational proficiency is necessary for students to achieve computational fluency.

Concepts emphasized in first grade are number and number relationships, including grouping of tens and ones; addition and subtraction; and shape relationships and properties. Measurement and data analysis are incorporated into these core content areas to enrich and extend student knowledge. Identifying, describing, and applying number patterns and properties in algebra offer students additional ways to explore number relationships. By making connections between the five content strands and the concepts emphasized in first grade, students build a solid foundation for becoming independent thinkers and lifelong problem solvers.

Number and Operations

Students will:

1. Demonstrate whole number relationships, including counting forward from a given number to 100 by ones, twos, fives, and tens; counting backwards from a given number; identifying position using ordinal numbers through 10th; and differentiating between odd and even numbers.
 - Using vocabulary, including *equal*, *not equal*, *all*, and *none*, to identify the quantity of sets of objects

2. Demonstrate concepts of number sense of two-digit numbers by composing and decomposing numbers in multiple ways, identifying the value of each digit, determining a number when given the quantity of tens and ones, and determining a number that is 10 more or 10 less than a given number.

Examples: composing—recognizing that 3 tens and 5 ones equals 35
recognizing that 3 tens and 5 ones equals 35
decomposing—recognizing 17 as being represented by 8 and 5 and 4,
recognizing 42 as being represented by 4 tens and 2 ones
numbers 10 more or 10 less—recognizing 53 as 10 more than 43, recognizing 7 as 10 less than 17

- Representing numbers with multiple models
Example: models—base ten blocks, number lines, linking cubes, straw bundles
- Estimating the number of objects in sets that contain up to 100 objects

3. Demonstrate addition and subtraction of one- and two-digit numbers by joining, separating, and comparing sets of objects in authentic situations.









- Applying the signs +, -, and = to actions of joining and separating sets
- Using three or more addends
- Using multiple strategies to add and subtract, including counting on, counting back, and using doubles
- Demonstrating the relationship between the operations of addition and subtraction
Example: addition and subtraction facts family $5 + 2 = 7$ $7 - 2 = 5$
 $2 + 5 = 7$ $7 - 5 = 2$
- Demonstrating computational fluency of addition problems with sums to 10 and subtraction problems with differences and minuends of 10 or less

4. Determine the monetary value of individual coins and sets of like coins up to \$1.00.

5. Identify parts of a whole with two, three, or four equal parts.

Algebra

6. Construct the same pattern with a variety of representations.

Examples: rhythmic—clap, snap, stomp; clap, snap, stomp; clap, snap, stomp
pictorial—, ,  ; , ,  ; , , 

- Identifying patterns in the environment
Example: stripes on a shirt

7. Recognize the identity and commutative properties of addition.


Examples: identity— $7 + 0 = 7$, $0 + 7 = 7$
commutative— $3 + 4 = 4 + 3$

Geometry

8. Describe attributes of two-dimensional (plane) geometric shapes, including quadrilaterals, pentagons, hexagons, heptagons, and octagons.

Examples: identifying a pentagon as having five sides and five angles, identifying a trapezoid as a quadrilateral

- Explaining how shapes are alike and different
- Recognizing shapes from different perspectives and orientations

Example: 

9. Identify three-dimensional (solid) geometric figures, including cubes, spheres, cones, cylinders, and rectangular prisms.

- Identifying two-dimensional shapes as faces of three-dimensional figures
- Locating three-dimensional figures in the environment
- Recognizing real-life examples of line symmetry

Example: recognizing a line of symmetry in a piece of folded paper

Measurement

10. Compare objects according to length, weight, or volume using a variety of nonstandard units.

Examples: length—using pencils or paper clips of equal length to measure the top of a desk

weight—determining which of two identical containers weighs more if one container is filled with water and one is filled with cotton balls

volume—using spoonfuls of sand to determine which container holds more sand

- Ordering objects according to length

11. Identify time to the hour and half hour using analog and digital clocks.

12. Locate days, dates, and months on a calendar.

Examples: locating the third Thursday of the month on a calendar; recognizing that today is Tuesday, January 24th

Data Analysis and Probability

13. Summarize information from graphs, including pictographs, tally charts, bar graphs, or Venn diagrams.

SECOND GRADE

Second graders are able to solve increasingly challenging problems, explore mathematical ideas in a variety of ways, and consider multiple strategies for solving problems. They begin to evaluate their own thinking as well as that of others in the mathematics classroom.

The second-grade learning environment should reflect developmental changes of students while focusing on the need for fundamental mathematics, interactive exploration, reflection, and justification of findings. Students reason and prove their findings, make connections between real-life experiences and mathematics, and communicate their mathematical understanding to others. They present ideas, with and without physical models, and use mathematical tools to aid their thinking. Students' knowledge of mathematical concepts is enhanced through participation in extended project investigations.

Content standards for second grade are designed to allow students to learn mathematics concepts with understanding. Learning with understanding makes subsequent learning easier as students are better able to connect new knowledge to existing knowledge. Learning with understanding also allows students to enhance problem-solving skills and become more adept in computational skills. According to the NCTM, development of a balance of and a connection between conceptual understanding and computational proficiency is necessary for students to achieve computational fluency.

Second-grade content focuses on number and operations, algebra, and measurement. Algorithms for addition and subtraction are formally introduced. Additionally, concepts such as using standard units of measure, creating and extending patterns, describing attributes of plane shapes and solid figures through geometry, and collecting data are addressed. These foundational skills prepare students to succeed as they begin to engage in more rigorous mathematical processes in future grades and everyday life.

Number and Operations

Students will:

1. Demonstrate the concept of number sense by comparing, ordering, and expanding whole numbers up to 1000; determining the place value of a digit in a number through 999; and determining a number when given the value of ones, tens, and hundreds.
Example: expanding—recognizing 251 as being represented by two hundred fifty-one, by 2 hundreds + 5 tens + 1 one, and by $200 + 50 + 1$
 - Identifying a number that is 100 more or 100 less than a given number
 - Counting forward in multiples from a given number
Examples: 3, 6, 9, 12; 4, 8, 12, 16
 - Identifying zero as a placeholder in two- and three-digit numbers
 - Comparing numbers using the symbols $>$, $<$, and $=$
 - Using estimation to compare sets of objects when the quantity of one set is known
Example: estimating the quantity of set B when compared to set A that contains 20 items

2. Solve two-digit addition and subtraction problems, with and without regrouping, using multiple strategies.
 Example: strategies—using concrete objects, mental calculations, or paper-and-pencil activities
 - Solving multistep addition and subtraction problems using authentic situations
 - Justifying the strategy used to solve addition and subtraction problems
 - Using estimation to determine if an answer is reasonable

3. Demonstrating computational fluency, including quick recall, of addition and subtraction facts with sums through 20 and differences with minuends through 20.

4. Demonstrate conceptual understanding of multiplication and division by solving authentic problems.
 Examples: *There are 3 trees in the orchard. On each tree there are 4 peaches. What is the total number of peaches on the trees? Answer: There are 12 peaches on the trees.*
The teacher has 12 sheets of paper. There are 6 students in the classroom. The teacher wants to give each student the same number of sheets of paper. How many sheets of paper will each student get? Answer: Each student will get 2 sheets of paper.

5. Illustrate fractions with multiple representations, including manipulatives, drawings, and verbal descriptions.
 - Recognizing that fractions such as $\frac{1}{1}$, $\frac{2}{2}$, $\frac{3}{3}$, and $\frac{4}{4}$ are equivalent to one whole
 - Using the terms *numerator* and *denominator* to label parts of a fraction
 - Recognizing that one-half of an object is not always the same as one-half of a different object
 Example: recognizing that one-half of a baseball is not equal to one-half of a basketball

6. Determine the monetary value of like and unlike sets of coins and bills up to \$2.00.
 - Identifying sets of coins of equivalent value
 - Selecting coins to make equivalent sets
 - Applying monetary symbols, including dollar (\$), cent (¢), and decimal point (.)
 - Recognizing decimal numbers .10, .25, .50, and .75 as related to money

Algebra

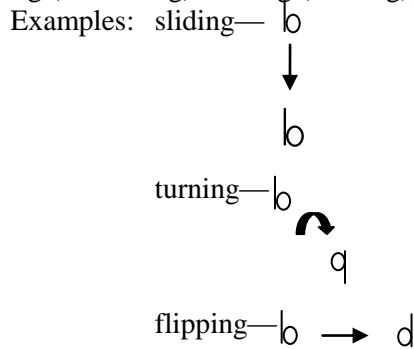
7. Describe a pattern in a number sequence.
 Examples: 3, 8, 13, 18, 23, ...
 50, 46, 42, 38, 34, ...

8. Recognize the associative property of addition.
 Example: $(3 + 4) + 2 = 3 + (4 + 2)$

9. Describe change over time in observable (qualitative) and measurable (quantitative) terms.
 Examples: observable—recognizing that a plant grew taller
 measurable—determining that a plant grew three inches

Geometry

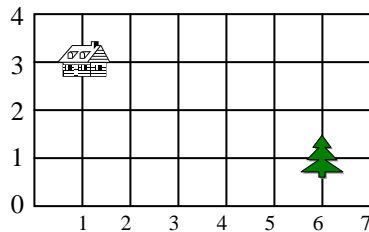
10. Describe attributes of three-dimensional (solid) figures, including cubes, cylinders, cones, pyramids, spheres, and rectangular prisms according to faces, sides, vertices, surfaces, edges, and angles.
- Identifying lines of symmetry in triangles, quadrilaterals, pentagons, hexagons, heptagons, and octagons
 - Recognizing results of changing the position (transformation) of objects or shapes by sliding (translating), turning (rotating), and flipping (reflecting)



11. Describe the route from one location to another by applying concepts of direction and distance.

Examples: direction—left, right, north, south, east, west
 nonstandard distance—twenty-five steps from the library
 standard distance—ten feet from the walkway

- Following multistep directions to locate objects
- Using grids for determining movement between points
 Example: moving from the house to the tree by moving 5 blocks to the right and 2 blocks down



Measurement

12. Measure length in standard units, including inches, feet, and yards.
 - Measuring length using metric units, including centimeter and meter
 - Measuring temperature in degrees Fahrenheit
 - Using measurement tools, including rulers, yardsticks, metersticks, tape measures, or thermometers
 - Estimating length to the nearest unit
13. Measure weight and volume of familiar objects with nonstandard units.
 - Estimating weight and volume using nonstandard units
Example: estimating how many buckets of sand it will take to fill a tub
14. Determine time to the minute using digital and analog clocks.
 - Interpreting time to the minute as part of an hour
Examples: 6:30 a.m. as half past six in the morning, 6:45 p.m. as a quarter to seven in the evening, 6:15 a.m. as a quarter past six in the morning

Data Analysis and Probability

15. Interpret data using graphs, including bar, line, and circle graphs and Venn diagrams.
 - Using labels and a title to complete a graph
16. Determine if one event related to everyday life is more likely or less likely to occur than another event.
Example: determining if it is more likely to rain or snow on July 4th in Alabama

THIRD – FIFTH GRADE OVERVIEW

In Grades 3-5, students acquire new knowledge and skills that build upon foundations gained in early learning experiences. Students develop increasingly complex mathematical skills and are able to apply these skills to situations in their daily lives. Although these students are primarily concrete learners, they begin to make the transition to abstract thinking through pictorial representations and symbols. They are inquisitive, enjoy being actively engaged in learning, and exhibit enthusiasm towards challenging mathematical concepts. As they become more self-reliant and begin the transition to independence, they also begin to show evidence of self-evaluation of mathematical ideas through explanation and justification of thought processes and solutions to problems.

Effective instructional strategies as well as a classroom environment in which exploration, effort, and progress are valued are important for maintaining student enthusiasm. Students in these grades enjoy working collaboratively and having their ideas appreciated. Modeling mathematical concepts through interesting and intellectually stimulating ways helps keep students engaged as they make connections among mathematical ideas, between mathematics and other disciplines, and between mathematics and daily life.

Conversations among peers and between student and teacher are important in helping students process and make sense of mathematics. As mathematical terminology is introduced, teachers and students incorporate this formal vocabulary on a daily basis in the classroom. Opportunities should be provided for students to write about mathematics and for teachers to provide assistance to ensure student writing regarding their thinking is correct, concise, and accurate.

Emphasis is placed on various mathematical concepts during the upper elementary years. The concept of equivalence is taught through money, fractions, decimals, measurement, and representation of numbers. Students increase multiplicative reasoning skills in area, volume, arrays, patterns, and relationships within a setting. Demonstration of expanded computational fluency is evidenced by students' use of quick recall of basic facts and mental mathematics and by their growing ability to choose, understand, and explain methods to produce accurate answers. To develop reasoning skills, students create and evaluate mathematical arguments. As Grades 3-5 students become more confident and proficient in their mathematical skills, they incorporate a greater variety of representations to model and solve problems.

THIRD GRADE

Third-grade students possess a natural interest in their world and enjoy exploring and discovering new ideas. Many are active, social individuals who excel when provided consistent support and encouragement. Some students' learning remains at the concrete level while other students are advancing to a more abstract level. Therefore, as new concepts are introduced, some profit by additional hands-on instruction and practice.

Third graders perform well when allowed to work in a variety of group settings within an active learning environment fostered by a sense of community and collaboration. Within this environment, students build a sense of personal self-worth as they realize their opinions are valued and accepted. Learning is stimulated by exposure to a variety of problem-solving activities, challenging classroom discussions, and engagement in activities that promote the development of higher-order thinking skills.

Content standards for third grade are designed to allow students to learn mathematics concepts with understanding. Learning with understanding makes subsequent learning easier as students are better able to connect new knowledge to existing knowledge. Learning with understanding also allows students to enhance problem-solving skills and become more adept in computational skills. According to the NCTM, development of a balance of and a connection between conceptual understanding and computational proficiency is necessary for students to achieve computational fluency.

Mathematics content at this level focuses on number sense and computational fluency. Students begin to use basic algebraic patterns to analyze mathematical relationships while expanding their current knowledge of data analysis through the use of graphs. Students also strengthen mathematical skills by identifying, comparing, and converting various forms of measurement.

Number and Operations

Students will:

1. Demonstrate concepts of number sense by comparing, ordering, and expanding whole numbers through 9,999.
 - Comparing numbers using the symbols $>$, $<$, $=$, and \neq
 - Determining the place value of a digit in a whole number through 9,999
 - Writing a four-digit number in words
 - Locating a positive integer through the thousands place and a negative integer between -21 and 0 on a number line
 - Converting a number written in expanded notation to standard form
Example: $5,000 + 600 + 70 + 3 = 5,673$
 - Rounding whole numbers to the nearest tens or hundreds place

2. Solve addition and subtraction problems, including word problems, involving two- and three-digit numbers with and without regrouping.

