Grade 2

The Private Eye® aligned with Common Core State Standards for Mathematical Practice and Content

Welcome!

The Private Eye makes math a language to love, even as it helps build a mathematical vocabulary. It turns math into something personal, intriguing, friendly, alive. The Private Eye's hands-on, interdisciplinary process and instructional strategy braids together three languages: verbal, visual, and mathematical.

The Private Eye begins with four simple questions, everyday objects, and a jeweler's loupe (an almost magical magnification tool). Using The Private Eye process students enhance concentration, heighten their awareness of pattern and detail, and learn to evoke analogic thinking for problem-solving. TPE delivers students directly to the "land of Math" — the science of patterns and relationships. Whenever you use The Private Eye, pattern is "in your face"—you're massaging the math brain, even as you massage the scientist's, writer's, artist's brain.

The Private Eye blends with your existing math course-of-study to develop habits of mind essential to mathematical practice. As you consider your math year, you'll find you can use TPE in your classroom to: introduce, enhance, cement and assess mathematical concepts and content. It helps students settle down and focus as preparation for a new or existing mathematical concept. It calms their fears that a math topic will be too difficult, too foreign. It grounds concepts in a student's personal knowledge and associations and in the five senses. It generates mathematical inquiries that live and breathe.

With its simple tools, rich questioning strategy, and everyday objects, students can write, draw, theorize, count, measure, compute, calculate, estimate, predict and perform mathematical operations. In the process they build four underlying *and interwoven habits of mind* critical to academic success: looking closely, thinking by analogy, changing scale, and theorizing. These are the intellectual "tools" not only for mathematical literacy, but for creativity, literacy, and scientific literacy as well. The book, *The Private Eye —(5X) Looking/Thinking by Analogy: A Guide to Developing the Interdisciplinary Mind,* shows how to fluently develop these essential habits. A special Math Tour of lesson connections begins on page 173.

* * *

This document correlates *The Private Eye—(5X) Looking/Thinking by Analogy* to the mathematical practices and content outlined in the Common Core State Standards for Grade 3. Along the way, the document provides many "how to" examples for meeting and practicing the content of each standard in the context of Private Eye use. (For Private Eye CCSS Literacy correlations, please see our separate publication.)

Common Core State Standards for Mathematics: GRADE 2

THE PRIVATE EYE® — (5X) LOOKING / THINKING BY ANALOGY® Correlation

Standards for Mathematical Practice	*THE PRIVATE EYE® — (5X) LOOKING / THINKING BY ANALOGY®* *A Guide to Developing the Interdisciplinary Mind*

Meet all eight CCSS Standards for Mathematical Practice using The Private Eye (TPE) in Math *and* across your curriculum day:

1. Make sense of problems and persevere in solving them. Thinking by Analogy (making associations and using them for theorizing, inferring, modeling) is how we make sense of the world. The Private Eye boosts analogic reasoning as it also builds concentration, ever-increasing attention to detail, and wonder at the world's patterns and relationships. Using TPE builds perseverance incrementally and naturally. The Private Eye's exploratory inquiry generates options to approach problem solving. It builds *problem-solving by analogy* using verbal, visual, and mathematical languages.

2. Reason abstractly and quantitatively.
Analogic reasoning is the abstract reasoning at the heart of mathematical reasoning. TPE process is rooted in analogic reasoning: proportional reasoning, making inferences, theorizing — based on strategic use of associations. (BTW, the term "analogy" was originally a math term!)

"Analogy is the Interstate Freeway of Cognition", notes Douglas Hofstadter. We use analogy in forms verbal, visual, and numerical — creating and using analogs, comparisons, and models — to understand and solve problems. TPE tools and strategy evoke and constantly build analogic / comparative thinking for students and adults. Hands-on explorations quicken abstract reasoning while keeping students grounded in real world applications. Repetition with TPE process makes analogic reasoning in verbal, visual and mathematical languages into a habit for students, an instinctive practice.

3. Construct viable arguments and critique the reasoning of others. TPE's inquiry approach includes: "Why is it like that?" "What's going on here?" TPE gives students a hypothesizing and theorizing strategy to answer these questions using words, numbers, images to generate models. Students work individually and collaboratively, examining and critiquing each other's methods and conclusions.

4. Model with mathematics.
Models are essentially analogies: an exploration and a representation of patterns, structures, behaviors, and relationships we discover in the world around us. Numbers are analogs that explore and represent specific quantities, interactions, operations, measurements, behaviors, and relationships. TPE helps students practice moving between modeling with mathematical analogs and modeling with verbal, visual, and structural analogs.

