

Introduction

The following document contains the Curriculum Guidelines for the Diocese of Covington. It was created by a team of teachers from different schools and grade levels throughout the Diocese. In accordance with Diocesan Policy 4265 concerning curriculum, it was created using the last version of the Diocesan Math Curriculum along with the Program of Studies for the state of Kentucky. It should be closely aligned with both the Terra Nova test and the textbooks that are currently being used.

As with all Curriculum Guidelines it is to be used by the schools as a guide in forming local curriculum. It represents the minimum that should be done by all schools within the Diocese. It is important that all teachers follow the scope and sequence so that we have consistency throughout the Diocese especially when students are entering high school. Grade level objectives are based on national and state standards and can be adjusted by the local schools if necessary.

Mathematics Philosophy

Mathematics plays an integral role in Catholic Schools since it reflects the order and unity in God's universe. Mathematics contributes to the formation of Christians who can respond wisely and effectively to a changing world. Contemporary society demands mathematical knowledge which requires students to develop their ability to reason and think logically and to discover creative ways of problem solving. Because of its nature, mathematics can contribute to the development of the whole person by enriching one's life and providing one with a practical tool for learning.

Toward these ends, students should:

- Learn to value mathematics
- Learn to reason mathematically
- Learn to communicate mathematically
- Learn to use technology to investigate and solve problems
- Become confident of their mathematical abilities
- Become creative mathematical problem solvers

Beliefs about Learners and Learning Expectations

Beliefs:

All students can learn.

Students learn by experience and doing.

Students often have negative feelings regarding mathematics.

Students can be motivated to achieve maximally their God-given potential.

Learning Expectations:

Students should be able to:

- see a reason for doing mathematics
- know that one can learn from mistakes.
- see mathematics as relevant to daily living
- be conceptually as well as computationally sound.
- use current technology
- communicate their knowledge to others.
- see the connection with other mathematics topics and other subject areas
- know that there is more than one strategy that can be used to solve a problem
- work in groups

NCTM Principles for School Mathematics

1. **Equity.** Excellence in mathematics education requires equity—high expectations and strong support for all students.
 - All students, regardless of their personal characteristics, backgrounds, or physical challenges, must have opportunities to study---and support to learn---mathematics.
2. **Curriculum.** A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.
 - Mathematics is a highly interconnected and cumulative subject. The mathematics curriculum therefore needs to introduce ideas in such a way that they build on one another.
3. **Teaching.** Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.
 - Students learn mathematics through the experiences that teachers provide. There is no one “right way” to teach.
4. **Learning.** Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.
 - Research has solidly established the importance of conceptual understanding in becoming proficient in a subject. When students understand mathematics, they are able to use their knowledge flexibly. They combine factual knowledge, procedural facility, and conceptual understanding in powerful ways.
5. **Assessment.** Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.
 - Assessment should be more than merely a test at the end of instruction to gage learning. It should be an integral part of instruction that guides teachers and enhances students’ learning.
6. **Technology.** Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.
 - Calculators and computers are reshaping the mathematical landscape, and school mathematics should reflect those changes. Students can learn more mathematics more deeply with the appropriate and reasonable use of technology. Technology can not replace the mathematic teacher.

NCTM Standards for School Mathematics

Instructional programs from pre-kindergarten through grade 12 should enable all students to—

1. Number and Operations

- understand numbers, ways of representing numbers, relationships among numbers, and number systems;
- understand meanings of operations and how they relate to one another;
- compute fluently and make reasonable estimate

2. Algebra

- understand patterns, relations, and functions;
- represent and analyze mathematical situations and structures using algebraic symbols;
- use mathematical models to represent and understand quantitative relationships;
- analyze change in various contexts.

3. Geometry

- analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships;
- specify locations and describe spatial relationships using coordinate geometry and other representational systems;
- apply transformations and use symmetry to analyze mathematical situations;
- use visualization, spatial reasoning, and geometric modeling to solve problems.

4. Measurement

- understand measurable attributes of objects and the units, systems, and processes of measurement;
- apply appropriate techniques, tools, and formulas to determine measurements.

5. Data Analysis and Probability

- formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them;
- select and use appropriate statistical methods to analyze data;
- develop and evaluate inferences and predictions that are based on data;
- understand and apply basic concepts of probability

6. Problem Solving

- build new mathematical knowledge through problem solving;
- solve problems that arise in mathematics and in other contexts;
- apply and adapt a variety of appropriate strategies to solve problems;
- monitor and reflect on the process of mathematical problem solving.

7. Reasoning and Proof

- recognize reasoning and proof as fundamental aspects of mathematics;
- make and investigate mathematical conjectures;
- develop and evaluate mathematical arguments and proofs;
- select and use various types of reasoning and methods of proof.

8. Communication

- organize and consolidate their mathematical thinking through communication;
- communicate their mathematical thinking coherently and clearly to peers, teachers, and others;
- analyze and evaluate the mathematical thinking and strategies of others;
- use the language of mathematics to express mathematical ideas precisely.

9. Connections

- recognize and use connections among mathematical ideas;
- understand how mathematical ideas interconnect and build on one another to produce a coherent whole;
- recognize and apply mathematics in contexts outside of mathematics.