- Estimating sums and differences using multiple methods, including compatible numbers and rounding, to judge the reasonableness of an answer

Examples: compatible numbers— $23 + 38$ is approximately $25 + 40$

$$\begin{array}{r} \text{rounding—}286 \text{ is approximately } 300 \\ +339 \qquad \qquad \qquad +300 \end{array}$$

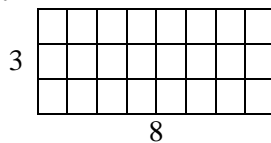
- Demonstrating computational fluency in addition and subtraction of two-digit whole numbers without regrouping
- Using mental computation strategies to solve addition and subtraction problems of two-digit numbers with and without regrouping
- Explaining problems and their solutions using diagrams, numbers, and symbolic expressions

3. Demonstrate computational fluency, including quick recall, of multiplication facts through 12×12 and division facts with divisors and quotients through 12.

4. Multiply one-, two-, and three-digit multiplicands, with and without regrouping, using single-digit multipliers.

- Applying concepts of multiplication through the use of manipulatives, number stories, skip-counting arrays, area of a rectangle, or repeated addition

Examples: array—



repeated addition— $8 + 8 + 8 = 24$

- Applying basic multiplication facts through 9×9 by using manipulatives, solving problems, and writing number stories
- Identifying product, multiplier, and multiplicand when given a completed problem
- Using the terms *product* or *factor* to label multiplication problems
- Naming the first 10 multiples of each one-digit natural number

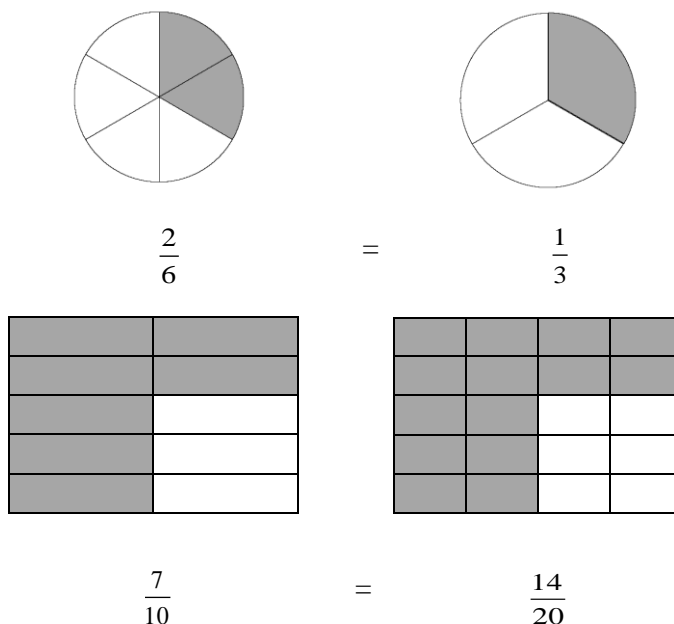
Example: 7, 14, 21, 28, 35, 42, 49, 56, 63, 70

5. Divide whole numbers using two-digit dividends and one-digit divisors.

- Recognizing division as either repeated subtraction, parts of a set, parts of a whole, or the inverse of multiplication
- Applying divisibility rules for 2, 5, and 10
Example: recognizing that 32 is divisible by 2 because the digit in the ones place is even
- Recognizing fractions as numerals that may represent division problems
- Identifying quotient, divisor, and dividend when given a completed problem
- Using the terms *quotient*, *divisor*, and *dividend* to label division problems

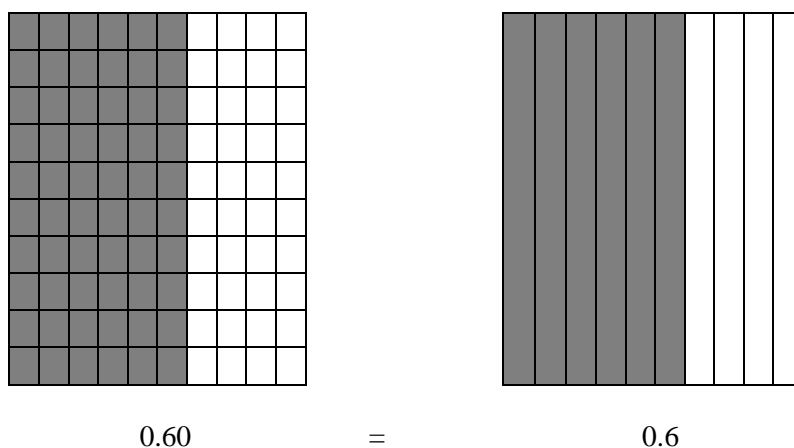
6. Demonstrate equivalent fractions using concrete objects or pictorial representations.

Examples:



- Recognizing pictorial representations of equivalent fractions and decimals in tenths and hundredths

Example:



- Recognizing different interpretations of fractions, including parts of a set or a collection, points on a number line, numbers that lie between two consecutive whole numbers, and lengths of segments on a ruler
- Locating proper fractions with common denominators 2 through 10 on a number line with fractional parts of the whole indicated on the number line
- Solving problems that involve addition or subtraction of fractions with common denominators
- Comparing fractions with common denominators using the symbols $<$, $>$, and $=$

7. Use coins to make change up to \$1.00.
- Determining the monetary value of a set of unlike coins and bills up to \$20

Example:



- Rounding money values to the nearest dollar
- Using coins and bills to make change up to \$20.00
- Using addition and subtraction to find money values up to \$20.00

Algebra

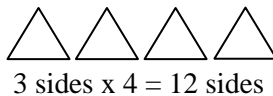
8. Complete a given geometric or numeric pattern.

Examples: Continue a geometric pattern for $\triangle \square \triangle \triangle \square \triangle \triangle _ _ _$ by drawing the next three shapes. Sample answer: $\square \triangle \triangle$.

Complete the numerical pattern for the following chart when given the rule, "Input + 5 = Output." Sample answer: "Input 5, Output 10;" "Input 9, Output 14."

Input	Output
3	8
4	9
5	?
7	12
9	?
12	17

- Analyzing patterns on a graph to determine change
Example: observing plant growth over a period of time
- Describing mathematical relationships in context
Example: recognizing the number of sides of all the shapes below as three times the number of triangles



9. Recognize commutative, associative, and identity properties of multiplication.

Examples: commutative— $4 \times 3 = 3 \times 4$

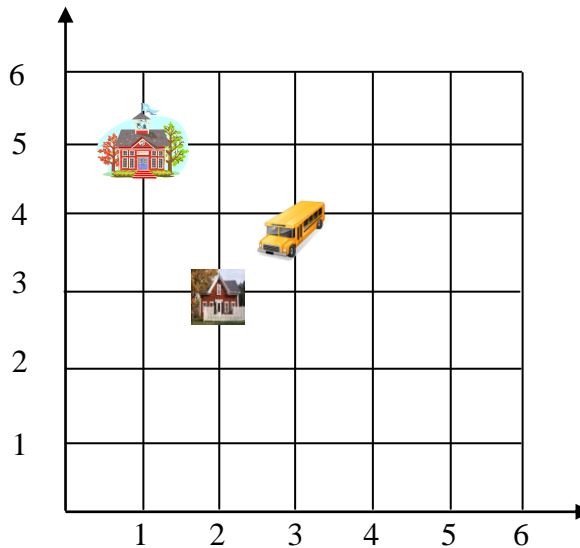
associative— $(6 \times 2) \times 3 = 6 \times (2 \times 3)$

identity— $450 \times 1 = 450$

- Using parentheses to signify grouping
Example: $4 \times (6 \times 5)$

Geometry

10. Identify geometric representations for points, lines, line segments, parallel and perpendicular lines, angles, and rays.
- Recognizing real-life examples of points, lines segments, parallel and perpendicular lines, and angles
 - Drawing points, lines, line segments, and parallel and perpendicular lines
 - Identifying angles as right, obtuse, or acute
 - Drawing lines of symmetry in triangles, quadrilaterals, pentagons, hexagons, and octagons
11. Specify locations on a coordinate grid by using horizontal and vertical movements.
Example: describing multiple routes for starting at the house, walking to the bus, and arriving at the school



- Demonstrating translations, reflections, and rotations using two-dimensional shapes

Measurement

12. Measure length in metric units.
- Converting linear measures in meters to centimeters
 - Estimating lengths to the nearest metric unit
 - Measuring weight, mass, volume, and capacity using metric and customary units
 - Measuring temperature in Celsius
 - Relating Celsius temperatures to Fahrenheit temperatures
Example: describing 30° as being hot, 20° as being pleasant, 10° as being cool, and 0° as being freezing
 - Calculating perimeter and area of rectangular shapes
13. Determine elapsed time to the day with calendars and to the hour with a clock.
- Calculating elapsed time to the minute within the same hour

Data Analysis and Probability

14. Recognize data as either categorical or numerical.
Examples: categorical—month, color, food, name
numerical—time, age, length, weight
- Comparing related data sets from Venn diagrams, bar graphs, line graphs, and line plots
 - Interpreting data from displays, including Venn diagrams, bar graphs, and line plots
 - Locating the mode of a data set represented on a bar graph or a line plot
15. Determine the likelihood of different outcomes in a simple experiment.
Example: determining that the letter “z” is most likely to be drawn from a bag containing all letters of the word “pizza”
- Defending predictions of outcomes of simple experiments

FOURTH GRADE

Students in fourth grade are gaining an awareness of themselves as distinct individuals. While working in a variety of active learning environments involving concrete learning experiences, students continue to perform well as they deepen their understanding of mathematics. Verbal communication is vital in helping them progress in their ability to use abstract reasoning and higher-order thinking skills and to determine cause-and-effect relationships.

Fourth-grade students need and respond well to encouragement. Therefore, it is important they be provided a supportive, positive learning environment in which they are actively engaged and work cooperatively and productively to solve problems. In this environment high expectations for student achievement should be communicated and value placed on quality work.

Content standards for fourth grade are designed to allow students to learn mathematics concepts with understanding. Learning with understanding makes subsequent learning easier as students are better able to connect new knowledge to existing knowledge. Learning with understanding also allows students to enhance problem-solving skills and become more adept in computational skills. According to the NCTM, development of a balance of and a connection between conceptual understanding and computational proficiency is necessary for students to achieve computational fluency.

Content in fourth grade builds upon basic number sense and operations skills. Students in fourth grade extend their computational skills to include fluency with multiplication and division. In addition to describing patterns and relationships, students explore geometric and spatial reasoning. Students in this grade are extending their measurement skills to include volume, capacity, mass, and weight in both metric and customary systems. Students also learn to represent categorical and numerical data using a variety of graphs.

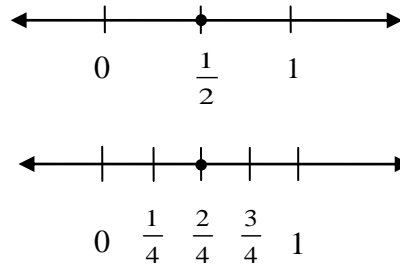
Number and Operations

Students will:

1. Demonstrate concepts of number sense by comparing and ordering decimals through the hundredths place and whole numbers to 999,999.
 - Writing a whole number in expanded notation through the hundred-thousands place
Example: $623,805 = 600,000 + 20,000 + 3,000 + 800 + 5$
 - Writing a number in expanded notation through the hundredths place
 - Determining the place value of a digit in a whole number through the hundred-thousands place and in a decimal through the hundredths place
2. Write money amounts in words and in dollar-and-cent notation.
 - Using coins and bills to make change up to \$100
 - Identifying equivalent sums of money

3. Write improper fractions as mixed numbers and mixed numbers as improper fractions.
 - Using a number line to compare and order fractions and mixed numbers
 - Simplifying fractions using parallel number lines

Example:



- Comparing fractions with uncommon denominators using the symbols $<$, $>$, and $=$
 - Writing equivalent forms of fractions
4. Solve problems, including word problems, involving addition and subtraction of fractions with common denominators.
 5. Round whole numbers to the nearest ten, hundred, or thousand and decimals to the nearest tenth.

Examples: whole number—determining a distance of 4,326 miles between Birmingham, Alabama, and London, England, rounded to the nearest hundred is 4,300 miles

decimal—determining a time of 5.46 seconds run in a 40-yard dash rounded to the nearest tenth is 5.5 seconds
 6. Solve problems, including word problems, involving addition and subtraction of four-digit numbers with and without regrouping.
 - Estimating sums and differences using various strategies, including rounding and compatible numbers, to judge the reasonableness of an answer
 - Using addition and subtraction to solve problems with decimals to the hundredths place
 - Using addition and subtraction to calculate the balance of an account

Examples: checking, savings, or credit card account; classroom store account

7. Solve problems, including word problems, involving multiplication and division of whole numbers through two-digit multipliers and one-digit divisors.
- Estimating products and quotients of whole numbers using various strategies, including rounding and compatible numbers
 - Identifying information needed to determine an operation to solve a problem
 - Demonstrating computational fluency in multiplication and division facts with products through 144 and quotients with dividends through 144 using horizontal and vertical forms
- Example: utilizing a variety of mental computation strategies to complete one hundred basic multiplication and division facts with 80 percent accuracy within a five-minute time limit
- Applying divisibility rules for 3, 4, 6, and 9
 - Identifying prime and composite numbers through 50
 - Listing all factors of natural numbers through 50
 - Recognizing that some integers can be expressed as a product of factors in more than one way
- Example: $18 = 3 \times 6 = 2 \times 9 = 2 \times 3 \times 3 = 18 \times 1$
- Using mental computation strategies to solve multiplication problems with factors that are multiples of 10
 - Using mental computation strategies to solve division problems with dividends and divisors that are multiples of 10
8. Recognize equivalent forms of fractions and decimals.
- Examples: $\frac{1}{4} = .25$, $\frac{1}{4}$ of a dollar = \$.25, $\frac{1}{2} = 0.5$, $\frac{2}{5} = 0.4$, $\frac{3}{10} = 0.3$, $\frac{3}{4} = \frac{9}{12}$

Algebra

9. Write number sentences for word problems that involve multiplication or division.
- Applying commutative, associative, and identity properties of multiplication to solve problems
 - Identifying a rule when given a pattern involving multiplication or division
- Example: determining from the information on the chart below a rule to be “Input \times 3 = Output”

Input	2	3	5	7	12
Output	6	9	15	21	36

10. Complete addition and subtraction number sentences with a missing addend or subtrahend.
- Applying commutative, associative, and identity properties of addition to solve problems
 - Identifying a rule when given a pattern involving addition or subtraction
- Example: determining from the information on the chart below a rule to be “Input + 8 = Output”

Input	1	17	21	28	30
Output	9	25	29	36	38

Geometry

11. Identify triangles, quadrilaterals, pentagons, hexagons, heptagons, and octagons based on the number of sides, angles, and vertices.
- Determining results of a reflection, rotation, or translation of a given shape
 - Identifying straight angles
 - Estimating angle measures using 45° , 90° , 180° , 270° , or 360° as referents
 - Identifying figures that have rotational symmetry

Example:



- Identifying congruent polygons
12. Find locations on a map or grid using Quadrant I ordered pairs.
- Identifying components of the Cartesian plane, including the x-axis, y-axis, origin, and quadrants

Measurement

13. Calculate elapsed time in hours and minutes.
14. Measure length, width, weight, mass, volume, and capacity using metric and customary units, and temperature using Celsius and Fahrenheit.
- Estimating perimeter and area of irregular shapes using unit squares and grid paper
 - Identifying a larger unit of measure equivalent to a smaller unit of measure within the same customary or metric system

Data Analysis and Probability

15. Represent categorical data using tables and graphs, including bar graphs and line plots.
- Collecting data using observations, surveys, or experiments
16. Determine outcomes of simple events as *likely*, *unlikely*, *certain*, *equally likely*, or *impossible*.
- Verifying predictions by testing possible outcomes of a simple event
17. Represent numerical data using tables and graphs, including bar graphs and line graphs.
- Locating the median from graphs or data sets

FIFTH GRADE

Fifth-grade students are social individuals who benefit from communication, value the opinions of others, and seek the acceptance of peers. These students possess a wide array of interests that define their social and emotional development. They continue to explore independent thinking in both academic and nonacademic settings. Content presented in an authentic context heightens their interest and enthusiasm for acquiring new knowledge and skills.

