Standard 1: Number and Computation – The student uses numerical and computational concepts and procedures in a variety of situations.

Benchmark 1: Number Sense – The student demonstrates number sense for whole numbers, fractions, and money using concrete objects in a variety of situations.

Second Grade Knowledge Base Indicators	Second Grade Application Indicators
The student… 1. ■ knows, explains, and represents whole numbers from 0 through 1,000 using concrete objects (2.4.K1a) **($)**. 2. compares and orders: a. whole numbers from 0 through 1,000 using concrete objects (2.4.K1a) **($)**; b. fractions greater than or equal to zero with like denominators (halves, fourths, thirds, eighths) using concrete objects (2.4.K1a,c). 3. uses addition and subtraction to show equivalent representations for whole numbers from 0 through 100 (2.4.K1a-b), e.g., 8 – 5 = 2 + 1 or 20 + 40 = 70 – 10. 4. identifies and uses ordinal positions from first (1^{st}) through twentieth (20^{th}) (2.4.K1a). 5. ▲identifies coins, states their values, and determines the total value to $1.00 of a mixed group of coins using pennies, nickels, dimes, quarters, and half-dollars (2.4.K1d) **($)**. 6. counts a like combination of currency ($1, $5, $10, $20) to $100 (2.4.K1d) **($)**.	The student... 1. solves real-world problems using equivalent representations and concrete objects to **($)**: a. compare and order whole numbers from 0 through 1,000 (2.4.A1b), e.g., using base ten blocks, represent the students in each class in the school; represent the numbers using digits (24) and compare and order in different ways; b. add and subtract whole numbers from 0 through 100 (2.4.A1b), e.g., using base ten blocks, represent the number of students in each class in the school; find the total of all students in grades K, 1, and 2 and the total of all of the students in grades 3, 4, and 5 and then subtract to find the difference between the primary and intermediate grades; c. compare and order a mixed group of coins to $1.00 (2.4.A1c), e.g., use actual coins to show 2 different amounts; students write: 47¢ is more than 31¢; d. find equivalent values of coins to $1.00 without mixing coins (2.4.A1c), e.g., 50 pennies = 2 quarters, 5 dimes = 2 quarters, or 10 nickels = 2 quarters. 2. determines whether or not numerical values that involve whole numbers from 0 through 1,000 are reasonable (2.4.A1a-b) **($)**, e.g., if there are 26 children, plus 10 more children, is it reasonable to say there are 50 children?

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Teacher Notes: Number sense refers to one's ability to reason with numbers and to work with numbers in a flexible way. The ability to compute mentally, to estimate based on understanding of number relationships and magnitudes, and to judge reasonableness of answers are all involved in number sense.

When we say that someone has good number sense, we mean that he or she possesses a variety of abilities and understandings that include an awareness of the relationships between numbers, an ability to represent numbers in a variety of ways, a knowledge of the effects of operations, and an ability to interpret and use numbers in real-world counting and measurement situations. Such a person predicts with some accuracy the result of an operation and consistently chooses appropriate measurement units. This "friendliness with numbers" goes far beyond mere memorization of computational algorithms and number facts; it implies an ability to use numbers flexibly, to choose the most appropriate representation of a number for a given circumstance, and to recognize when operations have been correctly performed. (Number Sense and Operations: Addenda Series, Grades K-6, NCTM, 1993)

Mathematical models such as concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or base ten blocks are necessary for conceptual understanding and should be used to explain computational procedures. If a mathematical model can be used to represent the concept, the indicator in the Models benchmark is identified in the parentheses. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models). Then, the indicator in the Models benchmark lists some of the mathematical models that could be used to teach the concept. In addition, each indicator in the Models benchmark is linked back to the other indicators. Those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3.

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Standard 1: Number and Computation – The student uses numerical and computational concepts and procedures in a variety of situations.

Benchmark 2: Number Systems and Their Properties – The student demonstrates an understanding of whole numbers with a special emphasis on place value and recognizes, uses, and explains the concepts of properties as they relate to whole numbers in a variety of situations.

Second Grade Knowledge Base Indicators	Second Grade Application Indicators
The student... 1. reads and writes **($)**: a. whole numbers from 0 through 1,000 in numerical form, e.g., 942 is read as nine hundred forty-two and is written in numerical form as 942; b. whole numbers from 0 through 100 in words, e.g., 76 is read as seventy-six and is written in words as seventy-six. c. whole numbers from 0 through 1,000 in numerical form when presented in word form, e.g., nine hundred forty-six is read as nine hundred forty-six and is written as 946. 2. ▲ represents whole numbers from 0 through 1,000 using various groupings and place value models emphasizing 1s, 10s, and 100s; explains the groups; and states the value of the digit in ones place, tens place, and hundreds place (2.4.K1b) **($)**, e.g., in 385, the 3 represents 3 hundreds, 30 tens, or 300 ones; the 8 represents 8 tens or 80 ones; and the 5 represents 5 ones. 3. counts subsets of whole numbers from 0 through 1,000 forwards and backwards (2.4.K1a) **($)**, e.g., 311, 312, …, 320; or 210, 209, …, 204. 4. ▲ identifies the place value of the digits in whole numbers from 0 through 1,000 (2.4.K1b) **($)**. 5. identifies any whole number from 0 through 100 as even or odd (2.4.K1a). 6. **uses** the **concepts** of these properties with whole numbers from 0 through 100 and demonstrates their meaning including the use of concrete objects (2.4.K1a) **($)**: a. commutative property of addition, e.g., 5 + 6 = 6 + 5;	The student... 1. solves real-world problems with whole numbers from 0 through 100 using place value models and the concepts of these properties to explain reasoning (2.4.A1a-b) **($)**: a. commutative property of addition, e.g., group 17 students into a 9 and an 8, add to find the total, then reverse the students to show 8 + 9 still equals 17; b. zero property of addition, e.g., have students lay out 22 crayons, tell them to add zero (crayons). How many crayons? 22 + 0 = 22. 2. performs various computational procedures with whole numbers from 0 through 100 using these properties and explains how they were used (2.4.A1b): a. commutative property of addition (5 + 6 = 6 + 5), e.g., given 6 + 5, the student says: I know that the answer is 11 because 5 + 6 is 11 and the order you add them in does not matter; b. zero property of addition (17 + 0 = 0 + 17*)*, e.g., given 17 + 0, the student says: I know that the answer is 17 because adding 0 does not change the answer (sum).

