Break It Down

Factoring Trinomials

Chelsea Shire, Brittany Bowens, Michell Eike, Corrie Matchell
Published by *K20 Center*

Grade Level	8th – 9th Grade	**Time Frame**	85 minutes
Subject	Mathematics	**Duration**	2 class periods
Course	Algebra 1		

Essential Question

How can we rewrite a trinomial in a different form?

Summary

In this lesson, students will use number sense to identify patterns that help them factor trinomials with a leading coefficient of one. Students will build on their understanding of multiplying binomials to recognize the relationship between expanding and factoring. Prerequisite knowledge for this lesson includes multiplying binomials.

Snapshot

Engage

Students recall factor pairs of a given set of numbers, and then find the sums and differences of those pairs to create a table of values.

Explore

Students analyze their table of values to find two numbers with a given product and given sum or difference.

Explain

Students make the connection between finding the right pair of numbers and factoring a quadratic expression.

Extend

Students apply their understanding by solving a real-world problem after watching an interview of a civil engineer who discusses key elements of his job.

Evaluate

Students practice factoring quadratic expressions through a game of Quiz, Quiz, Trade.

Standards

ACT College and Career Readiness Standards - Mathematics (6-12)

A508: Factor simple quadratics (e.g., the difference of squares and perfect square trinomials)

Oklahoma Academic Standards Mathematics (Algebra 1)

A1.A.3.3: Factor common monomial factors from polynomial expressions and factor quadratic expressions with a leading coefficient of 1.

Attachments

- Civil Engineering—Break It Down.docx
- Civil Engineering—Break It Down.pdf
- Factor Pairs (Key)—Break It Down.docx
- Factor Pairs (Key)—Break It Down.pdf
- Factor Pairs—Break It Down.docx
- Factor Pairs—Break It Down.pdf
- Factoring Quiz, Quiz, Trade—Break It Down.docx
- Factoring Quiz, Quiz, Trade—Break It Down.pdf
- Guided Notes (Model Notes)—Break It Down.docx
- Guided Notes (Model Notes)—Break It Down.pdf
- Guided Notes—Break It Down.docx
- Guided Notes—Break It Down.pdf
- Lesson Slides—Break It Down.pptx

Materials

- Lesson Slides (attached)
- Factor Pairs handout (attached; one per student; print two-sided)
- Factor Pairs (Key) document (attached)
- Guided Notes handout (attached; one per student; print two-sided)
- Guided Notes (Model Notes) document (attached)
- Civil Engineering handout (attached; one per student; print one-sided)
- Factoring Quiz, Quiz, Trade cards (attached, one set; print one-sided)
- Square tiles (30–50 per student); digital option available
- Individual whiteboards (optional; one per student)
- Dry erase markers and erasers (optional; one per student)
- Pencils
- Paper

20 minutes

Engage

Teacher's Note: Preparation

Depending on students' prior knowledge, this phase of the lesson may take longer than expected. Spend time on this number-sense portion of the lesson to help students build the foundation they need to move through the remainder of the lesson more easily.

Introduce the lesson using the attached **Lesson Slides**. Display the essential question on **slide 3** and move to **slide 4** to identify the lesson's learning objectives. Review each of these with students to the extent you feel necessary.

Display **slide 5** and give each student a copy of the attached **Factor Pairs** handout and approximately 30–50 square tiles. Explain to students that they are to use the square tiles to model the area of each rectangle (from the first column of their table). Specifically, using the prompt from the slide, ask students to model all possible rectangles with an area of 1. Students should quickly recognize that there is one possible option, and that the dimensions of this rectangle are 1 by 1. Have students record these side lengths in the second column of their table. Transition to **slide 6** to model where to write this.

Similarly, display **slide 7** and ask students to use their square tiles to model all possible rectangles with an area of 4. Here, students should notice that there are two options: 1 by 4 and 2 by 2. Move to **slide 8** to indicate where students should record these dimensions. Then click on the slide to trigger the animation that shows the second pair.

Display **slide 9** and direct students to continue this process to complete the second column of their table, using the square tiles to model the possible rectangles for each given area.

Use the **Factor Pairs (Key)** document as needed.

Optional Digital Integration

Have students use Polypad by Amplify. Students can select the square shape under "Polygons and Shapes" in the "Geometry" section to use digital square tiles.

Display **slide 10** and direct students' attention to the third column of their table. Here students are to find the positive and negative sums of their factor pairs for 1. Help students understand the reasoning: $(+1) \cdot (+1) = 1$ and $(-1) \cdot (-1) = 1$, and finding the sums of those factor pairs would be $(+1) + (+1) = +2$ and $(-1) + (-1) = -2$. Transition to **slide 11** to indicate how students should record their sums.

Similarly, show **slide 12** and prompt students to find the sums of their factor pairs for 4. Then move to **slide 13** to show students how to record these sums.

Display **slide 14** and direct students to continue this process to complete the third column of their table.