10. Representation

- create and use representations to organize, record, and communicate mathematical ideas;
- select, apply, and translate among mathematical representations to solve problems;
- use representations to model and interpret physical, social, and mathematical phenomena.

Estimation and Mental Computation

Estimation activities should be a step used in all computational activities, providing students with a problem-solving aid and as a means of judging reasonableness of solutions.

Deliberate and thorough development of the ability to estimate and do mental arithmetic must be a regular part of instruction.

These skills should be used to enhance number sense and spatial sense to help children develop insights into concepts and procedures, flexibility in working with numbers and measurements, and awareness of reasonable results. Estimation skills and understanding enhance the abilities of children to deal with everyday quantitative situations.

It is important that students learn a variety of methods of estimating, and develop reasoning and judgment in using estimation.

Mental arithmetic enables students to arrive at exact solutions without the use of paper-and-pencil algorithms. Students should be encouraged to develop non-standard techniques for performing calculations involving number properties and operations, including compensation and using the distributive property.

Increased use of calculator increases the need for both mental computations and estimation.

The learner will:

1. explore estimation strategies
2. recognize when an estimate is appropriate
3. use estimation to determine the reasonableness of results and as an aid in selecting a method for exact calculation
4. apply estimating in working with quantities, measurement, computation, and problem solving
5. use mental arithmetic for all simple operations and for manipulations

Calculators and Computers

The mathematics curriculum identifies skills needed to be mathematically literate in a world that increasingly relies on calculators and computers to carry out computational procedures.

Because technology is changing mathematics and its uses, appropriate calculators should be available to all students, and every student should have access to computers for individual and group work to be used as tools for processing information and performing calculations to investigate and solve problems. However, access to technology is no guarantee that any student will become mathematically literate. Calculating tools simplify, but do not accomplish the work at hand. Thus this curriculum is based on the fundamental mathematics students will need.

At the same time, they should learn that for some simple computations, use of the calculator is either cumbersome or, worse, can obscure the understanding of the calculation being performed. As they gain experience, students should be expected to judge whether use of the calculator will be effective and efficient. *Calculators do not replace the need to learn basic facts, to compute mentally, or to do reasonable paper and pencil computation. On the contrary, proper use of the calculator requires a knowledge of basic facts and strengthens number skills. It also requires the development of students' understanding of the meaning of arithmetic operations and when to apply each, and highlight the importance estimation skills and the ability to recognize whether computed results are reasonable.*

In mathematics education, computers have special importance. Their value in creating geometric display, organizing and graphing data, simulating real-life situations, and generating numerical sequences and patterns is already recognized. In general, computers should be used as an integral part of instruction, enabling teachers to demonstrate concepts, and students to explore and experiment with mathematical ideas.

The mathematics classroom envisioned in the Standards is one in which calculators, computers, courseware, and manipulative materials are readily available and regularly used in instruction. Although no rigid criteria exist for judging what constitutes adequate resources and equipment, every program should provide as many opportunities for learning, using these tools, as resources will allow.

All students should be able to:

- use a calculator correctly and confidently when mental calculation would be difficult or when paper and pencil calculation would be inefficient, and
- use a computer program, as appropriate, to perform extensive or repetitive calculations to simulate real situations, and to perform experiments that aid in understanding of mathematical concepts.

Manipulatives

The heart of an effective, well-taught mathematics program is the careful development of concepts and skills through extensive use of concrete materials. Students must be actively involved in constructing, modifying and integrating ideas by interacting with physical materials. They must investigate quantitative and spatial situations by manipulating the materials and then translating the ideas through pictures or diagrams to corresponding abstract symbolic representations. These are essential elements of a program in which mathematics is done with understanding rather than rote.

It is not sufficient to confine the use of concrete materials to teacher demonstration; each student must manipulate his/her own materials. K-8 classrooms especially must be equipped with a wide variety of physical materials and supplies. Manipulatives should continue to be used in grades 9-12 whenever appropriate.

Classrooms should have quantities of materials such as:

- counters
- interlocking cubes
- connecting links
- bean sticks and/or bundling sticks
- base ten, attribute, and pattern blocks
- geometric models
- rulers and other measuring devices
- spinners
- color rods
- geoboards
- balance scales
- fraction pieces
- graph, grid and dot paper
- upper grades should also have compasses and protractors
- geometric puzzles such as tangrams and pentaminoes

										DECIMALS		FRACTIONS		WHOLE #	
		<i>Spatial Relationships</i>	<i>Classification</i>			<i>Problem Solving</i>	<i>Measurement</i>	<i>Geometry</i>	<i>Probability</i>	<i>Concepts</i>	<i>Operations</i>	<i>Concepts</i>	<i>Operations</i>	<i>Concepts</i>	<i>Operations</i>
1 ++	Multilinks/Unifix Cubes	X	X	X	X	X	X	X	X			X	X	X	X
1 ++	Pattern Blocks	X	X	X	X	X	X	X	X			X	X	X	X
1,3 ++	Geoboards	X	X	X		X	X	X				X	X		X
1 ++	Base Ten Blocks					X				X	X			X	X
1,3,4 ++	Attribute Pieces	X	X			X		X							X
2	Geoblocks		X			X		X							X
2	One Inch Cubes	X		X	X	X	X	X	X	X		X		X	X
2,4 ++	Decimal Squares									X	X				X
2,3 ++	Color Tiles	X		X		X	X	X				X	X	X	
2,3 ++	Two Colored Counters			X	X	X			X						
2 ++	Cuisenaire Rods	X	X		X	X	X		X			X	X	X	X
2,4 ++	Geometric Shapes (3-D)		X					X							
2,3,4 ++	Geometric Shapes (2-D)	X	X					X							
2,3 ++	Jewels	X	X	X		X	X							X	X
3,4 ++	Tangrams	X	X			X	X	X							
3	Collections	X	X	X	X	X	X	X							

Chart lists basic manipulatives only.

