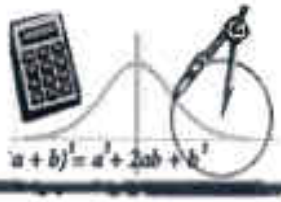
2007 Mississippi Mathematics Framework Revised



Mississippi Department of Education
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2007 Mississippi Mathematics Framework Revised

Hank M. Bounds, Ph.D., State Superintendent of Education

Beth H. Sewell, Ed.D., Executive to the State Superintendent

Kristopher Kaase, Ph.D., Associate State Superintendent

Trecina Green, Bureau Director, Office of Curriculum and Instruction

Camille Chapman, Division Director, Office of Curriculum and Instruction

Marcus Thompson, Mathematics Specialist

Mississippi Department of Education
Post Office Box 771
Jackson, Mississippi
39205-0771
(601) 359-2586

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Director, Office of Human Resources
Mississippi Department of Education
359 North West Street
Suite 359
Jackson, Mississippi 39201
(601) 359-3511

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MISSION STATEMENT

The Mississippi Department of Education is dedicated to student success including the improvement of student achievement in mathematics in order to produce citizens who are capable of making complex decisions, solving complex problems, and communicating fluently in a technological society. Through the utilization of the *2007 Mathematics Framework Revised*, teachers will challenge their students to think more deeply about the mathematics content, thus improving student understanding of mathematics. This document is based on premises that all children can learn, and that high expectations produce high achievement.

PURPOSE

The primary purpose of the *2007 Mathematics Framework Revised* is to provide a basis for curriculum development for K-12 mathematics teachers in Mississippi. The framework provides an outline of what students should learn through competencies and objectives. The *2007 Mathematics Framework Revised* replaces the *2007 Mississippi Mathematics Framework* that was piloted during the 2006-2007 school year. The content of the framework is centered on the strands of **number and operations**, **algebra**, **geometry**, **measurement**, and **data analysis & probability**. Instruction in these strands is designed to expose students to experiences, which reflect the value of mathematics, to enhance students' confidence in their ability to do mathematics, and to help students communicate and reason mathematically.

CYCLE

All Mississippi content area frameworks are reviewed on a six-year cycle. Approximately three years after a framework is implemented, a writing team is selected to review the current framework and recommend changes and modifications based on best practices in the teaching of content areas as reflected in state and national trends.

The implementation (required) year for the *2007 Mathematics Framework Revised* is school year 2007-2008.

ORGANIZATION

The framework is organized by grade level (K-8) and by secondary courses (grades 9-12). A general description that includes the purpose, overview, and prerequisites is found preceding each curriculum outline for the grade level/course. To enhance the implementation of the framework, a section of Literature Connections, Technology Connections, a Glossary, and Resources are included at the end of the framework. The curriculum outline for the *2007 Mathematics Framework Revised* is formatted as follows:

KINDERGARTEN → **COURSE**

CONTENT STRANDS: → **STRANDS**

Number and Operations
Geometry
Data Analysis & Probability
Algebra
Measurement

Competencies and Objectives:

NUMBER AND OPERATIONS → **STRAND**

1. **Identify and represent relationships among sets of whole numbers up to 20 using manipulatives.** → **COMPETENCY**

   a. Count forward to 20 and backward from 10. (DOK 1) → **OBJECTIVE**
   b. Create models of sets of objects 0 to 20. (DOK 1) → **DEPTH OF KNOWLEDGE (DOK) LEVEL**
   c. Recognize and write numbers to represent quantities 0 to 20. (DOK 1)

STRANDS

The *2007 Mathematics Framework Revised* is comprised of five content strands: **Number and Operations, Algebra, Geometry, Measurement,** and **Data Analysis & Probability**. The five process standards (problem solving, communication, reasoning and proof, connections, and representations) should permeate all instructional practices. The five interrelated content strands along with the five process strands combine to provide continuity to the teaching of K-12 mathematics. Students should be given the opportunity to use higher-order thinking to solve routine and non-routine problems as well as to connect the mathematical topics within and across strands and real-world applications. Communication strategies focus on the inclusion of reading, writing, speaking, and critical listening as ways for students to justify their answers or explain their thinking and reasoning. Communication strategies strengthen students' understanding and their achievement. Incorporating representations into lessons allow students to use tables, charts, graphs, diagrams, symbols, and physical materials to model mathematical ideas.

These strands overlap and should be integrated and embedded throughout teachers' daily lesson plans. This continuity provides the necessary foundation for successful completion of high school mathematics requirements. The five strands help to assure that appropriate processes are used and important concepts are learned throughout each grade level and secondary course. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

COMPETENCIES

The competencies, printed in bold face type, are the required learning standards for all students. The Mississippi Curriculum Test, Second Edition (MCT2) and Mississippi Subject Area Tests are aligned to the competencies. Competencies do not have to be taught in the order presented in the framework. The competencies are presented in outline form for consistency and for easy reference throughout the framework. Competencies are intentionally broad in order to allow school districts and teachers the flexibility to create a curriculum that meets the needs of their students. They may relate to one, many, or all of the mathematics framework strands and may be combined and taught with other competencies throughout the school year. Competencies provide a general guideline of on-going instruction, not isolated units, activities, or skills. The competencies are not intended to be a list of content skills that are taught and recorded as "mastered."

OBJECTIVES

The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that **objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.**

The Mississippi Curriculum Test, Second Edition (MCT2) will be developed based on the objectives found in the framework. At least fifty percent (50%) of the test items on the MCT2 must match the Depth of Knowledge (DOK) level assigned to the objectives for each competency. The Depth of Knowledge (DOK) level is indicated at the end of each objective.

DEPTH OF KNOWLEDGE

Each objective for the *2007 Mathematics Framework Revised* has been assigned a Depth of Knowledge (DOK) level based on the work of Norman L. Webb. DOK levels help administrators, teachers, and parents understand the objective in terms of the complexity of what students are expected to know and do. Standards (i.e., competencies and objectives) vary in terms of complexity. Some objectives expect students to reproduce a fact or complete a sequence of steps, while others expect students to reason, extend their thinking, synthesize information from multiple sources, and produce significant work over time. Teachers must know what level of complexity is required by an objective in order to ensure that students have received prior instruction or have had an opportunity to learn content at the level students will be expected to demonstrate or perform. Assessment items must be created to ensure that what is elicited from students on the assessment is as demanding cognitively as what students are expected to know and do as stated in the objectives.

Four levels of Depth of Knowledge (DOK) are used in the *2007 Mathematics Framework Revised*. The levels represent a hierarchy based on two main factors. (1) One factor is sophistication and complexity. Sophistication will depend on the abstractness of the activity, the degree to which simple knowledge and skills have to be recalled or drawn upon, the amount of cognitive processing required, the complexity of the content concepts used, the amount of content that has to be recalled or drawn upon, the lack of routine, and the need to extend knowledge meaningfully or produce novel findings. (2) The other factor is that students at the grade level tested have received prior instruction or have had an opportunity to learn the content. Objectives and assessment items that address complex knowledge can still have a low DOK level if the required knowledge is commonly known and students with normal instruction at a grade level should have had the opportunity to learn how to routinely (habitually) perform what is being asked.

The four levels of Depth of Knowledge (DOK) are described below.

Levels:

Level 1 (Recall) includes the recall of information such as a fact, definition, term, or a simple procedure, as well as performing a simple algorithm or applying a formula. That is, in mathematics a one-step, well-defined, and straight algorithmic procedure should be included at this lowest level. Other key words that signify a Level 1 include "identify," "recall," "recognize," "use," and "measure." Verbs such as "describe" and "explain" could be classified at different levels depending on what is to be described and explained.

Level 2 (Skill/Concept) includes the engagement of some mental processing beyond a habitual response. A level 2 assessment item requires students to make some decisions as to how to approach the problem or activity, whereas Level 1 requires students to demonstrate a rote response, perform a well-known algorithm, follow a set procedure (like a recipe), or perform a clearly defined series of steps. Keywords that generally distinguish a Level 2 item include "classify," "organize," "estimate," "make observations," "collect and display data," and "compare data." These actions imply more than one step. For example, to compare data requires first identifying characteristics of the objects or phenomenon and then grouping or ordering the objects. Some action verbs, such as "explain," "describe," or "interpret" could be classified at different levels depending on the object of the action. For example, if an item required students to explain how light affects mass by indicating there is a relationship between light and heat, this is considered a Level 2. Interpreting information from a simple graph, requiring reading information from the graph, also is a Level 2. Interpreting information from a complex graph that requires some decisions on what features of the graph need to be considered and how information from the graph can be aggregated is a level 3. Caution is warranted in interpreting Level 2 as only skills because some reviewers will interpret skills very narrowly, as primarily numerical skills, and such interpretation excludes from this level other skills such as visualization skills and probability skills, which may be more complex simply because they are less common. Other Level 2 activities include explaining the purpose and use of experimental procedures; carrying out experimental procedures; making observations and collecting data; classifying, organizing, and comparing data; and organizing and displaying data in tables, graphs, and charts.

Level 3 (Strategic Thinking) requires reasoning, planning, using evidence, and a higher level of thinking than the previous two levels. In most instances, requiring students to explain their thinking is a Level 3. Activities that require students to make conjectures are also at this level. The cognitive demands at Level 3 are complex and abstract. The complexity does not result from the fact that there are multiple answers, a possibility for both levels 1 and 2, but because the task requires more demanding reasoning. An activity, however, that has more than one possible answer and requires students to justify the response they give would most likely be a Level 3. Other Level 3 activities include drawing conclusions from observations; citing evidence and developing a logical argument for concepts; explaining phenomena in terms of concepts; and using concepts to solve problems.

Level 4 (Extended Thinking) requires complex reasoning, planning, developing, and thinking most likely over an extended period of time. The extended time period is not a distinguishing factor if the required work is only repetitive and does not require applying significant conceptual understanding and high-order thinking. For example, if a student has to take the water temperature from a river each day for a month and then construct a graph, this would be classified as a Level 2. However, if the student is to conduct a river study that requires taking into consideration a number of variables, this would be a Level 4. At Level 4, the cognitive demands of the task should be high and the work should be very complex. Students should be required to make several connections - relate ideas within the content area or among content areas - and have to select one approach among many alternatives on how the situation should be solved, in order to be at this highest level. Level 4 activities include designing and conducting experiments; making connections between a finding and related concepts and phenomena; combining and synthesizing ideas into new concepts; and critiquing experimental designs.

The Revision Process for the Mathematics Framework

From nominations by school district superintendents and others, the Mississippi Mathematics Curriculum Writing Team was selected in January 2003. The purpose of the team was to draft a new mathematics framework. The team was composed of teachers, administrators, and university professors throughout Mississippi.

All nominated, but not selected to the Mississippi Mathematics Curriculum Writing Team, were asked to serve on the Mathematics Curriculum Advisory Team. The Advisory Team was composed of teachers, administrators, university professors, and other professionals interested in mathematics education.

In order to gain a sufficient understanding of the direction of mathematics education, the writing team reviewed the National Council of Teachers of Mathematics (NCTM) *Principles and Standards for School Mathematics (2000)*, the National Assessment of Educational Progress (NAEP) *Mathematics Framework for 2005*, current literature and research. These resources served as a foundation for the development of the framework.

Drafts were distributed to the writing team and advisory team in March 2005 and to superintendents and curriculum coordinators in November 2005 as a part of the Administrative Procedures Act. Revisions were made in response to the submitted suggestions and feedback. The Mississippi Department of Education solicited further comment from the Norman Webb Group, and other outside evaluators to assure a vertical flow of mathematics with emphasis on rigorous mathematical content and alignment with national standards.