Transition to **slide 15** and direct students' attention to the fourth column of their table. Here students are to find the positive and negative differences of their factor pairs for 1. Help students understand the reasoning: $(+1) \cdot (+1) = 1$ and $(-1) \cdot (-1) = 1$, and finding the differences of those factor pairs would be $(+1) - (+1) = 0$ and $(-1) - (-1) = 0$. Since zero is neither positive nor negative, they only need to record zero once. Transition to **slide 16** to indicate how students should record this difference.

Similarly, display **slide 17** and prompt students to find the differences of their factor pairs for 4. Then move to **slide 18** to show students how to record these differences.

Display **slide 19** and direct students to continue this process to complete the fourth (last) column of their table.

10 minutes

Explore

Teacher's Note: Activity Preparation

For the following activity, students need to identify a pair of numbers with a given product and a given sum or difference. Consider your students' needs and available materials to determine how you would like students to share their responses.

If individual whiteboards and dry erase markers are available, consider having all students record their pair of numbers on their whiteboards and show you their answers. This allows all students time to think and participate.

If you would like to challenge your students by not having them not write (and just think about) the pair of numbers, then be sure to use wait time so all students have a chance to think. Make sure the same one or two students are not the only ones volunteering answers.

Once you have determined how students should share their responses, communicate this expectation to students.

Display **slide 20** and introduce the "Which Pair?" game. Explain that students identify a pair of numbers that have a given product (first number on the slide) and have a sum or difference of the second number on the slide. Each question will be of the following format, "What two numbers multiply to _____ and add/subtract to _____?" Encourage students to have their Factor Pairs handout available for easy reference for this game.

Communicate with students how you would like them to share their responses for this activity, and then display **slide 21**. Read the prompt, "What two numbers multiply to 12 and add/subtract to 7?"

After giving students time to think and share their responses, display **slide 22** to reveal that 3 and 4 are the two numbers.

Repeat this again using **slides 23–24**, "What two numbers multiply to –12 and add/subtract to 1?" If needed, give hints or ask guiding questions to help students. After this second example, draw their attention to the similarities and differences between this and the previous example.

Repeat this once again using **slides 25–26**, "What two numbers multiply to –20 and add/subtract to –8?"

Teacher's Note: Guiding the Lesson

This activity prepares students to think about factoring quadratic expressions and to consider what pair of numbers have a product of the constant and a sum or difference of the coefficient of *x*. Make sure students understand how to find the only correct pair of numbers before moving forward in the lesson.

As needed, ask students to explain their thinking using guided questions like the following:

- How do we know when the signs of the pairs of numbers should be the same or different?
- When the signs of the numbers are different, how do we decide which is negative?
- Looking at the last example on slide 26, how do we know that –2 and +10 are not the correct pair?

If students need additional practice, consider using the following examples:

- What two numbers multiply to –6 and add/subtract to –1? (2 and –3)
- What two numbers multiply to 18 and add/subtract to –9? (–3 and –6)
- What two numbers multiply to –32 and add/subtract to –14? (2 and –16)

15 minutes

Explain

Display **slide 27** and give each student a copy of the attached **Guided Notes** handout. Review the vocabulary of *trinomials* and *binomials*, and then share that today they are going to learn how to factor a trinomial into a product of binomials.

Move to **slide 28** and let students know that in the same way there are many ways to expand binomials (FOIL, Box Method, etc.), there are many ways to factor. Let students know that the "What Pair?" game they played earlier should sound similar to the factoring tips on the slide for $x^2 + bx + c$:

- What you are multiplying to is the value of c.
- What you are adding/subtracting to is the value of b.

Use the attached **Guided Notes (Model Notes)** document as needed.

Display **slide 29** and walk through factoring ($x^2 + 7x + 12$), using the following steps:

- Step 1: Identify b and c.
- Step 2: List the factor pairs that multiply to c.
- Step 3: Find the factor pair that multiplies to c and adds/subtracts to b.
- Step 4: Plug the factors into the binomials.

Then click on the slide, once per step, to trigger the animation to reveal the results for each step.

Display **slide 30** and walk through factoring ($x^2 + x - 12$).

Then click on the slide, once per step, to trigger the animation to reveal the results for each step.

Display **slide 31**. Have students independently try to factor ($x^2 + 9x + 20$) and check their work by expanding their binomials. As students work, circulate the room to check progress and answer questions. Once students are finished checking their work, move to **slide 32** to reveal the factored form. Give students time to make corrections and ask questions.

Take a moment to bring the class together for a quick discussion. Ask the class what they noticed when they checked their work.

Sample Student Response

If we use FOIL, the F gives us a product of x^2, the O and I added together to give us bx, then the L gives us a product of c. So this is why we are looking for what multiplies to c and adds/subtracts to b!

Similarly, display **slide 33**. Have students factor ($x^2 - 8x - 20$) and check their work. When students are done, show **slide 34** so students can check their work. Give students time to make corrections and ask questions.

Optional Resource: Factoring Polynomials Video

If students need additional support, unhide and display **slide 35**. Play the Khan Academy video *Factoring Polynomials as (x+a)(x+b)* on the slide. Consider making this resource available through your learning management system.