5. Use appropriate tools strategically.
The Private Eye Tools: a 5X Loupe (a marvelous magnification tool), everyday objects (manipulatives), loupe-drawing, and loupe-analogy observations are all mathematical tools in the context of math explorations. (TPE Questions are tools, as well!) The loupe allows students to change scale — to find mathematical numbers, shapes, concepts and relationships in small places in comparison with large scale situations. The loupe enlarges objects or parts of objects by 5X (10X if two loupes nested) creating a heightened interest in structures, patterns and measurements. It boosts Mathematical Practices #6, 7, and 8.

6. Attend to precision.
The Private Eye's loupe and questioning strategy gives students a jolt of attention to detail: it literally "teaches" what attention to detail and precision *means*. Using TPE students explore real world shapes, structures and relationships in conjunction with analogic observations — verbal, visual, mathematical — to express ever more precise communication / thinking. TPE hones ability to discern and distinguish less obvious similarities and differences.

7. Look for and make use of structure.
TPE loupes and Questions help students habitually look closely for structures, patterns and relationships at changes of scale, small and large. In a math context, this habit of mind translates into a heightened sensitivity to numerical structures and sequences.

8. Look for and express regularity in repeated reasoning. Thinking by Analogy fueled with Looking Closely is fundamental to pattern recognition. Using TPE in math — a repeating loop of questions for investigating and reasoning — sensitizes students to looking for regularity in mathematical structures.

When you use The Private Eye's interdisciplinary process in math, you not only meet math standards correlated to the lesson, but specific Science and Literacy Standards as well. See CCSS Literacy / TPE correlations.

Common Core State Standards for Mathematics: GRADE 2

THE PRIVATE EYE® — (5X) LOOKING / THINKING BY ANALOGY® Correlation

Standards for Mathematical Content	***THE PRIVATE EYE® — (5X) LOOKING / THINKING BY ANALOGY®*** *— A Guide to Developing the Interdisciplinary Mind —*
GRADE 2	***Prep:*** *Read "Process and Tools", pp. 11-31; and "Math Tour", pp.175-194. Introduce students to The Private Eye (TPE) loupe & process: looking closely, thinking by analogy, changing scale, and theorizing. TPE's holistic math activities connect to multiple standards and can be adapted for any grade. (Along the way, it's easy and fun to create your own lessons.)* ***Practice:*** *In the correlations we provide some "unpacking" of standards, grade-level examples, and a starter list of TPE book connections. On some days, you may choose merely to use the loupe with everyday objects for knock-your-socks-off, content-rich manipulatives to meet detailed elements of a standard. But connect these experiences to a Private Eye-listed activity — even better, to the full, interdisciplinary Private Eye process (TPE Questions / loupe-drawing / writing / science content / theorizing) — and you'll see a real difference in how students think and communicate mathematically. Students will rev up creative and critical thinking in tandem with math skills. They'll fall in love with math.*
Operations and Algebraic Thinking 2.OA	
Represent and solve problems involving addition and subtraction. **2.OA.1** 1. Use addition and subtraction within 100 to solve one- and two-step word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.	**Represent and solve problems involving addition and subtraction.** **Overview:** As students loupe-examine, draw, and manipulate loupe-study objects into various groups (sets of beans, seeds, pennies, popcorn kernels, leaves, small twigs, shells, etc.) **they investigate first-hand the meaning of addition and subtraction.** Students move into solving + and – problems and represent them in equations and drawings. They create problems for their peers to solve, as well. The teacher connects the loupe-study math to broader investigations across subjects as time permits. 1. Students **use addition and subtraction within 100 to solve one- and two-step word problems** involving sets of loupe-study objects in situations of *adding to, taking from, putting together, taking apart, and comparing*. The teacher creates word problems based on objects students have loupe-studied, or word problems arising from scientific investigations. Students solve the word problems, using drawings and equations to **represent the problem using a symbol for the unknown number**. Have the symbol for the unknown number shift to all positions. Students then create word problems for peers to solve. **Example:** After loupe-exploring a piece of popcorn and generating a loupe-analogy list, teacher and students alike create simple word problems within 100. E.g., You have a bag of popcorn with 100 kernels. You put it in the microwave, but only 85 pieces pop. How many kernels failed to pop? How could we represent that problem using drawings and equations with a symbol for the unknown number? Solution: In a sequence draw: a popcorn bag with #100 on it (and little dots to suggest 100 kernels), a minus sign, a bowl of popcorn with #85 on it. Finally, add: = r (100 – 85 = r) (100 – 85 = 15) • Math Plans & Ticklers: Sequence, p. 175 • Seeds! p.180 (Loupe-study beans, flowers, seedpods or cut sections of fruits / vegetables to view seeds. Practice adding / subtracting seeds: e.g., sunflowers, kiwis, melons.) • Seed Pods Pop, p. 145 • Seed Collections, p. 144