The Refinement Process for the Mathematics Framework

Through the process of developing performance level descriptors and test item specifications with teacher committees, misalignments and gaps in the framework were identified. In addition, the National Council of Teachers of Mathematics released the *Curriculum Focal Points for Pre-Kindergarten through Grade 8 Mathematics* in September 2006. The *Curriculum Focal Points* provides a guide for states to design more focused curricular expectations for pre-K through grade 8 mathematics curriculum. These sources of information, as well as feedback received from over 200 practitioners through survey responses on the 2007 framework, were used to refine the document. This revised edition is more focused and better aligned vertically and horizontally and coincides with the implementation of the Mississippi Curriculum Test, Second Edition (MCT2).

SEQUENCE

Students will progress according to grade level through the sixth grade. Beginning in the seventh grade, students are given course sequence options. Below are proposed secondary course sequence options:

Proposed Secondary Course Sequence Options

Grade Level	OPTION 1	OPTION 2	OPTION 3	OPTION 4
7	7th grade Math	7th grade Math	Pre-Algebra	Pre-Algebra
8	Pre-Algebra	Pre-Algebra	Transition to Algebra	Algebra I
9	Transition to Algebra	Algebra I	Algebra I	Geometry or Algebra II
10	Algebra I	Geometry or Algebra II	Geometry or Algebra II	Geometry or Algebra II
11	Geometry or Algebra II	Geometry or Algebra II	Geometry or Algebra II	Advanced Algebra, Trigonometry, or Elective
12	Geometry or Algebra II	Advanced Algebra, Trigonometry, or Elective	Advanced Algebra, Trigonometry, or Elective	Pre-Calculus, Calculus, Statistics, or Elective

The following secondary mathematics electives have been included in the *2007 Mathematics Framework Revised*:

- *Advanced Algebra, Pre-Calculus, Trigonometry, Discrete Mathematics, and Statistics*, which are designed for students who have successfully completed Algebra II; and
- *Calculus*, which provides a survey of Calculus without the theory and rigor necessary to receive advanced placement credit. This course is designed for the student who has a thorough knowledge of college preparatory mathematics.

The following secondary electives have been included in the *2007 Mathematics Framework Revised*:

- Survey of Mathematical Topics and Introduction to Engineering, which <u>may not</u> be included in the four mathematics courses required for graduation, however, these courses may be included in the 4 ½ general electives required for graduation.

TECHNOLOGY

The Mississippi Department of Education strongly encourages the use of technology in **all** mathematics classrooms. The learning and teaching of mathematics can be greatly enhanced when quality instructional technology is appropriately used.

The appropriate use of instructional technology is integrated throughout the *2007 Mathematics Framework Revised*. Suggested teaching strategies at each grade level and in every secondary course incorporate technology in the form of calculators, software, or on-line internet resources. The graphing calculator is an integral part of mathematics courses beginning with Seventh Grade.

The MDE believes strongly in NCTM's *Principles and Standards for School Mathematics* Technology Principle):

> "Electronic technologies - calculators and computers - are essential tools for teaching, learning, and doing mathematics. They furnish visual images of mathematical ideas, they facilitate organizing and analyzing data, and they compute efficiently and accurately. They can support investigation by students in every area of mathematics, including geometry, statistics, algebra, measurement, and number. When technological tools are available, students can focus on decision making, reflection, reasoning, and problem solving."
>
> "Students can learn more mathematics more deeply with the appropriate use of technology. Technology should not be used as a replacement for basic understandings and intuitions; rather, it can and should be used to foster those understandings and intuitions. In mathematics-instruction programs, technology should be used widely and responsibly, with the goal of enriching students' learning of mathematics." (NCTM, 2000, page 24-25)

KINDERGARTEN

Kindergarten is the foundation for the development of mathematical concepts. Students explore different representations of numbers 0 to 20, expressing them in symbolic form with manipulatives like base-ten blocks or in diagrams. The representations help to show how numbers can be decomposed or broken apart into groups. Two- and three-dimensional shapes, patterns, generalizations, units of measurement, and data analysis are also stressed. The instructional emphases are on mathematical language development with writing and talking mathematics, multiple representations, and critical thinking. Mathematics instruction at this level should include manipulatives, cooperative and collaborative learning experiences, and problem solving.

The framework is comprised of five content strands: **number and operations, algebra, geometry, measurement,** and **data analysis & probability.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The five interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

The competencies, printed in bold face type, are the required learning standards for all students. The Mississippi Curriculum Test, Second Edition (MCT2) and Mississippi Subject Area Tests are aligned to the competencies. Competencies do not have to be taught in the order presented in the framework. The competencies are presented in outline form for consistency and for easy reference throughout the framework. Competencies are intentionally broad in order to allow school districts and teachers the flexibility to create a curriculum that meets the needs of their students. They may relate to one, many, or all of the mathematics framework strands and may be combined and taught with other competencies throughout the school year. Competencies provide a general guideline of on-going instruction, not isolated units, activities, or skills. The competencies are not intended to be a list of content skills that are taught and recorded as "mastered."

The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

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KINDERGARTEN

CONTENT STRANDS:

Number and Operations	Algebra
Geometry	Measurement
Data Analysis & Probability	

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Identify and represent relationships among sets of whole numbers up to 20 using manipulatives.

a. Count forward to 20 and backward from 10. (DOK 1)
b. Create models of sets of objects 0 to 20. (DOK 1)
c. Recognize and write numbers to represent quantities 0 to 20. (DOK 1)
d. Compose and decompose two-digit numbers (up to 20) with representations in words and physical models. (DOK 2)
e. Determine "first" through "tenth" (ordinal numbers), "next," and "last" positions. (DOK 1)
f. Develop multiple representations for addition (combining of sets) and subtraction (take-away, missing addend, comparison). (DOK 2)
g. Apply mathematical language by telling when a certain number is "too many," "not enough," "just right," "more than," "less than," or "equal to" for a given situation. (DOK 1)

ALGEBRA

2. Identify, describe, and reproduce patterns using concrete objects.

a. Describe a rule for sorting objects. (DOK 2)
b. Identify, reproduce, and extend repeating patterns in visual, auditory, and physical contexts. (DOK 2)
c. Identify and describe qualitative changes (such as temperature changes – it feels hotter). (DOK 1)
d. Identify and describe quantitative changes (such as temperature increases five degrees). (DOK 1)

GEOMETRY

3. Identify and classify two-dimensional shapes.

a. Recognize and describe open and closed figures. (DOK 1)
b. Identify two-dimensional figures such as the square, rectangle, triangle, and circle. (DOK 1)
c. Demonstrate an understanding of positional words (e.g., in, above, below, over, under, beside, etc.). (DOK 1)

MEASUREMENT

4. Identify measurable attributes of objects.

a. Measure the length, weight, and capacity of objects using nonstandard units. (DOK 2)
b. Determine and describe comparisons of length (longer, shorter, the same), mass (heavier, lighter, the same), and capacity (holds more, less, or about the same) using different-shaped or congruent containers, objects or figures. (DOK 2)
c. Recognize the clock (analog and digital) and calendar as measurements of time. (DOK 1)
d. Determine attributes of objects that can be compared, such as length, area, mass or volume/capacity. (DOK 1)

DATA ANALYSIS & PROBABILITY

5. Collect, organize, and interpret data.

a. Collect and organize data by counting and using tally marks and other symbols. (DOK 1)
b. Describe data by using mathematical language such as more than, less than, etc. (DOK 1)

FIRST GRADE

The First Grade mathematics framework extends concepts from Kindergarten. Students explore number relationships through place value concepts (units, tens, and hundreds) as they develop addition and subtraction models. These models are related to the actions of the computations (joining for addition and take-away, comparison, and missing addend for subtraction). Students describe patterns in number, computational, and geometric contexts. Data analysis continues the generalizations of patterns in pictographs and bar graphs as interpretations are made. The instructional emphases are on mathematical language development with writing and talking mathematics, multiple representations, and critical thinking. Mathematics instruction at this level should include manipulatives, cooperative and collaborative learning experiences, and problem solving.

The framework is comprised of five content strands: **number and operations, algebra, geometry, measurement,** and **data analysis & probability.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The five interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

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FIRST GRADE

CONTENT STRANDS:

Number and Operations	Algebra
Geometry	Measurement
Data Analysis & Probability	

Competencies and Objectives:

NUMBER AND OPERATIONS

1. **Understand and represent relationships among numbers and compute operations (addition and subtraction) with and without manipulatives.**

   a. Recognize and write numbers 0 to 100. (DOK 1)
   b. Compose and decompose two-digit numbers with representations in words and physical models. (DOK 2)
   c. Explain how to compare and order two-digit numbers using the terms "more," "less," "greater than," "less than," "equal to," and "almost," and the symbols >, <, and =. (DOK 1)
   d. Use multiple representations for addition (combining of sets) and subtraction (take–away, missing addend, comparison) to solve problems. (DOK 1)
   e. Find the sums of 3 single-digit addends (for example: 3 + 6 + 2 =11). (DOK 1)
   f. Justify addition and subtraction of two-digit whole numbers without regrouping. (DOK 2)
   g. Find equal money amounts with different coin combinations up to $0.25. (DOK 1)
   h. Identify the value of coins (penny, nickel, dime, quarter). (DOK 1)
   i. Determine the value of like coins up to $1.00. (DOK 1)
   j. Find the value of mixed coins up to $1.00. (DOK 1)

ALGEBRA

2. **Recognize, extend, and create patterns.**

   a. Use a pattern rule to translate and recognize patterns from one pattern representation to another. (DOK 2)
   b. Formulate, explain, and generalize patterns within and across addition and subtraction. (DOK 2)
   c. Model situations and solve equations that require addition and subtraction of whole numbers; use objects, pictures, and symbols. (DOK 2)
   d. Count by different units when given a group of objects using 1's, 2's, 5's, and 10's. (DOK 1)

GEOMETRY

3. Identify and classify properties of two- and three-dimensional shapes.

a. Identify and classify two-dimensional figures (triangle, square, rectangle, circle, trapezoid, hexagon, and rhombus). (DOK 1)
b. Identify and classify three-dimensional figures (cube, rectangular prism, and sphere) according to their characteristics. (DOK 1)
c. Explain the part-whole relationships resulting from the composition or decomposition of plane and solid figures. (DOK 2)

MEASUREMENT

4. Identify and apply measurable attributes.

a. Use nonstandard units (paper clips, unifix cubes, etc.) and standard units (inches, centimeters) to measure length. (DOK 1)
b. Compare weight of objects using a balance scale with and without nonstandard units. (DOK 1)
c. Compare and estimate capacity of various containers in nonstandard units. (DOK 2)
d. Tell time to the hour and half-hour intervals using both digital and analog clocks. (DOK 1)

DATA ANALYSIS & PROBABILITY

5. Collect, organize, and interpret data in graphical form.

a. Gather data, construct, and interpret simple bar graphs and pictographs. (DOK 2)
b. Analyze and interpret data by using mathematical language such as more than, less than, etc. (DOK 1)

SECOND GRADE

Building on First Grade and Kindergarten, the Second Grade mathematics framework supports the development of fluency with addition and subtraction facts. Composition and decomposition of numerical quantities helps students understand multiple addition and subtraction algorithms with three-digit numbers. Generalizations involving growing and repeating patterns and numerical contexts are emphasized. Other concepts include the development of data analysis, prediction, measurement, and geometric topics. The instructional emphases are on mathematical language development with writing and talking mathematics, multiple representations, and critical thinking. Mathematics instruction at this level should include manipulatives, cooperative and collaborative learning experiences, and problem solving.

