Math Objectives

- Students will use algebra tiles to build a geometric model of a perfect square quadratic.
- Students will recognize the characteristics in the algebraic expression of a perfect square quadratic.
- Students will complete the square in an algebraic expression.
- Students will relate the patterns for $(x + n)^2$ to $(x - n)^2$.
- Student will model with mathematics (CCSS Mathematical Practice).
- Students will look for regularity in repeated reasoning (CCSS Mathematical Practice).

Vocabulary

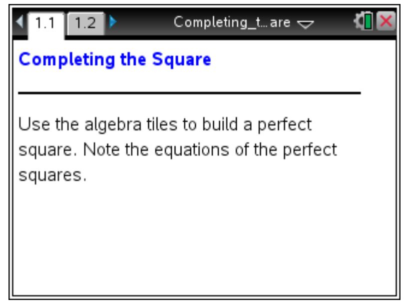
- perfect square quadratics
- coefficient of the *x*-term
- constant term

About the Lesson

- Students will begin the lesson by manipulating algebra tiles to build perfect square quadratics and recording the successful expressions.
- Students will continue the lesson by finding the patterns in the algebraic representation of a perfect square quadratic.
- Students will identify perfect square quadratic expressions.
- Students will fill in the missing terms of perfect square quadratics.
- Students will apply the patterns they found to perfect square quadratics with a negative coefficient in the *x*-term.

TI-Nspire™ Navigator™ System

- Use Screen Capture to examine patterns that emerge.
- Use Live Presenter to demonstrate how to build perfect square quadratics.
- Use Quick Polls to assess student understanding throughout the lesson.



TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Move between windows on a page
- Grab and drop algebra tiles

Tech Tips:

- Make sure the font size on your TI-Nspire handheld is set to Medium.

Lesson Materials:

Student Activity

Completing_the_Square_Student.pdf

Completing_the_Square_Student.doc

TI-Nspire document

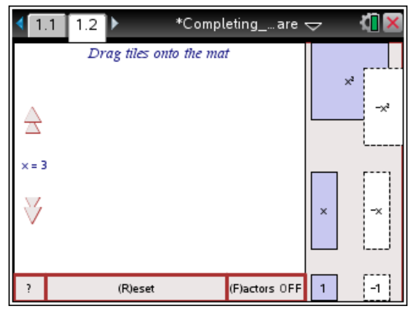
Completing_the_Square_Lua.tns

Visit www.mathnspired.com for lesson updates and tech tip videos.

Discussion Points and Possible Answers

Tech Tip: To manipulate the algebra tiles, reinforce the idea that the tiles are moved up by grabbing the point on the tile and dragging it to the middle space. The *x* tile may be placed on the bottom of the x^2 tile by moving the point to the bottom-left corner of the x^2 tile. Click the *x* tile to rotate it to horizontal. For the larger perfect squares, it is important to move the x^2 tile to the top of the space. In the bottom of the screen, students should click **(R)eset** to clear all tiles from the mat.

Move to page 1.2.



1. Build perfect square quadratics with lead coefficient 1 by dragging the algebra tiles to the middle window. Record the perfect squares found. Click **(R)eset** to start over to find a new perfect square.

<u>**Answer:**</u> Completed table is below.

Side of Square	Perfect Square Quadratic	Coefficient of *x*-term	Constant Term
x	x^2	0	0
$x + 1$	$x^2 + 2x + 1$	2	1
$x + 2$	$x^2 + 4x + 4$	4	4
$x + 3$	$x^2 + 6x + 9$	6	9
$x + 4$	$x^2 + 8x + 16$	8	16

Tech Tip: To clear the screen before trying to build another perfect square, click **(R)eset** and press enter.

Teacher Tip: If students are unfamiliar with using the TI-Nspire technology algebra tiles, a demonstration might be appropriate. Perfect squares can be built without actually creating a "square." If the tiles are just dragged into the middle window, the file keeps track of the tiles. Encourage students to put the tiles next to each other to create the "square." They will snap together. Make sure to connect the geometric with the algebraic relationship.

TI-Nspire Navigator Opportunities

If students have difficulty, use the *Screen Capture* or *Live Presenter* with TI-Nspire Navigator to demonstrate how to build perfect square quadratics.