Common Core State Standards for Mathematics: GRADE 2

THE PRIVATE EYE® — (5X) LOOKING / THINKING BY ANALOGY® Correlation

Add and subtract within 20. **2.OA.2** 2. Fluently add and subtract within 20 using mental strategies. By end of Grade 2, know from memory all sums of two one-digit numbers.	**Add and subtract within 20.** (2. If some students in the class are not yet fluent adding and subtracting within 20 using *mental* strategies and need more groundwork, have them link the + and – work to manipulating loupe-study objects.)
Work with equal groups of objects to gain foundations for multiplication. **2.OA.3** 3. Determine whether a group of objects (up to 20) has an odd or even number of members, e.g., by pairing objects or counting them by 2s; write an equation to express an even number as a sum of two equal addends.	**Work with equal groups of objects to gain foundations for multiplication.** 3. **Students determine whether a group of loupe-study objects (up to 20) has an odd or even number of members** (or odd or even number of parts, e.g., # of petals on a flower). Students use strategies such as *pairing objects* or *counting them by 2s*. Write an equation to express an even number as a sum of two equal addends. **Example:** Give each student a random number of loupe-study objects **up to 20** (pinto beans, leaves, seed pods, pieces of cloth, Velcro strips, etc.). Students determine whether they have an odd or even number of those objects. Consider, too, objects with multiple parts or characteristics: e.g., a daisy. Does your flower have an odd or even number of petals? Students **use strategies** to increase the speed of determining an odd or even count: how many pussy willow buds on a branch (count by 2s)? How many holes in a swatch of mesh fabric? (Count the number in one row and pair it with the next row to get the count.) And so on. Or consider the combined number of characteristics or features on an object that each person in the class has been loupe-exploring. E.g., if three students at a table each have a ladybug with 6 legs, how many insect legs are at the table? Will that be an even number or an odd number? Why? **Now write an equation** to express the strategy: an even number as a sum of two equal addends. **Example:** 10 beans = 5 beans + 5 beans then: 10 = 5 + 5 • Math Plans & Ticklers: Sequence, p. 175 • Seeds! p.180 — combined with Math Plans & Ticklers: *Sequence*, p. 175 (skip microscope)
2.OA.4 4. Use addition to find the total number of objects arranged in rectangular arrays with up to 5 rows and up to 5 columns; write an equation to express the total as a sum of equal addends.	4. Students **use addition to find the total number of loupe-study objects in a group** (or the number of parts of an objects, e.g., the number of petals on a daisy) **arranged in rectangular arrays** with up to 5 rows and up to 5 columns; students write an equation to express the total as a sum of equal addends. **Example:** Hand out paper cups of pinto beans, up to 25 in each cup. Have students arrange beans into rows and columns up to 5 in each, writing an equation to express the addition and total: 3 + 3 + 3 + 3 + 3 = 12 (beans) • Math Plans & Ticklers: Sequence, p. 175 • Seeds! p.180 — combined with Math Plans & Ticklers: *Sequence*, p. 175 (skip microscope) • Seed Pods Pop, p. 145 • Seed Collections, p. 144

Common Core State Standards for Mathematics: GRADE 2

THE PRIVATE EYE® — (5X) LOOKING / THINKING BY ANALOGY® Correlation

Numbers and Operations in Base Ten 2.NBT	
Understand place value. **2.NBT.1** 1. Understand that the three digits of a three-digit number represent amounts of hundreds, tens, and ones; e.g., 706 equals 7 hundreds, 0 tens, and 6 ones. Understand the following as special cases: a. 100 can be thought of as a bundle of ten tens — called a "hundred." b. The numbers 100, 200, 300, 400, 500, 600, 700, 800, 900 refer to one, two, three, four, five, six, seven, eight, or nine hundreds (and 0 tens and 0 ones).	**Understand place value.** 1. Though plastic manipulatives are convenient, for an even more powerful, **real-world discovery lesson in place value**, students can work with multiples of loupe-examined objects that are easy to bag or bundle into groups of ten and, in turn, into bags/bundles of ten tens (e.g., use pinto beans, corn kernels, seeds, sunflower seeds in shells, popcorn, pennies, tiny shells, etc.). Students work independently or in table teams to count and arrange their "manipulatives" **to understand the concept that three digits of a three-digit number — such as 207 — represents amounts of hundreds, tens, and ones**; i.e., 207 equals 2 hundreds, 0 tens, and 7 ones. Students focus on the following as special cases: a. 100 can be thought of as a bundle of ten tens — called a "hundred." b. The numbers 100, 200, 300, 400, 500, 600, 700, 800, 900 refer to one, two, three, four, five, six, seven, eight, or nine hundreds (and 0 tens and 0 ones). **Example: "**Pinto Bean Place Value". (Pinto beans have cool patterns under a loupe and evoke intriguing analogies in a "Loupe-List." There are science, nutrition and cultural connections to explore. For the math, don't tell students, but a typical one pound bag of pinto beans has about 1200 beans. Yes, we did a count!). Materials: Each student makes her own large place value mat (11"X17") divided into three columns: Hundred's Column; Ten's Column; One's Column. Even if students work in teams to find out how many beans are in a one pound bag, each student needs 10-20 small, empty plastic bags, and her own starting set of beans to count: 300+ beans to count and bag into sets of Ten and sets of Ten Tens (Hundreds) using the place value mat. Personal experience has a vivid mathematical impact! Each student begins by placing individual beans in the Ones Column. Each time the number in the One's Column reaches 10, the student creates a *unit* of those items and labels it "1 Ten". (E.g., she puts the beans in a small plastic bag and labels the bag with a "1 Ten" — then moves that set (ten-Ones-in-a-bag) to its new place in the Tens Column. When the number of Ten's Unit bags in the tens column reaches ten, students insert them into a larger bag and label it "1 Hundred" (ten units of ten items each, thus 100 individual objects) — and moves that bag into the Hundreds Column. The work gives students a deep-rooted understanding of place value. Students can work individually or in table teams to count the # of beans in a bag of pinto beans. (They can create a separate pile of broken or deformed beans as though they were on a quality control team for the Pinto Bean Company.) **Follow-Up Option**: The teacher (or students) can take turns calling out a three-digit number that the rest of the class must create by correctly assembling their sets of beans in the hundred's, ten's, and one's columns. Each student records the corresponding three-digit number on an index card or in a math journal and dates his work. • Math Plans & Ticklers: Sequence, p. 175

