Applying the Properties to Simplify Algebraic Expressions

STRAND: Patterns, Functions and Algebra

STRAND CONCEPT: Algebraic Expressions

SOL 5.4, 7.11, 8.14b

Remediation Plan Summary

Students model and discover the additive identity property and additive inverse property, using counters. They also investigate the multiplicative identity property, the multiplicative inverse property, and the multiplicative property of zero.

Note: The problems in the lesson are designed to help students understand and correctly apply the properties of real numbers, not to evaluate algebraic expressions.

Common Errors and Misconceptions

- Students may get the additive identity and additive inverse properties confused because they both use addition.
- Students may get the multiplicative identity and multiplicative inverse properties confused because they both use multiplication.
- Students may confuse the multiplicative property of zero and additive identity properties confused because they both have a zero in the expression.

Materials

- Let's Race activity sheet
- Timer
- Two-color counters or Algebra tiles (for the purposes of the lesson, counters are used)
- Find the Error recording sheet

Introductory Activity

Pass out the "Let's Race" activity sheet to students face down. Tell students when you say "GO", the students will flip their paper over and select one column to solve in 10 seconds. Time the activity and when ten seconds have passed, tell students to stop. Ask the students to fill in the question at the bottom of the page explaining why they chose the column they did. Ask student to share how many they finished and why they chose that column for each of the three columns. (Columns 2 and 3 will be part of the discussion later in the lesson but do not let students know at this point.) Ask how many students finished their column in under ten seconds.

Plan for Instruction

In this lesson, the emphasis is on how the properties function in solving mathematical expressions and equations rather than naming the properties.

1. Hand out a set of two-color counters to each student, and explain that the yellow side represents positive one (+1) and the red side represents negative one (−1). Have each

student place five positive counters on his/her desk. Ask how many counters could be added to this group to keep the number of counters the same. (none, or 0) Have students write an equation to model this demonstration. (Make sure to point out that the equation can be $5 + 0 = 5$ or $0 + 5 = 5$ because of the commutative property of addition.) When 0 is added to any number or variable, it is equal to the given number/variable. Explain this is the *additive identity property:* $a + 0 = a$.

2. Have students write three equations that demonstrate the *additive identity property,* e.g., $3 + 0 = 3$, $-2 + 0 = -2$, $\frac{1}{4} + 0 = \frac{1}{4}$, and $x + 0 = x$. Ask students to share their problems with a partner.
3. Then, ask students to replace the five positive counters and ask by what number these counters could be multiplied in order to keep the number of counters the same. (One or 1) Have students write an equation to model this demonstration. (Make sure to point out that the equation can be $5 \cdot 1 = 5$ or $1 \cdot 5 = 5$ because of the commutative property of multiplication.) When any number is multiplied by 1, it is equal to the given number. Explain this is the *multiplicative identity property:* $a \cdot 1 = a$. Refer back to the warm-up activity and students that chose column two in the "Let's Race" activity.
4. Have students write three equations that demonstrate the *multiplicative identity property,* e.g., $5 \cdot 1 = 5$, $137 \cdot 1 = 137$, $\frac{3}{8} \cdot 1 = \frac{3}{8}$, and $x \cdot 1 = x$. Ask students to share their problems with a different partner then before.
5. Next, ask students to replace the five positive counters. *What is the value of the expression?* Ask students to add five negative counters to their expression. *Now, what is the value of the expression? How would I write this as an equation?* Take student responses and display them for the class to see. (Make sure to point out that the equation can be $5 + (-5) = 0$ or $-5 + 5 = 0$ because of the commutative property of addition.) Explain to students that *inverses* are numbers that combine with other numbers and result in identity elements. The identity element for addition is 0. For the *additive inverse property,* the sum of the two numbers is zero.
6. Have students write three equations that demonstrate the additive inverse property, e.g., $4 + (-4) = 0$, $-12 + 12 = 0$, $\frac{1}{3} + (-\frac{1}{3}) = 0$, and $x + (-x) = 0$. Ask students to share their problems with a new partner.
7. To demonstrate the *multiplicative inverse property,* have students brainstorm which numbers could be used as factors to produce a product of 1. Some students may remember from fraction operations. Or you can encourage them to use variables in a few examples, such as $4 \cdot x = 1$ or $\frac{1}{3} \cdot x = 1$, to generate ideas about how to find the multiplicative inverse of a number, which is also called the *reciprocal* of the number. *If we place the five positive counters back down, what would you need to multiply by to get a product of 1?* Allow students to share their ideas. Once you have the answer $\frac{1}{5}$, ask students to write an equation to represent this problem. (Make sure to point out that the equation can be