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b. zero property of addition (additive identity), e.g., 4 + 0 = 4; c. associative property of addition, e.g., (3 + 2) + 4 = 3 + (2 + 4); d. symmetric property of equality applied to basic addition and subtraction facts, e.g., 10 = 2 + 8 is the same as 2 + 8 = 10 or 7 = 10 – 3 is the same as 10 – 3 = 7.	

Teacher Notes: From the *Mathematics Dictionary and Handbook (Nichols Schwartz Publishing, 1999)*, **property** as a mathematical term means a characteristic (an attribute) of a number, geometric shape, mathematical operation, equation, or inequality. To give an example:

- Property of a number: 8 is divisible by 2.
- Property of a geometric shape: Each of the four sides of a square is of the same length.
- Property of an operation: Addition is commutative. For all numbers x and y, x + y = y + x.
- Property of an equation: For all numbers a, b, and c, if a = b, then a + c = b + c.
- Property of an inequality: For all numbers a, b, and c, if a > b, then a – c > b – c.

Mathematical models such as concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or base ten blocks are necessary for conceptual understanding and should be used to explain computational procedures. If a mathematical model can be used to represent the concept, the indicator in the Models benchmark is identified in the parentheses. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models). Then, the indicator in the Models benchmark lists some of the mathematical models that could be used to teach the concept. In addition, each indicator in the Models benchmark is linked back to the other indicators. Those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3.

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Standard 1: Number and Computation – The student uses numerical and computational concepts and procedures in a variety of situations.

Benchmark 3: Estimation – The student uses computational estimation with whole numbers and money in a variety of situations.

Second Grade Knowledge Base Indicators	**Second Grade Application Indicators**
The student... 1. estimates whole number quantities from 0 through 1,000 and monetary amounts through $50 using various computational methods including mental math, paper and pencil, concrete objects, and appropriate technology (2.4.Ka-b,d) **($)**. 2. uses various estimation strategies to estimate whole number quantities from 0 through 1,000 (2.4.K1a) **($)**.	The student... 1. adjusts original whole number estimate of a real-world problem using numbers from 0 through 1,000 based on additional information (a frame of reference) (2.4.A1a) **($)**, e.g., given a pint container and told the number of marbles it has in it, the student would estimate the number of marbles in a quart container. 2. estimates to check whether or not the result of a real-world problem using whole numbers from 0 through 1,000 and monetary amounts through $50 is reasonable and makes predictions based on the information (2.4.A1a-c) **($)**, e.g., in the lunchroom, good behavior that day can earn the class an extra 5 minutes of recess. Is it reasonable to think you can earn an hour of extra recess in one week? After answering the first question, then ask: About how many days would it take? 3. selects a reasonable magnitude from three given quantities, a one-digit numeral, a two-digit numeral, and a three-digit numeral (5, 50, 500) based on a familiar problem situation and explains the reasonableness of the selection (2.4.A1a), e.g., could the basket of fruit on the kitchen table hold 7 apples, 70 apples, or 700 apples? The student chooses 7 apples because apples are about the size of baseballs and 7 will fit in a basket on the kitchen table.

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Teacher Notes: Estimate, as a verb, means to make an educated guess based on information in a problem or to give an answer close to the exact number. Estimation is used when an exact answer is not needed, as in many real-life situations for which "ballpark" computations are acceptable. Good number sense enables one to estimate a quantity, estimate a measure, or estimate an answer.

Estimation serves as an important companion to computation. It provides a tool for judging the reasonableness of computational methods including mental math, paper and pencil, concrete objects, and appropriate technology. However, being able to compute does not automatically lead to an ability to estimate or judge reasonableness of answers. Frequent modeling by the teacher helps students develop a range of estimation strategies. Students should be encouraged to frequently explain their thinking as they estimate. As with exact computation, sharing estimation strategies allows students access to others' thinking and provides opportunities for class discussion. Identifying the estimation strategy by name is not critical; however, explaining the thinking behind the strategy to make a valid estimation is important. (*Principles and Standards for School Mathematics*, NCTM, 2000)

Mental math and **estimation** are distinct but related mathematical skills. Proficiency in mental math contributes to increased skill in estimation. Students develop mental math and estimation easier when they are taught specific strategies. An estimation strategy for the early grades is front-end. The focus is on the "front-end" or the leftmost digit because these digits are the most significant for forming an estimate. In order for students to become more familiar with estimation, teachers should introduce estimation with examples where rounded or estimated numbers are used. Emphasis should be placed on real-world examples where only estimation is required, e.g., About how many hours do you sleep a night? Using the language of estimation is important, so students begin to realize that a variety of estimates (answers) are possible. In addition to front-end estimation and rounding, another estimation strategy is compatible "nice" numbers.

Mathematical models such as concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or base ten blocks are necessary for conceptual understanding and should be used to explain computational procedures. If a mathematical model can be used to represent the concept, the indicator in the Models benchmark is identified in the parentheses. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models). Then, the indicator in the Models benchmark lists some of the mathematical models that could be used to teach the concept. In addition, each indicator in the Models benchmark is linked back to the other indicators. Those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3.

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Standard 1: Number and Computation – The student uses numerical and computational concepts and procedures in a variety of situations.

Benchmark 4: Computation – The student models, performs, and explains computation with whole numbers and money using concrete objects in a variety of situations.