Understand place value. **2.NBT.2** 2. Count within 1000; skip-count by 5s, 10s, and 100s.	**Understand place value.** 2. Students **practice skip counting by 5s** using loupe-study objects **(**peppercorns, pennies, sunflower seeds in shells, popcorn kernels, pinto beans, etc.) bagged or bundled or arranged together into groups of 5**. Students practice skip counting by 10s and 100s** using loupe-study objects they've bundled or bagged into groups (sets) of 10 — as described in detail in the previous standard's example: 2.NBT.1. **Example**: Start with one student counting his/her groups (sets) of fives, tens or sets of hundreds and move around the room having each student add on his tens or hundreds. Start over when anyone reaches a thousand. For an advanced exercise, students can also work with objects having multiple parts, e.g., flowers have petals and leaves. • Math Plans & Ticklers: Sequence, p. 175
2.NBT.3 3. Read and write numbers to 1000 using base-ten numerals, number names, and expanded form.	
2.NBT.4 4. Compare two three-digit numbers based on meanings of the hundreds, tens, and ones digits, using >, =, and < symbols to record the results of comparisons.	4. In a game using loupe-study objects that have previously been assembled into bags of ten tens, tens, and loose ones (e.g., the pinto beans from 2.NBT.1 Place Value), students practice comparing two three-digit numbers — based on meanings of the hundreds, tens, and ones digits — using >, =, and < symbols to record the results of comparisons. **Game Example:** Each student randomly chooses from his bags of pinto beans and places them into a container, choosing: 100s (no more than 9), 10s (no more than 9), and loose ones. He calculates the total beans, and records the number it represents on an index card (then turns the card upside down) or records the number in his math journal. Students now swap containers with a partner or table-mate. Each table-mate now calculates the number of beans in the new container — based on the meaning of hundreds, tens, and ones and records the number — and records the number. Students check each other's calculations. Students compare values in the two containers and write statements in their math journals using >, =, < • Math Plans & Ticklers: Sequence, p. 175