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SECOND GRADE

CONTENT STRANDS:

Number and Operations
Geometry
Data Analysis and Probability
Algebra
Measurement

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Understand and represent relationships among numbers and operations (addition, subtraction, and multiplication). Compute fluently using effective strategies or rote memory.

a. Recall addition and subtraction facts. (DOK 1)
b. Justify addition and subtraction of two- and three-digit whole numbers with and without regrouping. (DOK 2)
c. Compose and decompose three-digit numbers with representations in words and physical models. (DOK 2)
d. Round up to three-digit whole numbers to the nearest hundreds. (DOK 1)
e. Compare and order three-digit numbers using the symbols <, >, and =, and justify reasoning. (DOK 1)
f. Determine and compare the value of money up to $5.00 using the appropriate symbols for dollars and cents. (DOK 1)

ALGEBRA

2. Analyze patterns, numbers, relationships, and functions.

a. Explain, analyze, and extend repeating and growing patterns. (DOK 2)
b. Use number patterns to skip count by 2's, 3's, 5's, and 10's. (DOK 1)
c. Model situations and solve equations that involve the addition and subtraction of whole numbers. (DOK 2)
d. Analyze and generalize the inverse relationships between addition and subtraction. (DOK 2)

GEOMETRY

3. Describe, classify, and sort geometric figures according to their properties.

a. Recognize and identify polygons (rhombus, square, triangle, trapezoid, rectangle, pentagon, hexagon, octagon, and decagon) according to the number of sides. (DOK 1)

b. Describe the effects of composition and decomposition of polygons when smaller shapes are substituted for a larger shape or a larger shape is substituted for smaller ones. (DOK 2)
c. Identify and classify three-dimensional figures (cone, pyramid, and cylinder) according to their characteristics. (DOK 1)

MEASUREMENT

4. Estimate, identify, and apply measurable attributes.

a. Select appropriate tools and units, estimate, and measure length (to the nearest inch, foot, yard, centimeter, and meter), capacity (to the nearest ounce, cup, pint, quart, gallon, and liter), and weight (to the nearest ounce, pound, gram, and kilogram). (DOK 2)
b. Read and write time to the hour, half-hour, quarter-hour, and five-minute intervals using digital and analog clocks. (DOK 1)

DATA ANALYSIS & PROBABILITY

5. Organize and interpret data in graphical form.

a. Tally, record, interpret, and predict outcomes based on given information. (DOK 3)
b. Create line graphs, bar graphs, and pictographs using real data. (DOK 2)

THIRD GRADE

The Third Grade competencies and objectives continue to develop number concepts with four-digit whole numbers and with fractions. These concepts include the properties of the four operations and multiple representations of the numerical quantities. Multiplication and division are formally introduced with their appropriate models. Students begin to use multiple approaches to find unknown quantities in word problems and equations that may include variables. Perimeter concepts are developed, leading to generalizations about the topic. Students apply the techniques of composition and decomposition to geometric contexts in addition to numerical ones. Data analysis now adds line plots as students interpret and use data. The instructional emphases are on mathematical language development with writing and talking mathematics, multiple representations, and critical thinking. Mathematics instruction at this level should include manipulatives, cooperative and collaborative learning experiences, and problem solving.

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THIRD GRADE

CONTENT STRANDS:

Number and Operations — Algebra
Geometry — Measurement
Data Analysis & Probability

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Understand and represent number relationships among numbers and the four basic operations. Compute fluently and make reasonable estimates.

a. Compose and decompose four-digit whole numbers with representations in words, physical models, and expanded and standard forms. (DOK 1)
b. Compare and order four-digit numbers using <, >, and =, and justify reasoning. (DOK 2)
c. Estimate sums and differences of whole numbers to include strategies such as rounding. (DOK 2)
d. Identify and model representations of fractions (halves, thirds, fourths, fifths, sixths, and eighths). (DOK 1)
e. Add (up to three addends) and subtract four-digit whole numbers with and without regrouping. (DOK 1)
f. Model multiplication using arrays, equal-sized groups, area models, and equal-sized moves on the number line. (DOK 2)
g. Model division with successive or repeated subtraction, partitioning, and sharing. (DOK 2)

ALGEBRA

2. Explain, analyze, and generate patterns, relationships, and functions using algebraic symbols.

a. Create, describe, and extend growing and repeating patterns with physical materials and symbols including numbers. (DOK 2)
b. Determine the value of missing quantities or variables within equations or number sentences, and justify the process used. (DOK 2)
c. Use real number properties to develop multiple algorithms and to solve problems. (DOK 2)
   - Associative property of addition
   - Commutative property of addition
   - Identity property of addition

d. Model and identify the inverse relationships of addition/subtraction. (DOK 2)
e. Create models for the concept of equality, recognizing that the equal sign (=) denotes equivalent terms such that 4 + 3 = 7, 4 + 3 = 6 + 1 or 7 = 5 + 2. (DOK 1)

GEOMETRY

3. Describe, compare, and contrast two- and three-dimensional shapes and relationships.

a. Describe, compare, analyze, and classify two-dimensional shapes by sides and angles. (DOK 1)
b. Explain and describe the process of decomposing, composing, and transforming polygons. (DOK 2)
c. Create three-dimensional shapes (prisms and pyramids) from two-dimensional nets, and create two-dimensional nets from prisms and pyramids. (DOK 2)

MEASUREMENT

4. Measure and explain the measurable attributes of objects, units, systems, and processes.

a. Develop and use methods to find perimeter of polygons and to solve problems involving perimeter. (DOK 2)
b. Estimate and measure length using fractional parts to the nearest ½ inch in the English system. (DOK 2)
c. Measure capacity, weight/mass, and length in both English and metric systems of measurement. (DOK 1)

DATA ANALYSIS AND PROBABILITY

5. Interpret and analyze data. Explore basic concepts of probability.

a. Compare data and interpret quantities represented on tables and different types of graphs (line plots, pictographs, and bar graphs), make predictions, and solve problems based on the information. (DOK 3)
b. Analyze, predict, and model the number of different combinations of two or more objects and relate to multiplication. (DOK 2)

FOURTH GRADE

While recall of multiplication and division facts is included in the Fourth Grade framework, students continue a conceptual development of rational and whole numbers. Benchmark numbers are emphasized with regard to decimals and fractions. Whole number computation begins a more concentrated focus on developing algorithms for multi-digit numbers. Because fourth-grade students can use more complex communication skills, they begin to justify solution processes for solving for unknowns in word problems and equations with variables. Transformational geometry is introduced at this grade level. Data analysis includes stem-and-leaf plot graphs and coordinate geometry explorations begin. The instructional emphases are on mathematical language development with writing and talking mathematics, multiple representations, and routine and non-routine problem solving. Mathematics instruction at this level should include manipulatives, cooperative and collaborative learning experiences, and justifications, proofs or arguments to support reasoning.

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FOURTH GRADE

CONTENT STRANDS:

Number and Operations	Algebra
Geometry	Measurement
Data Analysis & Probability	

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Understand relationships among numbers, use the four basic operations, compute fluently, and make reasonable estimates.

a. Add and subtract up to five-digit whole numbers with and without regrouping. (DOK 1)
b. Add and subtract decimals through hundredths. (DOK 1)
c. Explain two or more methods of multiplying whole numbers (one- and two-digits) with justification. (DOK 2)
d. Explain two or more methods of dividing four-digit dividends by one- and two-digit divisors, with and without remainders, and justify the processes. (DOK 2)
e. Add and subtract fractions with like denominators. (DOK 1)
f. Model and identify equivalent fractions. (DOK 2)
g. Represent equivalence relationships between fractions and decimals using concrete materials, diagrams, or other models. (DOK 1)
h. Estimate products and quotients of whole numbers to include strategies such as rounding. (DOK 2)
i. Recall multiplication and division facts. (DOK 1)
j. Compose and decompose five-digit numbers and decimal numbers through hundredths, with representations in words, physical models, and expanded and standard forms. (DOK 1)
k. Determine and use benchmark numbers such as 0, 0.5 (½), and 1 to judge the magnitude of whole numbers, decimals, and fractions. (DOK 2)
l. Model factors and multiples of whole numbers. (DOK 1)

ALGEBRA

2. Analyze and represent patterns, number relationships, and functions using algebraic symbols. Demonstrate an understanding of the properties of the basic operations.

a. Analyze a given numeric pattern and generate a similar pattern. (DOK 2)
b. Determine the value of variables in equations; justify the process used to make the determination. (DOK 2)
c. Construct input/output function tables and generalize the rule using words, models, and symbols. (DOK 3)

d. Explain the properties of the basic operations using models, numbers, and variables: (DOK 2)
   - Zero property of multiplication
   - Associative properties of addition and multiplication
   - Commutative properties of addition and multiplication
   - Identity properties of addition and multiplication
   - Distributive properties of multiplication over addition and subtraction

e. Demonstrate and explain the inverse operations of addition/subtraction and multiplication/division. (DOK 2)

GEOMETRY

3. Analyze characteristics, properties, and relationships of two- and three-dimensional geometric shapes. Use coordinate geometry.

a. Analyze and describe the similarities and differences between and among two- and three-dimensional geometric shapes, figures, and models using mathematical language. (DOK 2)
b. Identify and analyze the relationships between and among points, lines, line segments, angles, and rays. (DOK 2)
c. Identify transformations (rotations [turns], reflections [flips], and translations [slides]) of two-dimensional figures. (DOK 1)
d. Locate ordered pairs in the first quadrant of the coordinate plane. (DOK 1)

MEASUREMENT

4. Evaluate and justify measurable attributes of objects, units, systems, and processes. Perform measurements.

a. Estimate and measure a given object to the nearest eighth of an inch. (DOK 2)
b. Convert capacity, weight/mass, and length within the English and metric systems of measurement. (DOK 1)
c. Describe relationships of rectangular area to numerical multiplication. (DOK 2)
d. Use appropriate tools to determine, estimate, and compare units for measurement of weight/mass, area, size of angle, temperature, length, distance, and volume in English and metric systems and time in real-life situations. (DOK 1)

DATA ANALYSIS & PROBABILITY

5. Formulate and analyze data. Evaluate inferences and predictions.

a. Draw, label, and interpret bar graphs, line graphs, and stem-and-leaf plots. (DOK 2)
b. Find and interpret the mean, mode, median, and range of a set of data. (DOK 1)
c. Compare data and interpret quantities represented on tables and graphs including line graphs, bar graphs, frequency tables, and stem-and-leaf plots to make predictions and solve problems based on the information. (DOK 3)

FIFTH GRADE

In the Fifth Grade competencies and objectives, rational and whole number computations are now at a skill level. Students apply the properties of real numbers and computations in algebraic contexts. Generalizations and patterns are more formal. Transformational geometry is used as a tool for students to continue their geometric explorations. Students develop formulas for perimeter and area of polygons as part of these explorations. Data analysis now includes interpretations of line graphs, stem-and-leaf plots, histograms, and box-and-whisker plots. Continued emphases should be placed on communicating mathematically through writing, speaking, reading, and critical listening. Mathematics instruction at this level should include manipulatives, cooperative and collaborative learning experiences, and justifications, proofs or arguments to support reasoning.