Chart does not include all items needed for hands on instruction in measurement.

X on the chart indicates basic uses of manipulatives and does not limit utilization in other areas.

- 1 Priority Purchase
- 2 Purchase
- 3 Teacher/parent make or collect
- 4 Student makes as part of a concept lesson
- ++ Overhead model available

Primary Mathematics

The content in the primary level courses is directly aligned with Kentucky's academic expectations. Presented are the topics fundamental to mathematical literacy and mathematical power for all primary level students. The content statements are organized under common topic headings and can be related to other statements. An integral part of the learning process is the systematic review of earlier concepts and procedures in which students use previously learned skills to develop proficiency with more advanced concepts. Furthermore, the primary level mathematics program includes active, hands-on work with concrete materials and appropriate technologies.

Primary problem solving, mathematical communication, and mathematical reasoning should be a part of the mathematics curriculum. The use of these techniques enhances and extends students' arithmetic skills. Accuracy is an integral part of the mathematics program.

Problem solving involves developing and applying strategies to problems from everyday and mathematical situations and evaluating the solutions relative to the original problem situation.

Mathematical communication includes manipulatives (concrete materials), visual representations, and diagrams that relate language to mathematical symbols in speaking, reading, writing, and listening.

Mathematical connections include

- understanding how one concept relates to other concepts and procedures (e.g., the link between fractions and decimals)
- understanding how one major math topic relates to another (e.g., the link between geometry and measurement)
- understanding how a mathematical topic relates to other disciplines (e.g., the link between statistics and social studies)

Mathematical reasoning includes recognizing patterns and relationships and using models, known facts, and mathematical properties to explain and justify thinking.

In addition to specifying mathematics content, these guidelines provide connections to Kentucky's Learning Goal 5 (Think and Solve Problems) and Goal 6 (Connect and Integrate Knowledge). These connections provide a comprehensive link between essential content and the skills and abilities important to learning.

Kindergarten

Number Sense and Numeration

The learner will:

- match a number of objects with an equal number of objects (1-1 relationships)
- read, copy, count, and model numbers 0-20
- order and compare numbers from 0-20, using physical manipulatives
- recognize positions first through tenth
- match sets of objects with numerals 0-20
- recognize symbols (+ , - , =)
- explore appropriate estimation procedures

Operations and Computations

The learner will:

- recognize a calculator as a mathematical tool and know its name
- develop meaning of addition and subtraction by using manipulatives
- recognize part-part-whole relationships (e.g. $3+2=5$, $1+4=5$ and $3-1=2$, $4-2=2$)

Geometry and Spatial Sense

The learner will:

- recognize the spatial relationship of two objects
- identify, describe, and make plane figures (circle, square, triangle, rectangle)
- compare the size and shape of plane figures
- combine plane figures to form other plane figures (e.g. tangram puzzles)

Measurement

The learner will:

- recognize that a clock (digital and traditional) is used to tell time
- relate time to daily activity
- recognize that a thermometer is used to read temperature
- recognize that a calendar is used to measure days, weeks and months
- identify a penny and nickel and know the value
- compare and order by size, length, and width
- begin to use estimates of measurement in problem-solving situations

Probability and Statistics

The learner will:

- make a graph using manipulatives
- draw conclusions and make predictions based on data displayed on graphs

Fractions

The learner will:

- explore the concept that a fraction is part of a whole
- use models to explore and verbalize the meaning of whole and half

Patterns and Relationships

The learner will:

- identify an object different from a group
- sort objects according to one attribute (e.g., size, shape or color)
- identify, describe and create patterns
- classify objects into like groups and/or subgroups (e.g., given a group of farm animals the children sort into subgroups of sheep, cattle, and chickens)

Grade One

Number Sense & Numeration

The learner will:

- read, write, count and model whole numbers 0-100
- order and compare numbers 0-100
- recognize number words one to ten
- distinguish ordinal numbers first through twentieth
- introduce counting by 2's, 5's and 10's (skip counting)
- introduce whole number place value for 1's, 10's and 100's
- develop a sense of regrouping
- understand and apply symbols +, -, and =
- introduce odd and even numbers to 20
- count backwards by 1's from 10
- explore appropriate estimation procedures

Operations & Computations

The learner will:

- understand addition and subtraction using manipulatives to 18 and master facts to 10
- apply the commutative property to the operation of addition
- use models to solve one step story problems
- use calculators and/or computers to solve problems
- add 3 one digit numbers using manipulatives
- introduce the number line
- introduce fact families
- develop part – part- whole relationships