Common Core State Standards for Mathematics: GRADE 2

THE PRIVATE EYE® — (5X) LOOKING / THINKING BY ANALOGY® Correlation

Use place value understanding and properties of operations to add and subtract.	**Use place value understanding and properties of operations to add and subtract.**
2.NBT.5 5. Fluently add and subtract within 100 using strategies based on place value, properties of operations, and/or the relationship between addition and subtraction.	(5. If some students are not yet fluent adding and subtracting within 100 based on place value, etc.— as per this standard — build fluency foundations using the activities in the Grade 1 CCSS Math & The Private Eye Correlations. See "Understand Place Value"; "Use place value understanding and properties of operations to add / subtract.")
2.NBT.6 6. Add up to four two-digit numbers using strategies based on place value and properties of operations.	6. **Link the addition of up to four two-digit numbers** to loupe-study objects (or objects with multiple parts or characteristics) — using strategies based on place value and properties of operations. **Example:** Using the game idea in 2.NBT.4, students calculate and record the number of beans in up to 4 containers.
2.NBT.7 7. Add and subtract within 1000, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method. Understand that in adding or subtracting three- digit numbers, one adds or subtracts hundreds and hundreds, tens and tens, ones and ones; and sometimes it is necessary to compose or decompose tens or hundreds.	7. **For concrete models, students use sets of loupe-study objects to add and subtract within 1000.** Students can again use the sets of loupe-study objects and the Place Value mat they created in *standard 2.NBT.1* — or bag and bundle new objects into Tens Units and Hundred Units along with individual Ones Units, e.g., sunflower seeds in the shell. They use these objects and sets of objects to add and subtract within 1000 **— combined with strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; and they relate the strategy to a written method.** Students use these concrete models to understand that in adding or subtracting three- digit numbers, one adds or subtracts hundreds and hundreds, tens and tens, ones and ones; and **sometimes it is necessary to compose or decompose tens or hundreds.** **Example:** The teacher writes s 3-digit addition or subtraction problem on the board; each student solves the problem using the loupe-study objects he already bagged or bundled into sets of 10 and sets of 100 (in the previous standard's Private Eye example) **along with at least 9 individual objects:** peppercorns, pennies, sunflower seeds in shells, popcorn kernels, pinto beans (a typical 1 pound bag of Pinto Beans has about 1200 beans). The teacher continues to challenge the students with new 3-digit + or – problems to solve. As students solve the problems using their place value mats and objects, they discover that sometimes it is necessary to compose or decompose tens or hundreds. Students can also work in teams to count objects (or parts of objects or characteristics of objects), adding and subtracting within 1000. Or the class can combine individual counts of recorded objects (or parts of objects, such as petals of a flower) into larger collective counts, then add and subtract. As students move into subtraction, they will viscerally experience that **sometimes it is necessary to compose or decompose tens or hundreds.** (continued next page)

Use place value understanding and properties of operations to add and subtract. **2.NBT.7** (continued) 7. Add and subtract within 1000, using concrete models or drawings and strategies … **2.NBT.8** 8. Mentally add 10 or 100 to a given number 100–900, and mentally subtract 10 or 100 from a given number 100–900. **2.NBT.9** 9. Explain why addition and subtraction strategies work, using place value and the properties of operations.	**Use place value understanding and properties of operations to add and subtract.** (continued) • Math Plans & Ticklers: Sequence, p. 175 • Seeds! p.180 (skip the 50X microscope) • Seed Pods Pop, p. 145 • Seed Collections, p. 145 • Foxglove Towers, p. 180
Measurement and Data **2.MD**	
Measure and estimate lengths in standard units. **2.MD.1** 1. Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.	**Measure and estimate lengths in standard units.** **Overview:** Students loupe-examine and measure all kinds of objects, small or large, short or tall, long or wide, or objects combined into longer units (e.g., a postage stamp, egg carton, paper towel, length of twine or rope, slice of carrot, flower stem, petal, leaf, height of a shrub, a twig, a tree stump, apple seed, peppercorn, lima bean, Velcro strip, corrugated cardboard section, the fingers on a hand, a stretch of side-walk with cracks being loupe-explored, the arm of a coat, one brick in the school building wall, a cork, etc). 1. Students **measure the length of objects, small and large, that can first be loupe-explored.** Students select appropriate tools for measuring, such as rulers, yardsticks, meter sticks, and measuring tapes. **Examples:** "The Velcro strip is _____ inches long. The arm of my coat is _____ inches long. The tomato plant in the school garden is ____ meters high. The tomato leaf is _____ millimeters long. The sidewalk stretch is _____ yards long." • The Ultimate Portrait, p.177 – 178 • Thoreau's Backpack and a Tape Measure, p. 177 • Tape measure/ Ruler p. 177 • The Root of It All: Ratio, p. 182 • What to Collect / Study with The Private Eye, pp. 70-71

Common Core State Standards for Mathematics: GRADE 2

THE PRIVATE EYE® — (5X) LOOKING / THINKING BY ANALOGY® Correlation

Measure and estimate lengths in standard units. (con't)

2.MD.2

2. Measure the length of an object twice, using length units of different lengths for the two measurements; describe how the two measurements relate to the size of the unit chosen.

Measure and estimate lengths in standard units. (continued)

2. Students **measure the length of a loupe-study object twice, using length units of two different lengths for the two measurements. They describe and explain how the two measurements relate to the size of the unit chosen.** They reflect on the advantages of choosing one length unit vs. another, e.g., inches vs. feet, how the numbers relate to each other, how to convert measurement systems, etc. (Loupe-study objects are indoors and out: e.g., a cut length of twine, sheets of paper, paper towels, corrugated cardboard, egg cartons, bricks in the school building wall, flower petals, flower stems, the sleeve of a shirt, a tree stump, a magnolia pod, a length of Spanish Moss, a cork, etc.

Example: Give each student a cut length of twine that they loupe-observe (to see how twine is made). On once occasion each student gets the same length, but on follow-up sessions each member of a table team can be given a different length to measure and reflect on. Students can check each other's accuracy.