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FIFTH GRADE

CONTENT STRANDS:

Number and Operations
Geometry
Data Analysis & Probability
Algebra
Measurement

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Analyze relationships among numbers and the four basic operations, compute fluently, and make reasonable estimates.

a. Compare and order integers, decimals to the nearest thousandths, like and unlike fractions, and mixed numbers using >, <, and =. (DOK 1)
b. Compose and decompose seven-digit numbers and decimals through thousandths in word, standard, and expanded forms. (DOK 1)
c. Identify factors and multiples of whole numbers. (DOK 1)
d. Model and distinguish between prime and composite numbers. (DOK 1)
e. Model and identify equivalent fractions including conversion of improper fractions to mixed numbers and vice versa. (DOK 1)
f. Add, subtract, multiply, and divide (with and without remainders) using non-negative rational numbers. (DOK 1)
g. Estimate sums, differences, products, and quotients of non-negative rational numbers to include strategies such as front-end rounding, benchmark numbers, compatible numbers, and rounding. (DOK 2)

ALGEBRA

2. Explain and analyze number relationships and functions using algebraic symbols, and demonstrate an understanding of the properties of the basic operations.

a. Determine the value of variables in equations and inequalities, justifying the process.
(DOK 2)
b. Devise a rule for an input/output function table, describing it in words and symbols. (DOK 2)
c. Apply the properties of basic operations to solve problems: (DOK 2)
   - Zero property of multiplication
   - Commutative properties of addition and multiplication
   - Associative properties of addition and multiplication
   - Distributive properties of multiplication over addition and subtraction
   - Identity properties of addition and multiplication

d. Apply inverse operations of addition/subtraction and multiplication/division to problem-solving situations. (DOK 2)

GEOMETRY

3. Develop mathematical arguments about geometric relationships and describe spatial relationships using coordinate geometry.

a. Analyze and describe the characteristics of symmetry relative to classes of polygons (parallelograms, triangles, etc.). (DOK 2)
b. Explain the relationships between coordinates in each quadrant of the coordinate plane. (DOK 2)
c. Describe the characteristics, including the relationship of the pre-image and the image, of each type of transformation (rotations [turns], reflections [flips], and translations [slides]) of two-dimensional figures. (DOK 2)
d. Construct and analyze two- and three-dimensional shapes to solve problems involving congruence and symmetry. (DOK 3)
e. Label ordered pairs in the coordinate plane. (DOK 1)

MEASUREMENT

4. Develop concepts and apply appropriate tools and techniques to determine units of measure.

a. Estimate and measure length to nearest millimeter in the metric system and one-sixteenth inch in the English system. (DOK 2)
b. Convert units within a given measurement system to include length, weight/mass, and volume. (DOK 1)
c. Develop, compare, and use formulas to estimate and calculate the perimeter and area of rectangles, triangles, and parallelograms. (DOK 2)
d. Select and apply appropriate units for measuring length, mass, volume, and temperature in the standard (English and metric) systems. (DOK 1)

DATA ANALYSIS & PROBABILITY

5. Interpret and analyze data and make predictions.

a. Use the mean, median, mode, and range to analyze a data set. (DOK 2)
b. Compare data and interpret quantities represented on tables and graphs, including line graphs, stem-and-leaf plots, histograms, and box-and-whisker plots to make predictions, and solve problems based on the information. (DOK 2)

SIXTH GRADE

In the Sixth Grade mathematics framework, rational number computations are more fully developed. Solving algebraic equations in multiple ways (such as guess-and-check, tables, inspection, and algebraic manipulations) is part of the course of study as students move toward the middle grades where there is a stronger focus on algebraic topics. Using function tables and graphing supports the algebraic development. Rigid (translations, reflections and rotations) and non-rigid (dilations) motions are used in problem-solving situations and in making generalizations. Application problems using area and perimeter of regular and irregular shapes are part of the measurement strand, while volume is introduced. Data analysis includes box-and-whisker plots along with other graphical representations. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. Physical materials should continue to be part of the development of mathematical understanding.

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SIXTH GRADE

CONTENT STRANDS:

Number and Operations	Algebra
Geometry	Measurement
Data Analysis & Probability	

Competencies and Objectives:

NUMBER AND OPERATIONS

1. **Analyze numbers using place value and prime factorization. Solve problems involving basic operations of rational numbers.**

   a. Compare and order rational numbers using symbols (<, >, and =) and a number line. (DOK 1)
   b. Use estimation strategies to determine the reasonableness of results in a variety of situations including rational number computations. (DOK 2)
   c. Determine the Greatest Common Factor (GCF) and Least Common Multiple (LCM) of two numbers. (DOK 2)
   d. Compute using basic operations with fractions and mixed numbers. Express answers in the simplest form. (DOK 1)
   e. Solve problems by dividing whole and decimal numbers by decimals and interpret the quotient and remainder within the problem context. (DOK 2)
   f. Explain the relationship(s) among fractions, decimals, and percents and model and represent a specific quantity in multiple ways. (DOK 2)
   g. Model addition and subtraction of integers with physical materials and the number line. (DOK 2)
   h. Solve problems by finding the percentage of a number including percentages greater than 100 and less than 1. (DOK 2)
   i. Multiply four-digit numbers by two-digit numbers (including whole numbers and decimals). (DOK 1)
   j. Explain the meaning of multiplication and division of rational numbers. (DOK 2)
   k. Explain the meaning and relationship between absolute value and opposites. (DOK 2)

ALGEBRA

2. **Use algebraic functions, patterns, and language across a variety of contexts.**

   a. Solve simple equations using guess-and-check, diagrams, properties, or inspection, explaining the process used. (DOK 2)
   b. Complete a function table based on a given rule. (DOK 2)
   c. Formulate algebraic expressions, equations, and inequalities to reflect a given situation. (DOK 2)

d. State the following properties using variables and apply them in solving problems: (DOK 1)
   - Zero property of multiplication
   - Inverse properties of addition/subtraction and multiplication/division
   - Commutative and associative properties of addition and multiplication
   - Identity properties of addition and multiplication
   - Distributive properties of multiplication over addition and subtraction

e. Describe a rule for a function table using words, symbols, and points on a graph and vice versa. (DOK 2)

GEOMETRY

3. Analyze geometric relationships of lines, angles, two- and three-dimensional shapes, and transformations.

a. Compare, classify, and construct transformations (reflections, translations, and rotations). (DOK 3)
b. Construct three-dimensional figures using manipulatives and generalize the relationships among vertices, faces, and edges (such as Eular's Formula). (DOK 3)
c. Draw, label, and classify polygons to include regular and irregular shapes. Identify congruent and symmetrical figures. (DOK 1)
d. Identify, estimate, and compare right, acute, and obtuse angles. (DOK 1)
e. Explain the relationships between corresponding parts of the pre-image and image of a dilation. (DOK 2)

MEASUREMENT

4. Apply geometric formulas and standard (English and metric) units of measurement in mathematical and real-life situations.

a. Convert units within a given measurement system to solve problems. (DOK 1)
b. Calculate the perimeter and area of regular and irregular shapes using a variety of methods. (DOK 2)
c. Determine the radius, diameter, and circumference of a circle. (DOK 1)
d. Use scale factors to perform dilations and to solve ratio and proportion problems. (DOK 2)
e. Predict and calculate the volume of prisms. (DOK 2)
f. Apply techniques and tools to accurately find length, area, and angle measures to appropriate levels of precision. (DOK 1)
g. Explain the relationship of circumference of a circle to its diameter, linking to *pi*. (DOK 1)

DATA ANALYSIS & PROBABILITY

5. Organize, interpret, analyze, and display data to predict trends.

a. Construct, interpret, and explain line graphs, double bar graphs, frequency plots, stem-and-leaf plots, histograms, and box-and-whisker plots. (DOK 2)
b. Determine how changes in data affect mean, median, mode, and range. (DOK 2)
c. Predict trends based on graphical representation. (DOK 3)

SEVENTH GRADE

The Seventh Grade mathematics framework supports the more sophisticated computations that students can do with rational numbers and introduces exponents. Algebraic topics and the formation of generalizations are major foci as this course is preparing students for Pre-Algebra. Given the work with rational numbers, students explore probability ideas. Transformations are now carried out on the coordinate plane. Technology should be a component of the instruction. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. Physical materials should continue to be part of the development of mathematical understanding.

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SEVENTH GRADE

CONTENT STRANDS:

Number and Operations
Geometry
Data Analysis & Probability
Algebra
Measurement

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Apply concepts of rational numbers and perform basic operations emphasizing the concepts of ratio, proportion, and percent with and without the use of calculators.

a. Use the order of operations to simplify and/or evaluate whole numbers (including exponents and grouping symbols). (DOK 1)
b. Solve problems involving addition, subtraction, multiplication, and division of rational numbers. Express answers in simplest form. (DOK 2)
c. Convert among decimals, fractions, mixed numbers, and percents. (DOK 1)
d. Evaluate and estimate powers and square roots of real numbers. (DOK 2)
e. Explain the relationship between standard form and scientific notation. (DOK 1)
f. Multiply and divide numbers written in scientific notation. (DOK 1)
g. Solve real-life problems involving unit price, unit rate, sales price, sales tax, discount, simple interest, commission, and rates of commission. (DOK 1)
h. Solve contextual problems requiring the comparison, ordering, and application of integers. (DOK 2)
i. Develop a logical argument to demonstrate the 'denseness' of rational numbers. (DOK 3)

ALGEBRA

2. Develop and apply the basic operations of rational numbers to algebraic and numerical tasks. Create and apply algebraic expressions and equations.

a. Recognize, describe, and state the rule of generalized numerical and geometric patterns using tables, graphs, words, and symbols. (DOK 2)
b. Solve equations that represent algebraic and real-world problems using multiple methods including the real number properties. (DOK 1)
c. Formulate algebraic expressions, equations, and inequalities to reflect a given situation and vice versa. (DOK 2)
d. Complete a function table based on a given rule and vice versa. (DOK 1)

e. Identify the following properties using variables and apply them in solving problems: (DOK 1)
   - Zero property of multiplication
   - Inverse properties of addition/subtraction and multiplication/division
   - Commutative and associative properties of addition and multiplication
   - Identity properties of addition and multiplication
   - Distributive properties of multiplication over addition and subtraction.

f. Predict the shape of a graph from a function table. (DOK 2)

GEOMETRY

3. Apply geometric relationships of angles, two- and three-dimensional shapes, and transformations.

a. Classify and compare three-dimensional shapes using their properties. (DOK 1)
b. Construct two-dimensional representations of three-dimensional objects. (DOK 2)
c. Justify the congruency or symmetry of two figures. (DOK 2)
d. Perform transformations (rigid and non-rigid motions) on two-dimensional figures using the coordinate plane. (DOK 2)
e. Create an argument using the Pythagorean Theorem principles to show that a triangle is a right triangle. (DOK 2)
f. Construct and classify angles. (DOK 2)

MEASUREMENT

4. Apply appropriate techniques, tools, and formulas to determine measurements with a focus on real-world problems. Recognize that formulas in mathematics are generalized statements about rules, equations, principles, or other logical mathematical relationships.

a. Convert from one unit to another, perform basic operations, and solve real-world problems using standard (English and metric) measurements within the same system. (DOK 2)
b. Use formulas and strategies, such as decomposition, to compute the perimeter and area of triangles, parallelograms, trapezoids, the circumference and area of circles, and find the area of more complex shapes. (DOK 2)
c. Develop and justify geometric formulas for volume and surface area of cylinders, pyramids, and prisms. (DOK 3)
d. Solve problems involving scale factors using ratios and proportions. (DOK 2)

DATA ANALYSIS & PROBABILITY

5. Organize and interpret data. Analyze data to make predictions.

a. Use proportions, estimates, and percentages to construct, interpret, and make predictions about a population based on histograms or circle graph representations of data from a sample. (DOK 2)
b. Determine how outliers affect mean, median, mode, or range. (DOK 2)
c. Construct and interpret line graphs, frequency tables, circle graphs, box-and-whisker plots, and scatter plots to generalize trends from given data. (DOK 2)
d. Determine probabilities through experimentation, simulation, or calculation. (Note: Make and test conjectures and predictions by calculating the probability of an event.) (DOK 2)

PRE-ALGEBRA

The Pre-Algebra mathematics framework serves as a bridge between lower-grades' mathematics and Algebra. This course will build a foundation of algebraic concepts through the use of manipulatives and collaborative/cooperative learning. Concepts include real numbers, algebraic expressions, linear equations, polynomials, inequalities, geometry, ratios, proportions, percents, number theory, measurement, data analysis, statistics, and graphing. A variety of problem-solving techniques and technology will be used when applying these concepts, which will enable students to solve real-life application, routine word, and non-routine problems. Technology should be a component of the instruction. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. This course should provide a foundation for the development of justifications to support solutions and solution methods. Physical materials should continue to be part of the development of mathematical understanding. This course is designed to prepare students for Transition to Algebra or Algebra I.