The fifth-grade classroom should be characterized by actively engaged students working in collaborative groups to solve increasingly complex problems. A positive learning environment encourages and challenges students as they progress in mathematical knowledge and skills, recognizes students' efforts, and fosters students' mathematical self-confidence and self-reliance.

Content standards for fifth grade are designed to allow students to learn mathematics concepts with understanding. Learning with understanding makes subsequent learning easier as students are better able to connect new knowledge to existing knowledge. Learning with understanding also allows students to enhance problem-solving skills and become more adept in computational skills. According to the NCTM, development of a balance of and a connection between conceptual understanding and computational proficiency is necessary for students to achieve computational fluency.

The mathematics curriculum in fifth grade emphasizes fluency in computing and problem solving with whole numbers, decimals, and fractions. Students apply basic operations to problem-solving situations with a greater understanding of the meanings of operations and how they relate to one another. Although fifth-grade students may continue to benefit from the use of concrete models as well as symbolic models, they move toward an abstract level of thinking as they actively acquire new knowledge of symbolic representations.

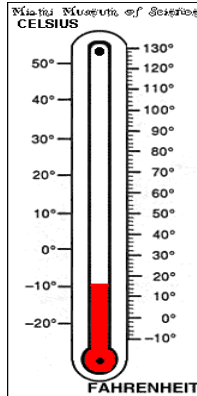
Number and Operations

Students will:

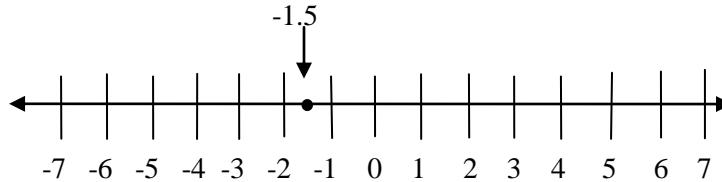
1. Demonstrate concepts of number sense by comparing, ordering, rounding, and expanding whole numbers through the millions place and decimals to the thousandths place.
 - Relating percents to parts out of 100 using equivalent fractions and decimals
 - Determining the place value of a digit in a whole number through the millions place and in a decimal through the thousandths place

2. Solve problems involving operations on whole numbers, including addition and subtraction of seven-digit numbers, multiplication with two-digit multipliers, and division with two-digit divisors.
 - Estimating products and quotients
 - Applying divisibility rules of 2, 3, 4, 5, 6, 9, and 10 to problems with dividends of four or more digits
 - Identifying prime and composite numbers through 100
 - Simplifying expressions with exponents 2 or 3
 - Using mental computation strategies to solve addition or subtraction problems with three-digit numbers
 - Using mental computation strategies to solve multiplication problems with three-digit factor and a one-digit factor or division problems with a three-digit dividend and a one-digit divisor
 - Recognizing the correct usage of the order of operations
 - Solving word problems involving addition, subtraction, multiplication, and division of whole numbers
3. Solve word problems that involve decimals, fractions, or money.
 - Demonstrating computational fluency with addition, subtraction, multiplication, and division of decimals
 - Converting fractions and mixed numbers to decimals and percents
4. Determine the sum and difference of fractions with common and uncommon denominators.
 - Solving word problems involving addition and subtraction of fractions with common and uncommon denominators
 - Using least common multiple (LCM) to find common denominators
 - Determining greatest common factor (GCF) to simplify fractions
 - Estimating sums and differences of fractions
 - Solving problems involving multiplication and division of fractions

5. Identify numbers less than zero by extending the number line.
 Example: identifying the temperature on the thermometer to be -10°C



- Locating fractions and decimals less than zero on a number line
 Example: locating -1.5 on the number line



Algebra

6. Demonstrate the commutative, associative, and identity properties of addition and multiplication of whole numbers.
- Recognizing the distributive property of multiplication over addition
 Example: $25(11 + 32) = (25 \times 11) + (25 \times 32)$
7. Write a number sentence for a problem expressed in words.
- Expressing unknowns in equations using variables
 Example: $84 - x = 27$
 - Justifying a rule when given a pattern involving addition, subtraction, multiplication, or division

Geometry

8. Identify regular polygons and congruent polygons.

- Classifying triangles as equilateral, isosceles, or scalene
- Identifying line and rotational symmetries of polygons
- Solving for a missing side of similar polygons given proportional dimensions

Example: Determine from the dimensions given for Figure 1. and Figure 2. the missing dimension on Figure 2. Answer: The missing dimension is 10.

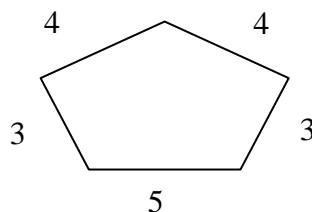


Figure 1.

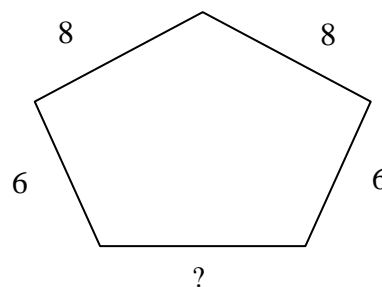


Figure 2.

- Identifying a three-dimensional object from a two-dimensional representation of that object

Example: recognizing Figure 2. as a three-dimensional object of the two-dimensional representation in Figure 1.

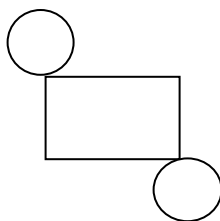


Figure 1.

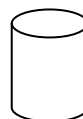


Figure 2.

- Identifying a two-dimensional representation of a three-dimensional object

Example: recognizing Figure 2. as a two-dimensional representation of the three-dimensional object in Figure 1.



Figure 1.

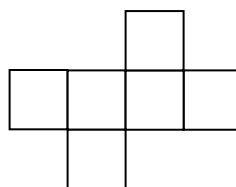


Figure 2.

9. Construct components of the Cartesian plane, including the x-axis, y-axis, origin, and quadrants.

- Locating ordered pairs on the Cartesian plane

10. Identify the center, radius, and diameter of a circle.

- Identifying a chord and an arc of a circle

Measurement

11. Estimate perimeter and area of irregular shapes using unit squares and grid paper.
12. Calculate the perimeter of rectangles from measured dimensions.
 - Determining surface areas of rectangular solids
 - Determining the perimeter of triangles and parallelograms
 - Determining how the perimeter or area of a rectangle is affected when either is held constant and the other is changed
Example: identifying rectangles with dimensions of 3 x 4, 2 x 6, and 1 x 12 as all having an area of 12 square units but having different perimeters
13. Convert a larger unit of measurement to a smaller unit of measurement within the same customary or metric system.
Examples: 4 cups = 32 fluid ounces, 2 meters = 200 centimeters, 2 miles = 10,560 feet
 - Solving multistep word problems involving elapsed time
Example: *Fourth-grade students go to lunch from 10:37 a.m. to 11:18 a.m. daily. How much time do the students spend at lunch during a five-day school week? Answer: The students spend 205 minutes or 3 hours and 25 minutes at lunch during a five-day school week.*

Data Analysis and Probability

14. Analyze data collected from a survey or experiment to determine results and factors that affect results.
 - Identifying the type of graph, including stem-and-leaf plot, line plot, bar graph, line graph, and Venn diagram, that most accurately represents given data
 - Determining the measures of central tendency to analyze data
Example: finding the mean, median, and mode for a set of data
 - Determining the range of a given data set
15. Use fractions to represent the probability of events that are neither certain nor impossible.
 - Solving word problems involving probability
Example: *Bob has a bag containing only 4 purple marbles, 6 black marbles, and 9 pink marbles. If his teacher selects one marble from the bag without looking, what is the probability that the marble is pink? Answer: The probability that the marble is pink is $\frac{9}{19}$.*
 - Identifying the probability of an event that is certain as 1 or impossible as 0

SIXTH – EIGHTH GRADE OVERVIEW

Grades 6-8 students mature and progress at varied rates. They are completing the transition from the learning of concrete topics to the understanding of more abstract concepts. They experience physical, emotional, and intellectual changes that mark the middle grades as a significant transition point in their lives. While some students are maturing earlier than others, all students continue to display some commonalities. For example, young adolescents are almost universally sensitive to the influence of peers. The differences in physical and intellectual development, emotional maturity, and sensitivity to peer-group perceptions make it especially important for teachers to establish a supportive classroom environment with clearly established norms where students feel comfortable sharing ideas. Within this environment, teachers are better able to create a challenging curriculum that allows all students to be actively involved in the learning of mathematics.

Mathematics instruction in Grades 6-8 should promote students' depth and retention of mathematics content and enhance skill development in inquiry, problem solving, and critical thinking. Mathematics concepts in the middle school curriculum are linked to mathematics concepts of earlier grades and to concepts learned in other disciplines. Students should be encouraged to be creative and innovative in their approach to problems, to be productive and persistent in seeking solutions, and to use multiple means to communicate their insights and understanding. Instruction should involve the use of a variety of methods and applications that deepen their understanding of these concepts. This helps students perceive themselves as learners of mathematics, while continuing to develop their competencies, attitudes, interests, and motivation.

Middle-grades teachers should utilize knowledge of mathematics, exemplary teaching practices, and findings of current research on students' mathematical learning to design classroom instruction. The mathematics classroom should provide an ambitious and rich experience for middle-grades students that prepares them to use mathematics effectively to deal with quantitative situations in their lives both in and outside the school environment while also establishing a solid foundation for the study of mathematics in high school. Students are expected to engage in rigorous, substantive mathematics where the emphasis is on thoughtful engagement and meaningful learning.

During these years, content focuses on rational numbers and algebraic, geometric, and proportional reasoning concepts that provide students with necessary prerequisite skills for success in high school mathematics courses. Students further their understanding of operations and properties of the rational number system, including ratios, rates, proportions, percents, and numbers expressed using whole number exponents. Geometry and the measurement of lines, angles, triangles, and circles consolidate knowledge gleaned during elementary years and offer teachers and students opportunities to connect the branches of mathematics through measurement formulas, similarity, and scaling.

SIXTH GRADE

Students in sixth grade are facing challenges physically, socially, emotionally, and cognitively. Sixth graders need support and guidance to help address these challenges as they make the transition to the middle grades. A nurturing classroom environment combined with individual activities and cooperative learning helps bridge the gap between elementary and middle school. The environment should challenge them and provide support as they become responsible individuals.

The sixth-grade curriculum is designed to maximize student learning through the use of manipulatives and technology. The curriculum serves as a tool to guide students as they continue the transition of mathematical thought processes from concrete to more abstract reasoning. Opportunities should be provided for students to gain a thorough understanding of decimals and fractions while integrating these number and operation concepts into the other strands.

Number and Operations

Students will:

1. Demonstrate computational fluency with addition, subtraction, multiplication, and division of decimals and fractions.
 - Comparing rational numbers written as fractions, decimals, mixed numbers, and percents
 - Using prime factorizations to identify GCF and LCM
 - Formulating algorithms using basic operations on fractions and decimals
 - Applying the distributive property to compute with fractions and decimals
Example: $5 \times 7\frac{1}{5} = 5 \times 7 + 5 \times \frac{1}{5} = 35 + 1 = 36$
 - Solving one-step equations involving addition, subtraction, multiplication, and division of integers
 - Using order of operations to simplify whole number expressions
Example: $5 + 4^2 \div 2 - 3 \times 2 = 5 + 16 \div 2 - 3 \times 2$
 $= 5 + 8 - 3 \times 2$
 $= 5 + 8 - 6$
 $= 13 - 6$
 $= 7$

2. Solve problems involving decimals, percents, fractions, and proportions.

Examples: *The regular price of a pair of jeans is \$35. The jeans are on sale for 20% off.*

What is the sale price? Answer: The sale price is \$28.

Today there is an additional 10% off the sale price. What is the price of the pair of jeans today? Answer: The price of the jeans today is \$25.20.