Geometry & Spatial Sense

The learner will:

- identify and describe and compare the properties of plane and solid figures
- determine lines of symmetry
- explore flips, slides and turns with manipulatives
- determine if shapes are congruent
- identify the spatial relationships of two objects
- introduce the concepts of area and perimeter

Measurement

The learner will:

- identify coins and know the value
- tell time to the hour and half hour on both traditional and digital clocks
- compare, order and measure objects in standard and non-standard units
- make combinations of coins up to \$1.00
- determine size relationships of two objects
- make and use estimates of measurement in problem solving

Probability & Statistics

The learner will:

- collect and display data to make graphs and tables
- interpret and record information from graphs and tables
- collect data using tally marks
- explore chance as illustrated in games and experiences

Fractions

The learner will:

- recognize equal parts
- introduce the concept of $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$
- identify how many $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{1}{4}$ are needed to make a whole by using manipulatives

Patterns and Relationships (algebraic Ideas)

The learner will:

- sort objects according to more than one attribute (e.g., size, shape, color and thickness)
- create, reproduce and extend patterns of shapes, objects, movement and sounds
- solve simple equations (e.g. $1+1 = \underline{\quad}$)
- explore function machines

Grade Two

Number Sense & Numeration

The learner will:

- read, write, count and model whole numbers 0-1000
- order and compare numbers 0- 1000
- understand and apply symbols $<$ and $>$
- understand regrouping 0-100 using manipulatives
- introduce and develop counting by 2,3,4,5 and 10 (skip counting, exploring multiples)
- develop a concept of place value 1's, 10's, 100's, and 1000's
- explore appropriate estimation procedures
- recognize even/odd numbers to 100

Operations & Computations

The learner will:

- develop and apply the number line
- solve two step story problems using addition or subtraction
- add and subtract two digit numbers, with and without regrouping
- explore the concepts of multiplication and division using models
- use calculators and/or computers to solve problems
- develop fact families
- master addition and subtraction facts to 18

Geometry & Spatial Sense

The learner will:

- identify, describe, and compare solid figures according to the number and shape of faces, edges, bases, and angles
- relate solid figures to plane figure representations of the objects in printed materials
- recognize geometric shapes
- develop lines of symmetry
- recognize representations of lines and line segments and angles
- develop the concepts of area and perimeter

Measurement

The learner will:

- tell time at five minute intervals
- identify the value of a combination of coins up to \$1.00 and give change
- compare, order, and measure objects in standard and non-standard units
- using appropriate tools, measure in metric and customary units

Probability & Statistics

The learner will:

display data on student invented representations, drawing conclusions and making predictions

- explore chance (probability) as two separate events (likely/unlikely outcomes)
- pose questions, collect and organize data, make graphs and tables, and line plots, draw conclusions and make predictions
- describe data displayed on graphs and tables
- perform simple probability experiments

Fractions & Decimals

The learner will:

- use illustrations and manipulatives to represent whole objects and sets of objects
- introduce and compare halves, thirds, and fourths using $<$ and $>$
- introduce decimals to represent money

Patterns and Relationships (Algebraic Ideas)

The learner will:

- classify objects according to one or more attributes
- recognize, extend and explain patterns in a sequence
- introduce ordered pairs
- solve function machine tasks
- solve for unknowns and open sentences

Grade Three

Number Sense & Numeration

The learner will:

- read, write, and model whole numbers 0-10,000
- understand even/odd numbers
- develop a concept of place value to 10,000
- demonstrate an understanding of counting, rounding, and regrouping
- order and compare numbers from 0-10,000
- understand number words and diagrams represent whole numbers
- master skip counting and multiples of 2, 5, 10, and 100
- explore appropriate estimation procedures

Operations & Computations

The learner will:

- add and subtract two and three digit numbers with and without regrouping
- use manipulatives to develop meaning for the four operations
- solve story problems using multiplication and division with basic facts through 12
- develop concepts of multiplication and division of two or three numbers by one digit
- demonstrate mastery of multiplication and division facts through 12
- use calculators and/or computers to solve problems

Geometry & Spatial Sense

The learner will:

- find the perimeter of a shape
- find the area of a shape by counting units
- understand congruent and similar shapes
- find the volume of a shape by counting cubic units
- understand solid figures and plane figure drawings in printed materials
- understand congruent and symmetrical figures
- identify, describe, model, draw, and classify plane figure and solid figures using properties
- draw representations of line segments and angles

Measurement

The learner will:

- identify the value of a combination of coins up to \$5.00 and be able to make change
- using appropriate tools, measure lengths in centimeters, meters and kilometers
- using appropriate containers, measure volume for liquid capacity in cubic centimeters and in liters
- using appropriate tools, measure mass, grams and kilograms
- compare, order, and measure objects in everyday situations (calendars, temperature, clocks)
- determine equivalent customary measurements
- tell time to one minute intervals and determine elapsed time

Probability & Statistics

The learner will:

- pose questions, collect and organize data, make graphs and tables, and line plots, draw conclusions and make predictions
- describe data displayed on graphs and tables
- perform simple probability experiments