$5 \bullet \frac{1}{5} = 1$ or $\frac{1}{5} \bullet 5 = 1$ because of the commutative property of multiplication.) Remind students that *inverses* are numbers that combine with other numbers and result in identity elements. The identity element for multiplication is 1. For the *multiplicative inverse property,* the product of a number and its reciprocal is one.

8. Have students write three equations that demonstrate the multiplicative inverse property, e.g., $7 \bullet \frac{1}{7} = 1$, $\frac{1}{2} \bullet 2 = 1$, $\frac{3}{5} \bullet \frac{5}{3} = 1$, and $x \bullet \frac{1}{x} = 1$. Allow students to share their problems with the class or a small group.
9. *Think back to when you learned your multiplication facts. What was the easiest fact to learn?* (the zero facts) If students say the one facts, then ask why they think this and take another answer. Refer back to the warm-up activity and students that chose column three in the "Let's Race" activity and ask them again why they chose this column. *Why were the zero facts easy to learn?* Students may answer that zero times and number is always zero. For the *multiplicative property of zero,* explain to students that this property is very simple: any number multiplied by zero is always equal to zero: $a \bullet 0 = 0$.
10. Have students create three equations that demonstrate the multiplicative property of zero, e.g., $7 \bullet 0 = 0$, $-3 \bullet 0 = 0$, $\frac{2}{3} \bullet 0 = 0$, and $x \bullet 0 = 0$.
11. Pull the discussion of properties together by asking students why they think properties are important in mathematics. One reason is like the order of operations the properties give mathematics order and a set of rules to follow.
12. Students will complete "Find the Error" recording sheet.

Pulling It All Together (Reflection)

Have students select two of the properties and write a few sentences describing the similarities and differences between the properties.

Note: The following pages are intended for classroom use for students as a visual aid to learning.

Virginia Department of Education 2018

Name:

Let's Race

Pick one of the three columns to solve when I say start. You will have 10 seconds to complete your column.

$0+1=$	$0\cdot1=$	$1\cdot0=$
$1+1=$	$1\cdot1=$	$2\cdot0=$
$2+1=$	$2\cdot1=$	$3\cdot0=$
$3+1=$	$3\cdot1=$	$4\cdot0=$
$4+1=$	$4\cdot1=$	$5\cdot0=$
$5+1=$	$5\cdot1=$	$6\cdot0=$
$6+1=$	$6\cdot1=$	$7\cdot0=$
$7+1=$	$7\cdot1=$	$8\cdot0=$
$8+1=$	$8\cdot1=$	$9\cdot0=$
$9+1=$	$9\cdot1=$	$10\cdot0=$
$10+1=$	$10\cdot1=$	$11\cdot0=$
$11+1=$	$11\cdot1=$	$12\cdot0=$
$12+1=$	$12\cdot1=$	$13\cdot0=$
$13+1=$	$13\cdot1=$	$14\cdot0=$
$14+1=$	$14\cdot1=$	$15\cdot0=$

Which column did you choose and why?

Name:

Find the Error

State whether a property of real numbers was applied correctly or not. If a property was not correctly applied, rewrite the problem correctly.

Problem	Property correctly applied?	Make it right
$-7+7=1$		
$\frac{3}{4}x \bullet \frac{4}{3}=1x$		
$1 \bullet b=1$		
$x \bullet 0=1$		
$\frac{1}{2}+0=\frac{1}{2}$		
$2x+3+(-3)=2x+6$		
$4x \bullet 3 \bullet \frac{1}{3}=4x$		