- Estimating solutions of problems involving fractions and decimals
- Computing simple interest
Example: $I = P \times r \times t$
- Converting terminating decimals, repeating decimals, and percents to fractions and mixed numbers

Algebra

3. Solve problems using numeric and geometric patterns.

Example: *The table below shows the amount of money Ajah earns for babysitting. If the pattern shown in the table continues to increase at the same rate after the first hour, how much would Ajah earn for 8 hours of work? Answer: Ajah would earn \$45.50 for 8 hours of work.*

Number of Hours	Amount Earned
1	\$7.00
2	\$12.50
3	\$18.00
4	\$23.50

- Determining a verbal rule for a function given the input and output
Example: determining from the information on the table below a rule to be “the cost of pizzas in dollars is 6 times the number of pizzas purchased”

Number of Pizzas	Cost of Pizzas in Dollars
1	6
2	12
3	18
4	24
5	30

Geometry

4. Identify two-dimensional shapes and three-dimensional figures based on their attributes, properties, and component parts.
 - Classifying quadrilaterals, including trapezoids and parallelograms, based on their attributes
 - Classifying triangles as right, obtuse, or acute
 - Recognizing similar shapes and figures based on their attributes
5. Plot points on grids, graphs, and maps using coordinates.
6. Classify angles as acute, obtuse, right, or straight.
 - Measuring angles to the nearest degree using a protractor

Measurement

7. Solve problems involving perimeter and area of parallelograms and rectangles.
 - Verifying formulas for determining perimeter and area of parallelograms and rectangles
 - Estimating perimeter and area of parallelograms and rectangles
 - Determining the volume of a rectangular prism
8. Determine the distance between two points on a scale drawing or a map using proportional reasoning.

Example: *On a map with a scale of 1 inch = 50 miles, city A is located 5 inches from city B. What is the distance in miles from city A to city B?*

Answer: $\frac{1}{50} = \frac{5}{x}$, $x = 250$ miles.

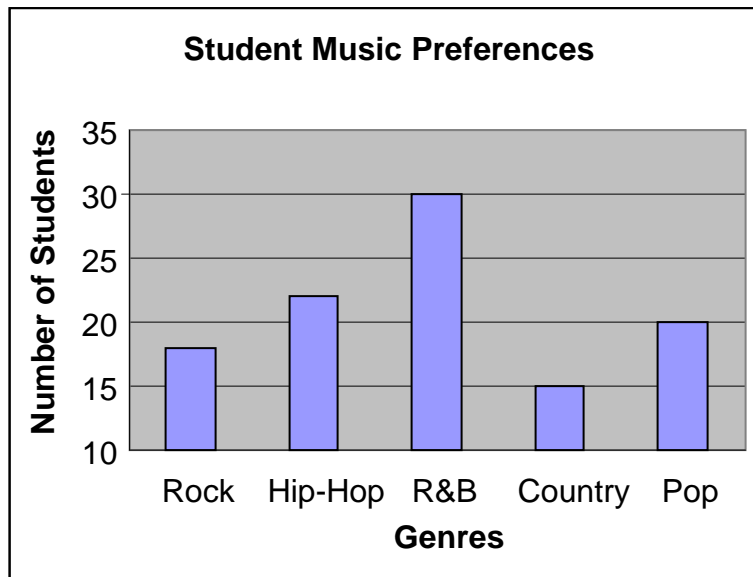
There are 250 miles from city A to city B.

 - Using different forms of notation to symbolize ratios and rates
9. Convert units of length, weight, or capacity within the same customary or metric system.

Data Analysis and Probability

10. Interpret information from bar graphs, line graphs, and circle graphs.

Example: *Using information from the graph on the chart below, the radio announcer stated that R & B music is preferred twice as much as pop music. Determine if the graph is misleading. Explain why or why not. Answer: Yes, the graph is misleading because the number of students does not begin at 0.*



11. Determine the probability of a simple event by expressing the probability as a ratio, percent, or decimal.

Example: *If a fair coin is tossed, what is the probability of the coin landing on heads? Express the solution as a fraction, a decimal, and a percent. Answer: The probability of the coin landing on heads is $\frac{1}{2}$ (fraction), 0.5 (decimal), or 50% (percent).*

SEVENTH GRADE

Students in seventh grade progress academically and psychologically at various stages. To meet the intellectual needs of all seventh-graders, the mathematics classroom incorporates differentiated instruction and the use of brain-compatible strategies embedded in day-to-day teaching. The application of research-based initiatives enhances students' critical-thinking and oral and written communication skills.

The seventh-grade curriculum addresses a number of important mathematical concepts, including using rational numbers, solving equations, and using proportional reasoning. Seventh-grade students should become confident in rational number operations and continue to build the foundation needed to become successful problem solvers. In addition, the mastery of solving equations prepares students as they advance to the study of algebra.

Number and Operations

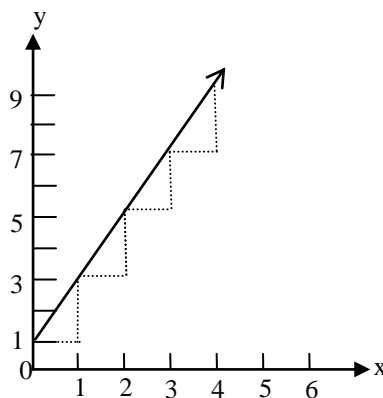
Students will:

1. Demonstrate computational fluency with addition, subtraction, multiplication, and division of integers.
 - Formulating algorithms for performing operations on integers
 - Determining which algorithms to use when performing operations on integers
2. Use order of operations to evaluate numerical expressions.
 - Determining absolute values of integers by finding their distance from zero
 - Naming square roots of perfect squares through 225
 - Applying laws of exponents to compute with integers
3. Solve problems requiring the use of addition, subtraction, multiplication, and division on rational numbers.
 - Describing the method used to solve problems involving rational numbers
 - Determining the reasonableness of the answer to a problem
 - Using percents to solve problems, including problems involving discounts, taxes, commissions, and simple interest
 - Identifying whether a number is rational or irrational
 - Using inverse properties of rational numbers with respect to addition and multiplication

Algebra

4. Write an algebraic equation that represents a pattern shown in a table, graph, or chart.
 - Recognizing the relationship between numerical patterns in tables and their respective graphs on the coordinate plane

Example: recognizing a pattern illustrated by the graph below as $y = 2x + 1$, where x is any real number

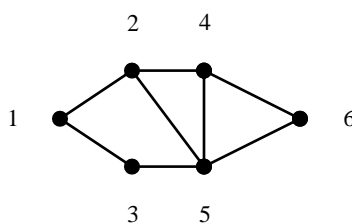


- Determining if a constant rate of change exists in a pattern
5. Write verbal phrases as algebraic expressions and algebraic expressions as verbal phrases.
 - Identifying a variable as an unknown quantity
 6. Solve one- and two-step equations.
 - Solving inequalities with one variable
 - Graphing solution sets of inequalities on a number line
 - Recognizing properties of equality

Geometry

7. Determine transformations, including translations, reflections, or rotations, used to alter the position of a polygon on the coordinate plane.
 - Determining if a figure has line or rotational symmetry when reflected or rotated
 - Graphing polygons and their transformations on the Cartesian plane by plotting the vertices
 - Graphing shapes that are similar to other shapes using dilations

8. Recognize geometric relationships among two-dimensional shapes and three-dimensional figures.
- Drawing geometric shapes and figures when given specified components, including base and height
 - Comparing properties and relationships among congruent shapes and figures
 - Comparing properties and relationships among similar shapes and figures
 - Identifying geometric concepts in real-life settings
 - Examples: recognizing Escher drawings as examples of tessellations, the geodesic dome as an example of triangulation, and architecture as an example of constructing three-dimensional figures; identifying area in landscape design
 - Using networks to represent and solve problems
 - Example: *Determine from the figure below the number of paths from point 1 to point 6 without passing through a point twice. Answer: There are 7 different paths from point 1 to point 6.*



Measurement

9. Solve problems involving circumference and area of circles.
- Identifying π as an irrational number
 - Verifying formulas for determining circumference and area of circles
 - Using the appropriate customary or metric unit for determining the circumference, diameter, radius, and area of circles
10. Calculate the perimeter of polygons and the area of triangles and trapezoids.
- Verifying formulas for determining perimeter and area of triangles and trapezoids
 - Using the Pythagorean Theorem for determining the measure of the sides of right triangles
11. Solve problems involving ratios or rates, using proportional reasoning.
- Determining the unit rate
 - Comparing rates by converting from one unit to another
 - Example: *A robot is programmed to travel 15 miles in 3 days. How many feet will the robot travel in 1 hour? Answer: The robot will travel 1,100 feet in 1 hour.*
 - Comparing units of length, weight, or capacity by converting from metric to customary and from customary to metric

Data Analysis and Probability

12. Determine measures of central tendency and range using a given set of data or graphs, including histograms, frequency tables, and stem-and-leaf plots.
- Using a data set to create charts and graphs, including histograms, frequency tables, and stem-and-leaf plots, to display measures of central tendency
13. Determine the probability of a compound event.
- Example: *A spinner is divided into four equal sections colored blue, green, red, and yellow. What is the probability of spinning a red on the first turn and a green on the second turn? Answer: The probability of spinning a red on the first turn and a green on the second turn is $\frac{1}{16}$.*
- Using a list, chart, picture, or tree diagram to represent outcomes
 - Determining the number of possible outcomes using the Fundamental Counting Principle or other techniques

EIGHTH GRADE

PRE-ALGEBRA

A wide range in the level of thinking skills exists among students in eighth grade. Some rely heavily on the use of concrete and semi-concrete materials and are able to perform both proportional and formal reasoning. They are still learning, developing, and practicing previously introduced mathematical skills and concepts while other students have advanced to more abstract reasoning.

Most students are best able to acquire mathematical knowledge through the use of carefully sequenced materials and with guidance through structured activities. The development of students' use of mathematical language is critical. Student understanding of rational numbers, numerals used to represent rational numbers, and basic operations enhances their ability to achieve fluency in computational skills.

Number and Operations

Students will:

1. Use various strategies and operations to solve problems involving real numbers.
 - Applying GCF, LCM, and prime and composite numbers, including justification for the reasonableness of results, when working with rational numbers
Example: *A new music store is having a grand opening and every 20th customer gets a free compact disk. Every 35th customer gets a free tote bag. Mark, the salesman, said the first customer to receive both gifts will be the 140th customer. Is his conclusion reasonable?*
Possible answer: Yes, Mark's conclusion is reasonable because 140 is the LCM of 20 and 35.
 - Using vocabulary associated with sets, including union, subsets, empty sets, and intersection
 - Utilizing alternative representations to solve problems involving rational numbers
Examples: models, drawings, grids, graphs
 - Applying proportional reasoning to application-based situations
Example: *Mr. Easterday needs to purchase 250 square yards of carpet to cover the living space in his home. How many square feet of living space does he have in his home? Answer: $\frac{250}{x} = \frac{1}{9}$, $x = 2,250$ square feet of living space.*
2. Apply one or more of the laws of exponents to simplify expressions containing natural number exponents.
 - Writing numbers using scientific notation

3. Use order of operations to evaluate and simplify algebraic expressions.
 - Applying the substitution principle to evaluate algebraic expressions

Algebra

4. Graph linear relations by plotting points or by using the slope and y-intercept.
 - Determining slopes and y-intercepts of lines
 - Calculating the slope of a linear relation given as a table or graph
 - Graphing linear relations by plotting x- and y-intercepts
5. Solve problems involving linear functions.

Example: determining from the information on the following chart a rule to be “ $y = 4.5x$ ”

Pounds of Peanuts Sold	Money Made
1	\$4.50
2	\$9.00
3	\$13.50
4	\$18.00

- Classifying variables in a function as independent or dependent
 - Classifying relations as linear or nonlinear by examining tables, graphs, or simple equations
 - Determining if a relation is a function from information in tables, sets of ordered pairs, equations, graphs, or mappings
6. Solve multistep linear equations, including equations requiring the use of the distributive property.

Example: Solve $-2x - 3 - 4x = -8 + x$. Answer: $x = 2$.

Geometry

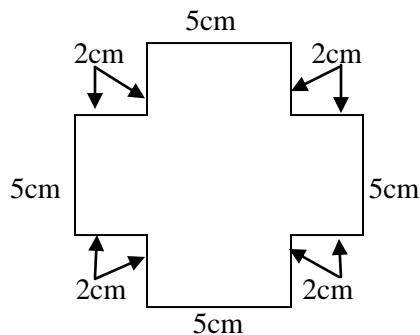
7. Solve problems using the Pythagorean Theorem.
 - Verifying the Pythagorean Theorem
 - Applying the Pythagorean Theorem to determine if a triangle is a right triangle
 - Applying the Pythagorean Theorem to solve multistep application-based problems
 - Applying the Triangle Inequality Theorem

Example: Determine if a triangle can be formed with sides of 1 inch, 2 inches, and 5 inches. Answer: No, because 5 is not less than the sum of the measures of the other two sides or 5 is not less than $2 + 1$.
 - Calculating distances on the coordinate plane using the Pythagorean Theorem

8. Compare quadrilaterals, triangles, and solids using their properties and characteristics.
- Formulating mathematical arguments about the relationships among types of quadrilaterals and triangles
 - Identifying angle bisectors, perpendicular bisectors, congruent angles, and congruent shapes
 - Constructing congruent and similar polygons, congruent angles, congruent segments, and parallel and perpendicular lines

Measurement

9. Determine measures of special angle pairs, including adjacent, vertical, supplementary, complementary angles, and angles formed by parallel lines cut by a transversal.
10. Determine the perimeter and area of regular and irregular plane shapes.
Example: determining the figure below to have a perimeter of 36 cm and an area of 65 cm^2



11. Determine surface area and volume of rectangular prisms, cylinders, and pyramids.
- Determining surface area and volume of solid figures, including cones and spheres
 - Estimating surface area and volume of solid figures, including cones and spheres
 - Determining appropriate units of measure to describe surface area and volume
 - Developing formulas for determining surface area and volume of rectangular prisms, cylinders, and pyramids
12. Determine lengths of missing sides and measures of angles in similar and congruent shapes.
- Applying proportional reasoning to identify similar and congruent shapes
 - Using dilations on the coordinate plane to determine measures of similar shapes
 - Determining ratios of perimeters and areas of similar triangles, trapezoids, and parallelograms

Data Analysis and Probability

13. Use given and collected data from samples or populations to construct graphs and interpret data.

Examples: box-and-whisker plot, circle graph, scatterplot, stem-and-leaf plot, double stem-and-leaf plot, double box-and-whisker plot

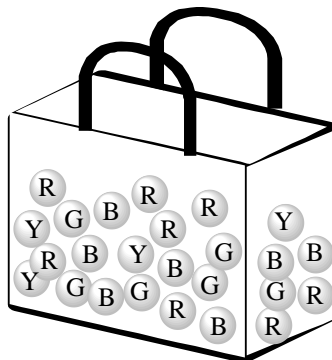
- Estimating a line of best fit from a scatterplot to make predictions
- Determining the measure of central tendency that is the most appropriate for a given situation

