



### Math Objectives

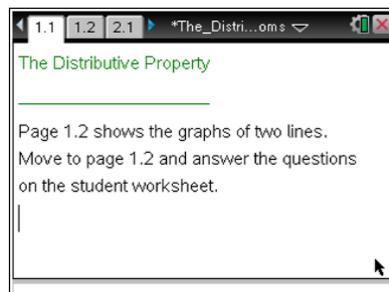
- Students will learn the distributive property of multiplication over addition for real numbers.
- Students will verify that algebraic expressions involving the distributive property are equivalent both graphically and algebraically.
- Apply the properties of operations to generate equivalent expressions (CCSS).
- Identify when two expressions are equivalent (CCSS).
- Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients (CCSS).
- Reason abstractly and quantitatively (CCSSM Mathematical Practice).
- Look for and make use of structure (CCSSM Mathematical Practice).

### Vocabulary

- Distributive Property of Multiplication over Addition
- real numbers
- equivalent expressions
- coinciding lines

### About the Lesson

- This lesson involves using the graphs of two lines to create equivalent expressions.
- As a result, students will:
  - Change the values of  $a$  and  $b$  in the second line until the graphs coincide and explain why this shows that they now have equivalent expressions.
  - Generate several other examples and derive a rule for generating equivalent algebraic expressions using the distributive rule, i.e.  $a(x + c) = ax + ac$ .
  - Change the values of  $a$  and  $c$  so that the graph  $a(x + c)$  matches the graph of one of the form  $ax + b$ .
  - Generate several other examples and derive a rule for generating equivalent algebraic expressions using the distributive rule in reverse, i.e.  $ax + ac = a(x + c)$ .



### TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Grab and drag a point
- Manually capture data

### Tech Tips:

- Make sure the font size on your TI-Nspire handhelds is set to Medium.
- You can hide the function entry line by pressing **ctrl** **G**.

### Lesson Materials:

#### Student Activity

The\_Distributive\_Property\_Student.pdf  
The\_Distributive\_Property\_Student.doc

#### TI-Nspire document

The\_Distributive\_Property.tns

Visit [www.mathnspired.com](http://www.mathnspired.com) for lesson updates and tech tip videos.



### TI-Nspire™ Navigator™ System

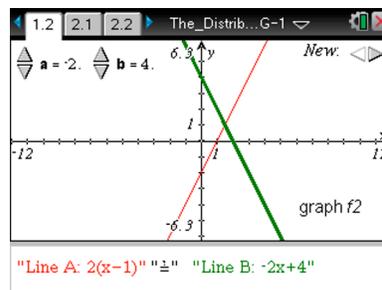
- Send a File.
- Use Screen Capture to examine patterns that emerge and formally assess students' understanding.
- Use Quick Poll to assess students' understanding.
- Use Teacher Edition computer software to review student documents.

### Discussion Points and Possible Answers

**Tech Tip:** If students experience difficulty with the sliders, check to make sure that they have moved the arrow until it becomes a hand (). When finished with a slider, press esc to release the slider.

#### Move to page 1.2.

1. On Page 1.2, Lines A and B are shown. Your goal is to make the lines coincide (or lie exactly on top of each other). You can change the values of  $a$  and  $b$  by clicking on the sliders. As you do, you will change Line B (the green line). When you have manipulated  $a$  and  $b$  to place Line B is on top of Line A (the red line), write the expression for Line B below.



Line A =  $2(x - 1)$  = Line B = \_\_\_\_\_

Now that the two lines coincide, are the expressions for Line A and Line B equivalent? Explain.

**Sample Answers:**  $2x - 2$ ; The expressions are equivalent because the lines are the same line.

**Teacher Tip:** You may want to demonstrate how to use a slider.

**TI-Nspire Navigator Opportunity: Quick Poll**

**See Note 1 at the end of this lesson.**



2. There is a third slider labeled “new” on Page 1.2. Click on this slider, and you will change the expression for Line A. Again, your goal is to make the two graphs coincide by changing the values of  $a$  and  $b$ , which in turn changes Line B. Record your results in the first line of the table below. Click on the slider for “new” several more times, and record your results in the next rows of the table.

**Sample Answers:**

Line A	$-3(x + 2)$	Line B	$-3x - 6$
Line A	$4(x - 2)$	Line B	$4x - 8$
Line A	$4(x + 4)$	Line B	$4x + 16$
Line A	$2(x - 1)$	Line B	$2x - 2$

**TI-Nspire Navigator Opportunity: *Screen Capture and Quick Poll***

**See Note 2 at the end of this lesson.**

3. Consider the findings you have made so far, and create a general rule for generating equivalent expressions for  $a(x + c)$ .

