Teacher Note

Learning the Addition Combinations

To develop efficient computation strategies, students need to become fluent with the addition combinations from 1 + 1 to 10 + 10. Fluency means that the combinations are quickly accessible, either because they are immediately known or because the calculation is so effortless as to be automatic (in the way that some adults quickly derive one combination from another; for example, thinking 8 + 9 = 8 + 10 − 1). In *Investigations,* all students should be fluent with all of the addition combinations up to 10 + 10 by the end of Grade 2. However, some students may need to review and practice some of these combinations in Grade 3.

Why Do We Call Them *Combinations*?

The addition problems from 1 + 1 through 10 + 10 are traditionally referred to as "addition facts." The *Investigations* curriculum follows the National Council of Teachers of Mathematics (NCTM) convention of calling these expressions *combinations* rather than *facts* for two reasons. First, referring to *only* particular addition and multiplication combinations as *facts* seems to give them elevated status. This makes them seem more important than other critical parts of mathematics.

In addition, the word *fact* implies that something cannot be learned through reasoning. For example, it is a fact that the first president of the United States was George Washington, and it is a fact that Rosa Parks was born in Alabama in 1913. If these facts are important for us to know, we can remember them or use reference materials to look them up. However, the sum of 7 + 8 can be determined in many ways; it is logically connected to our system of numbers and operations. If we forget the sum, but understand what addition is and know some related combinations, we can find the sum through reasoning. For example:

If we know that 7 + 7 = 14, we can add 1 more to get 15.

If we know that 8 + 8 = 16, we can subtract 1 to get 15.

If we know that 7 + 3 = 10, we can then add the 5 that is left from the 8 to get 15. (7 + 8 = 7 + 3 + 5 = 15)

The term *facts* does convey a meaning that is generally understood by some students and family members, so you will need to decide whether to use the term *facts* along with *combinations* in certain settings in order to make your meaning clear. Further, it does not seem appropriate to refer to the counterparts for subtraction and division as "combinations," because subtraction and division do not involve the action of combining. Therefore, for convenience we refer to "subtraction facts" and "division facts."

Learning the Addition Combinations Fluently

The *Investigations* curriculum, like NCTM, recognizes the importance of students' learning the basic combinations fluently through reasoning about number relationships: "Fluency with whole-number computation depends, in large part, on fluency with basic number combinations—the single digit addition and multiplication pairs and their counterparts for subtraction and division. Fluency with basic number combinations develops from well-understood meanings for the four operations and from a focus on thinking strategies". . . . "[*Principles and Standards for School Mathematics,* pp. 152–153]"

In other words, students learn these combinations best by using strategies, not simply by rote memorization. Relying on memory alone is not sufficient. If you forget—as we all do at times—you are left with nothing. If, on the other hand, your learning is based on an understanding of numbers and their relationships, you have a way to rethink and restructure your knowledge when you do not remember something you thought you knew.

In Grade 2, students learned these combinations in groups (make-10 combinations; plus-1, -2, or -10 combinations; doubles and near-doubles), which helped them learn good strategies for solving them easily. Fluency develops through frequent and repeated use; therefore, as students worked on a particular category of combinations, they played games and engaged in activities that focused on those combinations. For example, students reviewed the combinations that make

10 by playing *Make 10* and *Tens Go Fish.* The Classroom Routine *Today's Number* provided another opportunity for practice.

Students in Grade 2 used Addition Cards to think about combinations they knew and to practice those they did not yet know. Over the year, students collected a set of Addition Cards for each category and sorted them into two envelopes: "Combinations I Know" and "Combinations I Am Still Working On." Students wrote clues on these cards to help them remember the combinations they found difficult.

In Grade 3, students again use Addition Cards (M24–M28) as they review the addition combinations. At the beginning of Investigation 2, they sort these cards as they did in Grade 2 and focus on the combinations they have not yet learned. As you observe your students and assess their knowledge of combinations later in Investigation 2, you will note that some may need more practice in one or more of these categories, particularly the final group of remaining combinations. Addition Combinations Practice (M29) contains blank addition cards for you or students to fill in, according to their individual needs.

Knowing the addition combinations should be judged not only by quick recall but also by fluency in use. Can students call on these combinations and use them easily as they solve other problems? Through repeated use and familiarity, students will come to know most of the addition combinations quickly. For the others, they will be able to use some quick and comfortable strategy based on reasoning about the numbers.

Categories of Addition Combinations

The categories of combinations are listed below. There are also notes about when most students learn these combinations. Note that some combinations fall into more than one category. For example, 1 + 9 and 9 + 1 is both a combination that makes 10 and a plus-1 combination.

Plus-1 and plus-2 combinations Many students leave Grade 1 fluent with the combinations that involve adding 1 or 2 to any single-digit number (8 + 1 and 7 + 2). As second graders come to understand that addition is commutative, they also become fluent with combinations in which the order of the numbers is reversed (1 + 8 and 2 + 7).

Make-10 combinations These two-addend combinations of 10 (e.g., 3 + 7, 4 + 6) were a benchmark for the end of Grade 1; students review them in Grade 2.

Doubles By the end of first grade, many students know their doubles combinations up to 5 + 5. In Grade 2, students work on these combinations up to 10 + 10. Students practice these combinations throughout Grade 2 and should gain fluency with them by the end of the year.

Near doubles (or doubles plus or minus 1) Students learn these combinations in Grade 2—those that are one more or one less than the doubles (e.g., 5 + 6, 7 + 8)—by relating them to the doubles.

Plus-10 combinations As students work on ideas about place value in Grade 2, they learn the plus-10 combinations—the sums of 10 and the numbers 1–10 (10 + 1, 10 + 2, 10 + 3, . . . 10 + 10).

Plus-9 combinations Students learn these combinations—the sums of 9 and the numbers 1–10 (9 + 1, 9 + 2, 9 + 3, . . . 9 + 10)—by relating them to the plus-10 combinations.

Remaining combinations Students who are fluent with doubles plus or minus 1 may be able to use the "clue" that several of the remaining combinations are doubles *plus or minus 2.* Students who are fluent with the make-10 combinations and with breaking numbers apart can solve most of these quickly (e.g., by breaking apart 7 + 5 into 7 + 3 + 2). Similarly, students can use their knowledge of make-10 combinations to solve "near-10" combinations (6 + 3, 7 + 4, 8 + 3).