2. What patterns do you notice for all perfect squares?

Answer: Students may notice that the coefficient of the x-term is increasing by 2 and that the constant terms are the perfect squares.

a. What relationship exists between the side of the square and the coefficient of the x-term?

Answer: The constant term on the side of the square doubles to become the coefficient of the x-term.

b. What relationship exists between the side of the square and the constant term?

Answer: The constant term on the side of the square is squared to become the constant term of the perfect square quadratic.

c. What relationship exists between the coefficient of the x-term and the constant term?

Answer: The coefficient of the x-term is halved and then squared to become the constant term.

d. Why is this called "completing the square"?

Sample answer: Answers will vary but should include some discussion of the geometric model of building a square and/or the algebraic expression of $(x + n)^2$.

Teacher Tip: If you have TI-Nspire CAS handhelds, students can use **Menu > Algebra > Expand** to find the answers here.

3. Expand the following:

a. $(x)(x)$

Answer: x^2

b. $(x + 1)(x + 1)$

Answer: $x^2 + 2x + 1$

c. $(x + 2)(x + 2)$

Answer: $x^2 + 4x + 4$

d. $(x + 3)(x + 3)$

Answer: $x^2 + 6x + 9$

e. $(x + n)(x + n)$

Answer: $x^2 + 2xn + n^2$

TI-Nspire Navigator Opportunities

You could do a *Quick Poll* to ensure that students understand perfect squares. For example, have students expand $(x + 7)(x + 7)$.

4. Use either method to find $(x + 5)^2$.

Answer: Students may answer using the pattern of doubling the constant term in the binomial for the coefficient of the x-term and squaring the constant term in the binomial to get the constant term in the perfect square quadratic: $x^2 + 10x + 25$.

5. State whether the following are perfect square quadratics. Explain why or why not.

a. $x^2 + 3x + 9$

Answer: Not perfect; half of 3, squared is not 9.

b. $x^2 + 14x + 49$

Answer: Perfect square; half of 14, squared is 49.

c. $x^2 + 24x + 144$

Answer: Perfect square; half of 24, squared is 144.

d. $x^2 + 6x + 36$

Answer: Not perfect; half of 6, squared is not 36.

6. Fill in the missing terms to make the following perfect square quadratics.

a. $x^2 + 16x +$ _____

Answer: 64

b. $x^2 +$ _____ $+ 81$

Answer: $18x$

c. $x^2 + 22x +$ _____

Answer: 121

d. $x^2 +$ _____ $+ 100$

Answer: $20x$

e. $x^2 + 3x +$ _____

Answer: $\frac{9}{4}$ or 2.25

7. In your own words, explain how to “complete the square” algebraically.

Sample answer: Answers will vary but students should mention the relationship between the coefficient of the *x*-term and the constant term.

8. Expand the following:

a. $(x)(x)$

Answer: x^2

b. $(x – 1)(x – 1)$

Answer: $x^2 – 2x + 1$

c. $(x – 2)(x – 2)$

Answer: $x^2 – 4x + 4$

d. $(x – 3)(x – 3)$

Answer: $x^2 – 6x + 9$

e. $(x – n)(x – n)$

Answer: $x^2 – 2xn + n^2$

9. Do the negative values in question 8 change the pattern of perfect square quadratics? Explain.

Answer: The negatives do not change the pattern. The coefficient of the *x*-term is still double the constant term in the binomial, and the constant term is the square of the constant term in the binomial.

10. Fill in the missing terms to make the following perfect square quadratics.

a. x^2 – _____ + 289

Answer: $34x$

b. $x^2 - 26x$ + _____

Answer: 169

c. $x^2 - 36x$ + _____

Answer: 324

d. x^2 – _____ + 225

Answer: $30x$

e. $x^2 - 5x$ + _____

Answer: $\frac{25}{4}$ or 6.25

TI-Nspire Navigator Opportunities

Use *Quick Polls* throughout the lesson to assess student understanding.

Wrap Up

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

- The patterns present in perfect square quadratics.
- How to recognize a perfect square quadratic expression.
- How to “complete the square” in an algebraic expression.