Second Grade Knowledge Base Indicators	Second Grade Application Indicators
The student... 1. computes with efficiency and accuracy using various computational methods including mental math, paper and pencil, concrete objects, and appropriate technology (2.4.K1a) **($).** 2. **N** states and uses with efficiency and accuracy basic addition facts with sums from 0 through 20 and corresponding subtraction facts (2.4.K1a) **($)**. 3. skip counts by 2s, 5s, and 10s through 100 and skip counts by 3s through 36 (2.4.K1a). 4. uses repeated addition (multiplication) with whole numbers to find the sum when given the number of groups (ten or less) and given the same number of concrete objects in each group (twenty or less) (2.4.K1a) **($)**, e.g., five classes of 15 students visit the zoo; 15 + 15 + 15 + 15 + 15 = 75. 5. uses repeated subtraction (division) with whole numbers when given the total number of concrete objects in each group to find the number of groups (2.4.K1a) **($)**, e.g., there are 25 cookies. If each student gets 3 cookies, how many students get cookies? 25 – 3 – 3 – 3 – 3 – 3 – 3 – 3 – 3 or 25 minus 3 eight times means eight students get 3 cookies each and there is 1 cookie left over. 6. fair shares/measures out (divides) a total amount through 100 concrete objects into equal groups (2.4.K1a-b), e.g., fair sharing 48 eggs into four groups resulting in four groups of 12 eggs or measuring out 48 eggs with 12 eggs in each group resulting in four groups of 12 eggs.	The student... 1. solves one-step real-world addition or subtraction problems with various groupings of **($)**: a. two-digit whole numbers with regrouping (24A1a-b), e.g., for the food drive, the class collected 64 cans (cylinders) and 28 boxes (rectangular prisms). How many did they collect in all? This problem could be solved with base 10 models, or by saying 64 + 20 = 84 and 84 + 8 = 92 or 60 + 20 = 80 and 4 + 8 = 12 and 80 + 12 = 92 or with the traditional algorithm; b. monetary amounts to 99¢ with regrouping (2.4.A1a-c), e.g., an extra carton of milk costs 25¢. If three students want an extra carton, how much money should the teacher collect? The student could solve by using coins (q + q + q or d + d + n + d + d + n + d + d + n) or by counting by 25s or by drawing or using base 10 models or with the traditional algorithm. 2. generates a family of basic addition and subtraction facts given one fact/equation (2.4.A1a), e.g., given 9 + 8 = 17; the other facts are 8 + 9 = 17, 17 – 8 = 9, and 17 – 9 = 8.

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7. ▲ **N** performs and explains these computational procedures: a. ■ adds and subtracts three-digit whole numbers with and without regrouping including the use of concrete objects (2.4.K1a-b), b. adds and subtracts monetary amounts through 99¢ using cent notation (25¢ + 52¢) and money models (2.4.K1a-b,d) **($)**. 8. ▲**N** identifies basic addition and subtraction fact families (facts with sums from 0 through 20 and corresponding subtraction facts) (2.4.K1a). 9. reads and writes horizontally and vertically the same addition or subtraction expression e.g., 6 – 3 is the same as 6. -3	

Teacher Notes: Efficiency and accuracy means that students are able to compute single-digit numbers with fluency. Students increase their understanding and skill in single-digit addition and subtraction by developing relationships within addition and subtraction combinations and by counting on for addition and counting up for subtraction and unknown-addend situations. Students learn basic number combinations and develop strategies for computing that makes sense to them. Through class discussions, students can compare the ease of use and ease of explanation of various strategies. In some cases, their strategies for computing will be close to conventional algorithms; in other cases, they will be quite different. Many times, students' invented approaches are based on a sound understanding of numbers and operations, and these invented approaches often can be used with efficiency and accuracy. (*Principles and Standards for School Mathematics*, NCTM, 2000)

The definition of computation is finding the standard representation for a number. For example, 6 + 6, 4 x 3, 17 – 5, and 24 ÷ 2 are all representations for the standard representation of 12. **Mental math** is mentally finding the standard representation for a number — calculating in your head instead of calculating using paper and pencil or technology. One of the main reasons for teaching mental math is to help students determine if a computed/calculated answer is reasonable, in other words, using mental math to estimate to see if the answer makes sense. Students develop mental math skills easier when they are taught specific strategies. Mental math strategies for the early grades include counting on, counting back, counting up, doubling numbers (doubles), and making ten. Other mental math strategies for the early grades include skip counting and using number patterns.

One way to improve the understanding of numbers and operations is to encourage children to develop computational procedures that are meaningful to them. Invented procedures promote the idea of mathematics as a meaningful activity. This is not to suggest that algorithm invention is the only way to promote student understanding or that children should be discouraged from using a standard algorithm if that is their choice. Different problems are best solved by different methods. For example, solving 7000 – 25 by counting down by tens and fives, yet solving 41 – 25 by adding up, or decomposing, the numbers. Another example is adding 52 + 45; a student may count, "52, 62, 72, 82, 92, plus 5 is 97." ("Invented Strategies Can Develop Meaningful Mathematical Procedures") by William M. Carroll and Denise Porter, Teaching Children Mathematics, March 1997, pp. 370-374)

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Regrouping refers to the reorganization of objects. In computation, **regrouping** is based on a "partitioning to multiples of ten" strategy. For example, 46 + 7 could be solved by partitioning 46 into 40 and 6, then 40 + (6 + 7) = 40 + 13 (and then 13 is partitioned into 10 and 3) which then becomes (40 + 10) + 3 becomes 50 + 3 = 53 *or* 7 could be partitioned as 4 and 3, then 46 + 4 (bridging through 10) = 50 and 50 + 3 = 53. Before algorithmic procedures are taught, an understanding of "what happens" must occur. For this to occur, instruction should involve the use of structured manipulatives. To emphasize the role of the base ten numeration system in algorithms, some form of expanded notation is recommended. During instruction, each child should have a set of manipulatives to work with rather than sit and watch demonstrations by the teacher. Some additional computational strategies include *doubles plus one or two* (i.e., 6 + 8, 6 and 6 are 12, so the answer must be 2 more or 14), *compensation* (i.e., 9 + 7, if one is taken away from 9, it leaves 8; then that one is given to 7 to make 8, then 8 + 8 = 16), *subtracting through ten* (i.e., 13 – 5, 13 take away 3 is 10, then take 2 more away from 10 and that is 8), and *nine is one less than ten* (i.e., 9 + 6, 10 and 6 are 16, and 1 less than 16 makes 15). (Teaching Mathematics in Grades K-8: Research Based Methods, ed. Thomas R. Post, Allyn and Bacon, 1988)

Mathematical models such as concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or base ten blocks are necessary for conceptual understanding and should be used to explain computational procedures. If a mathematical model can be used to represent the concept, the indicator in the Models benchmark is identified in the parentheses. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models). Then, the indicator in the Models benchmark lists some of the mathematical models that could be used to teach the concept. In addition, each indicator in the Models benchmark is linked back to the other indicators. Those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3.

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Standard 2: Algebra – The student uses algebraic concepts and procedures in a variety of situations.

Benchmark 1: Patterns – The student recognizes, describes, extends, develops, and explains relationships in patterns using concrete objects in a variety of situations.

