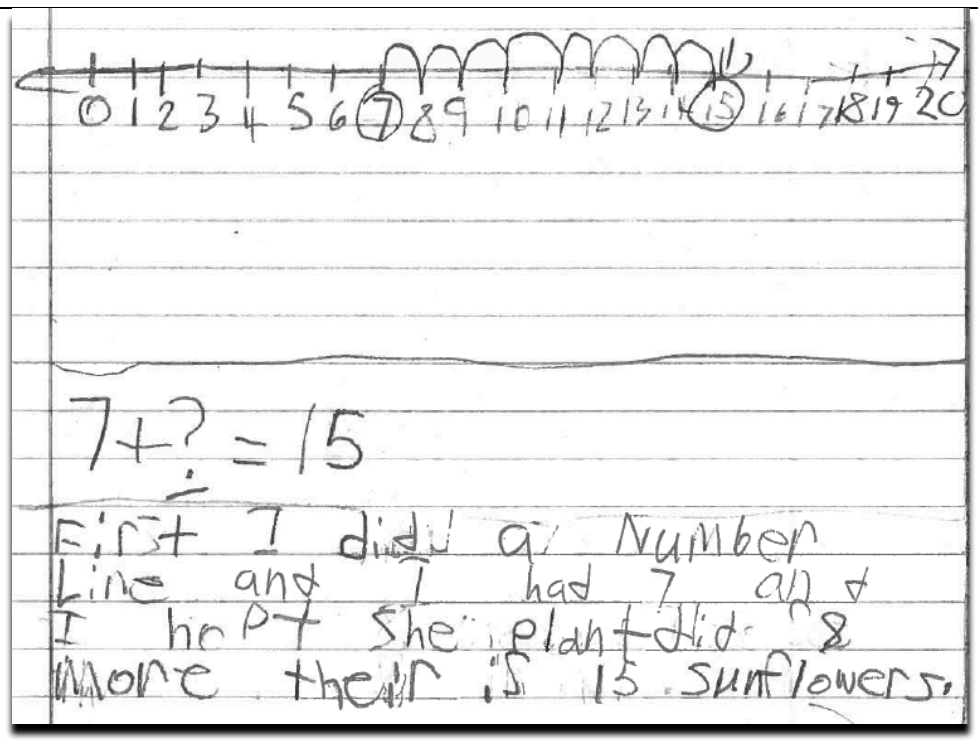
What to Look for in Students' Writing in Mathematics

(Lower Elementary Version)

What cognitive tools do we use to solve problems and communicate one's mathematical reasoning?	Writing in the mathematics is no different than any other objective writing. "Writing is thinking on paper, or talking to someone on paper" (William, 1976, p. vii). Writing in mathematics allows the teacher to peek into the writer's mind as the writer attempts to communicate her mathematical reasoning. In fact, the perceptive teacher can witness all Common Core Standards for Mathematics, Math Standards for Practices (MSP), one through eight, in the students' writing. In addition to seeking evidence of the MSP, the teacher is looking for evidence of certain thinking tools: • Images (e.g., models, drawings, pictures, schematics, etc.) • Concepts (i.e., mathematical ideas that govern the math problem) • Facts (i.e., declarative knowledge within the context of the specific problem) • Language (i.e., formal mathematical vocabulary and text in context), and • Procedures (i.e., models, strategies, algorithms, heuristics, etc.)
Problem: How many sunflowers did Granny Plant?	Granny has seven giant sunflowers lining her walkway. She plants some more. Now she has 15 giant sunflowers. How many sunflowers did she plant?
2nd grader's work	
Student's writing transcribed—this is where the teacher connects language arts to mathematics.	7 + ? = 15 First I did a number line and I had 7 and I hopt She plantdid 8 more their is 15 sunflowers. **Teacher Translation: I drew a number line and circled 7 and 15 because Granny started with 7 sunflowers and ended with 15 sunflowers. I hopped 8 times and landed on 15, so Granny planted a total of 15 sunflowers.**
Finding Thinking Tools: ICFLP	**Image:** Student provides a number line with the beginning and total sum of sunflowers after planting an unknown number—7 and 15 are circled, respectively. **Concept:** In the phrase, "She 'plantdid' (planted) 8 more…," and the equation (7 + ? = 15) confirms her use of the number line model for counting on and confirms the mathematical concept that governs the problem as addition. **Facts:** Student declares facts of problem although her grammar and word usage elementary, she does have the fact correct, she has 7 as the starting number of plant, 15 as the total number of plants after planting, finally, she has the correct distance between 7 and 15 on the number line. **Language:** Student uses mathematical language with phrases like: "I did a number line…"; "…I had 7 and I hopt…"; "…She plantdid 8 more…"; "…there is 15 sunflowers." **Procedure:** Student communicates procedure of determining solution through use of number line model and connects procedure to concept through written communication of mathematical reasoning.
Use of thinking tools (ICFLP) used by student to communicate mathematical thinking.	The student's use of the number line as a model for representing whole numbers is important in several ways. First, the student understands the number line as continuous by placing arrowheads at both ends of the number line. Second, the student represents distance as the unit, and this measure construct suggests iteration of the unit. Finally, the student maintains an equidistant between the respective whole numbers, so that eventually she can make equidistant hops between points 7 and 15 to arrive at the correct solution, 8. The number line model, then, embodies the concept that governs the problem, contains the facts and the procedure within the context of the problem, which the student than uses as a memory aide to communicate her mathematical thinking in writing.
Self-awareness & social-emotional implications	Although the student's written communication of her mathematical reasoning does not convey any negative emotions, emotions and feelings do affect students' performance and learning, according to Immordino-Yang (2016). What can be understood from the student's use of number line, equation, and written explanation of her mathematical thinking is that her mathematical thinking is clear, and she can connect among mathematical representations (i.e., images, concepts, fact within context, language, and procedures). The student, it seems, is confident because of previous positive learning experiences that have shaped and organized her problem-solving skills, that is, "Emotion forms the rudder that steers learners' thinking, in effect helping them to call up information and memories that are relevant to the topic or problem at hand" (Immordino-Yang, 2016, p.86).

Immordino-Yang, M.H. (2016). Emotions, learning, and the brain: Exploring the educational implications of affective neuroscience. New York, N.Y. W.W. Norton & Co.

Zinsser, W.K. (200?) On writing well: The classic guide to writing nonfiction. New York, N.Y. HarperCollins Publisher.