Fractions and Decimals

The learner will:

- understand and count fractional parts
- use symbols to record fractional parts to whole and whole to part objects or sets of objects
- using manipulatives and pictures, represent different names for equivalent fractions
- understand the terms numerator and denominator
- write a decimal for a number of tenths or hundredths
- recognize dimes and pennies as tenths and hundredths of a dollar
- identify a mixed number expressed as a decimal
- add and subtract decimals (money)
- introduce decimal place values using a calculator

Patterns and Relationships (Algebraic Ideas)

The learner will:

- extend and explain patterns in a sequence
- determine a location by reading ordered pairs of numbers on a rectangular grid
- extend function machine tasks to include four operations
- solve for unknowns and open sentences

Intermediate Mathematics

The content in the intermediate level course mathematical guidelines is directly aligned with Kentucky's academic expectations. Presented are the topics fundamental to mathematical literacy and mathematical power for all intermediate level students. The content statements are organized under common topic headings for fourth and fifth grades, and each statement can be related to other statements. The lists in parentheses (designated with an "e.g.") are suggestions for instruction and are not meant to be comprehensive.

Systematic review of earlier concepts and procedures is also an integral part of the intermediate program. Features of the intermediate level mathematics programs include active, hands-on work with manipulatives (concrete materials) and appropriate technologies.

Intermediate problem solving, mathematical communication, and mathematical reasoning should be a part of the mathematics curriculum.

Problem solving includes developing and applying strategies to problems from everyday and mathematical situations and evaluating the solutions relative to the original problem situation.

Mathematical communication includes concrete materials, visual representations, and diagrams that relate language to mathematical symbols in speaking, reading, writing, and listening to mathematical ideas.

Mathematical connections include

- relating concepts to other concepts and procedures (e.g., fraction, decimal),
- relating concepts of one mathematical topic to another (e.g., geometry, measurement),
- relating concepts of a mathematical topic to other disciplines (e.g., statistics, social studies).

Mathematical reasoning includes recognizing patterns and relationships and using models, known facts, and mathematical properties to explain and justify thinking. The guidelines included in this document for the intermediate levels are arranged sequentially by grade. However, it is the prerogative of school councils and local boards of education for schools exempt from school-based decision making to reorganize the content into a format that best meets the needs of their students. Schools have the opportunity to create integrated, interdisciplinary, and multidisciplinary programs.

Grade Four

Numbers, Integers and Place Value

Students will:

- read, write, and model whole numbers from 0 to 1,000,000, developing place value for hundred thousands and millions.
- order and compare numbers to 1,000,000.
- understand the relative magnitude of whole numbers to 1,000,000.
- determine factors/multiples of a whole number
- round numbers through thousands place

Fractions and Decimals

Students will:

- compare unit fractions (e.g., numerator of 1) using manipulatives.
- investigate multiple representations of equivalent fractions (e.g., $1/2 = 3/6$) with manipulatives.
- read, write, and identify decimals through one-thousandths with manipulatives.
- develop equivalent relationships between common fractions, decimals, and whole numbers (e.g., $1/2 = 0.5$, $4/2 = 2$, $2 = 2.0$).
- explore appropriate estimation procedures; such as comparing and rounding decimals and fractions

Number Computation

Students will:

- understand and apply computational procedures for adding, subtracting, multiplying, and dividing whole numbers using memorized basic facts.
- add and subtract whole numbers to the hundred-thousands place
- estimate the answer in whole number computation
- multiply 3 & 4 digit numbers by 2 digit numbers
- divide a 2, 3, or 4 digit number by a 1 or 2 digit number
- add and subtract fractions with common denominators using manipulatives and/or diagrams.
- explore adding and subtracting fractions with unlike denominators using manipulatives and/or diagrams
- add and subtract decimals to the thousandths place
- identify and solve multi-step problems involving the basic operations of whole numbers, fractions, and decimals
- use calculators and computers to extend problem solving skills

Geometry

Students will:

- analyze structures of geometric figures (e.g., points, rays, lines, segments, perpendicular lines, parallel lines, angles).
- investigate geometric relationship (e.g., similarity, congruence) through manipulatives and drawings.
- compare and contrast angles in relationship to right angles
- plot coordinate points on a whole number graph

Measurement

Students will:

- relate time to days, weeks, months, and years.
- add and subtract time.
- read and record temperatures to the nearest degree, using both Fahrenheit and Celsius
- measure and find area and perimeter of a rectangle.
- measure and find perimeter of regular/irregular shapes; and measure and find the area of rectangle.
- exchange units (e.g., linear, volume, mass) within a measurement system (e.g., 2 feet = 24 inches).
- understand such attributes as length, area, weight, volume, and angle and select the appropriate type of unit for measuring each attribute
- understand the need for measuring with standard units and become familiar with standard units in the customary and metric systems

Algebraic Ideas

Students will:

- compare and contrast number patterns.
- explore variables and solve equations using variables.
- formulate rules for number relationships.
- graph points on a number line.
- represent and describe relationships through the use of variables, ordered pairs, lists in tables, plots on graphs, and patterns.