Second Grade Knowledge Base Indicators	Second Grade Application Indicators
The student... 1. uses concrete objects, drawings, and other representations to work with **types** of patterns (2.4.K1a): a. repeating patterns, e.g., an AB pattern is like left-right, left-right, …; an ABC pattern is like dog-horse-pig, dog-horse-pig, …; an AAB pattern is like ↑↑→, ↑↑→, …; b. growing (extending) patterns, e.g., 7, 9, 11, … where the rule could be add 2 or the odd numbers beginning with 7. 2. uses the following **attributes** to generate patterns: a. counting numbers related to number theory (2.4.K1a), e.g., evens, odds, or skip counting by 3s, or 4s; b. whole numbers that increase or decrease (2.4.K1a) **($)**, e.g., 11, 22, 33, ... or 98, 88, 78, …; c. geometric shapes (2.4.K1f), e.g., Δ-O-O, Δ-O-O, …; d. measurements (2.4.K1a), e.g., 1”, 3”, 5”, … or 5 lbs, 10 lbs, 15 lbs, …; e. the calendar (2.4.K1a), e.g., Sunday, Monday, Tuesday, …; f. money and time (2.4.K1a,d) **($)**, e.g., $5, $10, $15, ... or 1:15, 1:30, 1:45, …; g. things related to daily life (2.4.K1a), e.g., seasons, temperature, or weather; h. things related to size, shape, color, texture, or movement (2.4.K1a), e.g., ◈◈,◈◈, ◈◈, … ; or snapping fingers, clapping hands, or stomping feet or over, under, or behind using a bean bag toss (kinesthetic patterns). 3. ▲ ■ identifies and continues a pattern presented in various formats including numeric (list or table), visual (picture, table, or graph), verbal (oral description), kinesthetic (action), and written (2.4.K1a) **($)**.	The student... 1. generalizes these patterns using a written description: a. whole number patterns(2.4.A1a) **($)**; b. patterns using geometric shapes (2.4.A1d); c. calendar patterns (2.4.A1a); d. money and time patterns (2.4.A1a,c) **($)**; e. patterns using size, shape, color, texture, or movement (2.4.A1a);- 2. recognizes multiple representations of the same pattern (2.4.A1a), e.g., the ABB pattern could be represented by clap, snap, snap, … or red, blue, blue, … or square, circle, circle, …. 3. uses concrete objects to model a whole number patterns (2.4.A1a), e.g., counting by twos: 💧💧, 💧💧 💧💧 💧💧, 💧💧 💧💧, …; counting by fives: xxxxx, xxxxx xxxxx xxxxx, xxxxx xxxxx, …; counting by tens: ■■■■■■■■■■■, ■■■■■■■■■■■ ■■■■■■■■■■■ ■■■■■■■■■■■, ■■■■■■■■■■■ ■■■■■■■■■■■, …; counting by twenty-fives: 

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4. generates (2.4.K1a): repeating patterns, e.g., 1-2, 1-2, 1-2, … where the elements repeat; growing (extending) patterns, e.g., 1, 4, 7, …where the rule is add 3.	

Teacher Notes: Working with **patterns** is an important process in the development of mathematical thinking. Patterns can be based on geometric attributes (shapes, regions, angles); measurement attributes (color, texture, length, weight, volume, number); relational attributes (proportion, sequence, functions); and affective attributes (values, likes, dislikes, familiarity, heritage, culture). (Learning to Teach Mathematics, Randall J. Souviney, Macmillan Publishing Company, 1994)

This process (working with patterns) can be used to develop or deepen understandings of important concepts in number theory, whole numbers, measurement, geometry, probability, and functions. Working with patterns provides opportunities for students to recognize, describe, extend, develop, and explain.

Number theory is the study of the properties of the counting numbers (positive integers), their relationships, ways to represent them, and patterns among them. Number theory includes the concepts of odd and even numbers, factors and multiples, primes and composites, and greatest common factor and least common multiple.

Mathematical models such as concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or base ten blocks are necessary for conceptual understanding and should be used to explain computational procedures. If a mathematical model can be used to represent the concept, the indicator in the Models benchmark is identified in the parentheses. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models). Then, the indicator in the Models benchmark lists some of the mathematical models that could be used to teach the concept. In addition, each indicator in the Models benchmark is linked back to the other indicators. Those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3.

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Standard 2: Algebra – The student uses algebraic concepts and procedures in a variety of situations.

Benchmark 2: Variables, Equations, and Inequalities – The student uses symbols and whole numbers to solve addition and subtraction equations using concrete objects in a variety of situations.

Second Grade Knowledge Base Indicators	Second Grade Application Indicators
The student... 1. explains and uses symbols to represent unknown whole number quantities from 0 through 100 (2.4.K1a). 2. finds the sum or difference in one-step equations with : **($)** a. whole numbers from 0 through 99 (2.4.K1a-b), e.g., 32 + 19 = Δ or Δ = 79 – 46; b. up to two different coins (2.4.K1d), e.g., nickel + penny = Δ¢. 3. finds unknown addend or subtrahend using basic addition and subtraction facts (fact family) (2.4.K1a) **($)**, e.g., 12 = Δ + 7 or 12 – Δ = 7. 4. describes and compares two whole numbers from 0 through 1,000 using the terms: is equal to, is less than, is greater than (2.4.K1a-b) **($)**.	The student... 1. represents real-world problems using symbols and whole numbers from 0 through 30 with one operation (addition, subtraction) and one unknown (2.4.A1a) **($)**, e.g., when asked to give the total number of students in class today, the students write: 14 boys and 9 girls = □ students. 2. generates (2.4.A1a) **($)**: a. addition or subtraction equations to match a given real-world problem with one operation and one unknown using whole numbers from 0 through 99, e.g., a boy has 45 stickers. How many more stickers does he need to have 80 stickers? This is represented by 45 + n = 80 or 80 – 45 = n. b. a real-world problem to match a given addition or subtraction equation with one operation using the basic facts, e.g., the student is given the addition equation, 9 + ■ = 17 and writes this problem situation: You have 9¢ and a piece of candy costs 17¢. How much more money do you need to buy the candy?

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Teacher Notes: Understanding the **concept of variable** is fundamental to algebra. In the early grades, students use various symbols including letters and geometric shapes to represent unknown quantities that both do and do not vary. Quantities that are not given and do not vary are often referred to as **unknowns** or **missing elements** when they appear in equations, e.g., 2 + 4 = Δ.