The framework is comprised of five content strands: **number and operations, algebra, geometry, measurement,** and **data analysis & probability.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The five interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

The competencies, printed in bold face type, are the required learning standards for all students. The Mississippi Curriculum Test, Second Edition (MCT2) and Mississippi Subject Area Tests are aligned to the competencies. Competencies do not have to be taught in the order presented in the framework. The competencies are presented in outline form for consistency and for easy reference throughout the framework. Competencies are intentionally broad in order to allow school districts and teachers the flexibility to create a curriculum that meets the needs of their students. They may relate to one, many, or all of the mathematics framework strands and may be combined and taught with other competencies throughout the school year. Competencies provide a general guideline of on-going instruction, not isolated units, activities, or skills. The competencies are not intended to be a list of content skills that are taught and recorded as "mastered."

The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

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PRE-ALGEBRA

CONTENT STRANDS:

Number and Operations	Algebra
Geometry	Measurement
Data Analysis & Probability	

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Apply concepts and perform basic operations using real numbers in real-world contexts.

a. Define, classify, and order rational and irrational numbers and their subsets. (DOK 1)
b. Formulate and solve standard and real-life problems involving addition, subtraction, multiplication, and division of rational numbers. (DOK 2)
c. Apply the concepts of Greatest Common Factor (GCF) and Least Common Multiple (LCM) to monomials with variables. (DOK 2)
d. Simplify and evaluate expressions using order of operations and use real number properties to justify solutions. (DOK 2)
e. Explain the rules of exponents related to multiplication and division of terms with exponents. (DOK 2)
f. Recognize and appropriately use exponential and scientific notation. (DOK 1)
g. Explain and use the inverse relationship between square roots and squares. (DOK 2)

ALGEBRA

2. Apply properties to simplify algebraic expressions, solve linear equations and inequalities, and apply principles of graphing.

a. Simplify and evaluate numerical and algebraic expressions. (DOK 1)
b. Apply properties of real numbers with an emphasis on the distributive properties of multiplication over addition and subtraction. (DOK 1)
c. Solve and check equations and inequalities using one variable. (DOK 2)
d. Model inequalities (and their solutions) on a number line. (DOK 1)
e. Graph linear equations and non-linear equations ($y = x^2$) using multiple methods including t-tables and slope-intercept. (DOK 2)
f. Given a linear graph, identify its slope as positive, negative, undefined, or zero, and interpret slope as rate of change. (DOK 2)
g. Determine slope, x-intercept, and y-intercept from a graph and/or equation in slope-intercept or standard form. (DOK 1)
h. Add, subtract, and multiply monomials and binomials. (DOK 1)
i. Predict characteristics of a graph given an equation or t-table. (DOK 2)

GEOMETRY

3. Identify and apply geometric principles to polygons, angles, and two- and three-dimensional figures.

a. Locate and identify angles formed by parallel lines cut by a transversal(s) (e.g., adjacent, vertical, complementary, supplementary, corresponding, alternate interior, and alternate exterior). (DOK 1)
b. Find missing angle measurements for parallel lines cut by a transversal(s) and for a vertex of a polygon. (DOK 1)
c. Explain the Pythagorean Theorem and apply it to solve routine and non-routine problems. (DOK 3)
d. Solve real-world and non-routine problems involving congruent and similar figures. (DOK 3)
e. Use two-dimensional representations (nets) of three-dimensional objects to describe objects from various perspectives. (DOK 2)

MEASUREMENT

4. Understand measurable attributes of objects and apply various formulas in problem solving situations.

a. Solve real-world application problems that include length, area, perimeter, and circumference using standard measurements. (DOK 2)
b. Develop, analyze, and explain methods for solving problems involving proportions, such as scaling and finding equivalent ratios. (DOK 3)
c. Use formulas and/or appropriate measuring tools to find length and angle measures (to appropriate levels of precision), perimeter, area, volume, and surface area of polygons, circles, spheres, cones, pyramids, and composite or irregular figures. (DOK 1)

DATA ANALYSIS & PROBABILITY

5. Interpret, organize, and make predictions about a variety of data using concepts of probability.

a. Use a given mean, mode, median, and range to summarize and compare data sets including investigation of the different effects that change in data values have on these measures. (DOK 2)
b. Select the appropriate measures of central tendency for a particular purpose. (DOK 2)
c. Make and list conjectures by calculating probability for experimental or simulated contexts. (DOK 3)
d. Construct and interpret scatter plots to generalize trends from given data sets. (DOK 3)

TRANSITION TO ALGEBRA

Transition to Algebra is designed to give students an additional opportunity to develop foundational skills required to be successful in Algebra I. Students should enter Transition to Algebra with fluency in computing with rational numbers and an understanding of solving and interpreting linear equations and graphs. In Transition to Algebra, students continue the development of their understanding by making generalizations about the characteristics of graphs and their associated equations, expanding the techniques used to solve equations, and applying properties in real-world applications, routine word, and non-routine problems. Technology should be a component of the instruction. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. Physical materials should continue to be part of the development of mathematical understanding.

The framework is comprised of five content strands: **number and operations, algebra, geometry, measurement,** and **data analysis & probability.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The five interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

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The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

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TRANSITION TO ALGEBRA

CONTENT STRANDS:

Number and Operations	Algebra
Geometry	Measurement
Data Analysis	

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Understand relationships between numbers and their properties and perform operations fluently.

a. Compare and contrast the subsets of real numbers. (DOK 1)
b. Simplify and evaluate expressions using order of operations and use real number properties to justify solutions. (DOK 2)
c. Express, interpret, and compute numbers using scientific notation in meaningful contexts. (DOK 1)
d. Apply the concept of Greatest Common Factor (GCF) and Least Common Multiple (LCM) to monomials with variables. (DOK 2)
e. Use the inverse relationship to develop the concept of roots and perfect squares. (DOK 2)

ALGEBRA

2. Understand, represent, and analyze patterns, relations, and functions.

a. Given a literal equation, solve for a specified variable of degree one. (DOK 1)
b. Explain and illustrate how changes in one variable may result in a change in another variable. (DOK 2)
c. Solve and check multi-step equations and inequalities, including distributive property, variables on both sides, and rational coefficients. (DOK 2)
d. Use real-world data to express slope as a rate of change. (DOK 2)
e. Graph solutions to linear inequalities. (DOK 2)
f. Write linear equations given slope and y-intercept or two points. (DOK 2)
g. Identify domain, range, slope, and intercepts of functions. (DOK 1)
h. Develop generalizations to characterize the behaviors of graphs (linear, quadratic, and absolute value). (DOK 2)
i. Classify and determine degree of a polynomial and arrange polynomials in ascending or descending order of a variable. (DOK 1)
j. Apply ratios and use proportional reasoning to solve real-world algebraic problems. (DOK 2)
k. Add, subtract, multiply, and divide polynomial expressions. (DOK 1)
l. Analyze the relationship between x and y values, and determine whether a relation is a function. (DOK 2)

GEOMETRY

3. Understand geometric principles of polygons, angles, figures.

a. Apply the Pythagorean Theorem to solve problems. (DOK 2)
b. Apply proportional reasoning to determine similar figures and find unknown measures. (DOK 2)

MEASUREMENT

4. Demonstrate and apply various formulas in problem-solving situations.

a. Solve real-world problems involving measurements (i.e., circumference, perimeter, area, volume, distance, temperature, etc.). (DOK 2)
b. Explain and apply the appropriate formula to determine length, midpoint, and slope of a segment in a coordinate plane (i.e., distance formula, Pythagorean Theorem). (DOK 2)

DATA ANALYSIS

5. Interpret data.

a. Construct graphs, make predictions, and draw conclusions from tables, line graphs, and scatter plots. (DOK 3)
b. Use a given mean, mode, median, and range to summarize and compare data sets including investigation of the different effects that change in data have on these measures of central tendency, and select the appropriate measures of central tendency for a given purpose. (DOK 2)
c. Calculate basic probability of experiments and simulations to make and test conjectures about results. (DOK 3)

ALGEBRA I

The Algebra I framework provides the minimum competencies required for students to be successful in higher-level math courses. Students should enter Algebra I with fluency in computing with all four operations using rational numbers and basic knowledge and understanding of how to use formulas to solve problems. Solving equations and graphing is extended to include linear and non-linear functions and relations and higher-degree equations. Concepts and computations with matrices are introduced. The analysis of graphs includes scatter plots. Written and oral justifications to support solution methods and solutions are required. Technology should be a component of the instruction. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. Physical materials should continue to be part of the development of mathematical understanding including area models for polynomial operations.

The framework is comprised of five content strands: **number and operations, algebra, geometry, measurement,** and **data analysis & probability.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The five interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

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The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time.

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ALGEBRA I

CONTENT STRANDS:

Number and Operations	Algebra
Geometry	Measurement
Data Analysis & Probability	

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Understand relationships between numbers and their properties and perform operations fluently.

a. Apply properties of real numbers to simplify algebraic expressions, including polynomials. (DOK 1)
b. Use matrices to solve mathematical situations and contextual problems. (DOK 2)

ALGEBRA

2. Understand, represent, and analyze patterns, relations, and functions.

a. Solve, check, and graph multi-step linear equations and inequalities in one variable, including rational coefficients in mathematical and real-world situations. (DOK 2)
b. Solve and graph absolute value equations and inequalities in one variable. (DOK 2)
c. Analyze the relationship between *x* and *y* values, determine whether a relation is a function, and identify domain and range. (DOK 2)
d. Explain and illustrate how a change in one variable may result in a change in another variable and apply to the relationships between independent and dependent variables. (DOK 2)
e. Graph and analyze linear functions. (DOK 2)
f. Use algebraic and graphical methods to solve systems of linear equations and inequalities in mathematical and real-world situations. (DOK 2)
g. Add, subtract, multiply, and divide polynomial expressions. (DOK 1)
h. Factor polynomials by using Greatest Common Factor (GCF) and factor quadratics that have only rational roots. (DOK 1)
i. Determine the solutions to quadratic equations by using graphing, tables, completing the square, the Quadratic formula, and factoring. (DOK 1)
j. Justify why some polynomials are prime over the rational number system. (DOK 2)
k. Graph and analyze absolute value and quadratic functions. (DOK 2)
l. Write, graph, and analyze inequalities in two variables. (DOK 2)

GEOMETRY

3. Understand how algebra and geometric representations interconnect and build on one another.

a. Apply the concept of slope to determine if lines in a plane are parallel or perpendicular. (DOK 2)
b. Solve problems that involve interpreting slope as a rate of change. (DOK 2)

MEASUREMENT

4. Demonstrate and apply various formulas in problem-solving situations.

a. Solve real-world problems involving formulas for perimeter, area, distance, and rate. (DOK 2)
b. Explain and apply the appropriate formula to determine length, midpoint, and slope of a segment in a coordinate plane. (i.e., distance formula, Pythagorean Theorem). (DOK 2)
c. Represent polynomial operations with area models. (DOK 2)

DATA ANALYSIS & PROBABILITY

5. Represent, analyze and make inferences based on data with and without the use of technology.

a. Draw conclusions and make predictions from scatter plots. (DOK 3)
b. Use linear regression to find the line-of-best fit from a given set of data. (DOK 3)

GEOMETRY

Students should enter Geometry with an understanding and the ability to solve and interpret linear equations and associated graphs, be familiar with quadratic equations, understand the Pythagorean Theorem, be able to identify two- and three-dimensional shapes, and be familiar with the basic geometric (measurement) formulas. Geometry provides a graphical and visual representation of the mathematical world around us. These representations should be included across all objectives. Students should be given an opportunity to develop spatial sense and an understanding of a variety means of providing reasoning, mathematical arguments, and proofs. The justifications used in geometry should include a variety of techniques including paragraph and algebraic proofs. Technology should be a component of the instruction. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. Physical materials should continue to be part of the development of mathematical understanding.

