Multiplying Polynomials

Beyond FOILing

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Grade Level	10th – 11th Grade	**Time Frame**	90-100 minutes
Subject	Mathematics	**Duration**	2-3 class periods
Course	Algebra 2		

Essential Question

How can you use multiplication to simplify polynomial expressions?

Summary

Moving past the First, Outer, Inner, Last (FOIL) method used for multiplying two binomials, this lesson introduces students to other methods for multiplying polynomials. Students recall properties of exponents and explore different methods of multiplying binomials. Students apply this knowledge to multiply more advanced polynomial expressions or multiply polynomial expressions in the context of a geometry setting.

Snapshot

Engage

Students activate prior knowledge using the properties of exponents to complete a puzzle.

Explore

Students explore multiplying polynomials and create a poster illustrating the steps.

Explain

Students learn and reflect on their peers' posters and find a favorite method for multiplying polynomials.

Extend

Students apply their understanding to new scenarios through a Choice Board.

Evaluate

Students reflect on their learning using the What Did I Learn Today? strategy.

Standards

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

A404: Multiply two binomials
A505: Add, subtract, and multiply polynomials

Oklahoma Academic Standards Mathematics (Algebra 2)

A2.A.2.2: Add, subtract, multiply, divide, and simplify polynomial expressions.

Attachments

- Algebra Two Ways—Multiplying Polynomials - Spanish.docx
- Algebra Two Ways—Multiplying Polynomials - Spanish.pdf
- Algebra Two Ways—Multiplying Polynomials.docx
- Algebra Two Ways—Multiplying Polynomials.pdf
- Lesson Slides—Multiplying Polynomials.pptx
- Multiplying Methods—Multiplying Polynomials - Spanish.docx
- Multiplying Methods—Multiplying Polynomials - Spanish.pdf
- Multiplying Methods—Multiplying Polynomials.docx
- Multiplying Methods—Multiplying Polynomials.pdf

Materials

- Lesson Slides (attached)
- Algebra Two Ways handout (attached; one per student; printed front only)
- Multiplying Methods handout (attached; one page per student, printed front only; see printing instructions in Explore, below)
- Pencil
- Paper
- Markers
- Chart Paper
- Sticky notes
- Amplify Classroom (Desmos) account
- Student devices with internet access
- Clipboards (optional)

10 minutes

Engage

Teacher's Note: Purpose

The purpose of this activity is to activate students' prior knowledge on exponent rules for multiplication. Use the engagement section as formative assessment to decide whether your students need to review exponent rules of multiplication before moving on to the rest of the lesson.

Introduce the lesson using the attached **Lesson Slides**. **Slide 3** displays the lesson's essential question. **Slide 4** identifies the lesson's learning objective. Review each of these with your class to the extent you feel necessary.

Transition to **slide 5** and give each student a copy of the attached **Algebra Two Ways** handout**.** Preview the activity with the students by explaining that they will be given a puzzle on the next slide and they must use prior knowledge of the exponent rules of multiplication to complete the puzzle.

Teacher's Note: Guiding the Activity

Two Ways are self-checking puzzles. In these puzzles, the first two expressions in a row must have a product of the expression in the right column. Similarly, the first two expressions in a column must have a product of the expression in the bottom row.

With these puzzles, let students have a healthy struggle, then praise their mental math skills that they used (possibly unknowingly) when they solved the puzzles.

Move to **slide 6**. Have students add the given information to their Puzzle 1 on their handout, then independently solve their puzzle.

Transition to **slide 7** to reveal the answer to Puzzle 1.

Next, have students find a partner and show **slide 8**. Have pairs copy the given information to Puzzle 2 from the slide then work together to solve the puzzle. Have pairs repeat this collaboration for Puzzle 3.

After a few minutes, transition to **slide 9** and have groups share their process and support different ways the students thought about solving both puzzles.

35 minutes

Explore

Teacher's Note: Purpose and Preparation

Purpose: This activity is to activate prior knowledge from Algebra 1 of multiplying two binomial expressions and apply this knowledge to multiplying a binomial by trinomial, a trinomial by trinomial, a binomial by binomial by binomial, etc.