Embedded video

https://youtube.com/watch?v=1kfq0aR3ASs

20 minutes

Extend

Teacher's Note: Activity Preparation

The following video features an interview with a civil engineer who not only describes his job but also introduces how he uses volume and surface area in his job. This lesson is designed to stop the video at 3:56. However, you should review the full video prior to facilitating the lesson. Depending on your specific class needs, you may want to include the entire video.

Display **slide 36** and give each student a copy of the attached **Civil Engineering** handout. Introduce the *Civil Engineer and Rectangular Prisms* video, which features an interview with Bobby Williams talking about his career as a civil engineer. Direct students' attention to the "Career-Focused Video" section of their handout and have them review the questions they need to be able to answer from the video. Then play the video on the slide, stopping at 3:56.

Embedded video

https://youtube.com/watch?v=qrQ2Mrg6Vg0

After the video, display **slide 37** and facilitate a whole-class discussion using the prompts from the handout and slide:

- Describe one part of the civil engineer's job.
- What is the most enjoyable part of the civil engineer's job?
- What is at least one challenging aspect of being a civil engineer?
- What are actions you could take or classes you should take if you are interested in becoming a civil engineer?

Have students form groups of three. Show **slide 38** and direct students' attention to the "Factoring and Area" portion of their handout.

Teacher's Note: Guiding the Activity

Consider having one student in each group be the "roamer," who can go to other groups when needed to get assistance and bring back what they learned to their own group. This can be helpful with a class that is quick to ask for help and may just need a little clarification from a peer to get them started.

Use the handout or **slides 38–40** to read the real-world scenario. In this scenario, students examine a square foundation with a 2-meter concrete border and a total area of 81 square meters. They are shown the work of the quadratic equation set up, expanded, and manipulated to equal zero. Students are then asked to factor the resulting quadratic expression (on one side of the equation) and check their work by multiplying their resulting binomials. Here students should find that $(x^2 + 8x - 65) = (x - 5)(x + 13)$.

Teacher's Note: Guiding the Activity

When students later solve quadratic equations, students would set each factor equal to zero and then solve for x, resulting in $x = 5$ and $x = -13$. Since x cannot be a negative length, $x = 5$ is the only reasonable solution. This value means that the square foundation, without the border, is 5 meters by 5 meters. This is outside of the scope of this lesson but this information can be fun to share with curious students.

20 minutes

Evaluate

Display **slide 41** and introduce the Quiz, Quiz, Trade strategy. Let students know that they should remain seated for the first round to make sure everyone understands the procedure for this activity before getting up to find a new partner for the second round. Here students are going to practice factoring.

Give each student one of the **Factoring Quiz, Quiz, Trade** cards. Explain that they should hold the card such that the side with the question (and question mark) is facing away from them. The side with the question is what they will show their partner. Have students remain seated and introduce themselves to their neighbor (now partner). Have students hold their cards as directed.

Show **slide 42**. Explain the reasoning for the name of the activity, "Quiz, Quiz, Trade," by sharing that Student A reads Student B's card, answering the "quiz" question aloud. Student B checks Student A's answer using the answer on the card (that is facing them). Then Student B does the same by answering Student A's "quiz" question. Once partners have correctly answered the "quiz" and "quiz" questions, they now "trade" cards and find a new partner. Once students understand the process, have them get up and find a new partner around the room. If needed, practice one more round with students seated.

Use the 2-minute timer on the slide to pace the activity, giving students two minutes to find a new partner, each answer a question, and trade cards. When the timer expires, direct students to trade cards, if they have not done so already, and find a new partner. Repeat this process as many times as you deem necessary.

Teacher's Note: Guiding the Activity

Since factoring is a new skill for students, the Quiz, Quiz, Trade activity will likely be challenging since students are being asked to do a lot of mental math. Listen to discussions during this activity; if students indicate that they need more time, consider using a 3-minute timer. If you hear that students feel that they are struggling to keep the numbers straight in their head, consider having them carry their Factoring Pairs handout from the beginning of the lesson or have them use scratch paper or individual whiteboards. Students can place their cards question-side up on a desk while they write.

Allow students to have a healthy struggle with this activity, but do not let them get frustrated. It is often encouraging to let students know that you would like them to try some "strength training" for their brain, which may feel difficult but is beneficial.

Resources

- K20 Center. (n.d.). Polypad. Tech Tools. https://learn.k20center.ou.edu/tech-tool/4556
- K20 Center. (n.d.). Quiz, quiz, trade. Strategies. https://learn.k20center.ou.edu/strategy/3086
- K20 Center. (2021, September 21). *2-minute timer*. [Video]. YouTube. https://www.youtube.com/watch?v=HcEEAnwOt2c
- K20 Center. (2021, September 21). *3-minute timer*. [Video]. YouTube. https://www.youtube.com/watch?v=iISP02KPau0
- K20 Center. (2023, March 21). *Civil engineer and rectangular prisms* [Video]. YouTube. https://www.youtube.com/watch?v=qrQ2Mrg6Vg0
- Khan Academy. (2015, July 14). *Factoring polynomials as (x+a)(x+b)* [Video]. YouTube. https://www.youtube.com/watch?v=1kfq0aR3ASs