14. Determine the theoretical probability of an event.

- Calculating the probability of complementary events and mutually exclusive events
- Determining the probability of two independent events or two dependent events

Example: *The bag below contains red, green, blue, and yellow marbles. If one marble is randomly removed from the bag and replaced before a second marble is removed, what is the probability that the first marble will be red and the second marble will be green?*

$$\text{Answer: } \frac{8}{25} \times \frac{6}{25} = \frac{48}{625}.$$



R = red marble
G = green marble
B = blue marble
Y = yellow marble

- Determining the probability of an event through simulation

NINTH – TWELFTH GRADE OVERVIEW

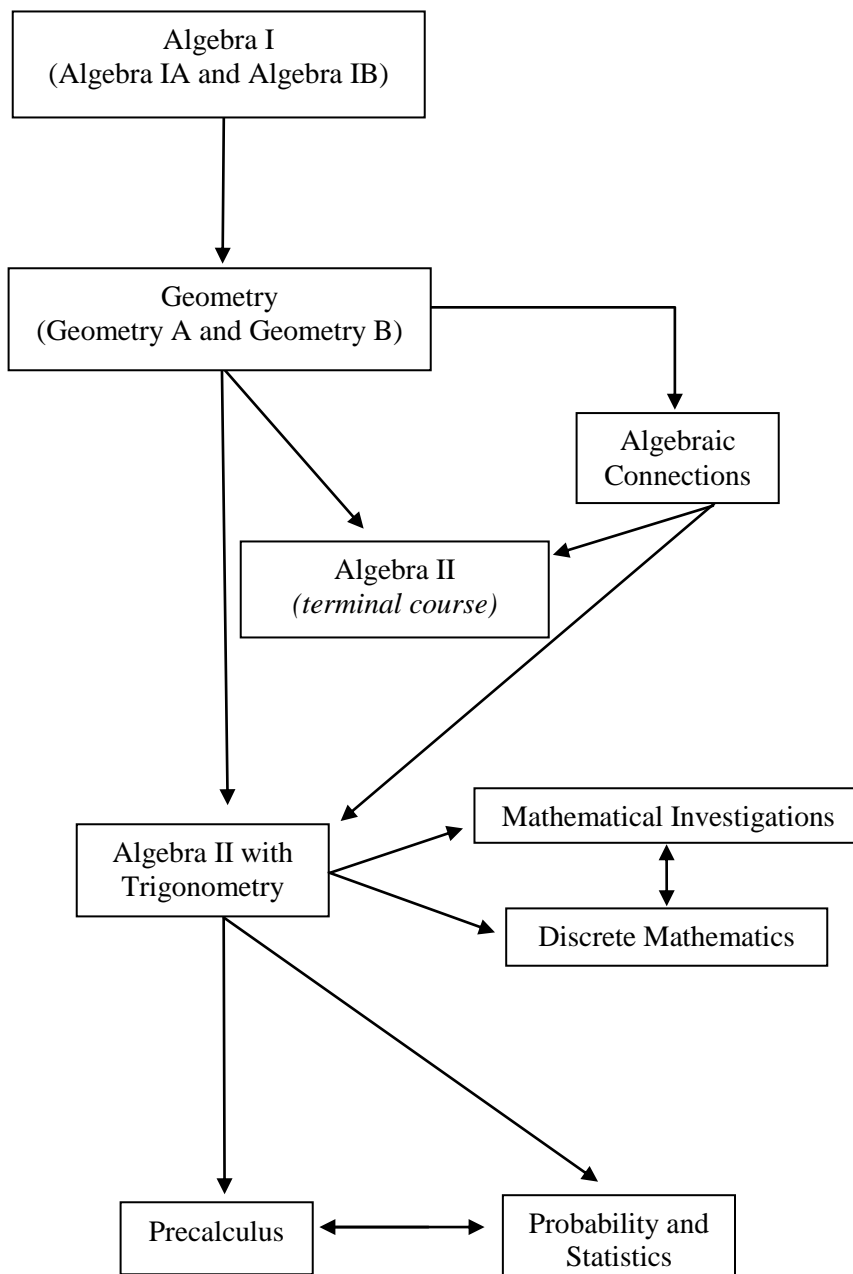
The demands on today's youth continue to increase with advances in technology and constant changes in the global market. With these new challenges comes the formidable task of preparing students to be problem-solving, independent thinkers. Therefore, the mathematics program for Grades 9-12 continues to provide rigorous and comprehensive content that prepares Alabama students for these future challenges. Whether a student plans to pursue postsecondary education or enter the workforce, all Alabama students must earn four credits in mathematics, including Algebra I and Geometry. Any student pursuing the *Alabama High School Diploma with Advanced Academic Endorsement* must also complete Algebra II with Trigonometry. However, students are encouraged to go beyond these minimum requirements to achieve their maximum potential.

To satisfy the two mathematics elective credits needed to complete the four required mathematics credits for high school graduation, additional courses have been included to more adequately accommodate the needs of all students. Course choices following Geometry are Algebraic Connections, Algebra II, Algebra II with Trigonometry, Discrete Mathematics, Mathematical Investigations, Precalculus, and Probability and Statistics. The study of mathematics in Advanced Placement and International Baccalaureate courses may also be options students choose to pursue.

During the high school years it is imperative for students to be afforded opportunities to realize connections among various mathematics topics and ideas as well as mathematics connections to other subject areas and to aspects of everyday life. Content standards in this course of study address these important connections and also address the need for students to engage in a variety of problem-solving activities that involve multiple ways to express their thinking in both oral and written form. In addition, students need opportunities to develop algebraic, graphical, numerical, and verbal representations that demonstrate their understanding of mathematical concepts.

Instruction should incorporate a healthy balance between paper-and-pencil activities; multiple types of assessments, including traditional and alternative approaches; and the utilization of technology. While technological tools are important in the study of mathematics, they are not intended to replace manual computation or critical thought, but rather to enhance classroom instruction.

POSSIBLE COURSE PROGRESSION IN GRADES 9-12



POSSIBLE COURSE SEQUENCES

There are several pathways by which a student can meet the high school graduation requirements for earning four credits in mathematics in Grades 9-12. Local school systems may determine which pathways lead to completion of the requirements for a specific diploma, provided the minimum requirements set forth by the Alabama State Board of Education are followed. Some pathways in Grades 9-12 are indicated below and on the next page.

Pathways for Students Who Begin Algebra I in Grade 9

Algebra IA
Algebra IB
Geometry A
Geometry B

Algebra IA
Algebra IB
Geometry
Algebra II

Algebra IA
Algebra IB
Geometry
Algebraic Connections

Algebra IA
Algebra IB
Geometry
Algebra II with Trigonometry

Algebra I
Geometry A
Geometry B
Algebraic Connections

Algebra I
Geometry A
Geometry B
Algebra II with Trigonometry

Algebra I
Geometry A
Geometry B
Algebra II

Algebra I
Geometry
Algebra II with Trigonometry
Probability and Statistics

Algebra I
Geometry
Algebra II with Trigonometry
Precalculus

Algebra I
Geometry
Algebraic Connections
Algebra II

Algebra I
Geometry
Algebraic Connections
Algebra II with Trigonometry

Algebra I
Geometry
Algebra II with Trigonometry
Mathematical Investigations

Algebra I
Geometry
Algebra II with Trigonometry
Discrete Mathematics

Some Pathways for Students Who Complete Algebra I in Grade 8

Geometry
Algebra II with Trigonometry
Probability and Statistics
Precalculus

Geometry
Algebra II with Trigonometry
Precalculus
Probability and Statistics

Geometry
Algebra II with Trigonometry
Precalculus
Advanced Placement (AP)
Mathematics Course

Geometry
Algebra II with Trigonometry
Mathematical Investigations
Discrete Mathematics

Geometry
Algebraic Connections
Algebra II with Trigonometry
Probability and Statistics

Geometry
Algebraic Connections
Algebra II with Trigonometry
Precalculus

Geometry
Algebra II with Trigonometry
Discrete Mathematics
Mathematical Investigations

Geometry
Algebraic Connections
Algebra II with Trigonometry
Mathematical Investigations

Geometry
Algebra II with Trigonometry
Mathematical Investigations
Precalculus

Geometry
Algebra II with Trigonometry
Discrete Mathematics
Precalculus

Geometry
Algebraic Connections
Algebra II with Trigonometry
Discrete Mathematics

ALGEBRA I

The Algebra I course provides students with mathematical experiences that are useful in everyday life. The reasoning and problem-solving skills used in Algebra I may be applied to life situations beyond the classroom. Algebra I is also the cornerstone of high school mathematics. Every course beyond Algebra I requires the knowledge of these content standards. Therefore, it is of utmost importance that each standard be mastered. Algebra I builds on foundational content learned by students in Grades K-8 by expanding mathematics understanding to provide students with a strong mathematics education.

Algebra I is the basis for the majority of the mathematics content included on the *Alabama High School Graduation Exam (AHSGE)*. Therefore, it is one of the courses required for all students. School systems may offer Algebra I and Algebra IA and Algebra IB. Content standards 1, 2, 3, 4, 12, 13, 14, 15, and linear equations and inequalities from content standard 7 must be taught in the Algebra IA course. Content standards 5, 6, 8, 9, 10, 11, and the remainder of content standard 7 must be taught in the Algebra IB course. Systems offering Algebra I in the eighth grade have the responsibility of ensuring that all Algebra I course content standards be included in instruction.

Number and Operations

Students will:

1. Simplify numerical expressions, including those involving square roots, radical form, and decimal approximations using properties of real numbers and order of operations.

Example: Express $\sqrt{27} + \sqrt{75}$ in simplified form. Answer: $8\sqrt{3}$.

- Applying laws of exponents to simplify expressions, including those containing zero and negative integral exponents

Examples: Simplify $\frac{x^3y^4}{x^3y^{-2}}$. Answer: y^6 .

Multiply 2.4×10^5 by 3.1×10^3 . Answer: 7.44×10^8 .

Divide $\frac{2.4 \times 10^5}{1.2 \times 10^7}$. Answer: 2×10^{-2} .

Algebra

2. Analyze linear functions from their equations for their characteristics, including slopes and intercepts.

Example: Evaluate $f(0)$ for $f(x) = 3x + 4$. Answer: $f(0) = 4$.

- Determining the slope of a line from its equation or by applying the slope formula
- Determining equations of linear functions given two points, a point and the slope, tables of values, graphs, or ordered pairs
- Graphing two-variable linear equations and inequalities on the Cartesian plane

3. Determine properties of a relation, including domain, range, and whether it is a function, when given graphs, tables of values, mappings, or sets of ordered pairs.
 - Finding the range of a function when given its domain
 Example: Find the range of $f(x) = -x^2 + 2x - 3$ when given the domain $\{-4, -2, 0, 2, 4\}$. Answer: $\{-11, -3\}$.
4. Construct graphs of common relations, including $x = \text{constant}$, $y = \text{constant}$, $y = x$, $y = \sqrt{x}$, $y = x^2$, and $y = |x|$.
 - Identifying applications modeled by common relations, including $x = \text{constant}$, $y = \text{constant}$, $y = x$, $y = \sqrt{x}$, $y = x^2$, and $y = |x|$
5. Perform operations of addition, subtraction, and multiplication on polynomial expressions.
 - Dividing a polynomial by a monomial
 - Evaluating polynomial functions
6. Use GCF, difference of squares, perfect square trinomials, and grouping to factor binomials, trinomials, and other polynomials.
7. Solve multistep equations and inequalities, including linear, radical, absolute value, and literal equations.

Example: solving for x in problems, including $\sqrt{x} - 4 = 0$, $\sqrt{x-4} < 2$, $|x| = 6$, $|x+3| \geq 10$, $y = mx + b$, and $ax + by + c = 0$

 - Writing the solution of an equation or inequality in set notation
 Example: Find the solution of $|x+3| \geq 10$. Answer: $\{x \mid x \geq 7 \text{ or } x \leq -13\}$.
 - Formulating the design of application-based problems by developing and solving equations and inequalities, including those involving direct and inverse variation, distance, uniform motion, and mixture
8. Solve systems of linear equations and inequalities in two variables graphically and algebraically.
 - Designing models of application-based problems by developing and solving systems of linear equations and inequalities
9. Solve quadratic equations using the zero product property.
 - Determining approximate solutions of quadratic equations graphically and numerically
 - Solving quadratic equations using the quadratic formula and completing the square

Geometry

10. Calculate length, midpoint, and slope of a line segment when given coordinates of its endpoints on the Cartesian plane.
 - Deriving distance, midpoint, and slope formulas for line segments
 - Utilizing the Pythagorean Theorem to solve application-based problems

Measurement

11. Solve problems algebraically involving area and perimeter of a polygon, area and circumference of a circle, and volume and surface area of right circular cylinders or right rectangular prisms.

- Applying area and volume formulas to solve application-based problems

Example: *Find the radius of a circle with an area of 75 square inches.*

$$\text{Answer: } \sqrt{\frac{75}{\pi}} \text{ or } 5\sqrt{\frac{3}{\pi}}.$$

Data Analysis and Probability

12. Compare various methods of data reporting, including scatterplots, stem-and-leaf plots, histograms, box-and-whisker plots, and line graphs, to make inferences or predictions.

- Determining effects of linear transformations of data

Example: concluding that if the teacher adds 5 points to each student's grade on an algebra test with mean score of 78, the new mean score will be 83

- Determining effects of outliers
- Critiquing the design of a survey

13. Identify characteristics of a data set, including numerical or categorical and univariate or bivariate.

Example: conducting a survey of 100 students to determine whether boys and girls prefer to watch the same genres of movies to get a bivariate, categorical data set

14. Use a scatterplot and its line of best fit or a specific line graph to determine the correlation existing between two sets of data, including positive, negative, or no correlation.

15. Calculate probabilities given data in lists or graphs.

- Comparing theoretical and experimental probabilities for data in lists or graphs

GEOMETRY

Geometry-based applications are observable in many aspects of life. Because of its importance, this Euclidean Geometry course is required of all students receiving an Alabama High School Diploma.

Geometry builds on Algebra I concepts and increases students' knowledge of shapes and their properties. This knowledge helps develop visual and spatial sense and strong reasoning skills. The Geometry course requires students to make conjectures and to use reasoning to validate or negate these conjectures. The use of proofs and constructions is a valuable tool that enhances reasoning skills and enables students to better understand more complex mathematical concepts. Technology should be used to enhance students' mathematical experience, not replace their reasoning abilities.