Probability and Statistics

Students will:

- explore circle, pictorial, line, and bar graphs
- choose appropriate means to collect and represent data.
- explore line graphs to show change over time.
- pose questions, collect, organize, and display data.
- draw conclusions and make predictions based on data
- make predictions to determine the fairness of possible outcomes of simple probability experiments using a variety of appropriate manipulatives.
- use counting techniques and/or tables to explore probability experiments.
- find mean, median, and mode of a set of numbers

Grade Five

Numbers, Integers, and Place Value

Students will:

- read, write, and model whole numbers from 0 to 100,000,000, developing place value for ten millions and one hundred millions.
- order and compare numbers to 100,000,000.
- Develop place value of large and small numbers (include decimals)
- Determine prime numbers, composite numbers, factors, multiples, greatest common factors, and least common multiples
- explore appropriate estimation procedures.

Fractions and Decimals

Students will:

- compare and apply the relative sizes of common and mixed fractions
- continue to develop number sense including fractions and decimals
- investigate multiple representations of equivalent fractions (e.g., $1/2 = 3/6$, mixed numbers $1\ 1/2 = 3/2$) with manipulatives, drawings, and fractional notation.
- continue to develop equivalent relationships between common fractions, decimals, and whole numbers
- compare, order, and convert between whole numbers, fractions, and decimals, using concrete materials, drawings or pictures, and mathematical symbols (<, >, =, order on a number line)
- read, write, and identify decimals through ten-thousandths.
- explore appropriate estimation procedures.

Number Computation

Students will:

- add and subtract fractions with common and unlike denominators
- master addition and subtraction of larger numbers with regrouping
- master multiplication of larger numbers and long division using 2-digit divisors
- extend understanding of operations (+, -, x, ÷) to include fractions and decimals
- extend and apply addition, subtraction, multiplication, and division of common fractions and decimals with manipulatives and symbols
- explore appropriate estimation procedures.

Geometry

Students will:

- identify and model basic two- and three-dimensional shapes by appearance and in different orientations (i.e., turn models different ways).
- introduce reading and using measurement tools (rulers, scales, protractors)
- measure and construct angles to the nearest degree.
- classify angles as acute, obtuse, or right.
- find the volume of rectangular solids

Measurement

Students will:

- use charts and tables to determine time schedules and work with time zones.
- determine area and perimeter of triangles and rectangles.
- relate units (e.g., linear, volume, mass) within a measurement system (e.g., 125 cm = 1 m 25 cm).
- review English system of measurement

Algebraic Ideas

Students will:

- create, recognize, extend, find, and write rules for number patterns.
- explore variables and solve equations using variables.
- generalize a rule for ordered pairs.

Probability and Statistics

Students will:

- develop meaning and interpretation of arithmetic mean (average) for numerical data.
- pose questions; collect, organize, display data; and choose an appropriate way to collect and represent data.
- use counting techniques, tree diagrams, and tables to explore probability experiments.
- explore how sample size affects the reliability of the outcome.
- make predictions and draw conclusions
- find mean, median, mode, and range for a set of data.

Middle Level Mathematics

The content is directly aligned with Kentucky's academic expectations. These guidelines are designed to present the mathematical topics fundamental to mathematical literacy and mathematical power for all middle school students. Each content statement is interrelated with other statements and designed to be delivered in meaningful contexts, developing mathematical problem solving, communication, reasoning, and connections.

Features of middle school mathematics programs include exploration, communication, mathematical tools, manipulatives (concrete materials), calculators, hands-on activities, and group work. The students' interrelated mathematical explorations and experiences contribute to their confidence and ability to understand and address real quantitative, scientific, and technological issues.

Middle level problem solving, mathematical communications and mathematical reasoning should be a part of the mathematics curriculum.

Problem solving includes multiple strategies for modeling, interpreting, and formulating problems based in real-world situations, within and outside mathematics, and aids in investigating and understanding mathematical content.

Mathematical communication includes modeling problems including oral, written, concrete, visual, graphical, and algebraic methods to define, interpret, and argue mathematical ideas. Mathematical communication includes mathematical symbolic notation (letters and marks used in mathematics to name numbers, operations, sets, relations).

Mathematical connections include relating mathematical ideas within mathematics and with other disciplines using graphic, numerical, physical, algebraic, and verbal models.

Mathematical reasoning includes deductive and inductive reasoning necessary in developing conjectures and validating arguments. The guidelines included in this document for the middle levels are arranged sequentially by grade. However, it is the prerogative of school councils and local boards of education for schools exempt from school-based decision making to reorganize the content into a format that best meets the needs of their students, creating integrated, interdisciplinary, or multidisciplinary programs, or offer higher level coursework.

Each topic organizer is followed by the relevant academic expectations. Bulleted points denote the required content statements. Lists in parentheses (designated with an "e.g.") are suggestions for instruction and are not meant to be comprehensive. Schools or districts may arrange the content to meet the needs of their students. For example, they may offer the content in a grade-level arrangement or as integrated courses that focus on topics within units or alternate configurations. The mathematics content also provides connections to Kentucky's Learning Goal 5 (Think and Solve Problems) and Goal 6 (Connect and Integrate Knowledge). These connections provide a comprehensive link between essential content and the skills and abilities important to learning.