Preparation: The Multiplying Methods handout used in this section has four multiplication methods, with one multiplication method per page. Try to divide the class into groups of four for this activity:

- For 4 equal groups, make copies so that everyone in each group receives a copy each of the same page. For instance, everyone in Group 3 receives one copy each of page 3.
- For 8 equal groups, make copies so that the same page can be distributed to students in each group, so groups 1 and 5 receive copies of Page 1, groups 2 and 6 receive copies of page 2, and so on.

Display **slide 10** and divide the class into 4 or 8 equal groups. If possible, try to have no more than 4 students in a group. Number the students into groups with 1-4 students can help with this. This may result in multiple groups working on the same method at one time, but keeping groups smaller will ensure greater individual ownership. Adjust groups as needed to fit the size of your class. Pass out the attached **Multiplying Methods** handout. Preview the activity with students by explaining that each group has been assigned a method to explore multiplying polynomial expressions:

- Geometric area (algebra tiles).
- Distributive property.
- Vertical (standard) multiplication.
- Box method.

In each group, for their assigned method, students will have four different expanded expressions that they will need to analyze in order to see a pattern. For the pattern, students need to think about how the expression was expanded and what characteristics each problem has in common. Students are to then use the recognized pattern to come up with generalizations or steps to simplifying polynomial expressions using multiplication. Students will use these generalizations to multiply a binomial by a trinomial.

Teacher's Note: Guiding the Activity

Here, students are asked to generalize their observations, and for some students, that is a challenging task. Help students by asking guiding questions or giving suggestions:

- Instead of writing "x times x," could we represent "x" without saying "x" and instead use its location in the expression to describe it?
- If we refer to "x" as the "first term," we have generalized our pattern and can use that pattern on later problems where the first term is not "x".

After about 10 minutes, transition to **slide 11** and introduce the Anchor Charts activity. Set up materials either by distributing sticky chart paper and markers to students or by directing them to the designated supply area in the classroom. Explain that once students complete their handout, they will create a poster to teach their classmates about simplifying polynomials using their specific multiplication method, and they will share the insights they gained during the exploration. These anchor charts will serve as teaching tools for peer instruction. The posters should have the following information:

- The name of their multiplying method.
- The completed problem from the Applying section of their handout showing how they used their method to simplify the polynomials.
- Notes or numbered steps someone can follow if they choose to use that method.

Teacher's Note: Pacing

This is a good place to end day 1. It is recommended that students finish their posters on day 1 for preparation for day 2.

25 minutes

Explain

Teacher's Note: Pacing

If you ended day 1 with the Explore portion of the lesson, start day 2 with students in the groups they were in on day 1 and quickly review the essential question and learning objective (**slides 3-4**).

Give groups 5 minutes to review the posters they created on day 1 and to hang their posters around the room. If you have 8 groups, have groups 1-4 hang their posters in one location and groups 5-8 in a different location to prevent students from seeing the same method twice when rotating during the four rounds of the following activity.

Display **slide 12** and introduce the Expert Stay and Stray strategy.

- Give each group some sticky notes to write suggestions and questions. Have them take out paper to take notes.
- Consider giving students clipboards to make it easier to write as they go around to each poster.
- Explain to students that one student from the group will stay at the poster as the expert and explain their group's multiplying method to their audience.
- Everyone else from that group rotates (strays) to the next poster to listen and learn from the expert of that poster.
- Those who are listening need to pay careful attention because during each round, a new person stays and becomes the new expert/prese
  nter.
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  ontinue previewing the activity by explaining that there will be four rounds and that everyone will have a turn as the expert.
- There will be 3 minutes per round.
- The expert will also use a different color marker to add important information to the poster as they answer clarifying questions from their audience or sticky notes to add the information instead of writing directly on the poster.

Within each group, assign each student a number.

Show **slide 13** and begin round 1. Direct all student *number 1s* in each group to stay at their posters, ready to present. Direct everyone else to move (stray) to the next poster and take notes and ask questions. Remind them that they are preparing to be the next expert. Stress to students that there are two goals by their learning different methods: they need to decide for themselves (1) when would this method be most efficient to use for multiplying polynomial expressions and (2) which method is their favorite and why.

Display **slide 14** and start the 3-minute timer.

Teacher's Note: Guiding the Activity

As students are explaining and listening, circulate the room and listen to the conversations. If you hear something that is not correct, ask guiding questions to help students understand.