School systems may offer Geometry and Geometry A and Geometry B. Content standards 1, 2, 3, 5, 9, 10, 13, and 14 must be taught in the Geometry A course. Content standards 4, 6, 7, 8, 11, 12, 15, 16, 17, and 18 must be taught in the Geometry B course.

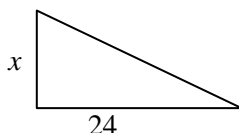
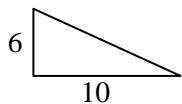
Algebra

Students will:

1. Determine the equation of a line given two points, a point and a slope, a table of values, a graph, ordered pairs, or the equation of a line parallel or perpendicular to another line through a given point.

Geometry

2. Prove theorems related to pairs of angles, including vertical, adjacent, complementary, and supplementary, as well as those formed by parallel lines cut by a transversal and perpendicular lines.
Example: proving vertical angles congruent
3. Justify relationships among different classes of polygons by using their properties.
Example: showing that a square has all the properties of both a rectangle and a rhombus
4. Apply proportional reasoning to determine missing lengths of sides, measures of angles, and ratios of perimeters and areas of similar polygons.
Example: *Determine from the following similar triangles the missing length of side x .*
Answer: 14.4.



5. Determine the measure of interior and exterior angles associated with polygons.
 - Verifying formulas for measures of interior and exterior angles of polygons inductively and deductively

6. Solve problems, including application-based problems, using properties and theorems related to circles, quadrilaterals, and other geometric shapes.

Example: finding the center of a solid wooden wheel using the perpendicular bisectors of two chords

- Determining the center and radius of a circle given its equation
- Determining the equation of a circle given its center and radius

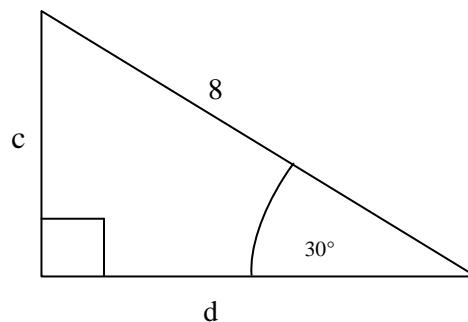
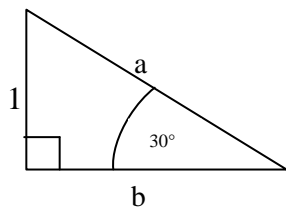
7. Apply the Pythagorean Theorem and its converse to solve application problems, including expressing answers in simplified radical form or as decimal approximations and using Pythagorean triples where applicable.

- Proving the Pythagorean Theorem

8. Apply properties of special right triangles, including 30-60-90 and 45-45-90 triangles, to find missing side lengths.

Example: Determine from the two triangles below the missing side lengths a , b , c , and d , and the relationship between the two triangles.

Answer: $a = 2$, $b = \sqrt{3}$, $c = 4$, and $d = 4\sqrt{3}$; relationship: The two triangles are similar.



9. Determine relationships between two triangles, including proving congruence or similarity of the triangles from given information, using the relationships to solve problems and to establish other relationships.
- Calculating the geometric mean to find missing lengths in right triangles
10. Use inductive reasoning to make conjectures and deductive reasoning to justify conclusions.
- Recognizing limitations of a conclusion through inductive reasoning
 - Using deductive reasoning to prove theorems
 - Using proof by negation to prove theorems
 - Writing conditional statements of a given conjecture
11. Solve for missing measures of sides and angles in right triangles by applying the right triangle ratios of sine, cosine, and tangent.
12. Determine areas and perimeters of regular polygons, including inscribed or circumscribed polygons, given the coordinates of vertices or other characteristics.
13. Apply distance, midpoint, and slope formulas to solve problems and to confirm properties of polygons.

Examples: finding the area of a rectangle given the coordinates of its vertices, showing the median of a trapezoid is half the sum of the bases

14. Identify coordinates of vertices of the image of a given polygon that is translated, rotated, reflected, or dilated.

Example: rotating a triangle a given number of degrees around a specific point and comparing vertices of the image and pre-image

15. Classify polyhedra according to properties, including the number of faces.

Example: identifying a figure having six vertices and twelve edges as a form of polyhedron

- Identifying Euclidean solids

Measurement

16. Calculate measures of arcs and sectors of a circle from given information.

Examples: finding the area of a sector given its arc length and radius, finding the arc length of a sector given its area and radius, finding the area or arc length of a sector given the measure of the central angle and the radius

17. Calculate surface areas and volumes of solid figures, including spheres, cones, and pyramids.

- Deriving formulas for surface area and volume of spheres, cones, and pyramids
- Calculating specific missing dimensions of solid figures from surface area or volume
- Determining the relationship between surface areas of similar figures and volumes of similar figures

Example: *Determine the scale factor for the surface areas of two similar rectangular solids whose volumes are 8 and 216.*

Answer: The scale factor is $\frac{1}{9}$ or 1 to 9 or 1:9.

Data Analysis and Probability

18. Calculate probabilities arising in geometric contexts.

Example: finding the probability of hitting a particular ring on a dartboard where the rings are formed by equally spaced concentric circles

ALGEBRAIC CONNECTIONS

Algebraic Connections is a course designed for students who wish to increase their mathematical knowledge and skills prior to enrollment in the Algebra II course or the Algebra II with Trigonometry course. Algebraic Connections expands upon the concepts of Algebra I and Geometry, with an emphasis on application-based problems. This course provides opportunities to incorporate the use of technology through its emphasis on applying functions to make predictions and to calculate outcomes. The prerequisites for Algebraic Connections are Algebra I and Geometry.

Algebra

Students will:

1. Create algebraic models for application-based problems by developing and solving equations and inequalities, including those involving direct, inverse, and joint variation.
Example: *The amount of sales tax on a new car is directly proportional to the purchase price of the car. If the sales tax on a \$20,500 car is \$1,600, what is the purchase price of a new car that has a sales tax of \$3,200? Answer: The purchase price of the new car is \$41,000.*
2. Solve application-based problems by developing and solving systems of linear equations and inequalities.
3. Use formulas or equations of functions to calculate outcomes of exponential growth or decay.
Example: solving problems involving compound interest, bacterial growth, carbon-14 dating, and depreciation
4. Determine maximum and minimum values of a function using linear programming procedures.
Example: observing the boundaries $x \geq 0$, $y \geq 0$, $2x - 3y + 15 \geq 0$, and $x \leq 9$ to find the maximum and minimum values of $f(x, y) = 3x + 5y$
5. Determine approximate rates of change of nonlinear relationships from graphical and numerical data.
 - Creating graphical representations from tables, equations, or classroom-generated data to model consumer costs and to predict future outcomes
6. Use the extreme value of a given quadratic function to solve applied problems.
Example: determining the selling price needed to maximize profit

7. Use analytical, numerical, and graphical methods to make financial and economic decisions, including those involving banking and investments, insurance, personal budgets, credit purchases, recreation, and deceptive and fraudulent pricing and advertising.

Examples: banking—determining best choice of certificates of deposit, savings accounts, checking accounts, or loans
credit purchases—comparing costs of fixed- or variable-rate mortgage loans, comparing costs associated with various credit cards
personal budgets—determining the best cellular telephone plan

- Creating, manually or with technological tools, graphs and tables related to personal finance and economics

Example: using spreadsheets to create an amortization table for a mortgage loan or a circle graph for a personal budget

Geometry

8. Determine missing information in an application-based situation using properties of right triangles, including trigonometric ratios and the Pythagorean Theorem.

Example: construction or landscape problem

9. Analyze aesthetics of physical models for line symmetry, rotational symmetry, or the golden ratio.

Example: identifying the symmetry found in nature, art, or architecture

Measurement

10. Critique measurements in terms of precision, accuracy, and approximate error.

Example: determining whether one candidate has a significant lead over another candidate when given their current standings in a poll and the margin of error

11. Use ratios of perimeters, areas, and volumes of similar figures to solve applied problems.

Example: using a blueprint or scale drawing of a house to determine the amount of carpet to be purchased

Data Analysis and Probability

12. Create a model of a set of data by estimating the equation of a curve of best fit from tables of values or scatterplots.

Examples: election results as a function of population change, inflation or employment rate as a function of time, cholesterol density as a function of age or weight of a person

- Predicting probabilities given a frequency distribution

ALGEBRA II

Algebra II is a terminating course designed to extend students' algebraic knowledge and skills beyond Algebra I. Students are encouraged to solve problems using a variety of methods that promote the development of improved communication skills and foster a deeper understanding of mathematics. To help students appreciate the power of algebra, application-based problems are incorporated throughout the course. The use of appropriate technology is also encouraged for numerical and graphical investigations.

In contrast to the Algebra II with Trigonometry course, Algebra II does not meet the graduation requirements for the *Alabama High School Diploma with Advanced Academic Endorsement* due to the fact that it does not contain trigonometry content. This course does not provide sufficient background to prepare students to pursue higher-level mathematics courses. The prerequisites for Algebra II are Algebra I and Geometry.

Number and Operations

Students will:

1. Determine relationships among subsets of complex numbers.
Example: using Venn diagrams or tree diagrams to show how subsets of complex numbers are related
2. Use order of operations, conjugates, and absolute value to simplify expressions involving complex numbers.

Examples: Simplify $\sqrt{-8}$. Answer: $2i\sqrt{2}$.

Simplify $4 - 2i^2$. Answer: $12 - 16i$.

Simplify $\frac{3+i}{3-i}$. Answer: $\frac{4+3i}{5}$.

Algebra

3. Determine effects of shifts, reflections, and dilations on families of functions, including $y = \frac{k}{x}$ (inverse variation), $y = kx$ (direct variation/linear), $y = x^2$ (quadratic), $y = a^x$ (exponential), and $y = \log_a x$ (logarithmic).

Example: comparing the graphs of $y = 2^x$, $y = -2^x + 1$, $y = 2^{x+1}$, and $y = -2^x$

- Identifying the domain and range of a relation given its graph, a table of values, or its equation, including those with restricted domains

Examples: Find the domain of $y = \frac{1}{x-3}$. Answer: $(-\infty, 3) \cup (3, \infty)$.

Find the domain of $y = \sqrt{x-2}$. Answer: $x \geq 2$.

- Identifying application-based situations corresponding to families of functions

4. Determine the nature of solutions of a quadratic equation.
 Examples: *Use the discriminant to determine the nature of the roots of $x^2 - 3x + 5 = 0$.*
Answer: There are no real roots.
Use the discriminant to determine the nature of the roots of $x^2 + 4x + 3 = 0$.
Answer: There are 2 real roots.
Use the discriminant to determine the nature of the roots of $x^2 + 2x + 1 = 0$.
Answer: There is 1 real root.
5. Determine approximate real zeros of functions graphically and numerically and exact real zeros of polynomial functions by completing the square and applying the zero product property and the quadratic formula.
 Example: *Approximate real zeros of $f(x) = x^2 + 6x - 10$ on a graphing calculator.*
Answer: $x = -3 \pm \sqrt{19}$.
- Deriving the quadratic formula
6. Identify characteristics, including maximum and minimum values, of quadratic functions from their roots, graphs, or equations.
- Determining a quadratic equation when given its graph or roots
 - Constructing the graph of a function when given its equation
 Examples: graphing equations of the form $y = a(x - h)^2 + k$, graphing equations of the form $y = ax^2 + bx + c$
 - Using the maximum or minimum value of a quadratic function to solve application-based problems
7. Perform operations, including addition, subtraction, multiplication, division, and composition of functions, with polynomial and rational expressions containing variables.
 Example: *Simplify $\frac{3}{x+5} + \frac{5}{x^2 + 6x + 5}$. Answer: $\frac{3x + 8}{x^2 + 6x + 5}$.*
- Determining the inverse of a function or a relation
 - Evaluating rational functions
8. Apply laws of exponents to simplify expressions, including those containing zero and negative integral exponents.
- Applying laws of logarithms to simplify expressions and solve equations
9. Solve equations, inequalities, and applied problems involving rational and irrational exponents, absolute values, radicals, and quadratics over complex numbers, as well as exponential and logarithmic functions with the solution represented as a graph on a number line, set notation, and interval notation.
 Examples: *Solve $x^2 - 4 > 0$. Answer: $(-\infty, -2) \cup (2, \infty)$.*
Solve $3^x = 81$. Answer: $x = 4$.

10. Solve systems of linear equations or inequalities in two and three variables using algebraic techniques, including those involving matrices.
 - Calculating the determinant of a 2×2 and a 3×3 matrix
 - Solving two- and three-variable word problems involving application-based situations

Geometry

11. Solve coordinate geometry problems using algebraic techniques.
Examples: finding missing coordinates of vertices of polygons, determining properties of polygons given the coordinates of their vertices, determining perpendicularity of the sides of a polygon on a coordinate plane

Data Analysis and Probability

12. Use multiple representations, including graphical, numerical, analytical, and verbal, to compare characteristics of data gathered from two populations.
 - Identifying characteristics of the design of an experimental study
 - Describing effects of an experimental study design on its outcome
 - Predicting population characteristics using sample statistics
 - Identifying characteristics, including the mean and standard deviation, of a normal distribution
13. Analyze data to determine if a linear or quadratic relationship exists.
 - Determining an equation of linear regression from a set of data to predict outcomes
14. Calculate probabilities of events using permutations, combinations, the laws of probability, and the binomial theorem.
 - Calculating conditional probability

ALGEBRA II WITH TRIGONOMETRY

Algebra II with Trigonometry is a course designed to extend students' knowledge of Algebra I with additional algebraic and trigonometric content. Mastery of the content standards for this course is necessary for student success in higher-level mathematics. The use of appropriate technology is encouraged for numerical and graphical investigations that enhance analytical comprehension.

Algebra II with Trigonometry is required for all students pursuing the *Alabama High School Diploma with Advanced Academic Endorsement*. Prerequisites for this course are Algebra I and Geometry. If a student chooses to take the Algebraic Connections course, it must be taken prior to the Algebra II with Trigonometry course.

Number and Operations

Students will:

1. Determine relationships among subsets of complex numbers.
Example: using Venn diagrams or tree diagrams to show how subsets of complex numbers are related
2. Use order of operations, conjugates, and absolute value to simplify expressions involving complex numbers.