Mathematical models such as concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or base ten blocks are necessary for conceptual understanding and should be used to explain computational procedures. If a mathematical model can be used to represent the concept, the indicator in the Models benchmark is identified in the parentheses. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models). Then, the indicator in the Models benchmark lists some of the mathematical models that could be used to teach the concept. In addition, each indicator in the Models benchmark is linked back to the other indicators. Those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3.]

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Standard 2: Algebra – The student uses algebraic concepts and procedures in a variety of situations.

Benchmark 3: Functions – The student recognizes and describes whole number relationships using concrete objects in a variety of situations.

Second Grade Knowledge Base Indicators	Second Grade Application Indicators
The student... 1. states mathematical relationships between whole numbers from 0 through 100 using various methods including mental math, paper and pencil, and concrete objects (2.4.K1a) **($)**, e.g., every time a dog is added to the pack, 2 more ears are added to the total. 2. finds the values and determines the rule that involve addition or subtraction of whole numbers from 0 through 100 using a horizontal or vertical function table (input/output machine, T-table) (2.4.K1e), e.g., after looking at the function table, different students might respond that the rule is In + 2 equals Out, the rule is N + 2, or the rule is plus 2. (see table below) 3. generalizes numerical patterns using whole numbers from 0 through 100 with one operation (addition, subtraction) by stating the rule using words, e.g., if a set of numbers is 2, 4, 6, 8,10, …; the rule is add two.	The student... 1. represents and describes mathematical relationships between whole numbers from 0 through 100 using concrete objects, pictures, oral descriptions, and symbols (2.4.A1a) **($)**. 2. finds the rule, states the rule, and extends numerical patterns with whole numbers from 0 through 100 (2.4.A1a), e.g., given 1, 3, 5, 7, 9 and continues with 11, 13, 15, 17, … recognizing that the pattern could be the odd numbers.

In	Out
9	11
2	4
13	15
42	44
57	59
6	?
72	?
N	?

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Teacher Notes: Functions are relationships or rules in which each member of one set is paired with one, and only one, member of another set (an ordered pair). The concept of function can be introduced using function machines. Any number put in the machine will be changed according to some rule. A record of inputs and corresponding outputs can be maintained in a two-column format. Function tables, input/output machines, and T-tables may be used interchangeably and serve the same purpose.

Function concepts should be developed from **growing patterns**. Each term in a number sequence is related to its position in the sequence — the functional relationship. The pattern – 4, 7, 10, 13, 16, 19, and so on – is an arithmetic sequence *with a difference of 3*. The pattern could be described as *add 3* meaning that 3 must be added to the previous term to find the next. This pattern is explained by using the recursive definition for a sequence. The recursive definition for a sequence is a statement or a set of statements that explains how each successive term in the sequence is obtained from the previous term(s).

In the pattern 1, 4, 9, 16, 25, …, 225; there is *no common difference.* This sequence is not arithmetic or geometric (no common ratio between geometric terms). Neither is it a combination of the two; however, there is a pattern and the missing terms between 25 and 225 can be found. To find the term value, square the number of the term. The next missing terms would be 36, 49, 64, 81, 100, 121, and 144. This pattern is explained by using the explicit formula for a sequence. The explicit formula for a sequence defines a rule for finding each term in the number sequence related to its position in the sequence. In other words, to find the term value, square the number of the term — the 5^{th} term is 5^2, the 8^{th} term is 8^2, ….

Patterns themselves are not explicit or recursive. The *RULE* for the pattern can be expressed explicitly or recursively and *MOST* patterns can be explained using either format especially *IF* that pattern reflects either an arithmetic sequence or geometric sequence.

Mathematical models such as concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or base ten blocks are necessary for conceptual understanding and should be used to explain computational procedures. If a mathematical model can be used to represent the concept, the indicator in the Models benchmark is identified in the parentheses. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models). Then, the indicator in the Models benchmark lists some of the mathematical models that could be used to teach the concept. In addition, each indicator in the Models benchmark is linked back to the other indicators. Those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3.

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Standard 2: Algebra – The student uses algebraic concepts and procedures in a variety of situations.

Benchmark 4: Models – The student uses mathematical models including concrete objects to represent, show, and communicate mathematical relationships in a variety of situations.

Second Grade Knowledge Base Indicators	Second Grade Application Indicators
The student... 1. knows, explains, and uses mathematical models to represent mathematical concepts, procedures, and relationships. Mathematical models include: a. process models (concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or measurement tools) to model computational procedures and mathematical relationships, to compare and order numerical quantities, and to represent fractional parts (1.1.K1-4, 1.2.K3, 1.2.K5-6, 1.3.K1-2, 1.4.K1-8, 2.1.K1, 2.2K1, 2.1K1a-b, 2.1K1d-h, 2.1.K3-4, 2.2.K2a, 2.2.K3-4, 2.3.K1, 3.2.K1-5, 3.3.K1, 3.4.K1-3, 4.2.K3-5) **($)**; b. place value models (place value mats, hundred charts, or base ten blocks) to compare, order, and represent numerical quantities and to model computational procedures (1.1.K3, 1.2.K2, 1.2.K4, 1.3.K1, 1.4.K6-7, 1.4.K7a, 2.2.K2a, 2.2.K4) **($)**; c. fraction models (fraction strips or pattern blocks) to compare, order, and represent numerical quantities (1.1.K2b) **($)**; d. money models (base ten blocks or coins) to compare, order, and represent numerical quantities (1.1.K5-6, 1.3.K1, 1.4.K7b, 2.1.K1f, 2.2.K2b) **($)**; e. function tables (input/output machines, T-tables) to model numerical relationships (2.3.K2) **($)**; f. two-dimensional geometric models (geoboards, dot paper, pattern blocks, tangrams, or attribute blocks) to model perimeter and properties of geometric shapes and three-dimensional geometric models (solids) and real-world objects to compare size and to model attributes of geometric shapes (2.1.K2c, 3.1.K1-6, 3.3.K2-3);	The student... 1. recognizes that various mathematical models can be used to represent the same problem situation. Mathematical models include: a. process models (concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or measurement tools) to model computational procedures and mathematical relationships, to compare and order numerical quantities, and to model problem situations (1.1.A1a-b, 1.1.A2, 1.2.A1-2, 1.3.A1, 1.4.A1-2, 2.1.A1a, 2.1.A1c-e, 2.2.A1-2, 2.3.A1-2, , 3.2.A1-4, 3.3.A1-2, 3.4.A1, 4.2.A2) **($)**; b. place value models (place value mats, hundred charts, or base ten blocks) to compare, order, and represent numerical quantities and to model computational procedures (1.1.A1a-b, 1.1.A2, 1.2.A1-2, 1.3.A2, 1.4.A1a) **($)**; c. money models (base ten blocks or coins) to compare, order, and represent numerical quantities (1.1.A1c-d, 1.3.A2, 1.4.A1b, 2.1.A1d) **($)**; d. two-dimensional geometric models (geoboards, dot paper, pattern blocks, tangrams, or attribute blocks) to model perimeter and properties of geometric shapes and three-dimensional geometric models (solids) and real-world objects to compare size and to model attributes of geometric shapes (2.1.A1b, 3.1.A1-3); e. two-dimensional geometric models (spinners), three-dimensional geometric models (number cubes), and process models (concrete objects) to model probability (4.1.A1) **($)**;