The framework is comprised of five content strands: **number and operations, algebra, geometry, measurement,** and **data analysis & probability.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The five interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

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GEOMETRY

CONTENT STRANDS:

Number and Operations	Algebra
Geometry	Measurement
Data Analysis & Probability	

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Compute and determine the reasonableness of a result in mathematical and real-world situations with and without technology.

a. Apply problem-solving skills to solve and verify the solutions for unknown measures in similar polygons. (DOK 2)
b. Given exact irrational solutions, determine the best rational estimation. (DOK 2)
c. Solve real-world or application problems that involve square roots and the Pythagorean Theorem. (DOK 3)

ALGEBRA

2. Understand relations, functions, and patterns. Analyze change using various geometric properties.

a. Represent data from geometric and real-world contexts with expressions, formulas, tables, charts, graphs, relations, and functions. (DOK 2)
b. Recognize and write the equation of a circle in standard form $(x-h)^2 + (y-k)^2 = r^2$ and identify the center and radius. (DOK 2)
c. Use slope to analyze and write equations for parallel and perpendicular lines. (DOK 2)
d. Apply the Midpoint and Distance Formulas to solve application problems involving the coordinate plane. (DOK 2)
e. Determine the effects of rigid (translations, rotations, and reflections) and non-rigid (dilations) motions and compositions when performed on objects on the coordinate plane. (DOK 2)

GEOMETRY

3. Investigate, apply, and prove properties and theorems from postulates and definitions related to angles, lines, circles, polygons, and two- and three-dimensional figures. Explore applications of patterns and transformational geometry.

a. Use inductive reasoning to make conjectures and deductive reasoning to make valid conclusions. (DOK 3)
b. Develop and evaluate mathematical arguments and proofs to include paragraph, two-column, and flow chart forms. (DOK 3)
c. Identify, classify, and apply angle relationships formed by parallel lines cut by transversals. (DOK 2)
d. Use the properties of altitudes, medians, angle bisectors, and perpendicular bisectors of triangles to solve problems. (DOK 2)
e. Classify triangles and apply postulates and theorems to test for triangle inequality, congruence, and similarity. (DOK 2)
f. Determine and justify if a given shape could be tessellated. (DOK 2)
g. Describe and draw cross-sections of prisms, cylinders, pyramids, and cones. (DOK 1)
h. Graph a vector and determine the magnitude and direction of a given vector. (DOK 2)
i. Given the pre-image or image, find figures obtained by applying reflections, translations, rotations, and dilations; describe and justify the method used. (DOK 2)

MEASUREMENT

4. Select and apply various strategies, tools, and formulas to calculate length, surface area, volume, and angle measurements.

a. Use the properties of circles using arc, angle, and segment relationships to find missing measures. (DOK 2)
b. Solve real-world applications and mathematical problems to find missing measurements in right triangles by applying special right triangle relationships, geometric means, or trigonometric functions. (DOK 2)
c. Solve real-world and mathematical problems involving the lateral area, surface area and volume of three-dimensional figures, including prisms, cylinders, cones, pyramids, and spheres. (DOK 2)
d. Explain and use the properties of 45-45-90 and 30-60-90 triangles. (DOK 2)
e. Apply the relationships of sine, cosine, and tangent to problems involving right triangles. (DOK 2)

DATA ANALYSIS & PROBABILITY

5. Represent, analyze, and make inferences based on data with and without the use of technology.

a. Apply multiple strategies and representations, including area models, to solve probability problems. (DOK 2)

ALGEBRA II

Algebra II builds on earlier experiences with linear equations and functions. The genre of functions expands to include polynomial, exponential, rational, and radical examples. Attention is given to inverses, composition of functions, and families of graphs. Computations with matrices, logarithms, and complex numbers are introduced. Conic sections increase the sophistication level of graphing and the geometric aspects. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. Justifications, written and oral, should continue to be part of regular instruction. Physical materials should continue to be part of the development of mathematical understanding.

The framework is comprised of five content strands: **number and operations, algebra, geometry, measurement,** and **data analysis & probability.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The five interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

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ALGEBRA II

CONTENT STRANDS:

Number and Operations	Algebra
Geometry	Measurement
Data Analysis & Probability	

Competencies and Objectives:

NUMBER AND OPERATIONS

1. **Understand relationships among numbers and compute fluently. Verify with technology.**

   a. Diagram the relationship among the subsets of the complex number system. (DOK 2)
   b. Compute with rational and radical expressions and complex numbers, expressing in simplest form. (DOK 1)
   c. Evaluate powers of the imaginary unit, *i*. (DOK 1)
   d. Perform computations, including addition, scalar multiplication, multiplication, determinants, and inverses on matrices. (DOK 1)
   e. Solve applications and problems in mathematical settings involving arithmetic and geometric sequences and series. (DOK 3)
   f. Explain and use the inverse relationship between exponential and logarithmic expressions. (DOK 2)
   g. Use the properties of logarithms to simplify logarithmic expressions and to find their approximate values. (DOK 1)
   h. Solve application problems involving exponential functions related to growth and decay. (DOK 3)

ALGEBRA

2. **Use algebraic concepts to identify patterns, use multiple representations of relations and functions, and apply operations to expressions, equations, and inequalities.**

   a. Solve compound and absolute value inequalities, graphing and writing solutions in interval notation. (DOK 2)
   b. Solve systems of absolute value and quadratic equations using a variety of solution methods including graphing. (DOK 2)
   c. Given constraints, find the maximum and minimum value(s) of a system of linear inequalities and explain your reasoning. (DOK 2)
   d. Given the solution(s) to a quadratic equation, find a quadratic equation to fit the solution(s) and explain or justify the solution process. (DOK 2)
   e. Use the discriminant to classify and predict the types of solutions of quadratic equations and justify the classification. (DOK 2)

f. Factor sums and differences of cubes and factor polynomials by grouping. (DOK 2)
g. Solve radical equations. (DOK 2)
h. Write equivalent forms of rational expressions using real and complex conjugates. (DOK 2)
i. Solve equations involving rational expressions and verify solutions. (DOK 2)
j. Explain the results of compositions of functions. (DOK 2)
k. Explain the Binomial Theorem and use it to expand binomial expressions raised to positive integral powers. (DOK 2)
l. Interpret the zeros and maximum or minimum value(s) of quadratic functions. (DOK 2)

GEOMETRY

3. Use coordinate geometry to specify locations, describe relationships, and apply transformations to analyze algebraic relationships.

a. Determine and justify whether the inverse of a relation or a function exists. (DOK 2)
b. Classify functions based on sketches of their graphs. (DOK 2)
c. Sketch and describe transformations of quadratic and absolute value functions. (DOK 2)
d. Represent complex numbers and the sum of complex numbers in a complex coordinate plane. (DOK 1)
e. Identify and sketch the essential graphs of the four conic sections: circle, parabola, ellipse, and hyperbola. (DOK 1)

MEASUREMENT

4. Understand measurable attributes of objects and apply appropriate techniques and formulas to determine measurements.

a. Verify the appropriateness of the numerical value and the units of a variable in an equation. (DOK 2)
b. Describe the level of accuracy of measurements in real-world situations by using absolute value inequalities. (DOK 1)

DATA ANALYSIS & PROBABILITY

5. Use technology to represent, analyze, and make inferences based on data.

a. Through the use of technology, use scatter plots and linear and quadratic regression analysis to determine an appropriate function to model real-life data. (DOK 3)
b. Solve simple combinations. (DOK 2)
c. Model a data set using the median-fit-method with a linear equation and make predictions based on the model and the equation. (DOK 3)
d. Identify the difference between permutations and combinations and use them to solve real-world problems. (DOK 2)

ADVANCED ALGEBRA

Advanced Algebra requires skills developed in earlier courses to investigate advanced topics such as conic sections, higher-order polynomials, matrices, functions, and data representations. The justifications of solutions and solution methods should be expected. The use of technology, especially graphing calculators, should be an integral part of this course. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. Physical materials should continue to be part of the development of mathematical understanding. Prerequisites for this course include Geometry and Algebra II. This is a one-half credit course.

The framework for this course is comprised of four content strands: **number and operations, algebra, geometry,** and **data analysis & probability.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The four interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

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The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time. The Depth of Knowledge (DOK) level is indicated at the end of each objective.

ADVANCED ALGEBRA

CONTENT STRANDS:

Number and Operations
Geometry
Data Analysis & Probability
Algebra

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Understand and perform computations with different representations of numbers.

a. Express a series using summation notation. (DOK 2)
b. Evaluate the sum of a series. (DOK 2)
c. Explain expansion by minors and find the determinant of a 3 x 3 matrix with that process. (DOK 2)
d. Use problem-solving strategies to solve non-routine problems. (DOK 3)
e. Solve application problems involving *e* and exponential functions related to growth and decay. (DOK 3)

ALGEBRA

2. Use algebraic concepts to identify patterns and use multiple representations of relations and functions. Apply operations to expressions and equations.

a. Find the sum, difference, product, and quotient of functions, noting any restrictions on the domain. (DOK 2)
b. Provide a convincing argument (or proof) regarding the inverse relationship of two functions. (DOK 3)
c. Describe patterns found in Pascal's Triangle and explain the relationship to the Binomial Theorem. (DOK 2)
d. Write and graph the equations of conic sections. (DOK 1)
e. Solve linear-quadratic and quadratic-quadratic systems of equations and inequalities. (DOK 2)

GEOMETRY

3. Recognize, analyze, and graph conic sections.

a. Describe and explain the conic sections resulting from cutting a cone. (DOK 1)
b. Explain and perform the geometric constructions of conic sections. (DOK 2)

DATA ANALYSIS & PROBABILITY

4. Apply simple probability and curve fitting to data.

a. Use technology and regression analysis to determine appropriate quadratic and cubic functions modeling real-life data. (DOK 3)

TRIGONOMETRY

Trigonometry builds on a well-developed geometry and algebra background to explore the study of unit circles and triangles. Computations with complex numbers are extended. Trigonometric functions, their properties, and graphs are analyzed and studied in the context of real and complex numbers. Proofs should include a variety of techniques and sophisticated reasoning should be applied to verbal justifications. Graphing calculators and software aid students in the analysis and application of concepts. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. Physical materials should continue to be part of the development of mathematical understanding. Trigonometry, a one-half credit course, is taken by students who have successfully completed Algebra II and Geometry and is a pre-requisite for Calculus.

