Notes for the Teacher

This activity is the first of three balance activities in which students develop intuitive strategies for writing and solving simple algebraic equations. Students drag a shape whose numerical value is known onto one side of a scale. They then drag copies of a shape with an unknown numerical value to the other side of the scale until both sides are level. They write a repeated addition equation to represent the relationship and simplify the equation by replacing repeated addition with multiplication. Students then solve the equation to determine the value of the unknown shape. This method is repeated with each of the shapes whose value is unknown.

Objectives:

- Students will use a scale to represent algebraic equations.
- Students will understand that repeated addition can be expressed as multiplication.
- Students will develop and use intuitive strategies to write and solve algebraic equations in which there is one unknown value.
- Students will develop and use intuitive strategies to solve for an unknown value in cases where that value is only on one side of an equation.

Common Core Mathematical Practices: (1) Make sense of problems and persevere in solving them; (2) Reason abstractly and quantitatively; (3) Construct viable arguments and critique the reasoning of others; (5) Use appropriate tools strategically; (7) Look for and make use of structure.

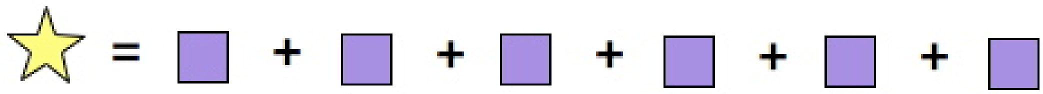
Common Core State Standards: 6.EE2, 4, 5, 6, 7; 7.EE4

Grade Range: Grades 4–7

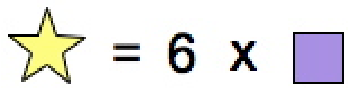
Introduce:

Open **Balance--Solving for Unknowns Part One.gsp** and distribute the worksheet. Use a projector to show sketch page “Puzzle A.” Explain that students will solve puzzles using a scale. Drag a star onto one side of the scale using the **Arrow** tool. Ask, “What is the value of one star?” (12) “How can we figure out the value of the other shapes?” Let students suggest strategies. A student may suggest dragging another shape, such as a square, to the other side and keep adding squares until the balance is level.

Have a volunteer come to the computer and drag a square onto the other side of the balance. Ask, “Does the scale balance?” (no) Have the student continue dragging squares one at a time until the scale balances. Ask, "How many squares balance one star?" (6 squares) Have the student write an equation on the board to represent the balance model. Make sure students use the addition symbol, rather than just six squares without an operation between them.



Say, "Wow, that took a lot of work to write. Can you think of an easier way to write the relationship?" Some students may make the connection that repeated addition can be expressed as multiplication. Ask students how to change the addition statement into a multiplication statement. Work with students to develop the following notation:



Ask students to explain what the equation means. Possible responses include:

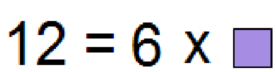
It takes six squares to balance one star.

One star is equal to six squares.

The value of the star is 6 times the value of the square.

The value of the square is 6 times the value of the star. (Examine this misconception, fostered by notation that may be new to some students.)

Ask, "What does this equation look like if we replace the star with its numerical value?" Write the following on the board after students suggest it:



Ask, "What is the numerical value of the square? How do you know?" (The square is 2 because $12 = 6 \times 2$.)

Continue finding the values of the other shapes in a similar way: Clear the scale by pressing *Reset*, drag one star onto one side of the scale, and then drag multiple copies of another shape, one by one, onto the other side of the scale until it balances. Every problem in this activity has been designed so that the scale will exactly balance with whole number multiples of each shape.

Have volunteers come to the board, drag copies of a shape to one side of the scale until it balances, write the matching addition and multiplication equations, substitute the value for the star, and then solve for the unknown value of each shape. (Answers: star = 12, square = 2, circle = 3, triangle = 4, heart = 6)

Explore:

Assign students to partners and send them in pairs to the computers. Have students open **Balance--Solving for Unknowns Part One.gsp** and go to page "Puzzle B." Tell students that after they solve this puzzle they should move on to pages "Puzzle C" and "Puzzle D." Be sure students understand how to record their solutions by writing a repeated addition equation and then the related multiplication equation.

As you circulate, observe students as they work. In Puzzles B and D, students will discover that two shapes can have the same value. This may confuse students at first if they think that each shape must have a different value. It is an important concept for students to understand that two different unknowns can have the same value.

Look for students who are struggling to write repeated addition equations as related multiplication equations. Ask questions to help these students see the relationship between the number of identical addends and the factor in the multiplication equation.

Discuss:

Call students together to discuss and summarize what they have learned. Open **Balance--Solving for Unknowns Part One.gsp** and go to page "Puzzle B." Have a volunteer come to the computer, show how to balance the scale and write the related addition and multiplication equations on the board.

Answers:

Puzzle B: star = 1, square = 6, circle = 6, triangle = 2, heart = 3
Puzzle C: star = 4, square = 8, circle = 12, triangle = 6, heart = 24
Puzzle D: star = 9, square = 36, circle = 18, triangle = 9, heart = 6

Ask students to discuss what they observed while solving the various puzzles. Here are some possible replies:

- *We noticed in Puzzle B that the value of the square and the circle was the same, 6. It took only one square to balance the circle. We had to check our work because we thought each shape had to have a different value. But our work with the scale showed that more than one shape can have the same value.*
- *We learned the same thing. In Puzzle D, the star had the same value as the triangle. It took the same number of stars as triangles to balance one square.*

- *We decided that it was much easier to use multiplication than addition to find the value of each shape. We could think of the missing factor instead of finding the missing addend.*
- *When we looked at the values of the shapes, we noticed that they were all factors of the shape whose value we were given. For example, in Puzzle C, the heart had a value of 24 and the values of the other shapes were 4, 6, 8, and 12, all of which are factors of 24. That makes sense because the values were the missing factors in the multiplication equations we wrote.*
- *In each of these Puzzles, we were able to balance the scale. But that would not always be true. For example, if the value of a star was 18 and the value of a square was 15, then one star could not be balanced by any whole number of squares.*

Related Activities:

- *Balance—Solving for Unknowns, Part Two*
- *Balance—Solving for Unknowns, Part Three*
- *Sneaky Sums—Unknowns in a Grid*
- *Mystery Sums, Part One—Deduce the Unknown Addends*
- *Mystery Sums, Part Two—Deduce the Unknown Addends*
- *Mystery Sums, Part Three—Dancing Addends*

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