Examples: Simplify $\sqrt{8}$. Answer: $2i\sqrt{2}$.

Simplify $4 - 2i^2$. Answer: $12 - 16i$.

Simplify $\frac{3+i}{3-i}$. Answer: $\frac{4+3i}{5}$.

Algebra

3. Determine effects of shifts, reflections, and dilations on families of functions, including

$y = \frac{k}{x}$ (inverse variation), $y = kx$ (direct variation/linear), $y = x^2$ (quadratic),

$y = a^x$ (exponential), and $y = \log_a x$ (logarithmic).

Example: comparing the graphs of $y = 2^x$, $y = 2^x + 1$, $y = 2^{x+1}$, and $y = -2^x$

- Identifying the domain and range of a relation given its graph, a table of values, or its equation, including those with restricted domains

Examples: Find the domain of $y = \frac{1}{x-3}$. Answer: $(-\infty, 3) \cup (3, \infty)$.

Find the domain of $y = \sqrt{x-2}$. Answer: $x \geq 2$.

- Identifying application-based situations corresponding to families of functions

4. Determine the nature of solutions of a quadratic equation.
 Examples: *Use the discriminant to determine the nature of the roots of $x^2 - 3x + 5 = 0$.*
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Answer: There are 2 real roots.
Use the discriminant to determine the nature of the roots of $x^2 + 2x + 1 = 0$.
Answer: There is 1 real root.
5. Determine approximate real zeros of functions graphically and numerically and exact real zeros of polynomial functions by completing the square and applying the zero product property and the quadratic formula.
- Deriving the quadratic formula
 Example: *Approximate real zeros of the polynomial function $f(x) = x^2 + 6x - 10$ on a graphing calculator.*
Answer: $x = -3 \pm \sqrt{19}$.
6. Identify characteristics, including maximum and minimum values, of quadratic functions from their roots, graphs, or equations.
- Determining a quadratic equation when given its graph or roots
 - Constructing the graph of a function when given its equation
 Examples: graphing equations of the form $y = a(x - h)^2 + k$, graphing equations of the form $y = ax^2 + bx + c$
 - Using the maximum or minimum value of a quadratic function to solve application-based problems
7. Perform operations, including addition, subtraction, multiplication, division, and composition of functions, with polynomial and rational expressions containing variables.
- Example: *Simplify $\frac{3}{x+5} + \frac{5}{x^2 + 6x + 5}$.* *Answer: $\frac{3x + 8}{x^2 + 6x + 5}$.*
- Determining the inverse of a function or a relation
 - Evaluating rational functions
8. Apply laws of exponents to simplify expressions, including those containing zero and negative integral exponents.
- Applying laws of logarithms to simplify expressions and solve equations
9. Solve equations, inequalities, and applied problems involving rational and irrational exponents, absolute values, radicals, and quadratics over complex numbers, as well as simple trigonometric, exponential, and logarithmic functions with the solution represented as a graph on a number line, set notation, and interval notation.
- Examples: *Solve $x^2 - 4 > 0$.* *Answer: $(-\infty, -2) \cup (2, \infty)$.*
Solve $3^x = 81$. *Answer: $x = 4$.*

10. Solve systems of linear equations or inequalities in two and three variables using algebraic techniques, including those involving matrices.
 - Calculating the determinant of a 2×2 and a 3×3 matrix
 - Solving two- and three-variable word problems involving application-based situations
11. Determine specific unit circle coordinates associated with special angles.
 - Converting angle measures from degrees to radians and from radians to degrees
 - Graphing angles in standard position
 - Determining the value of the six trigonometric functions for special angles
12. Graph trigonometric functions of the form $y = a \sin(bx)$, $y = a \cos(bx)$, $y = a \tan(bx)$, $y = a \sec(bx)$, $y = a \csc(bx)$, and $y = a \cot(bx)$.
 - Determining period and amplitude of sine, cosine, and tangent functions from graphs or basic equations
 - Example: solving problems involving harmonic motion
 - Graphing angles in standard position

Geometry

13. Solve coordinate geometry problems using algebraic techniques.
 - Examples: finding missing coordinates of vertices of polygons, determining properties of polygons given the coordinates of their vertices, determining perpendicularity of the sides of a polygon on a coordinate plane
14. Define the six trigonometric functions using ratios of the sides of a right triangle, coordinates on the unit circle, and the reciprocal of other functions.
 - Applying the law of sines and the law of cosines to determine missing measures of triangles
15. Verify simple trigonometric identities using Pythagorean and reciprocal identities.
 - Example: verifying $\cos^2 \alpha + \tan^2 \alpha \cos^2 \alpha = 1$

Data Analysis and Probability

16. Use multiple representations, including graphical, numerical, analytical, and verbal, to compare characteristics of data gathered from two populations.
 - Identifying characteristics of the design of an experimental study
 - Describing effects of an experimental study design on its outcome
 - Predicting population characteristics using sample statistics
 - Identifying characteristics, including the mean and standard deviation, of a normal distribution
17. Analyze data to determine if a linear, quadratic, or exponential relationship exists.
 - Determining an equation of linear regression from a set of data to predict outcomes
18. Calculate probabilities of events using permutations, combinations, the laws of probability, and the binomial theorem.
 - Calculating conditional probability

DISCRETE MATHEMATICS

Discrete Mathematics is a course designed for students who have successfully completed the Algebra II with Trigonometry course and who choose not to continue mathematics study in the Precalculus or Probability and Statistics courses. This course may be offered as an elective for students who have completed the four mathematics requirements for graduation.

Discrete Mathematics expands upon the topics of matrices, combinatorial reasoning, counting techniques, algorithms, sequences, series, and their applications. Students are expected to work in both individual and group settings to apply problem-solving strategies and to incorporate technological tools that extend beyond traditional instructional practices. The prerequisites for this course are Algebra I, Geometry, and Algebra II with Trigonometry.

Number and Operations

Students will:

1. Analyze topics from elementary number theory, including perfect numbers and prime numbers, to determine properties of integers.
2. Determine characteristics of sequences, including the Fibonacci sequence, the triangular numbers, and pentagonal numbers.
Example: writing a sequence of the first 10 triangular numbers and hypothesizing a formula to find the n^{th} triangular number
3. Use the recursive process and difference equations to create fractals, population growth models, sequences, series, and compound interest models.
4. Convert between base ten and other bases.

Algebra

5. Determine results of operations upon 3×3 and larger matrices, including matrix addition and multiplication of a matrix by a matrix, vector, or scalar.
6. Analyze determinants and inverses of 2×2 , 3×3 , and larger matrices to determine the nature of the solution set of the corresponding system of equations, including solving systems of equations in three variables by echelon row reduction and matrix inverse.

7. Solve problems through investigation and application of existence and nonexistence of Euler paths, Euler circuits, Hamilton paths, and Hamilton circuits.
Example: showing why a 5 x 5 grid has no Hamilton circuit
 - Developing optimal solutions of application-based problems using existing and student-created algorithms
8. Apply algorithms, including Kruskal's and Prim's, relating to minimum weight spanning trees, networks, flows, and Steiner trees.
 - Using shortest path techniques to find optimal shipping routes
9. Determine a minimum project time using algorithms to schedule tasks in order, including critical path analysis, the list-processing algorithm, and student-created algorithms.

Geometry

10. Use vertex-coloring techniques and matching techniques to solve application-based problems.
Example: using graph-coloring techniques to color a map of the western states of the United States so that no adjacent states are the same color, including determining the minimum number of colors needed and why no fewer colors may be used
11. Solve application-based logic problems using Venn diagrams, truth tables, and matrices.

Data Analysis and Probability

12. Use combinatorial reasoning and counting techniques to solve application-based problems.
Example: *Determine the probability of a safe opening on the first attempt given the combination uses the digits 2, 4, 6, and 8 with the order unknown.*
Answer: The probability of the safe opening on the first attempt is $\frac{1}{24}$.
13. Analyze election data to compare election methods and voting apportionment, including determining strength within specific groups.

MATHEMATICAL INVESTIGATIONS

Mathematical Investigations is a course designed for students who have successfully completed the Algebra II with Trigonometry course and who choose not to continue mathematics study in the Precalculus or Probability and Statistics courses. This course may be offered as an elective for students who have completed the four mathematics requirements for graduation.

Mathematical Investigations is intended to extend students' knowledge of mathematical development. Beginning with ancient numeration systems, students explore relationships between mathematics and nature, music, art, and architecture as well as the contributions of well-known mathematicians. It extends the scope of prerequisite courses, integrating topics with an emphasis on application-based problem solving. The wide range of topics and applied problems may lend itself to organizing the content into thematic units. The prerequisites for this course are Algebra I, Geometry, and Algebra II with Trigonometry.

Number and Operations

Students will:

1. Critique ancient numeration systems and applications, including astronomy and the development and use of money and calendars.
 - Determining relationships among mathematical achievements of ancient peoples, including the Sumerians, Babylonians, Egyptians, Mesopotamians, Chinese, Aztecs, and Incas
 - Explaining origins of the Hindu-Arabic numeration system
Example: performing addition and subtraction in both the Hindu-Arabic and the Roman numeration systems to compare place value and place holders
2. Analyze mathematical relationships in music to interpret frequencies of musical notes and to compare mathematical structures of various musical instruments.
Examples: comparing frequencies of notes exactly one octave apart on the musical scale; using frequencies and wave patterns of middle C, E above middle C, and G above middle C to explain why the C major chord is harmonious
 - Determining lengths of strings necessary to produce harmonic tones as in Pythagorean tuning
3. Use special numbers, including e , i , π , and the golden ratio, to solve application-based problems.
 - Identifying transcendental numbers
Example: calculating e to ten decimal places using a summation with $\frac{1}{n!}$

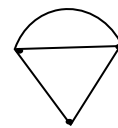
4. Explain the development and uses of sets of numbers, including complex, real, rational, irrational, integer, whole, and natural numbers.
- Analyzing contributions to the number system by well-known mathematicians, including Archimedes, John Napier, René Descartes, Sir Isaac Newton, Johann Carl Friedrich Gauss, and Julius Wilhelm Richard Dedekind
- Example: plotting solutions to the polynomial equation,
 $x^2 - 6x + 11 = 0$, on the Gaussian plane

Algebra

5. Identify beginnings of algebraic symbolism and structure through the works of European mathematicians.
- Creating a Fibonacci sequence when given two initial integers
 - Investigating Tartaglia's formula for solving cubic equations
6. Explain the development and applications of logarithms, including contributions of John Napier, Henry Briggs, and the Bernoulli family.
7. Justify the historical significance of the development of multiple perspectives in mathematics.
- Example: relating the historical development of multiple perspectives to the works of Sir Isaac Newton and Gottfried Wilhelm von Leibniz in the foundations of calculus
- Summarizing the significance of René Descartes' Cartesian coordinate system
 - Interpreting the foundation of analytic geometry with regard to geometric curves and algebraic relationships

Geometry

8. Solve problems from non-Euclidean geometry, including graph theory, networks, topology, and fractals.
- Examples: observing the figure to the right to determine if it is traversable, and if it is, describing a path that will traverse it; verifying that two objects are topologically equivalent; sketching four iterations of Sierpinski's triangle



9. Analyze works of visual art and architecture for mathematical relationships.
Examples: using Leonardo da Vinci's *Vitruvian Man* to explore the golden ratio; identifying mathematical patterns in Maurits Cornelis Escher's drawings, including the use of tessellations in art, quilting, paintings, pottery, and architecture
- Summarizing the historical development of perspective in art and architecture
10. Determine the mathematical impact of the ancient Greeks, including Archimedes, Eratosthenes, Euclid, Hypatia, Pythagoras, and the Pythagorean Society.
Example: using Euclid's proposition to inscribe a regular hexagon within a circle
- Constructing multiple proofs of the Pythagorean Theorem
 - Solving problems involving figurate numbers, including triangular and pentagonal numbers
- Example: writing a sequence of the first 10 triangular numbers and hypothesizing a formula for finding the n^{th} triangular number

Measurement

11. Describe the development of mathematical tools and their applications.
Examples: knotted ropes—counting
Napier's bones—multiplication
slide rule—multiplying; calculating values of trigonometric, exponential, and logarithmic functions
graphing calculator—analyzing functions graphically and numerically

Data Analysis and Probability

12. Summarize the history of probability, including the works of Blaise Pascal; Pierre de Fermat; Abraham de Moivre; and Pierre-Simon, marquis de Laplace.
Example: discussing the impact of probability on gaming, economics, and insurance

PRECALCULUS

Precalculus is designed for students who have successfully completed the Algebra II with Trigonometry course. This course is considered to be a prerequisite for success in calculus and college mathematics. Algebraic, graphical, numerical, and verbal analyses are incorporated during investigations of the Precalculus content standards. Parametric equations, polar relations, vector operations, conic sections, and limits are introduced. Content for this course also includes an expanded study of polynomial and rational functions, trigonometric functions, and logarithmic and exponential functions.

Application-based problem solving is an integral part of the course. Instruction should include appropriate use of technology to facilitate continued development of students' higher-order thinking skills.

Number and Operations

Students will:

1. Perform vector operations of addition, scalar multiplication, and absolute value.
 - Determining coincidence, parallelism, collinearity, or perpendicularity of vectors
 - Using vectors to model application-based and mathematical situations
2. Define e using the limit forms of $\sum_{n=0}^{\infty} \frac{1}{n!}$, $\lim_{n \rightarrow \infty} \left(1 + \frac{1}{n}\right)^n$, and $\lim_{n \rightarrow 0} \left(1 + n\right)^{\frac{1}{n}}$.
3. Determine numerically, algebraically, and graphically the limits of functions at specific values and at infinity.
 - Applying limits in problems involving convergence and divergence

Algebra

4. Determine characteristics of arithmetic and geometric sequences and series, including those defined with recurrence relations, first terms, common differences or ratios, n^{th} terms, limits, or statements of convergence or divergence.
 - Solving problems modeled by finite geometric series, including home mortgage problems
 - Expanding binomials raised to a whole number power using the binomial theorem
5. Create graphs of conic sections, including parabolas, hyperbolas, ellipses, circles, and degenerate conics, from second-degree equations.

Example: graphing $x^2 - 6x + y^2 - 12y + 41 = 0$ or $y^2 - 4x + 2y + 5 = 0$

 - Formulating equations of conic sections from their determining characteristics
Example: Write the equation of an ellipse with center $(5, -3)$, a horizontal major axis of length 10, and a minor axis of length 4.
Answer: $\frac{(x-5)^2}{25} + \frac{(y+3)^2}{4} = 1.$
6. Determine the inverse of a function and a relation.