The framework for this course is comprised of four content strands: **number and operations, algebra, geometry, and measurement.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The four interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

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TRIGONOMETRY

CONTENT STRANDS:

Number and Operations	Algebra
Geometry	Measurement

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Represent and compare numbers in various forms and perform operations.

a. Perform conversions across measurement systems including degree to radian measurements of angles, radian measurements to degree measurements of angles, polar to rectangular coordinates, rectangular to polar coordinates, rectangular to trigonometric forms of complex numbers, and trigonometric to rectangular forms of complex numbers. (DOK 1)
b. Determine the product and quotient of complex numbers in trigonometric form. (DOK 1)
c. Apply De Moivre's theorem to determine the *n*th roots of a complex number given in polar form. (DOK 1)
d. Explain the addition formulas for sine and cosine and use them to prove (or simplify) other trigonometric functions. (DOK 2)

2. Investigate basic concepts of vectors and operations with vectors.

a. Recognize and draw different notations for vectors to represent a quantity. (DOK 1)
b. Analyze properties of vectors and the effects of these properties on operations with vectors. (DOK 2)
c. Apply the limit definition of *e*. (DOK 2)

ALGEBRA

3. Compare and produce equivalent forms of trigonometric expressions and solve trigonometric equations.

a. Determine the domain and range of trigonometric functions. (DOK 2)
b. Identify and apply trigonometric identities. (DOK 2)
c. Verify identities analytically and with technology. (DOK 2)
d. Solve trigonometric equations in real-world situations or mathematical settings. (DOK 2)

GEOMETRY

4. Use geometric modeling to analyze trigonometric relationships.

a. Use the unit circle to solve real-world applications and problems in mathematical settings. (DOK 3)
b. Apply the six trigonometric functions in relation to a right triangle to solve real-world applications and problems in mathematical settings. (DOK 3)
c. Find exact values of trigonometric functions of special angles in the unit circle. (DOK 1)
d. Recognize, sketch, and interpret graphs of the six trigonometric functions and include restrictions on their domain. (DOK 2)
e. Model and apply right triangle formulas, Law of Sines, and Law of Cosines to problem-solving situations. (DOK 2)
f. Use the graph of polar coordinates and associated equations to model real-world applications and mathematical situations. (DOK 2)

MEASUREMENT

5. Select and apply formulas to determine length and area.

a. Find arc length and sector area of a circle. (DOK 2)
b. Using graphs of functions of the form $f(t) = A \sin (Bt + C)$ or $f(t) = A \cos (Bt + C)$, interpret A, B, C in terms of amplitude, frequency, period, and phase shift. (DOK 2)
c. Given one angle and the measures of two adjacent sides, determine the area of a triangle and explain the process used. (DOK 2)

PRE-CALCULUS

Pre-Calculus covers those skills and objectives necessary for success in calculus. Topics of study include sequences and series, functions, and higher order polynomials. Polynomial functions provide the context for higher-order investigations. Topics are addressed from a numeric, graphical, and analytical perspective. Technology is to be used to enhance presentation and understanding of concepts. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. Pre-Calculus, a one-half-credit course, is taken by students who have successfully completed Algebra II and Geometry and is a prerequisite for Calculus.

The framework for this course is comprised of four content strands: **number and operations, algebra, geometry,** and **data analysis & probability.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The four interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

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PRE-CALCULUS

CONTENT STRANDS:

Number and Operations
Geometry
Data Analysis & Probability
Algebra

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Explore and illustrate the characteristics and operations connecting sequences and series.

a. Express sequences and series using recursive and explicit formulas. (DOK 2)
b. Evaluate and apply formulas for arithmetic and geometric sequences and series. (DOK 2)
c. Calculate limits based on convergent and divergent series. (DOK 2)
d. Evaluate and apply infinite geometric series. (DOK 2)

ALGEBRA

2. Analyze, manipulate, and solve equations and inequalities.

a. Determine characteristics of graphs of parent functions (domain/range, increasing/decreasing intervals, intercepts, symmetry, end behavior, and asymptotic behavior). (DOK 2)
b. Determine horizontal, vertical, and slant asymptotes and holes of rational functions and explain how each was found. (DOK 2)
c. Determine the domain and range of functions, including piece-wise functions. (DOK 2)
d. Determine the end behavior of polynomial functions. (DOK 2)
e. Decompose composite functions into component functions. (DOK 2)
f. Solve exponential and logarithmic equations to include real-world applications. (DOK 2)
g. Find the possible rational roots using the Rational Root Theorem. (DOK 1)
h. Find the zeros of polynomial functions by synthetic division and the Factor Theorem. (DOK 1)
i. Graph and solve quadratic inequalities. (DOK 2)
j. Decompose a rational function into partial fractions. (DOK 2)

GEOMETRY

3. Recognize, sketch, and transform graphs of functions.

a. Describe the attributes of graphs and the general equations of parent functions (linear, quadratic, cubic, absolute value, rational, exponential, logarithmic, square root, cube root, and greatest integer). (DOK 1)
b. Explain the effects of changing the parameters in transformations of functions. (DOK 2)
c. Predict the shapes of graphs of exponential, logarithmic, rational, and piece-wise functions, and verify the prediction with and without technology. (DOK 2)
d. Relate symmetry of the behavior of even and odd functions. (DOK 2)

DATA ANALYSIS & PROBABILITY

4. Adapt curves to data.

a. Use regression methods available through technology to determine appropriate exponential and logarithmic functions that model real-life data. (DOK 3)
b. Use regression methods available through technology to determine appropriate cubic functions that model real-life data. (DOK 3)

5. Explore and apply fundamental principles of probability.

a. Analyze expressions in summation and factorial notation to solve problems. (DOK 2)
b. Expand and apply the Binomial Theorem to problem-solving situations. (DOK 2)

DISCRETE MATHEMATICS

Discrete Mathematics is the study of processes that involve sequences of individual or countable steps as opposed to the study of continuously changing processes addressed in Calculus. Topics of study include number systems, logic of compound statements, mathematical induction and recursion, graph theory and set theory. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. Discrete Mathematics, a one-half credit course, is designed to provide students who have completed Geometry and Algebra II with an overview of concepts needed for computer science, electrical engineering, or fields requiring networking.

The framework for this course is comprised of four content strands: **number and operations**, **algebra, geometry,** and **data analysis & probability.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The four interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

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DISCRETE MATHEMATICS

CONTENT STRANDS:

Number and Operations
Algebra
Geometry
Data Analysis & Probability

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Explore relationships among number systems.

a. Use matrices to model and solve problems. (DOK 2)
b. Model relationships and solve problems using Graph Theory. (DOK 2)

ALGEBRA

2. Use algebraic methods to represent simple and complex relationships among statements. Use models to represent patterns and operations.

a. Define sentence (proposition), and use logic to determine if the sentence is true or false. (DOK 2)
b. Define simple compound statements: negation, conjunction, disjunction, contradiction, and tautology using truth tables. (DOK 2)
c. Define a conditional statement using truth tables. (DOK 2)
d. Apply the principles of logic to determine the validity of arguments. (DOK 3)
e. Define a sequence recursively and explicitly. (DOK 2)
f. Find the explicit formula for a recursively-defined sequence using iteration. (DOK 2)
g. Use mathematical induction to verify explicit formulas for arithmetic, geometric, and other sequences and/or series. (DOK 2)
h. Add, subtract, multiply, and divide sets and find unions, intersections, differences, and complements of sets. (DOK 2)

GEOMETRY

3. Use geometric models to describe and analyze mathematical relationships, establish the validity of conjectures, and determine solutions to real applications.

a. Construct a logic circuit from a Boolean expression to determine output. (DOK 2)
b. Construct a Boolean expression given a logic circuit. (DOK 2)
c. Construct a logic circuit and Boolean expression given an input/output table. (DOK 2)
d. Use Venn diagrams to represent basic operations on sets. (DOK 1)

e. Determine the number of vertices and edges as well as walks, paths, and circuits in a graph. (DOK 2)
f. Construct walks, paths, and circuits given an edge/vertex string. (DOK 2)
g. Determine whether Euler and Hamiltonial (Hamiltonian) circuits exist in a given graph. (DOK 2)
h. Construct a graph given the adjacency matrix of the graph and vice versa. (DOK 1)
i. Determine connectivity of a graph using an adjacency matrix. (DOK 1)
j. Determine the number of walks between two vertices using powers of the adjacency matrix. (DOK 2)
k. Explain why a graph is a tree. (DOK 2)
l. Determine the level, parent, siblings, ancestors, descendants and height of a rooted tree. (DOK 1)
m. Determine the shortest route in a spanning tree. (DOK 2)

DATA ANALYSIS & PROBABILITY

4. Investigate and explain strategies for solving simple games.

a. Determine the characteristics that result in a fair game. (DOK 2)
b. Identify winning strategies for basic games. (DOK 3)
c. Create and use simulations for probability models. (DOK 3)
d. Solve problems using discrete random variables. (DOK 2)

CALCULUS

Calculus is the study of the mathematics of change. The major focus is on differential and integral calculus. The use of graphing calculators and other technologies are major components of the course. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. This one-credit course is designed for the student who has a thorough knowledge of college preparatory mathematics.

The framework for this course is comprised of four content strands: **number and operations, algebra, geometry, and measurement.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The four interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

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CALCULUS

CONTENT STRANDS:

Number and Operations	Algebra
Geometry	Measurement

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Compute and determine the reasonableness of results in mathematical and real world situations.

a. Estimate limits from graphs or tables. (DOK 2)
b. Estimate numerical derivatives from graphs or tables of data. (DOK 2)
c. Prove statements using mathematical induction. (DOK 3)

ALGEBRA

2. Demonstrate basic knowledge of functions, including their behavior and characteristics.

a. Predict and explain the characteristics and behavior of functions and their graphs (domain, range, increasing/decreasing intervals, intercepts, symmetry, and end behavior). (DOK 2)
b. Investigate, describe, and determine asymptotic behavior using tables, graphs, and analytical methods. (DOK 2)
c. Determine and justify the continuity and discontinuity of functions. (DOK 2)

3. Evaluate limits and communicate an understanding of the limiting process.

a. Solve mathematical situations and application problems involving or using derivatives, including exponential, logarithmic, and trigonometric functions. (DOK 2)
b. Calculate limits using algebraic methods. (DOK 2)
c. Verify the behavior and direction of non-determinable limits. (DOK 2)

4. Use the definition and formal rules of differentiation to compute derivatives.

a. State and apply the formal definition of a derivative. (DOK 1)
b. Apply differentiation rules to sums, products, quotients, and powers of functions. (DOK 2)
c. Use the chain rule and implicit differentiation. (DOK 2)
d. Describe the relationship between differentiability and continuity. (DOK 2)

5. Apply derivatives to find solutions in a variety of situations.

a. Define a derivative and explain the purpose/utility of the derivative. (DOK 2)
b. Apply the derivative as a rate of change in varied contexts, including velocity, speed, and acceleration. (DOK 2)
c. Apply the derivative to find tangent lines and normal lines to given curves at given points. (DOK 2)
d. Predict and explain the relationships between functions and their derivatives. (DOK 2)
e. Model rates of change to solve related rate problems. (DOK 2)
f. Solve optimization problems. (DOK 2)

6. Employ various integration properties and techniques to evaluate integrals.

a. State and apply the First and Second Fundamental Theorem of Calculus. (DOK 2)
b. Apply the power rule and u-substitution to evaluate indefinite integrals. (DOK 2)

GEOMETRY

7. Use geometric concepts to gain insights into, answer questions about, and graph various implications of differentiation.

a. Demonstrate and explain the differences between average and instantaneous rates of change. (DOK 2)
b. Apply differentiation techniques to curve sketching. (DOK 2)
c. Apply Rolle's Theorem and the Mean Value Theorem and their geometric consequences. (DOK 2)
d. Identify and apply local linear approximations. (DOK 1)
e. Analyze curves with attention to non-decreasing functions (monotonicity) and concavity. (DOK 2)

MEASUREMENT

8. Adapt integration methods to model situations to problems.

a. Apply integration to solve problems of area. (DOK 2)
b. Utilize integrals to model and find solutions to real-world problems such as calculating displacement and total distance traveled. (DOK 2)

9. Apply appropriate techniques, tools, and formulas to determine values for the definite integral.

a. Interpret the concept of definite integral as a limit of Riemann sums over equal subdivisions. (DOK 3)

STATISTICS

Statistics introduces students to the major concepts and tools for collecting, analyzing, and drawing conclusions from data. Four major areas of concentration include data explorations, design of experiments, production of models using probability, and simulation and statistical inference. Students are required to design, conduct, represent, and interpret statistical and probabilistic studies. The use of technology will be an integral part of the course. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. This course is designed for students who have successfully completed Algebra II. This is a one-credit course.