A student reports and records: "The segment of twine is 24 *inches* long or 2 *feet* long."

After students provide measurements, the teacher asks students to reflect: "Why are there two different numbers? 24 is a bigger number than 2, how can both numbers apply to the same length of twine?"

- The Ultimate Portrait, p.177 – 178
- Thoreau's Backpack and a Tape Measure, p. 177
- Tape measure/ Ruler p. 177
- The Root of It All: Ratio, p. 182

2.MD.3

3. Estimate lengths using units of inches, feet, centimeters, and meters.

3. Students **estimate lengths of objects they will also loupe-observe** (e.g., a cut length of twine, paper towels, a cracker, egg cartons, bricks in the school building wall, flower petals, flower stems, the sleeve of a shirt, magnolia pod, a car headlight, etc.) — **using units of inches, feet, centimeters, and meters.**

Example: Ask students: "How many inches long do you think your leaf is if you measured it with a ruler?" Students practice offering an estimate, then check it with a ruler.

- The Ultimate Portrait, p.177 – 178
- Thoreau's Backpack and a Tape Measure, p. 177
- Tape measure/ Ruler p. 177
- Spider Math, p. 182 (web length)

2.MD.4

4. Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.

4. Students **measure to determine how much longer one loupe-study object is than another, expressing the length difference in terms of a standard length unit.**

Examples: The student chooses two objects to measure and expresses the difference:

"The foxglove leaf is 9 inches long and the oak leaf is 5 inches long. *The foxglove leaf is 4 inches longer than the oak leaf."*

After measuring a lima bean and a pinto bean: *"The pinto bean is ½ inch shorter than the lima bean."*

- The Ultimate Portrait, p.177 – 178
- Thoreau's Backpack and a Tape Measure, p. 177
- Tape measure/ Ruler p. 177
- The Root of It All: Ratio, p. 182

Common Core State Standards for Mathematics: GRADE 2

THE PRIVATE EYE® — (5X) LOOKING / THINKING BY ANALOGY® Correlation

Relate addition and subtraction to length. **2.MD.5** 5. Use addition and subtraction within 100 to solve word problems involving lengths that are given in the same units, e.g., by using drawings (such as drawings of rulers) and equations with a symbol for the unknown number to represent the problem. **2.MD.6** 6. Represent whole numbers as lengths from 0 on a number line diagram with equally spaced points corresponding to the numbers 0, 1, 2, ..., and represent whole-number sums and differences within 100 on a number line diagram.	**Relate addition and subtraction to length** (within 100). 5. Students begin with loupe-study objects small or large; teacher and students create and solve addition and subtraction word problems within 100 involving lengths of these objects (or their parts). Lengths are given in the same units. Students use drawing and equations with a symbol for the unknown number to represent the problem. **Example:** Kate's piece of yarn is 17 centimeters long. Jessica's piece of yarn is 38 centimeters long. How much longer is Jessica's piece than Kate's? 38 cm – 17 cm = x cm longer (x = 21 cm) **Example:** In November the narcissus bulb has developed a stalk 1 inch long. By December the flower stalk has grown 11 inches longer! What is the length of the entire stalk in December? 1 inch + 11 inches = x (x = 12 inches) • The Ultimate Portrait, p.177 – 178 • Thoreau's Backpack and a Tape Measure, p. 177 • Tape measure/ Ruler p. 177 • Spider Math, p. 182 (web length) • The Root of It All: Ratio, p. 182
Work with time and money. **2.MD.7** 7. Tell and write time from analog and digital clocks to the nearest five minutes, using a.m. and p.m.	**Work with time and money.** 7. Students **record the time of a loupe-study observation / loupe-list writing using analog and digital clocks** to the nearest five minutes, using a.m. and p.m. **Examples:** Students record the time of day in a journal to the nearest five minutes, using a.m. and p.m. when they begin a fresh observation of a plant or critter — whether the analogy-driven observations are stand-alones or continue over an extended period of time (days or weeks), whether the observations are directly related to math or not. The time-telling math comes into play if students record when they begin — and perhaps when they finish — any Private Eye writing/observation/ investigation. Students might be required to jot down the time of day that they observe changes in the growth of a plant, indoors or out; the emergence of roots followed by leaves when sprouting a lima bean; the time it takes a bud in spring to leaf out; how long it takes clipped fingernails to grow; how long it takes a cut or scrape to heal, etc. • Math Plans & Ticklers: Sequence, p. 175 • Adopt a Seed, p. 144 and Adopt a Tree, p. 144 • Flower Power, p. 114 (Grow amaryllis bulb or paper whites — or other plants — in class and mark down observed changes over elapsed time, and time of observation.) • A Yard of Yard, p. 148 (Observe the same spot over time; note time of observation; record changes.)