When the timer expires, direct students to “freeze” and show **slide 15** for round 2. Direct all *number 4s* to stay at the posters where they are. They are the new experts of that poster. Direct everyone else to move (stray) to the next poster and take notes, ask questions, and listen carefully enough to be ready to be the next expert. Remind students of what they should be considering:

- When would this method be efficient?
- Is this their favorite method?
- If so, why? If not, why?

Display **slide 16** and start the 3-minute timer to begin round 2.

When the timer expires, repeat these steps using slides **17-20**, where all *number 2s* are the experts for round 3, and all *number 3s* are the experts for round 4.

When the timer expires the final time, direct students to find their original group.

Display **slide 21** and have the students answer the questions on the slide and write their responses on the back of their Multiplying Methods handout.

- What did you notice that all the posters had in common?
- Was one method more efficient than the others? When and why?
- Which method is your favorite and why?

Once you discuss the questions above as a whole class, consider the misunderstandings that you heard and take time to clear up these misunderstandings for the students. Ask the class if there are any questions. Use this time to make sure students understand how to simplify polynomial expressions using multiplication.

15 minutes

Extend

Teacher's Note: Desmos Classroom Activity Preparation

The following directions were created for Desmos Classroom, which has since transitioned to Amplify Classroom. While the core functionality remains the same, the interface and navigation may look slightly different than what's shown in the instructions.

To use this Desmos Classroom activity, select the following link: "Multiplying Polynomials." Create an account or sign in under the "Activity Sessions" heading. After you log in, the green "Assign" dropdown button will be active. Click the arrow next to the word "Assign," then select "Single Session Code." After making some setting selections, select "Create Invitation Code" and give the session code to students. For more information about previewing and assigning a Desmos Classroom activity, go to https://k20center.ou.edu/externalapps/using-activities/.

For more detailed information about Desmos features and how-to tips, go to https://k20center.ou.edu/externalapps/desmos-home-page/.

Show **slide 22**. Provide students with your session code. Then, have students go to student.amplify.com/join/ and enter the session code.

Teacher's Note: Sign-in Options

If students sign in with their Google or Desmos accounts, then their progress is saved, and they can resume the activity or view their work later. If students continue without signing in, they can complete the activity, but they must do so in one sitting. It is strongly recommended that students sign in; otherwise, they risk losing their work.

Direct students' attention to **screen 1** and introduce students to the Choice Boards strategy. Let students know that they are going to complete one of three card matches. They can pick the card set on **screen 2**, **screen 3**, or **screen 4**. It is their choice. Let students know that when they correctly match the cards they will notice the directions at the top of the screen change to read "Well done! Go to screen 5."

Once students complete their card match, they are expected to go to **screen 5** and answer the area question on that screen. Once they correctly answer that question, students are prompted to go to the next screen.

On **screen 6**, students are again given a choice. They can either answer the volume question on **screen 7** or the one on **screen 8**. These volume questions are written mostly as word problems. After answering either question correctly, students are prompted to go to **screen 9**.

On screen 9, students are again given a choice: to answer a volume question on **screen 10**, **screen 11**, or **screen 12**. These volume questions are presented with diagrams. After answering one of these questions correctly, students are prompted to go to the last screen.

5 minutes

Evaluate

On **screen 13**, students are directed to use the slider on the screen to answer the following:

- How well did you understand the math today?
- How did you feel about learning math today?
- Can you elaborate on those responses?

Lastly, students are prompted to reflect on their learning using the What Did I Learn Today? strategy and write 2-3 sentences about what they learned during this lesson.

Resources

- Amplify. (n.d.). [Multiplying Polynomials]. Amplify. https://classroom.amplify.com/activity/65148bd8490805228e09242d
- K20 Center. (2021, September 21). K20 Center 3-minute timer. [Video]. YouTube. https://youtu.be/iISP02KPau0?si=2VHRShyG44tA3TV9
- K20 Center. (n.d.). Anchor charts. Strategies. https://learn.k20center.ou.edu/strategy/58
- K20 Center. (n.d.). Choice boards. Strategies. https://learn.k20center.ou.edu/strategy/73
- K20 Center. (n.d.). Desmos classroom. Tech Tools. https://learn.k20center.ou.edu/tech-tool/1081
- K20 Center. (n.d.). Expert stay and stray. Strategies. https://learn.k20center.ou.edu/strategy/2650
- K20 Center. (n.d.). What did I learn today? Strategies. https://learn.k20center.ou.edu/strategy/169