The framework for this course is comprised of four content strands: **number and operations, algebra, geometry,** and **data analysis & probability.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The four interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

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STATISTICS

CONTENT STRANDS:

Number and Operations
Algebra
Geometry
Data Analysis & Probability

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Explore phenomena using probability and simulation. Compute appropriate statistical and probabilistic measures.

a. Describe the comparison of center and spread within groups and between or across group variation. (DOK 2)
b. Interpret and apply the concept of the Law of Large Numbers. (DOK 2)
c. Apply the counting principles, including permutations and combinations. (DOK 1)
d. Construct and interpret sample spaces, events, and tree diagrams. (DOK 2)
e. Identify types of events, including mutually exclusive, independent, and complements. (DOK 1)
f. Calculate geometric probability using two-dimensional models, and explain the processes used. (DOK 2)
g. Create simulations and experiments that correlate to theoretical probability. (DOK 2)
h. Use Markov Chains to calculate probability by constructing matrix models. (DOK 2)
i. Apply the concept of a random variable to generate and interpret probability distributions. (DOK 2)

ALGEBRA

2. Analyze one and two variable data using algebraic concepts and methods.

a. Analyze and describe outliers and shape of the data including linearity and correlation across graphs and data sets. (DOK 2)
b. Calculate mean, median, mode, standard deviation, z-scores, t-scores, quartiles, and ranges, and explain their applications. (DOK 2)
c. Select and use appropriate statistical methods in decision-making and hypothesis testing. (DOK 2)
d. Use algebraic concepts and methods to determine mathematical models of best fit. (DOK 2)

GEOMETRY

3. Design an appropriate form of displaying data collected, whether in tabular or graphic form.

a. Organize data using graphs that are appropriate to the data set, including frequency distributions, stacked line and bar graphs, stem-and-leaf plots, scatter plot, frequency polygon, and histograms. (DOK 2)
b. Determine and justify the graph type that best represents a given set of data. (DOK 2)
c. Create graphs with scales that fairly display the data. (DOK 2)

DATA ANALYSIS & PROBABILITY

4. Collect, read, interpret, and analyze data as it relates to the real world.

a. Make inferences and predictions from charts, tables, and graphs that summarize data. (DOK 3)
b. Determine the most appropriate measure to describe a data set, including mean, median, mode, standard deviation, and variance. (DOK 2)
c. Use curve-fitting to make predictions from collected data. (DOK 2)
d. Explain and defend regression models using correlation coefficients and residuals. (DOK 2)

5. Design a study by clarifying a question and deciding upon a method of data collection and analysis.

a. Design and execute a statistical experiment, including the preparation of a report that communicates the statement of the problem, methodology, results, and conclusions. (DOK 4)
b. Explain the generalizability of results and types of conclusions that can be drawn from observational studies, empirical experiments, and surveys. (DOK 2)
c. Analyze sources of bias and sampling error(s) in studies. (DOK 3)
d. Compare and contrast sampling methods, including simple random sampling, stratified random sampling, and cluster sampling with regard to benefits and trade-offs. (DOK 2)

SURVEY OF MATHEMATICAL TOPICS

Survey of Mathematical Topics is designed to provide students with the skills necessary in making wise financial decisions. The basic concepts of algebra will be reviewed and extended as students solve real-life problems that affect them and their families. This course will provide skills in probability and statistics, logic, linear programming, and regression analysis. Students are encouraged to use a variety of techniques and appropriate technology (calculators and/or computers) to solve problems. The instructional approach should provide opportunities for students to work together collaboratively and cooperatively as they solve routine and non-routine problems. Communication strategies should include reading, writing, speaking, and critical listening as students present and evaluate mathematical arguments, proofs, and explanations about their reasoning. This course is designed for students who have successfully completed Algebra I, Geometry, and/or Algebra II. This is a one-credit course.

The framework for this course is comprised of three content strands: **number and operations, algebra,** and **data analysis & probability.** The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The three interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

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The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time. The Depth of Knowledge (DOK) level is indicated at the end of each objective.

SURVEY OF MATHEMATICAL TOPICS

CONTENT STRANDS:

Number and Operations
Data Analysis & Probability
Algebra

Competencies and Objectives:

NUMBER AND OPERATIONS

1. **Compute, analyze, and develop a variety of skills necessary to manage personal and business finance to include aspects of employer-employee decision making and consumer credit.**

   a. Develop a household budget. (DOK 2)
   b. Use and apply basic accounting procedures to maintain and balance a checkbook. (DOK 2)
   c. Identify the terminology and apply the process of filing personal income tax. (DOK 2)
   d. Identify and explain the components and processes involved in the purchase, operation, and maintenance of a personal vehicle. (DOK 2)
   e. Determine the advantages and disadvantages of housing alternatives. (DOK 2)
   f. Use information and data to make sound decisions regarding personal savings. (DOK 3)
   g. Identify life and health insurance terminology and apply it to real world situations. (DOK 2)
   h. Compute and compare various forms of earnings and calculate gross pay, deductions, and net pay. (DOK 2)
   i. Compare and contrast the finances of credit cards. (DOK 2)
   j. Identify and evaluate modes of transportation. (DOK 2)
   k. Identify and explain the components and processes involved in the stock market and apply them to real world applications. (DOK 2)

ALGEBRA

2. **Identify and apply the practices that affect employer and employee decision-making.**

   a. Identify and apply appropriate algebraic formulas to personal finance situations. (DOK 2)
   b. Apply linear programming to business decisions. (DOK 2)
   c. Identify and apply appropriate algebraic formulas to personal and business investments. (DOK 2)

3. Demonstrate an understanding of the impact of consumer credit.

a. Identify and explain the advantages and disadvantages of installment loans. (DOK 2)
b. Identify and apply appropriate algebraic formulas to consumer credit. (DOK 2)

DATA ANALYSIS & PROBABILITY

4. Collect and apply information for planning a trip.

a. Investigate and evaluate modes of transportation. (DOK 2)
b. Create a travel budget. (DOK 2)
c. Make travel plans based upon airline schedules. (DOK 2)
d. Apply map-reading skills. (DOK 1)
e. Apply appropriate formulas used for planning a trip. (DOK 1)

INTRODUCTION TO ENGINEERING

Introduction to Engineering is a unique projects-based course designed to give students an opportunity to evaluate their interest in engineering. Not only will students learn about what engineers do, they will also understand the differences in various types of engineering professions. Focus is given to civil, mechanical, electrical, chemical, and geological engineering, as well as computer science. The highly emphasized problem-solving skills promoted in this course should be useful to both the engineering and non-engineering bound students.

Engineers solve problems. Engineers design new things. Engineers understand how things work. This course introduces students to fundamental engineering concepts and encourages the use of creative, innovative, problem-solving skills. Students actively engage in hands-on design projects and participate on engineering teams as often as possible. Typical course projects may include but are not limited to the following: Design and build an automated coffee maker; Analyze gas chromatography (GC) lab data to solve a chemical crime scene mystery (poisons); Design and build a throwing device capable of hitting a target 20 feet away; Design a swimming pool on a steep hill; Reinforce a model building to withstand a simulated earthquake; Create and program an animated cartoon using virtual world software; Design and build an AM radio; and Study and evaluate the engineering aspects of the most catastrophic dam failure in U.S. history.

The framework is comprised of five content strands: **number and operations, algebra, geometry, measurement,** and **data analysis & probability**. The five process strands are **problem solving, reasoning & proof, communication, connections,** and **representation**. The five interrelated content strands along with the five process strands combine to provide continuity to the teaching of K – 12 Mathematics. Even though the process strands are not listed throughout the framework, these strands should be incorporated when presenting the content of the curriculum.

The competencies, printed in bold face type, are the required learning standards for all students. Competencies do not have to be taught in the order presented in the framework. The competencies are presented in outline form for consistency and for easy reference throughout the framework. Competencies are intentionally broad in order to allow school districts and teachers the flexibility to create a curriculum that meets the needs of their students. They may relate to one, many, or all of the mathematics framework strands and may be combined and taught with other competencies throughout the school year. Competencies provide a general guideline of on-going instruction, not isolated units, activities, or skills. The competencies are not intended to be a list of content skills that are taught and recorded as "mastered."

The objectives indicate how competencies can be fulfilled through a progression of content and concepts at each grade level and course. Many of the objectives are interrelated rather than sequential, which means that objectives are not intended to be taught in the specific order in which they are presented. Multiple objectives can and should be taught at the same time. The Depth of Knowledge (DOK) level is indicated at the end of each objective.

INTRODUCTION TO ENGINEERING

CONTENT STRANDS:

Number and Operations
Geometry
Data Analysis & Probability
Algebra
Measurement

Competencies and Objectives:

NUMBER AND OPERATIONS

1. Compute unit conversions and illustrate graphical interpretations.

a. Convert units using a standardized method. (DOK 1)
b. Convert decimal to binary numbers and binary to decimal numbers. (DOK 1)
c. Interpret analytical data for graphical depiction. (DOK 2)
d. Determine the proper outputs from graphical configurations of numeric value. (DOK 2)
e. Determine and convert the values of molarity, weight percent, mass percent, volume percent, and ppm of chemical solutions by hand calculations and Excel spreadsheet calculations. (DOK 1)

ALGEBRA

2. Apply algebraic equations and functions to engineering situations.

a. Write mass and energy balance equations to solve for some unknown value. (DOK 2)
b. Find voltage, current, resistance, and solve power in series, parallel, and complex electric circuit theory problems using simultaneous equations generated from Ohm's Law, Kirchhoff's Voltage Law, and Kirchhoff's Current Law (i.e., 3 equations and 3 unknowns). (DOK 2)
c. Graph a "Line of Best Fit" from given lab data and determine the degree of linearity (R^2 value), slope of the line, and equation of the line. (DOK 2)
d. Determine the BTU requirements and associated utility costs of an engineering operation. (DOK 2)

GEOMETRY

3. Apply geometric principles to engineering situations.

a. Solve general surveying problems. (DOK 2)
b. Compute dynamic moment calculations using numeric values as well as geometric/spatial positions. (DOK 2)
c. Calculate seepage under a dam and interpret a geological flownet diagram. (DOK 2)

d. Identify the five basic types of internal stresses in structural members. (DOK 1)
e. Select optimal geometric shapes for providing structural support. (DOK 2)
f. Calculate the maximum force a member can withstand before failure. (DOK 2)

MEASUREMENT

4. Apply fundamental concepts of measurement such as time, distance, area, and volume with principles of engineering in a variety of contexts.

Note: This is a projects-based course. The teaching strategies to accompany the following three items are an integral part of the course.

a. Design and construct a chemical engineering system to meet specific criteria. (DOK 4)
b. Design and construct an electronic device to meet specific criteria. (DOK 4)
c. Design and construct a mechanical device to meet specific criteria. (DOK 4)

DATA ANALYSIS & PROBABILITY

5. Interpret charts, graphs, and other data obtained from actual or hypothetical engineering events and situations.

a. Evaluate a failed engineering project. (DOK 4)