Notes for the Teacher

Students play games in which they factor quadratic expressions using virtual algebra tiles. They play each game multiple times, with random challenges generated by Sketchpad, and work to improve their score. The activity concludes with students identifying the factoring strategies they used.

Objectives:

- Students will use a grid of algebra tiles to factor quadratic expressions.
- Students will develop strategies for factoring quadratic expressions.

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:

Open **Factoring Games Part One--Dynamic Algebra Tiles.gsp** and distribute the worksheet. Use a projector to show sketch page "Game A." Explain that students will play games in which they try to find the two binomial factors of a given quadratic.

The goal of each game is to earn as many points as possible. Each game has 10 problems, and each problem is initially worth 10 points, for a total of 100 possible points.

Point to the grid. Ask, "What two binomials are being multiplied here?" [$(x + 3)$ and $(x + 5)$]

"Are these the factors of $x^2 + 10x + 25$? Explain how you know." Students may explain that $(x + 3)(x + 5)$ are not the factors of $x^2 + 10x + 25$ because the constant term of the trinomial would be 15, not 25, since the area of the $3 \cdot 5$ array is 15.

Say, "Let's try different factors." Demonstrate how to drag the orange points with the **Arrow** tool to change the addends of each binomial factor. "What two factors should we try?" Test students' suggestions or have volunteers come to the computer to find the factors.

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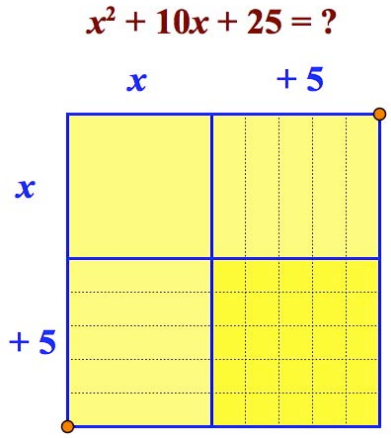
Students will eventually conclude that $(x + 5)(x + 5) = x^2 + 10x + 25$. Be sure students understand how the algebra tile arrays represent $x^2 + 10x + 25$. The area of the $x \cdot x$ array is x^2, the area of the $x \cdot 5$ array is $5x$, the area of the $5 \cdot x$ array is $5x$, and the area of the $5 \cdot 5$ array is 25. The sum of the partial products is $x^2 + 5x + 5x + 25$, or $x^2 + 10x + 25$.



When the class agrees on the factors, demonstrate how to check the answer. Students have two choices: If they are certain of their answer, they can press *Next Problem*. They will be taken to the next random problem to solve and receive full credit (initially 10 points) for a correct answer and 0 points for an incorrect answer. If students are uncertain of their answer, they can press *Check Answer*. Doing so will give them the opportunity to retry the problem if they solved it incorrectly, but the value of a correct problem will be reduced by 2 points with each answer check.

Also indicate the *Show Hints* button. Tell students they can press this button if they need help solving a problem, but they will lose 2 points of the remaining number of available points. The *Show Hints* button shows the partial products. Tell students they can press *Next Problem*, *Check Answer*, or *Show Hints* at any point in the game.

Explore:

Assign students to partners and send them in pairs to the computers. Tell students that they will play four games in which they must find the two binomial factors of quadratic expressions. Ask students to start on page "Game A" and continue through page "Game D" if they have time. Students can play each game more than once. Game A is the easiest and Game D is the hardest.

The games are all slightly different because of the quadratics students are factoring. Here is a summary of the games:

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Game	$ax^2 + bx + c$
A	$a = 1$ b and c = positive integers
B	a, b, and c = positive integers
C	$a = 1$ b and c = positive or negative integers
D	a = positive integer b and c = positive or negative integers

As you circulate, observe students as they work. Keep track of the games that seem difficult for students. Students may have more trouble finding factors of quadratics when the *a* coefficient is not 1 or when the *b* and *c* coefficients are negative. This information can help identify what types of problems students may need additional practice modeling. Make sure students record their scores and their explanations on the worksheet.

Discuss:

Call students together to discuss and summarize what they have learned. Have students share the strategies they used to find the two binomial factors for each game:

- *For all of the games, we dragged the points until we found areas that matched the quadratic expressions. Games C and D were hardest because we had to work with negative areas.*
- *For Game A, we looked for factors of the constant term of the quadratic that added up to the coefficient of x. For example, to factor $x^2 + 7x + 12$, we chose factors of 12 that added up to 7. These were 3 and 4, so we knew the binomial factors were $(x + 3)(x + 4)$.*
- *For Game B, we first focused on the coefficient of the x^2 term. We found two factors that worked, and then we found two factors of the constant term. We tried different combinations of factors until we got the second term right. For example, to factor $6x^2 + 19x + 15$, we used 2 and 3 as factors of 6. Then we tried 5 and 3 for factors of 15. First we tried $(2x + 5)(3x + 3)$, but we got 21x for the second term. Then we tried $(2x + 3)(3x + 5)$ and that worked!*

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- *For Game C, we knew if the constant term of the quadratic was negative, then we had to find a negative factor and a positive factor. If the coefficient of x was also negative, then we knew the larger factor had to be negative. For example, to factor $x^2 - 1x - 20$, we knew the factors of 20 that had a difference of 1 were 5 and 4. We knew the larger factor had to be negative because the coefficient of x was negative. We tried $(x - 5)(x + 4)$, and we were right!*

- *For Game C, we knew if the constant term was positive and the coefficient of x was negative, then we had to find two negative factors of the constant term. If the constant term was positive and the x coefficient was also positive, then we had to find two positive factors of the constant term.*

- *We thought Game D was really hard! We had to use the hints and then move the algebra tiles around until it worked. We tried different factors of the coefficient of the first term and of the last term until they finally summed to the middle term.*

Related Activities:

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

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