Work with time and money. (continued) **2.MD.8** 8. Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies, using $ and ¢ symbols appropriately. *Example: If you have 2 dimes and 3 pennies, how many cents do you have?*	**Work with time and money.** (continued) 8. Examining money with a loupe is a fascinating experience for any age. Students **loupe-explore, discuss and loupe-draw dollar bills and various coins — then solve word problems based on students using $ and ¢ symbols** appropriately. The teacher generates word problems (with the help and involvement of students, too) for students to solve. Then have students generate word problems about coin values for peers to solve. Use dollar bills, quarters, dimes, nickels, and pennies. *Example: If you have 4 dimes and 6 pennies, how many cents do you have?* **Note:** Because coins have such small and often surprising details to discover with a loupe and, along with paper bills, are rich in symbolism, many teachers using The Private Eye have students loupe-study coins and paper money and loupe-draw them — then conjecture what the symbols on the money mean. They then delve into research. Consider exploring money from other cultures, too! • Drawing as Close Observation" p. 26; "Loupe-Draw" p. 125, and "Drawing Tips", p. 127. • Math Plans & Ticklers: Sequence, p. 175
Represent and interpret data. **2.MD.9** 9. Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units. **2.MD.10** 10. Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph.	**Represent and interpret data.** 9. Students **generate measurement data by measuring lengths of several loupe-study objects to the nearest whole unit**. **Or they make repeated measurements of the same object:** growing plants, for example. **They show the measurements by making a line plot**, where the horizontal scale is marked off in whole-number units. **Examples:** A) Students measure all the leaves on a branch (leaves on one branch are typically younger/shorter at one end and older/longer at the other). B) Students measure an emerging leaf on a deciduous tree (longest dimension) and after a week or two pluck an adjacent leaf for comparison to see how it's grown. Make several more measurements of leaves over time to plot growth. In either case, students show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units. • Dandelion Math – The Graph (use something with bigger seeds, e.g., calendula, sunflower), p. 178 • The Ultimate Portrait, p.177 – 178 • 36 Portraits with Statistics, p. 178 • Leaf Math to Tree Math, p. 182 10. Students **draw a picture graph and a bar graph (with single-unit scale) to represent a data set gathered from observing loupe-study objects. Consider representing data gathered in 2.MD.9** (above). (Measurement data is about loupe-study objects / parts of objects / or characteristics observed) — with up to four categories. Teacher and students create and solve simple put- together, take-apart, and compare problems using information presented in a bar graph. • Dandelion Math – The Graph (use something with bigger seeds, e.g., calendula, sunflower), p. 178 • The Ultimate Portrait, p.177 – 178 • 36 Portraits with Statistics, p. 178 • Leaf Math to Tree Math, p. 182 • Dusty Miller data, pp. 54-55

Common Core State Standards for Mathematics: GRADE 2

THE PRIVATE EYE® — (5X) LOOKING / THINKING BY ANALOGY® Correlation

Geometry 2.G	
Reason with shapes and their attributes. **2.G.1** 1. Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces. Identify triangles, quadrilaterals, pentagons, hexagons, and cubes. **2.G.2** 2. Partition a rectangle into rows and columns of same-size squares and count to find the total number of them.	**Reason with shapes and their attributes.** 1. To reinforce the learning in this standard: **after students are able to recognize and draw shapes having specified attributes** (e.g., a given number of angles or a given number of equal faces)… challenge them to try to find those shapes with their distinguishing characteristics in nature, e.g., beehives are made of hexagons, bubbles pack in hexagons, little triangles and squares are found on one's skin, etc. **Extension example:** Have **students go on a Geometry Hunt in nature or in manmade things**, first at a large scale using just their eyes, then using objects to loupe-explore (as noted in correlated activities below). Students will learn to recognize geometric shapes found in nature — using the loupe to aid discovery and TPE Questions focused for math. While loupe-observing something manmade (e.g., fabric or a sponge) or natural (the skin on your own hand or a sand dollar or a flower) students will ask themselves: "What math shapes can I find? What shape does this small part remind me of — in math?" **Students will focus on finding triangles, quadrilaterals, pentagons, hexagons, and cubes** found in manmade or natural objects (e.g., florets in the center of composite flowers are packed in the shape of pentagons and hexagons). Give students challenges: On this amethyst can you find any angles? Can you find shapes with 3 faces? 4, 5, 6 faces? Where? In addition to having students **analyze ever more complex** geometric shapes found in nature — using the loupe to aid discovery — have students loupe-draw objects and the small shapes and patterns in the object. • Traveling a Mathematical Loupe: Missing Piece, p. 176 • Drawing Plans & Ticklers: "Sequence" and "5-in-1", p. 130 • Your Hand, p. 84 ("What else do the shapes in your hand remind you of in math? Why?") • Crystal Hunting p. 162 • Microcosm to Macrocosm p. 162 • Nature's Geometry, p. 176

Reason with shapes and their attributes. (continued)

2.G.3

3. Partition circles and rectangles into two, three, or four equal shares, describe the shares using the words *halves, thirds, half of, a third of,* etc., and describe the whole as two halves, three thirds, four fourths. Recognize that equal shares of identical wholes need not have the same shape.