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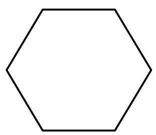
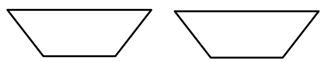
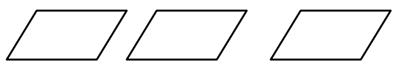
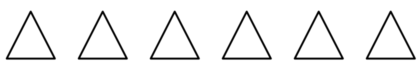
g. two-dimensional geometric models (spinners), three-dimensional geometric models (number cubes), and process models (concrete objects) to model probability (4.1.K1-2) **($)**;
h. graphs using concrete objects, representational objects, or abstract representations, pictographs, frequency tables, horizontal and vertical bar graphs, Venn diagrams or other pictorial displays, and line plots to organize and display data (4.1.K2, 4.2.K1, 4.2.K2) **($)**;
i. Venn diagrams to sort data.

2. creates a mathematical model to show the relationship between two or more things, e.g., using pattern blocks, a whole (1) can be represented using

a  (1/1) or

two  (2/2) or

three  (3/3) or

six  (6/6).

f. graphs using concrete objects, representational objects, or abstract representations, pictographs, horizontal and vertical bar graphs (4.1.A1, 4.2.A1-4) **($)**.

2. selects a mathematical model that is more useful than other mathematical models in a given situation.

Teacher Notes: For assessment purposes, the mathematical modeling process appropriate to the indicator may be included as part of the item being assessed.

The **mathematical modeling** process involves:

a. selecting key features and relationships within the real-world situation and representing these concepts in mathematical terms through some sort of mathematical model,
b. performing manipulations and mathematical procedures within the mathematical model,
c. interpreting the results of the manipulations within the mathematical model,
d. using these results to make inferences about the original real-world situation.

The use of **mathematical models** is necessary for conceptual understanding. The ways in which mathematical ideas are represented is fundamental to how students understand and use those ideas. As students begin to use multiple representations of the same situation, e.g., comparing the number of boys and girls in the classroom can be represented by lining them up in two different lines. The same situation also can be represented by pictures of the children (pictograph), a bar graph, or by using two different colors of the same manipulative (unifix cubes or color tiles). As students work with the different representations of the same situation, they begin to develop an understanding of the advantages and disadvantages of the various representations/models.

Many **mathematical models** are listed in this benchmark. The indicator lists some of the mathematical models that could be used to teach a concept. Each indicator in this benchmark is linked to other indicators in other benchmarks; those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3. In addition, the indicator in the other benchmarks identifies, in parentheses, the Models' indicator. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models).

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Standard 3: Geometry – The student uses geometric concepts and procedures in a variety of situations.

Benchmark 1: Geometric Figures and Their Properties – The student recognizes geometric shapes and describes their properties using concrete objects in a variety of situations.

Second Grade Knowledge Base Indicators	Second Grade Application Indicators
The student... 1. recognizes and investigates properties of circles, squares, rectangles, triangles, and ellipses (ovals) (plane figures/two-dimensional shapes) using concrete objects, drawings, and appropriate technology (2.4.K1f). 2. ■ recognizes, draws, and describes circles, squares, rectangles, triangles, ellipses (ovals) (plane figures) (2.4.K1f). 3. recognizes cubes, rectangular prisms, cylinders, cones, and spheres (solids/three-dimensional figures) (2.4.K1f). 4. recognizes the square, triangle, rhombus, hexagon, parallelogram, and trapezoid from a pattern block set (2.4.K1f). 5. compares geometric shapes (circles, squares, rectangles, triangles, ellipses) to one another (2.4.K1f). 6. recognizes whether a shape has a line of symmetry (2.4.K1f).	The student... 1. solves real-world problems by applying the properties of plane figures (circles, squares, rectangles, triangles, ellipses) (2.4.A1d), e.g., which shape could be used to completely cover the lid of a pencil box with no overlapping? 2. demonstrates how (2.4.A1d): a. ▲ plane figures (circles, squares, rectangles, triangles, ellipses) can be combined or separated to make a new shape; b. solids (cubes, rectangular solids, cylinders, cones, spheres) can be combined or separated to make a new shape. 3. identifies the plane figures (circles, squares, rectangles, triangles, ellipses) used to form a composite figure (2.4.A1d).

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Teacher Notes: Geometry is the study of shapes, their properties, and their relationships to other shapes. Symbols and numbers are used to describe their properties and their relationships to other shapes. The fundamental concepts in geometry are point (no dimension), line (one-dimensional), plane (two-dimensional), and space (three-dimensional). Plane figures are referred to as two-dimensional and solids are referred to as three-dimensional.

From the *Mathematics Dictionary and Handbook (Nichols Schwartz Publishing, 1999)*, **property** as a mathematical term means a characteristic (an attribute) of a number, geometric shape, mathematical operation, equation, or inequality. To give an example:

- Property of a number: 8 is divisible by 2.
- Property of a geometric shape: Each of the four sides of a square is of the same length.
- Property of an operation: Addition is commutative. For all numbers x and y, x + y = y + x.
- Property of an equation: For all numbers a, b, and c, if a = b, then a + c = b + c.
- Property of an inequality: For all numbers a, b, and c, if a > b, then a – c > b – c.