Grade Six

Numbers and Computation

Students will:

- continue to develop number sense including percents with fractions and decimals (including percents greater than 100% and improper fractions).
- work fluently with operations (+, -, x, ÷) of fractions and decimals.
- develop meaning of ratio and proportion (describe and compare two sets of data using ratios and appropriate notations: 3:5, 3/5, 3 to 5).
- explore exponents (e.g., squares, cubes).
- simplify fractions with prime factorization (numbers that divide exactly into a given number).
- estimate with large and small quantities of objects.
- estimate and mentally compute using fractions and decimals.
- use prime numbers, composite numbers, factors, multiples, and divisibility to solve problems.
- compare, order, and convert between whole numbers, fractions, decimals, and percents using concrete materials, drawings or pictures, and mathematical symbols (<, >, =, order on a number line).
- explore how applications of properties (e.g., commutative, associative, inverse, identity) show relationships among numbers and operations.
- solve-real world problems using a combination of the four basic operations

Geometry and Measurement

Students will:

- find perimeter of regular and irregular polygons in metric and U.S. customary units.
- extend the use of measurement tools (e.g., rulers, scales, protractor, compass).
- find area of plane figures composed of squares and rectangles through subdividing and measuring and use square units appropriately.
- estimate, compare, and convert units of measures for length, weight/mass, and volume/capacity within the U.S. customary system and within the metric system:
 - a) length (e.g., parts of an inch, inches, feet, yards, miles, millimeter, centimeter, kilometer;
 - b) weight/mass (e.g., pounds, tons, grams, kilograms); and
 - c) volume/capacity (e.g., cups, pints, quarts, gallons, milliliters, liters). (The intent of this standard is for students to make ballpark comparisons and not to memorize conversion factors between U.S. and metric units.)
- estimate and find angle measurement and segment measurements.
- formulate the rule that the sum of angle measurements is 180 degrees in a triangle and 360 degrees in a quadrilateral.

- identify properties and classify line segments, rays, planes, and points.
- recognize regular polygons; special quadrilaterals including squares, rectangles, rhombuses, trapezoids, and parallelograms; and special triangles including acute, obtuse, scalene, and isosceles.
- identify characteristics of lines (e.g., parallel, perpendicular).
- use lines of symmetry and sketch plane figures with multiple lines of symmetry.

Probability and Statistics

Students will:

- collect, organize, analyze, and interpret data in a variety of graphical methods, including line plots, line graphs, bar graphs, and stem and leaf plots.
- make predictions, draw conclusions, and verify results from statistical data and probability experiments.
- select an appropriate graph to represent given data.
- compare data from various types of graphs.
- investigate solutions to probability problems, using counting techniques, tree diagrams, charts, and tables.
- recognize the role of probability in decision making.
- apply range and measures of central tendency (mean, median, mode).

Algebraic Ideas

Students will:

- recognize, create, and continue patterns (give an informal description for the continuance of the pattern and/or generalize patterns through a verbal rule).
- represent, interpret, and describe function relationships through tables, graphs, and verbal rules.
- write and solve equations with one variable, using concrete and/or informal methods that model everyday situations.
- explore the concept of variable, expression, and equation.
- solve problems involving simple formulas (i.e., $A = 1w$, $P = 21 + 2w$).
- interpret relationships between tables and graphs.
- organize data into tables and plot points onto the first quadrant of a coordinate (Cartesian) system/grid.

Grade 7

Numbers and Computation

Students will:

- extend number sense for percents and integers.
- extend understanding of operations ($=$, $-$, \times , \div) to include integers.
- develop number sense for pi as one example of an irrational number.
- apply meaning of ratio and proportion to problems.
- use whole number exponents.
- extend and apply addition, subtraction, multiplication, and division of integers both concretely and symbolically (mental, pencil and paper, calculators).
- extend concepts and application of operations with fractions and decimals to include percents.
- compute percentages of numbers and use percentages in proportional reasoning.
- estimate and mentally compute using integers and percents.
- solve proportions.
- compare, order, and determine equivalent relationships among fractions, decimals, and percents.
- explain and apply properties (e.g., commutative, associative, distributive, inverse, identity).
- develop proportional thinking, rates, scaling, and similarity.
- extend positive and negative number operations
- use estimation to check reasonableness of results
- solve real-world problems using a combination of the four basic operations
- perform calculations involving conversions between units within a system (length, capacity, mass)

Geometry and Measurement

Students will:

- find circle measurements (radius, diameter, circumference, area) and the relationships among them.
- develop and use the formulas for area of triangles, parallelograms, and trapezoid; relate to the formula for area of rectangles ($l \times w$).
- investigate fixed area with changing perimeter and fixed perimeter with changing area.
- investigate area of polygons and other two-dimensional shapes.
- identify and classify characteristics of two-dimensional shapes, such as regular and irregular quadrilaterals, special triangles, and regular polygons.
- identify characteristics of angles (e.g., adjacent, vertical, corresponding, interior, exterior).

