

## Money Investigation 2

### Teacher Materials

#### Mathematics Contained in the Lesson

The mathematics in this activity includes:

- understanding and using the distributive property
- solving linear equations involving the distributive property
- understanding order of operations

#### Set-up

Ask each student to bring to class at least:

- 10 nickels,
- 5 dimes
- 8 quarters, and

This is enough so that if one member of a group of four students forgets, the group will still have enough to work with. Alternatively, you could make paper "coins", although we strongly recommend using **real** coins. To use paper coins, have each student write the appropriate amount on pieces of paper. It would help if all paper "pennies" were one size, all paper "nickels" a second size, and so on.

#### Organization

Students should have finished **Money Investigation 1** sometime (but not necessarily immediately) before they do this lesson together in class. For the in-class lessons, students should work in groups of 4, insofar as possible.

The main idea is to give students an opportunity to model with familiar concrete objects, coins, in order to develop their conceptual understanding of the four basic binary operations in algebraic expressions, which in turn will help them develop a conceptual understanding of the meaning of linear equations in one variable and how to solve them.

Students may attempt these problems without actually using the coins. If they have difficulty, have them actually perform the concrete manipulations.

#### Answers to Problems and Teaching Suggestions for **Money Investigation 2**

- 1. a.** Varying, depending on the number of students in the group. For 4 students, \$5.30.

**Reflection point:** Help students analyze what they did. Some may have calculated  $n(75 + 50) + 30$ ; others may have calculated  $75n + 50n + 30$ . Pointing out that their equivalence is an example of the distributive property of multiplication over addition and that knowing that two such expressions are equivalent is often a useful tool may prove helpful. Likewise, if students varied order, you can note the use of commutativity. The key is to get students to recognize that they know and use these properties already.



- b.  $n(15 + 10x) + 30$  or  $15n + 10nx + 30$ , where  $n$  is the number of students in a given group.
- c. For example: "Sarah has four children and \$9. She is going to give each child the same number of dimes and the same number of nickels. How much will she have left?" When  $x = 2$  and  $y = 6$ ,  $900 - 4(10x + 5y) = 700$ . It means there are \$7 remaining from the \$9.
- d. In our problem, it would mean Sarah had \$2 left after giving the dimes and nickels to her children. If  $y = 7$  then  $x = 14$ .

**Reflection Point:** Students are to explain how they determine the value of  $x$ . They can describe their process in terms of the problem they made up in part c or otherwise; however, if they make an error, persuade them to analyze it in terms of their problem. The end result is for them to learn how to solve more complicated expressions,  $x = \frac{700}{40} - \frac{5y}{10}$  in this case.

- e. Try to use what students tell you here in class discussion. Help them recognize that their own thinking about the mathematics is valuable.
2. a. If any students find the puzzle difficult, ask questions to help them determine the number. For example, "What did your partner do to the number she chose?" (Added 5 and then doubled the total.) "How can you un-do that?" "Which operation do you think should be un-done first?" "How can you un-do doubling?" Et cetera.
- b. For example: "First I divided by 2, and then I subtracted 5."
  - c. For example, someone might write  $(n + 5) \times 2 = T$ . Then they should follow their instructions from part a. They would write:  $n + 5 = \frac{T}{2}$  so  $n = \frac{T}{2} - 5$ . Students might try it on some numbers to see if it gave back the original  $n$ . Or, they might try their original instructions for "hiding"  $n$  on  $\frac{T}{2} - 5$ . Thus, "add 5 to  $\frac{T}{2} - 5$ ; I get  $\frac{T}{2}$ . Multiply that by 2; I get T."

For homework, have students finish these questions and also assign **Money Investigations 2, Homework**. You could assign homework problems on (1) using the distributive property and (2) solving linear equations involving the distributive property for for a given variable.

You might also assign students to write a problem situation for two of the equations in their textbook. They could be submitted under categories like "funny," "important real-world," "everyday life," and you could pick out the best of these to share with the class.

**Answers to Problems and Teaching Suggestions for Homework to follow Money Investigation 2**

- 1. a.**  $(x + 3) \times 5$
  - b.** 50
  
- 2. a.**  $5x + 3$
  - b.** 38
  
- 3.** The difference is the order of the operations. In problem 1, we add three first and then multiply by 5; in problem 2, we multiply by 5 first and then add three. The reason the answers are different is that in the first method the 3 gets multiplied by 5 but in the second it doesn't.
  
- 4. a.**  $x = 140$
  - b.** For example: "My 3 brothers and I each needed \$20 for a bus ticket, but I owed my brothers money from an old debt. I had \$500, so I had to figure out how much beyond the \$20 I could afford to give each one and still have \$20 left for my own bus ticket." Our solution in part a says that after the bus fare, each of the brothers will get \$140 besides their busfare.