Notes for the Teacher

Students use grids of virtual algebra tiles to interpret and solve binomial multiplication problems. They focus on problems of the form $(ax + b)(cx + d)$, where the values of a, b, c, and d are positive integers. Students determine the dimensions of the grid and then add the partial products to find the total product.

Objectives:

- Students will find the products of two binomials using a grid of algebra tiles.
- Students will relate a multiplication problem represented in numerical form to the same problem represented with algebra tiles.

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 Content Standards: A-APR; A-SSE3a

Grade Range: Grades 8–9

Introduce:

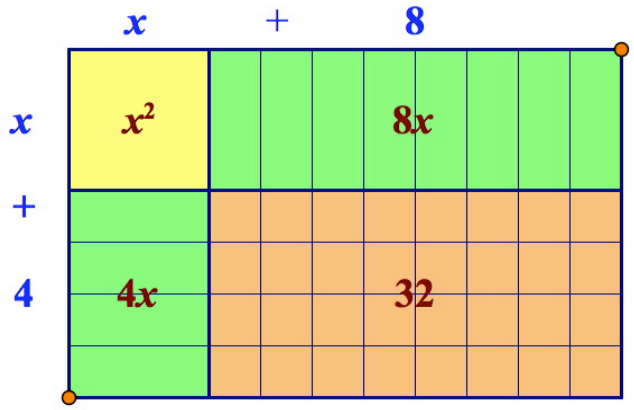
Use a projector to show http://geometricfunctions.org/links/binomial-multiplication. Distribute the worksheet, and tap the section heading "Binomial Multiplication Part 1."

Ask, "What multiplication problem is represented by this model?" The model shows $(x + 4)(x + 8)$ using three sizes of algebra tiles: large squares, long rectangles, and small squares. If you have algebra tiles, show them to the class so that students can relate the physical blocks to their virtual counterparts.

Ask students to find the dimensions and area of each type of tile. If you are using a whiteboard to display the Sketchpad model, write this information directly onto the model. Students should state that the side lengths of the large yellow square are x and x, so the area is $x \cdot x$, or x^2; the side lengths of the green rectangles are 1 and x, so their area is $1 \cdot x$, or x; and the side lengths of the small orange squares are 1 and 1, so their area is $1 \cdot 1$, or 1.

There are four color-coded grids within the overall grid: a yellow grid, two green grids, and an orange grid. Ask students to state the dimensions and areas of each of the four grids.

Remind students of the term *partial products,* and have a volunteer identify the partial products: x^2, $4x$, $8x$, and 32. Use the **Arrow** tool to press the *Partial Products On/Off* button to check.



Ask, "The area of the entire grid is equal to the product of $(x + 4)$ and $(x + 8)$. How can we find the total area of the grid?" Students should state that to find the total product, they need to add the partial products. Ask students to simplify the expression by combining tiles that have the same area, or shape; in this case, all the rectangular x tiles can be combined. Explain that combining tiles that have the same area to write a simpler expression is called *combining like terms*.

$$x^2 + 4x + 8x + 32 = x^2 + 12x + 32$$

Press the *Product On/Off* button with the **Arrow** tool to check.

Show students how to drag the orange points on the grid with the **Arrow** tool to create a new multiplication problem (On this page of the sketch, the coefficient of each x is always 1.)

If the grid gets too big for the page, drag the points on the vertical sliders labeled 'x' and '1' to adjust the sizes of the blocks. Have volunteers take turns creating and solving several problems until students understand how to use and interpret the model.

Explore:

Assign students to partners and send them in pairs to the computers. Have students open show http://geometricfunctions.org/links/binomial-multiplication and tap "Binomial Multiplication Part 1." Ask students to use the model to multiply binomials. Make sure students understand how to record the results on the worksheet. Explain that students should sketch the grids, write the partial products, and find their sum.

Encourage students who appear to understand the model to turn off the grid lines by pressing the *Grid Lines On/Off* button with the **Arrow** tool.

As you circulate, observe students as they work. Do they need to see the grid lines outlining the algebra tiles to solve the problems? Can students find the partial products easily? Are students combining like terms? When students go to page 2 to solve problems, can they apply what they have learned to find the area of the yellow grid?

Discuss:

Use a projector to display http://geometricfunctions.org/links/binomial-multiplication and open section "Binomial Multiplication Part 1."

Call students together to discuss their worksheet results. Ask volunteers to model their solutions to several problems on page 1 and several problems on page 2. Ask them questions such as the following as they share their solutions:

- *How does your model represent the multiplication problem?*
- *What do the partial products show?*
- *Why did you add the partial products together?*
- *Why can you combine like terms?*
- *On page 2, how did you find the area of the yellow grid?*
- *Did you notice any patterns in your solutions?*

Note that this activity does not make any assumptions about whether students are acquainted with the so-called FOIL method of binomial multiplication (FOIL is an mnemonic for finding partial products: multiply the First terms; multiply the Outside terms; multiply the Inside terms; and multiply the Last terms.) The grid model used in this activity is superior to the FOIL method as an introduction to binomial multiplication because it provides students with a way to visually understand why the multiplication algorithm works.

Answers:

2. $(x + 3)(x + 3) = x^2 + 6x + 9$

3. $(x + 2)(x + 5) = x^2 + 7x + 10$

4. $(x + 7)(x + 6) = x^2 + 13x + 42$

5. $(3x + 3)(4x + 8) = 12x^2 + 36x + 24$

6. $(5x + 4)(2x + 7) = 10x^2 + 43x + 28$

7. $(2x + 5)(2x + 5) = 4x^2 + 20x + 25$

Related Activities:

- *Binomial Multiplication, Part Two—Dynamic Algebra Tiles*
- *Factoring Games, Part One—Dynamic Algebra Tiles*
- *Factoring Games, Part Two—Developing Factoring Fluency*

License (CC-BY-NC-SA 3.0)

Portions of this material are based upon work supported by the National Science Foundation under award number DRL-0918733. Any opinions, findings, and conclusions or recommendations expressed in this work are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.