Reason with shapes and their attributes. (continued)

3. It's exciting for students to **practice partitioning and applying their knowledge of *halves, thirds, half of, a third of,* etc., in their investigations, descriptions, and discussions of loupe-study objects that are circular** (e.g., sand dollar or a coin) or rectangular (bread slice or a square of newsprint). **Extend partitioning exercises to loupe-based drawings.**

Starter List of of Circular Loupe-study Objects and Opportunities:

- sand dollar
- coins
- Ritz-style crackers
- cross-sectional slices of apples, oranges, kiwis, cucumbers, carrots
- cross-sectional slices of tree limb (2" – 5" across for convenience).
- flat top of a tree stump (it may have a whole ecosystem living on it!)
- lay a hula hoop on the grass or yard and loupe-investigate partition by partition: who lives there "in Whoville"? What the habit is composed of? Gather data. Graph. Compare partitions. Create a portrait of each section of the habitat. Draw beginning conclusions.

Starter List of of Rectangular Loupe-study Objects and Opportunities:

- slice of rectangular bread
- dollar bill
- rectangle of newsprint (loupe-examine the dots that make up black-and-white vs. color)

Example: Sand dollar. After a general loupe-examination and loupe-analogy list, focus on the shape and partitions. Explain that in nature circles are not as exact as on paper, but there are circular shapes to investigate. 1) Lay a sand dollar face-side up on a dark sheet of paper for contrast. Lay a second sheet of paper to Cover up the left half of the sand dollar and study just the right half using The Private Eye 1st question to help you see. Now cover the right half and see if you can find for differences and similarities in the left half. Discuss. Let's do a study of fourths. (Continue on to help students notice ways in which the patterns stay the same or change in each partition.)

Example: Fruits and Vegetables. The teacher cuts an apple in ¼ inch cross sections for students to study on a paper plate or napkin. Students also need plastic knives to cut their apple slices. Students first loupe-explore the whole cross section with The Private Eye process and discussion. Then direct them to cut their apple circles in half, then in fourths, and re-loupe to see if they notice more, or anything they missed before. Partitioning can help focus attention. Do the same with other vegetable and fruits that are basically circular when sliced in one direction. Link to questions about placement of seeds, compare one fruit/vegetable seed strategy with another, and so on. Have students loupe-draw one partition very carefully and label the partition. Combine with a sandwich poem for display.

(continued next page)

Reason with shapes and their attributes. (continued) **2.G.3**	**Reason with shapes and their attributes.** (continued) **Example:** Bread. Each student needs a slice of square or rectangular bread, a paper plate, a plastic knife. Direct students to score with their knife various partitions, simple or complex. Each table team can be given a different visual diagram for partitioning, then actually cut the partitions apart. Have students cut each half into half again and again until they have approximately a one-inch unit. Loupe-study this one-inch rectangle and see if you can count the air bubbles. Each student records the number and compares with others in the class. Now ask each student to estimate, using addition and an equation (based on how many units are in the entire slice), how many air bubbles are in one bread slice. Discuss where the bubbles come from (yeast process) and how cool it is that bread bakers are selling such a huge fraction of a product as air! **Partitioning Exercises and Loupe-Drawings:** **Note:** In the initial phase of a loupe-drawing, students typically loupe-draw their object inside a circular frame or a rectangular frame (though they can use any shape frame). **Example:** For variety and an exploration in perception, direct students to loupe-draw just half the flower, a just a fourth of the sand dollar, just a third of the newsprint segment, etc. (Students can cover-up half of their object to help them in this.) **Example:** After the black-and-white drawing is done, experiment and add color to only half your drawing. **Example:** Use three colors on your loupe-drawing, one color for each third. • Traveling a Mathematical Loupe: Missing Piece, p. 176 • Drawing as Close Observation" p. 26; "Loupe-Draw" p. 125, and "Drawing Tips", p. 127 • Drawing Plans & Ticklers: "Sequence" and "5-in-1", p. 130 • Nature's Geometry, p. 176 • Habitats – Systems, (See the inset text box) p. 181 • A Yard of Yard, p. 148 (Partition into halves, thirds, fourths, for study loupe-analogy studies. Investigate partition by partition: who lives there "in Whoville"? What the habit is composed of? Gather data. Graph. Compare partitions. Create a portrait of each section of the habitat. Draw beginning conclusions