- represent three-dimensional geometric figures with special attention to developing spatial sense (e.g., top view, side view, three-dimensional shapes drawn on isometric dot paper).
 - move shapes in a plane: (e.g., translate (slide), rotate (turn), reflect (flip))
 - construct, analyze, and compare 2-dimensional figures (e.g. perpendicular bisector, angle bisector)
 - develop and apply formulas for volume and surface area of prisms, pyramids, cylinders, etc. and investigate relationships between and among them
 - extend conversion units (i.e. length, capacity, and mass) within the U.S. customary system and within the metric system
 - identify temperatures of boiling water, normal body temperature, or water freezing in Fahrenheit and Celsius

Probability and Statistics

Students will:

- collect, organize, analyze, and interpret data in a variety of graphical methods, including circle graphs, multiple line graphs, bar graphs, and stem and leaf plots.
- make predictions, draw conclusions, and verify results from statistical data and probability experiments.
- select an appropriate graph to represent given data and justify its use.
- compare data from various types of graphs.
- determine appropriate techniques to use when investigating solutions to probability problems (using counting techniques; tree diagrams; area models; and exhaustive, organized lists, charts, and tables).
- investigate and explain the role of probability in decision making.
- determine and apply the most appropriate measures of central tendency (e.g. mean, median, mode) and/or dispersion (e.g., range).
- design and conduct probability experiments.
- determine theoretical (mathematical) probabilities, compare to experimental results, and explain reasons why there might be differences, (e.g., express probability as a ratio, decimal, or a percent as appropriate for a given situation).
- explore concepts of randomness and independent events.
- determine and interpret clusters, quartiles, gaps, and outliers in data

Algebraic Ideas

Students will:

- recognize, create, and continue patterns and generalize the pattern by giving the rule for any term.
- represent, interpret, and describe functional relationships through tables, graphs, and verbal rules (input/output).
- understand the concept of equations and inequalities using variables as they relate to everyday situations.
- simplify numeric and algebraic expressions.
- use a variety of methods and representations to create and solve single-variable equations that may be applied to everyday situations.
- solve problems involving formulas.
- organize data into tables and plot points onto all four quadrants of a coordinate (Cartesian) system/grid and interpret resulting patterns or trends.
- interpret relationships between tables, graphs, verbal rules, and equations.

Grade Eight

Number and Computation

Students will:

- use percents, decimals, integers, and fractions (include percents less than 1).
- use percentages and proportions in consumer applications (e.g., simple interest, percentages of increase or decrease, discounts, unit pricing, sale prices).
- use irrational numbers (e.g., square roots).
- relate irrational and rational numbers (e.g., magnitude, order on a number line).
- determine the inverse relationship between addition and subtraction, multiplication and division, or raising to an exponent and taking the root of a number.
- extend positive and negative number operations

Geometry and Measurement

Students will:

- discover and apply the Pythagorean theorem.
- derive and use formulas for various rates (e.g., distance/time, miles per hour).
- develop and apply formulas for volume and surface area of cubes, cylinders, and rectangular prisms; and investigate relationships between and among them.
- develop and apply proportionality and relationships between scale models and actual figures.
- investigate transformations' congruence, proportionality, and similarity (e.g., enlargements, reductions, proportional triangles) in a coordinate plane.
- investigate counting techniques through shortest paths (e.g., networks).

Probability and Statistics

Students will:

- collect, organize, analyze, and interpret data in a variety of graphical methods (e.g., circle graphs, scatter plots, box and whisker plots, histograms).
- make predictions, draw conclusions, and verify results from statistical data and probability experiments.
- select an appropriate graph to represent given data and justify its use.
- compare data from various types of graphs.
- recognize that statistics can be interpreted in many ways.
- analyze situations, such as games of chance, board games, or grading scales, and make predictions using knowledge of probability.

- identify and describe the number of possible arrangements of several objects, using a tree diagram or the basic counting principle, and make a sample space represented in the form of a list, picture, chart, or a tree diagram.
- investigate and explain the role of probability in everyday decision making.
- design and conduct probability experiments and interpret the results.
- explore concepts of randomness and independent events.
- determine theoretical (mathematical) probabilities, compare that to experimental results, and explain reasons why there might be differences (e.g., express probability as a ratio, decimal, percent as appropriate for a given situation).
- determine and interpret clusters, quartiles, gaps, and outliers in data.

Algebraic Ideas

Students will:

- recognize, create, and continue patterns (generalize the pattern by giving the rule for the n th term and defend the generalization).
- represent, interpret, and describe functional relationships through tables, graphs, and symbolic rules (input/output).
- explain how change in one variable affects change in another variable (e.g., in distance equals rate times time, increasing time, increases distance).
- use a variety of methods and representations to create and solve one- and two-variable linear equations that require two steps.
- simplify algebraic expressions.
- investigate inequalities using a variety of methods and representations.
- solve problems involving substitutions and formulas.
- organize data into tables, plot points onto all four quadrants of a coordinate (Cartesian) system/grid, interpret resulting patterns or trends.
- interpret and explain relationships between tables, graphs, verbal rules, and equations.
- graph linear functions in a four quadrant (Cartesian) system/grid and interpret the results.
- determine the slope and equation of a line by analyzing the line (e.g., $Y = mx + b$; m is rise/run, b is y - intercept).

*The high school
curriculum guidelines are
not available at the
time of this printing.*