7. Analyze rational, logarithmic, exponential, trigonometric, and piecewise-defined functions graphically and algebraically to determine the domain and range; to identify symmetries; to identify vertical, horizontal, or oblique asymptotes; to classify functions as increasing or decreasing, continuous or discontinuous; and to identify the type of discontinuity if one exists.

- Using the difference quotient to approximate rates of change

Examples: Use $f(x) = x^2 + 3$ to find $\frac{f(x+h) - f(x)}{h}$. Answer: $2x + h$.

Use $f(x) = \sqrt{x+1}$ to find $\frac{f(x+h) - f(x)}{h}$.

Answer: $\frac{1}{\sqrt{x+h+1} + \sqrt{x+1}}$.

Use $f(x) = \frac{1}{x}$ to find $\frac{f(x+h) - f(x)}{h}$. Answer: $\frac{-1}{x(x+h)}$.

8. Compare effects of parameter changes on graphs of transcendental functions.
Example: explaining the relationship of the graph $y = e^{x-2}$ to the graph $y = e^x$
9. Determine the amplitude, period, phase shift, domain, and range of trigonometric functions and their inverses.
10. Solve trigonometric equations using sum, difference, and half- and double-angle identities.
Example: Solve $2 + \tan(2\theta) = 3$ over the interval $0 \leq \theta < 2\pi$.

Answer: $\frac{\pi}{8}, \frac{5\pi}{8}, \frac{9\pi}{8}, \frac{13\pi}{8}$

- Verifying trigonometric identities
11. Apply the law of sines and the law of cosines to determine missing measures of triangles, including application-based problems.
- Deriving formulas for the law of sines and the law of cosines
 - Determining the area of oblique triangles
12. Determine the value of the six trigonometric functions for special angles.
- Examples: Determine the value of $\sin \frac{7\pi}{6}$. Answer: $-\frac{1}{2}$
- Determine the value of $\cos 135^\circ$. Answer: $-\frac{\sqrt{2}}{2}$.
- Determine the value of $\tan \frac{\pi}{3}$. Answer: $\sqrt{3}$.
- Using the sum, difference, and half-angle identities to find the exact value of a trigonometric function
13. Utilize parametric equations by graphing and by converting to rectangular form.
- Solving application-based problems involving parametric equations
 - Solving applied problems that include sequences with recurrence relations

14. Apply laws of logarithms to simplify expressions and to solve equations using common logarithms, natural logarithms, and logarithms with other bases.

Geometry

15. Determine the location of polar coordinates and complex numbers on the complex plane and convert coordinates, equations, and complex numbers from Cartesian form to polar form and from polar form to Cartesian form.
- Constructing graphs of simple polar equations on the polar coordinate plane
Example: graphing $r = 2 + 2 \cos \theta$ or $r = 2 \sin 3\theta$

Data Analysis and Probability

16. Determine the equation of a curve of best fit from a set of data using exponential, quadratic, or logarithmic functions.

PROBABILITY AND STATISTICS

Probability and Statistics is a course designed to be taken after the Algebra II with Trigonometry course. This course provides a structured introduction to important areas of emphasis in most postsecondary studies of mathematics. Given the increased importance of statistics in understanding and evaluating the vast amount of data encountered in everyday life, a strong emphasis is placed on collecting, organizing, analyzing, and interpreting data. To assist students with numerical and graphical analysis, the use of advanced technological tools is highly recommended.

Algebra

Students will:

1. Use the binomial theorem to expand powers of binomials.
 - Using Pascal's triangle to expand powers of binomials

Data Analysis and Probability

2. Compare summary statistics for sets of data represented in a graph, a stem-and-leaf chart, a box-and-whisker graph, a histogram, a linear or quadratic equation of best fit of a scatterplot, and a frequency distribution.
3. Calculate descriptive statistics of univariate data, including measures of central tendency, measures of dispersion, and measures of position.
 - Defining vocabulary associated with probability and statistics, including descriptive and inferential statistics
 - Comparing descriptive statistics for samples of various sizes generated by simulation
4. Calculate probabilities of mutually exclusive, independent, and dependent events using permutations, combinations, and laws of probability.
 - Predicting outcomes of events involving conditional probabilities
5. Determine the probability of an event using a frequency distribution curve.
 - Comparing terms of a binomial expansion to terms of a binomial probability distribution
 - Analyzing data from a student-designed study to create a distribution curve, including determining the resulting confidence interval
 - Using data from a study in quality control applications to compute distributions and confidence intervals
6. Analyze experimental, simulation, and theoretical probability techniques for differences, including advantages and disadvantages of each.
 - Evaluating data-based reports by examining the design of the study, appropriateness of data analysis, and validity of conclusion

7. Determine the validity of a hypothesis for a study involving one or two populations, including generating appropriate descriptive statistics.
 - Designing a study to answer questions about characteristics of a population
Example: designing a study to determine if males at a particular school watch more television than females at that school, including generating appropriate descriptive statistics and testing the hypothesis
 - Critiquing the instrument used in a study of populations
 - Using z-scores in a study of populations
 - Using a t-test, when appropriate, to test a hypothesis for a study
8. Interpret linear relationships of bivariate data using power and exponential regression and linear correlation.
Example: constructing a scatterplot to determine the relationship between the age of an automobile and annual expenses for its maintenance
 - Determining the validity of a hypothesis by displaying a scatterplot of experimental data and examining its correlation
 - Calculating the regression coefficient, regression equation, and the correlation coefficient
9. Describe methods of data collection in a census, sample survey, experiment, and observational study.
10. Develop a method of solution for an application-based problem.
Examples: planning and conducting a survey using sampling techniques, including simple random and stratified, and discussing methods to reduce bias; planning and conducting an experiment addressing control, randomization, and measurement of experimental error
11. Apply the binomial probability distribution for discrete random variables, including computing the mean and standard deviation for the binomial variable.

Alabama High School Graduation Requirements

(Alabama Administrative Code 290-3-1-02(8)(a) (b) and (c))

1. COURSE REQUIREMENTS

The Alabama courses of study shall be followed in determining minimum required content in each discipline. Students seeking the Alabama High School Diploma with Advanced Academic Endorsement shall complete advanced level work in the core curriculum. Students receiving the Alabama High School Diploma with Credit-Based Endorsement shall complete the prescribed credits, including at least one Career and Technical Education course, for the Alabama High School Diploma and pass three of the five sections of the Alabama High School Graduation Exam, including the Mathematics section, Reading section, and one additional section.

COURSE REQUIREMENTS	Alabama High School Diploma Credits	Alabama High School Diploma with Advanced Academic Endorsement Credits	Alabama High School Diploma with Credit-Based Endorsement Credits
ENGLISH LANGUAGE ARTS	4	4	4
Four credits to include the equivalent of: English 9 English 10 English 11 English 12	1 1 1 1	1 1 1 1	1 1 1 1
MATHEMATICS	4	4	4
Four credits to include the equivalent of: Algebra I Geometry Algebra II with Trigonometry Mathematics Elective(s)	1 1 2	1 1 1 1	1 1 2
SCIENCE	4	4	4
Four credits to include the equivalent of: Biology A physical science Science Electives	1 1 2	1 1 2	1 1 2
SOCIAL STUDIES*	4	4	4
Four credits to include the equivalent of: Grade 9 Social Studies Grade 10 Social Studies Grade 11 Social Studies Grade 12 Social Studies	1 1 1 1	1 1 1 1	1 1 1 1
PHYSICAL EDUCATION	1	1	1
HEALTH EDUCATION	0.5	0.5	0.5
ARTS EDUCATION	0.5	0.5	0.5
COMPUTER APPLICATIONS**	0.5	0.5	0.5
FOREIGN LANGUAGE***		2	
ELECTIVES	5.5	3.5	5.5
Local boards shall offer foreign languages, fine arts, physical education, wellness education, career and technical education, and driver education as electives.			
TOTAL CREDITS	24	24	24

* All four required credits in Social Studies shall comply with the current *Alabama Course of Study*.

** May be waived if competencies outlined in the computer applications course are demonstrated to qualified staff in the local school system. The designated one-half credit shall then be added to the elective credits, making a total of six elective credits for the Alabama High School Diploma and the Alabama High School Diploma with Credit-Based Endorsement or four elective credits for the Alabama High School Diploma with Advanced Academic Endorsement.

*** Students earning the diploma with the advanced academic endorsement shall successfully complete two credits in the same foreign language.

2. ASSESSMENT REQUIREMENTS

Pass the required statewide assessment for graduation.

Alabama High School Graduation Requirements (continued)

(Alabama Administrative Code 290-3-1-.02(8)(g)1.)

Course and assessment requirements specified below must be satisfied in order to earn the Alabama Occupational Diploma (AOD).

1. COURSE REQUIREMENTS

Effective for students with disabilities as defined by the *Individuals with Disabilities Education Act*, students must earn the course credits outlined in *Alabama Administrative Code* r. 290-3-1-.02(8)(g)1.

COURSE REQUIREMENTS	Alabama Occupational Diploma Credits
ENGLISH LANGUAGE ARTS	4
*Four credits to include the equivalent of: English I English II English III English IV	1 1 1 1
MATHEMATICS	4
*Four credits to include the equivalent of: Math I Math II Math III Math IV	1 1 1 1
SCIENCE	4
*Four credits to include the equivalent of: Science I Science II Science III Science IV	1 1 1 1
SOCIAL STUDIES	4
*Four credits to include the equivalent of: Social Studies I Social Studies II Social Studies III Social Studies IV	1 1 1 1
CAREER AND TECHNICAL EDUCATION	2
COORDINATED STUDIES OR TRANSITIONAL SERVICES	1
COOPERATIVE CAREER AND TECHNICAL EDUCATION	1
HEALTH EDUCATION	0.5
PHYSICAL EDUCATION	1
ARTS EDUCATION	0.5
ELECTIVES	2
Existing laws require LEAs to offer arts education, physical education, wellness education, career and technical education, and driver education as electives.	
TOTAL CREDITS	24

* All AOD credits shall comply with the current curriculum guides designated for AOD implementation. Local Education Agencies may add additional credits or requirements.

2. ASSESSMENT REQUIREMENTS

Take the required statewide assessment for graduation at least once (during the spring of the eleventh-grade year).

Guidelines and Suggestions for Local Time Requirements and Homework

Total Instructional Time

The total instructional time of each school day in all schools and at all grade levels shall be not less than 6 hours or 360 minutes, exclusive of lunch periods, recess, or time used for changing classes (*Code of Alabama*, 1975, §16-1-1).

Suggested Time Allotments for Grades 1 - 6

The allocations below are based on considerations of a balanced educational program for Grades 1-6. Local school systems are encouraged to develop a general plan for scheduling that supports interdisciplinary instruction. Remedial and/or enrichment activities should be a part of the time schedule for the specific subject area.

<u>Subject Area</u>	<u>Grades 1-3</u>	<u>Grades 4-6</u>
Language Arts	150 minutes daily	120 minutes daily
Mathematics	60 minutes daily	60 minutes daily
Science	30 minutes daily	45 minutes daily
Social Studies	30 minutes daily	45 minutes daily
Physical Education	30 minutes daily*	30 minutes daily*
Health	60 minutes weekly	60 minutes weekly
Technology Education (Computer Applications)	60 minutes weekly	60 minutes weekly
Character Education	10 minutes daily**	10 minutes daily**
Arts Education		

Dance
Music
Theatre
Visual Arts

Daily instruction with certified arts specialists in each of the arts disciplines is the most desirable schedule. However, schools unable to provide daily arts instruction in each discipline are encouraged to schedule in Grades 1 through 3 two 30- to 45-minute arts instruction sessions per week and in Grades 4 through 6 a minimum of 60 minutes of instruction per week. Interdisciplinary instruction within the regular classroom setting is encouraged as an alternative approach for scheduling time for arts instruction when certified arts specialists are not available.

* Established by the Alabama State Department of Education in accordance with *Code of Alabama*, 1975, §16-40-1

** Established by the Alabama State Department of Education in accordance with *Code of Alabama*, 1975, §16-6B-2(h)

Kindergarten

In accordance with *Alabama Administrative Code* r. 290-5-1-.01(5) Minimum Standards for Organizing Kindergarten Programs in Alabama Schools, the daily time schedule of the kindergartens shall be the same as the schedule of the elementary schools in the systems of which they are a part since kindergartens in Alabama operate as full-day programs. There are no established time guidelines for individual subject areas for the kindergarten classroom. The emphasis is on large blocks of time that allow children the opportunity to explore all areas of the curriculum in an unhurried manner.

It is suggested that the full-day kindergarten program be organized utilizing large blocks of time for large groups, small groups, center time, lunch, outdoor activities, snacks, transitions, routines, and afternoon review. Individual exploration, small-group interest activities, interaction with

peers and teachers, manipulation of concrete materials, and involvement in many other real-world experiences are needed to provide a balance in the kindergarten classroom.

Grades 7-12

One credit may be granted in Grades 9-12 for required or elective courses consisting of a minimum of 140 instructional hours or in which students demonstrate mastery of Alabama course of study content standards in one credit courses without specified instructional time (*Alabama Administrative Code* r. 290-3-1-.02 (9)(a)).

In those schools where Grades 7 and 8 are housed with other elementary grades, the school may choose the time requirements listed for Grades 4-6 or those listed for Grades 7-12.

Character Education

For all grades, not less than 10 minutes instruction per day shall focus upon the students' development of the following character traits: courage, patriotism, citizenship, honesty, fairness, respect for others, kindness, cooperation, self-respect, self-control, courtesy, compassion, tolerance, diligence, generosity, punctuality, cleanliness, cheerfulness, school pride, respect of the environment, patience, creativity, sportsmanship, loyalty, and perseverance.

Homework

Homework is an important component of every student's instructional program. Students, teachers, and parents should have a clear understanding of the objectives to be accomplished through homework and the role it plays in meeting curriculum requirements. Homework reflects practices that have been taught in the classroom and provides reinforcement and remediation for students. It should be student-managed, and the amount should be age-appropriate, encouraging learning through problem solving and practice.

At every grade level, homework should be meaning-centered and mirror classroom activities and experiences. Independent and collaborative projects that foster creativity, problem-solving abilities, and student responsibility are appropriate. Parental support and supervision reinforce the quality of practice or product as well as skill development.

Each local board of education shall establish a policy on homework consistent with the Alabama State Board of Education resolution adopted February 23, 1984 (Action Item #F-2).

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