Mathematical models such as concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or base ten blocks are necessary for conceptual understanding and should be used to explain computational procedures. If a mathematical model can be used to represent the concept, the indicator in the Models benchmark is identified in the parentheses. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models). Then, the indicator in the Models benchmark lists some of the mathematical models that could be used to teach the concept. In addition, each indicator in the Models benchmark is linked back to the other indicators. Those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3.

Pattern blocks are a collection of six geometric shapes in six colors. Each set contains 250 pieces — 50 green triangles, 25 orange squares, 50 blue rhombi, 50 tan rhombi, 50 red trapezoids, and 25 yellow hexagons. The blue rhombus and the tan rhombus also are parallelograms, and the orange square is a parallelogram. The blocks are designed so that their sides are all the same length with the exception that the trapezoid has one side twice as long. This feature allows the blocks to be nested together and encourages the exploration of relationships among the shapes. Activities with pattern blocks help students explore patterns, functions, fractions, congruence, similarity, symmetry, perimeter, area, and graphing. A pattern block template can be found in the Appendix.

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Standard 3: Geometry – The student uses geometric concepts and procedures in a variety of situations.

Benchmark 2: Measurement and Estimation – The student estimates and measures using standard and nonstandard units of measure with concrete objects in a variety of situations.

Second Grade Knowledge Base Indicators	Second Grade Application Indicators
The student... 1. uses whole number approximations (estimations) for length, weight, and volume using standard and nonstandard units of measure (2.4.K1a) **($)**, e.g., the height of the classroom door is 14 chalkboard erasers laid end to end or 7 feet high or an apple weighs about 42 unifix cubes. 2. ▲ reads and tells time by five-minute intervals using analog and digital clocks (2.4.K1a). 3. selects and uses appropriate measurement tools and units of measure for length, weight, volume, and temperature for a given situation (2.4.K1a) **($)**. 4. measures (2.4.K1a) **($)**: a. ▲ length to the nearest inch or foot and to the nearest whole unit of a nonstandard unit; b. weight to the nearest nonstandard unit; c. volume to the nearest cup, pint, quart, or gallon; d. temperature to the nearest degree. 5. states (2.4.K1a): a. the number of minutes in an hour, b. the number of days in each month.	The student... 1. compares the weights of more than two concrete objects using a balance (2.4.A1a) **($)**. 2. solves real-world problems by applying appropriate measurements (2.4.A1a): a. length to the nearest inch or foot, e.g., a cookie is almost how many inches wide? b. length to the nearest whole unit of a nonstandard unit, e.g., how many paper clips long is a candy bar? 3. estimates to check whether or not measurements or calculations for length in real-world problems are reasonable (2.4.A1a) **($)**, e.g., is it reasonable to say that you measured your thumb and it is 2 feet long? 4. adjusts original measurement or estimation for length and weight in real-world problems based on additional information (a frame of reference) (2.4.A1a), e.g., I estimated that the stapler is 20 paperclips long. Then I lay out 4 paper clips next to the stapler. I realize that since I am half done, my estimate is too high; so I adjust my estimate to 8 paper clips.

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Teacher Notes: The term *geometry* comes from two Greek words meaning "earth measure." The **process of learning to measure** at the early grades focuses on identifying what property (length, weight, volume) is to be measured and to make comparisons. **Estimation in measurement** is defined as making guesses as to the exact measurement of an object without using any type of measurement tool. Estimation helps students develop a relationship between the different sizes of units of measure. It helps students develop basic properties of measurement, and it gives students a tool to determine whether a given measurement is reasonable.

Mathematical models such as concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or base ten blocks are necessary for conceptual understanding and should be used to explain computational procedures. If a mathematical model can be used to represent the concept, the indicator in the Models benchmark is identified in the parentheses. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models). Then, the indicator in the Models benchmark lists some of the mathematical models that could be used to teach the concept. In addition, each indicator in the Models benchmark is linked back to the other indicators. Those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3.

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Standard 3: Geometry – The student uses geometric concepts and procedures in a variety of situations.

Benchmark 3: Transformational Geometry – The student recognizes and shows one transformation on simple shapes and concrete objects in a variety of situations.

Second Grade Knowledge Base Indicators	Second Grade Application Indicators
The student... 1. knows and uses the cardinal points (north, south, east, west) (2.4.K1a). 2. recognizes that changing an object's position or orientation including whether the object is nearer or farther away does not change the name, size, or shape of the object (2.4.K1f). 3. recognizes when a shape has undergone one transformation (flip/reflection, turn/rotation, slide/translation) (2.4.K1f).	The student... 1. shows two concrete objects or shapes are congruent by physically fitting one shape or object on top of the other (2.4.A1a). 2. follows directions to move objects from one location to another using appropriate vocabulary and the cardinal points (north, south, east, west) (2.4.A1a).

Teacher Notes: Transformational geometry is another way to investigate geometric figures by moving every point in a plane figure to a new location. To help students form images of shapes through different transformations, students can use concrete objects, figures drawn on graph paper, mirrors or other reflective surfaces, or appropriate technology.

Mathematical models such as concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or base ten blocks are necessary for conceptual understanding and should be used to explain computational procedures. If a mathematical model can be used to represent the concept, the indicator in the Models benchmark is identified in the parentheses. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models). Then, the indicator in the Models benchmark lists some of the mathematical models that could be used to teach the concept. In addition, each indicator in the Models benchmark is linked back to the other indicators. Those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3.

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Standard 3: Geometry – The student uses geometric concepts and procedures in a variety of situations.

Benchmark 4: Geometry From An Algebraic Perspective – The student identifies one or more points on a number line in a variety of situations.

Second Grade Knowledge Base Indicators	Second Grade Application Indicators
The student... 1. locates and plots whole numbers from 0 through 1,000 on a segment of a number line (horizontal/vertical) (2.4.K1a), e.g., using a segment of a number line from 800 to 820 to locate the whole number 805. 2. represents the distance between two whole numbers from 0 through 1,000 on a segment of a number line (2.4.K1a). 3. uses a segment of a number line to model addition and subtraction using whole numbers from 0 through 1,000 (2.4.K1a), e.g., 333 + n = 349 or 333 + 16 = n or 400 – n = 352 or 400 – 48 = n.	The student... 1. solves real-world problems involving counting, adding, and subtracting whole numbers from 0 through 1,000 using a segment of a number line (2.4.A1a) **($)**, e.g., Adam had collected 894 marbles. He lost nine marbles. How many does he have now? Using the number line, Adam shows how he solved the problem.