**Sample Answers:**  $a(x + c) = ax + ac$ .

**TI-Nspire Navigator Opportunity: *Quick Poll***

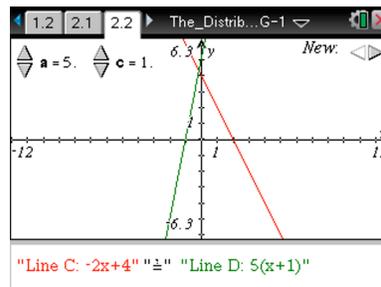
**See Note 3 at the end of this lesson.**

**Teacher Tip:** At this point, you may want to discuss the formal name of the rule, the *distributive property of multiplication over addition*. You may have to discuss how the examples with subtraction actually apply as they can be rewritten as addition problems. i.e.  $2(x - 1) = 2(x + -1)$ .



Move to page 2.2.

4. On Page 2.2, you are given Lines C and D. Again, your goal is to make the two graphs coincide, but now you will change the values of  $a$  and  $c$  to change Line D. Try several examples. Record your results in the first line of the table below.



### Sample Answers:

Line C	$-2x + 4$	Line D	$-2(x - 2)$
Line C	$-4x + 4$	Line D	$-4(x - 1)$
Line C	$-4x - 8$	Line D	$-4(x + 2)$
Line C	$3x + 9$	Line D	$3(x + 3)$

### TI-Nspire Navigator Opportunity: *Screen Capture and Quick Poll*

See Note 4 at the end of this lesson.

5. Consider the findings you have made so far, and create a general rule for generating equivalent expressions for  $ax + ac$ .

**Sample Answers:**  $ax + ac = a(x + c)$

### TI-Nspire Navigator Opportunity: *Quick Poll*

See Note 5 at the end of this lesson.

**Teacher Tip:** At this point, you may want to discuss the formal name of the rule. Sometimes it is called the *reverse distributive property* and other times it is called it *factoring*.

6. Richie believes that the expression  $3(x - 4)$  is equivalent to the expression  $3x - 4$ . Is he correct? Why or why not?

**Sample Answers:** Richie is incorrect. He did not distribute the 3 to the 4.  $3(x - 4)$  is actually equivalent to  $3x - 12$ .

### TI-Nspire Navigator Opportunity: *Quick Poll*

See Note 6 at the end of this lesson.



**Teacher Tip:** Insert teacher/Tech tip as needed.

7. Alice believes that the expression  $-2x - 4$  is equivalent to the expression  $-2(x + 2)$ . Is she correct? Why or why not?

**Sample Answers:** Alice is correct. She used the distribute property (factored) in reverse correctly.

**TI-Nspire Navigator Opportunity: Quick Poll**

**See Note 7 at the end of this lesson.**

8. In your own words, state how you can use the Distributive Property to form equivalent algebraic expressions.

**Sample Answers:** You can use the distributive property to get rid of a set of parentheses by multiplying the inside terms by the factor on the outside. Or you can add a set of parentheses by factoring out a common factor from the two terms.

**TI-Nspire Navigator Opportunity: Quick Poll**

**See Note 8 at the end of this lesson.**

### Extension

Students can be asked to extend to linear expressions involving fractions, such as:

$$\frac{1}{2}(x + 4) = \frac{1}{2}x + 2$$

$$\frac{-1}{3}x + 1 = \frac{-1}{3}(x - 3)$$

### Wrap Up

Upon completion of the discussion, the teacher should ensure that students are able to understand:

- Algebraic expressions of the form  $a(x + c)$  can be rewritten in an equivalent form without parentheses using the distributive property of multiplication over addition.
- Algebraic expressions of the form  $ax + ac$  can be factored using the reverse distributive property of multiplication over addition.



**TI-Nspire Navigator**

**Note 1**

**Question 1 Quick Poll (*Open Response*):** Send an Open Response Quick Poll, asking students to submit their answers to question 1.

**Note 2**

**Question 2 Screen Capture:** Take a Screen Capture of page 1.2 where students have selected new expressions for lineA. As a class, discuss the various cases that occur.

**Question 2 Quick Poll (*Open Response*):** Send an Open Response Quick Poll, asking students to submit the results in one row of their table. Student results could also be aggregated, displayed and discussed as a class.

**Note 3**

**Question 3 Quick Poll (*Open Response*):** Send an Open Response Quick Poll, asking students to submit their answer to Question 3.

**Note 4**

**Question 4 Screen Capture:** Take a Screen Capture of Page 2.1 where students have selected new expressions for lineA. As a class, discuss the various cases that occur.

**Question 4 Quick Poll (*Open Response*):** Send an Open Response Quick Poll, asking students to submit the results in one row of their table. Student results could also be aggregated, displayed, and discussed as a class.

**Note 5 Quick Poll (*Open Response*):** Send an Open Response Quick Poll, asking students to submit their answer to question 5.

**Note 6 (*Open Response*):** Send an Open Response Quick Poll, asking students to submit their answer to question 6.

**Note 7 (*Open Response*):** Send an Open Response Quick Poll, asking students to submit their answer to question 7.

**Note 8 (*Open Response*):** Send an Open Response Quick Poll, asking students to submit their answer to question 8.