Teacher Notes: A **number line** (a mathematical model) is a diagram that represents numbers with equal distances marked off as points on a line, and is an example of one-to-one correspondence (a relation). A number line can be used as a visual representation of numbers and operations. In addition, a number line used horizontally and vertically is a precursor to the coordinate plane; and the distance between two numbers on a number line is a precursor to absolute value.

Mathematical models such as concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or base ten blocks are necessary for conceptual understanding and should be used to explain computational procedures. If a mathematical model can be used to represent the concept, the indicator in the Models benchmark is identified in the parentheses. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models). Then, the indicator in the Models benchmark lists some of the mathematical models that could be used to teach the concept. In addition, each indicator in the Models benchmark is linked back to the other indicators. Those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3.

The National Standards in **Personal Finance** identify what K-12 students should know and be able to do in personal finance; benchmarks are provided at three grade levels (grades 4, 8, and 12) and are grouped into four major categories: Income, Spending and Credit, Saving and Investing, and Money Management. Although the National Standards in Personal Finance are benchmarked at three grade levels, the indicators in the Kansas Curricular Standards for Mathematics that correlate with the National Standards in Personal Finance are indicated at each grade level with a **($)**. The National Standards in Personal Finance are included in the Appendix.

▲ – Assessed Indicator
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Standard 4: Data – The student uses concepts and procedures of data analysis in a variety of situations.

Benchmark 1: Probability – The student applies the concepts of probability using concrete objects in a variety of situations.

Second Grade Knowledge Base Indicators	Second Grade Application Indicators
The student... 1. recognizes any outcome of a simple event in an experiment or simulation as impossible, possible, certain, likely, or unlikely (2.4.K1g) **($)**. 2. lists some of the possible outcomes of a simple event in an experiment or simulation including the use of concrete objects (2.4.K1g-h).	The student... 1. makes a prediction about a simple event in an experiment or simulation; conducts the experiment or simulation including the use of concrete objects; records the results in a chart, table, or graph; and makes an accurate statement about the results (2.4.A1e-f).

Teacher Notes: Ideas from **probability** reinforce concepts in the other Standards, especially Number and Computation and Geometry. Students need to develop an intuitive concept of chance – whether or not something is unlikely or likely to happen. Probability experiences should be addressed through the use of concrete objects, coins, and geometric models (spinners or number cubes).

Mathematical models such as concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or base ten blocks are necessary for conceptual understanding and should be used to explain computational procedures. If a mathematical model can be used to represent the concept, the indicator in the Models benchmark is identified in the parentheses. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models). Then, the indicator in the Models benchmark lists some of the mathematical models that could be used to teach the concept. In addition, each indicator in the Models benchmark is linked back to the other indicators. Those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, … with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3.

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Standard 4: Data – The student uses concepts and procedures of data analysis in a variety of situations.

Benchmark 2: Statistics – The student collects, organizes, displays, and explains numerical (whole numbers) and non-numerical data sets including the use of concrete objects in a variety of situations.

Second Grade Knowledge Base Indicators	Second Grade Application Indicators
The student... 1. organizes, displays, and reads numerical (quantitative) and non-numerical (qualitative) data in a clear, organized, and accurate manner including a title, labels, categories, and whole number intervals using these **data displays** (2.4.K1h) **($)**: a. ▲ graphs using concrete objects; b. ▲ pictographs with a whole symbol or picture representing one, two, or ten (no partial symbols or pictures); c. ▲ ■ frequency tables (tally marks); d. ▲ horizontal and vertical bar graphs; e. Venn diagrams or other pictorial displays, e.g., glyphs; f. line plots. 2. collects data using different techniques (observations, interviews, or surveys) and explains the results (2.4.K1h) **($)**. 3. identifies the minimum (lowest) and maximum (highest) values in a whole number data set (2.4.K1a) **($)**. 4. finds the range for a data set using two-digit whole numbers (2.4.K1a) **($)**. 5. finds the mode (most) for a data set using concrete objects that include (2.4.K1a) **($)**: a. quantitative/numerical data (whole numbers through 100); b. qualitative/non-numerical data (category that occurs most often).	The student... 1. communicates the results of data collection and answers questions based on information from (2.4.A1f) **($)**: a. graphs using concrete objects, b. pictographs with a whole symbol or picture representing one (no partial symbols or pictures), c. horizontal and vertical bar graphs. 2. determines categories from which data could be gathered (2.4.A1f) **($)**, e.g., categories could include shoe size, height, favorite candy bar, or number of pockets in clothing. 3. recognizes that the same data set can be displayed in various formats including the use of concrete objects (2.4.A1f) **($)**. 4. recognizes appropriate conclusions from data collected (2.4.A1f) **($)**.

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Teacher Notes: Graphs (data displays) are pictorial representations of mathematical relationships and are used to tell a story. When a graph is made, the axes and the scale (numbers running along a side of the graph) are chosen for a reason. The difference between numbers from one grid line to another is the interval. The interval will depend on the lowest and highest values in the data. Emphasizing the importance of using equal-sized pictures or intervals is critical to ensuring that the data display is accurate. Graphs take many forms: bar graphs and pictographs compare discrete data, frequency tables show how many times a certain piece of data occurs using tally marks to record the data, circle graphs (pie charts) model parts of a whole, line graphs show change over time, Venn diagrams show relationships between sets of objects, and line plots show frequency of data on a number line.

The **measures of central tendency** (averages) of a data set are mean, median, and mode. Conceptual understanding of mean, median, and mode is developed through the use of concrete objects that represent the data values.

Mathematical models such as concrete objects, pictures, diagrams, number lines, unifix cubes, hundred charts, or base ten blocks are necessary for conceptual understanding and should be used to explain computational procedures. If a mathematical model can be used to represent the concept, the indicator in the Models benchmark is identified in the parentheses. For example, (2.4.K1a) refers to Standard 2 (Algebra), Benchmark 4 (Models), and Knowledge Indicator 1a (process models). Then, the indicator in the Models benchmark lists some of the mathematical models that could be used to teach the concept. In addition, each indicator in the Models benchmark is linked back to the other indicators. Those indicators are identified in the parentheses. For example, *process models* are linked to 1.1.K3, 1.2.K6, 1.3.K1, with 1.1.K3 referring to Standard 1 (Number and Computation), Benchmark 1 (Number Sense), and Knowledge Indicator 3.

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