Simply Radical, Part 1

Simplifying Radical Expressions

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Grade Level	8th – 9th Grade	**Time Frame**	75 minutes
Subject	Mathematics	**Duration**	2–3 class periods
Course	Algebra 1		

Essential Question

What does it mean to simplify a radical expression?

Summary

In this lesson, students will use their knowledge of factoring to simplify radical expressions. Students will practice simplifying square roots and cube roots through a game of Bingo. This is an introductory lesson to simplifying radicals.

Snapshot

Engage

Students identify numbers as perfect squares, perfect cubes, both, or neither through a Card Sort activity.

Explore

Students recall factoring to complete factor trees and practice writing expressions in multiple forms.

Explain

Students learn the vocabulary for radical expressions and relate the process for simplifying radicals to that of factoring.

Extend

Students practice simplifying radical expressions with a game of Bingo.

Evaluate

Students apply their learning to simplify a radical expression and then reflect on their learning.

Standards

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

A509: Work with squares and square roots of numbers
A510: Work with cubes and cube roots of numbers

Oklahoma Academic Standards Mathematics (Algebra 1)

A1.N.1.1: Write square roots and cube roots of constants and monomial algebraic expressions in simplest radical form.

Attachments

- Card Sort—Simply Radical, Part 1.docx
- Card Sort—Simply Radical, Part 1.pdf
- Factor Trees—Simply Radical, Part 1.docx
- Factor Trees—Simply Radical, Part 1.pdf
- Guided Notes (Model Notes)—Simply Radical, Part 1.docx
- Guided Notes (Model Notes)—Simply Radical, Part 1.pdf
- Guided Notes—Simply Radical, Part 1.docx
- Guided Notes—Simply Radical, Part 1.pdf
- Lesson Slides—Simply Radical, Part 1.pptx
- Radical Bingo Cards—Simply Radical, Part 1.docx
- Radical Bingo Cards—Simply Radical, Part 1.pdf
- Radical Bingo Slides—Simply Radical, Part 1.pptx
- Radical Bingo Tracking Sheet—Simply Radical, Part 1.docx
- Radical Bingo Tracking Sheet—Simply Radical, Part 1.pdf
- Radical Thinking—Simply Radical, Part 1.docx
- Radical Thinking—Simply Radical, Part 1.pdf

Materials

- Lesson Slides (attached)
- Card Sort cards (attached; one set per group; print one-sided)
- Factor Trees handout (attached; one per student; print two-sided)
- Guided Notes handout (attached; one per student; print one-sided)
- Guided Notes (Model Notes) document (attached)
- Radical Bingo Cards handout (attached; one set per class; print one-sided)
- Radical Bingo Slides (attached)
- Radical Bingo Tracking Sheet (attached)
- Radical Thinking handout (attached; one half page per student; print one-sided)

10 minutes

Engage

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

Display **slide 5** and have students get into small groups of 2–3 or assign groups. Give each group a set of the attached **Card Sort** cards. Introduce the Card Sort strategy and explain to students that they are to work in their group to sort the cards with numbers into one of the following categories: *perfect squares*, *perfect cubes*, *both*, or *neither*. Give students approximately 8 minutes to complete this task. If they need a hint, you can tell students that there are only three cards in the "Both" category, and five in each of the others.

Use the hidden **slide 6** for quick reference or unhide and show it for students to check their work.

Teacher's Note: Purpose

The purpose of this activity is to help students recall the factors of numbers and to help them begin to recognize numbers that are perfect squares and/or perfect cubes to help with simplifying radical expressions.

20 minutes

Explore

Show **slide 7**. Give each student a copy of the attached **Factor Trees** handout and tell them to not yet write anything until you are finished with all of the directions, as you are going to complete the first problem together. Have students find a partner or assign partners. Explain to students that for each problem, they are going to need to create a factor tree to find all of the prime factors, then write the expression in its expanded form and its exponential form.

Move to **slide 8** and introduce the Pass the Problem strategy. Explain to students how they will use this strategy to create the factor trees. Each student will create the first pair of branches, then trade papers with their partner, who will continue their work with the next step. They will repeat this process until the factor tree is complete. If students are familiar with this strategy, use the following slides to describe the process. If students are not familiar with this strategy, consider the following approach.

Have each pair determine who wants to be Student A and who wants to be student B, then show **slide 9**. Tell Student A that they wanted to start their factor tree for 12 using the branches of 2 and 6 (so Student A should write this like they see on the slide). And tell Student B that they wanted to start their factor tree for 12 using the branches of 3 and 4 (similarly, writing that down). Direct partners to trade papers.

Display **slide 10** and point out to students that even though their friend started the factor tree differently than how they would have, they still did it correctly, and it is now their job to continue where their partner stopped.

Show **slide 11** and point out that even though their work looks different, their final answers for both the expanded and exponential formats will be the same.

Give students a chance to ask questions about the process, then move to **slide 12**. Tell them to continue this process but stop after finishing the fifth problem.

As students work, circulate the room. Listen to discussions and questions being asked. Make note of misunderstandings. Since this activity is a review of prior knowledge, use this as a formative assessment to determine if your students are ready for the lesson or need to pause for intervention. As you notice pairs completing the fifth problem, have them stop using the Pass the Problem strategy and instead work collaboratively on the remaining problems. Once the majority of students are done with the first five problems, display **slide 13** and announce that they should work with their partner on the remaining three problems, no longer taking turns and passing the problem.

Teacher's Note: Productive Struggle

There are many ways to show variables in a factor tree, and none of them are necessarily “more correct” than the others. Students are working together here to come up with a way that makes sense for them to break down and represent the expressions. Avoid giving methods or answers away during this part, as it is good for the students to struggle and make their own meaning from the material.

Sample Responses

- **Problem 1:** $2 \cdot 2 \cdot 3 = 2^2 \cdot 3$
- **Problem 2:** $3 \cdot 3 \cdot 7 = 3^2 \cdot 7$
- **Problem 3:** $3 \cdot 3 \cdot 3 \cdot 5 = 3^3 \cdot 5$
- **Problem 4:** $2 \cdot 2 \cdot 5 \cdot 29 = 2^2 \cdot 5 \cdot 29$
- **Problem 5:** $2 \cdot 2 \cdot 5 \cdot 101 = 2^2 \cdot 5 \cdot 101$
- **Problem 6:** $x \cdot x \cdot x \cdot y \cdot y \cdot y = x^3 \cdot y^4$
- **Problem 7:** $r \cdot r \cdot s \cdot t \cdot t \cdot t \cdot t \cdot t = r^2 \cdot s \cdot t^5$
- **Problem 8:** $2 \cdot 2 \cdot 2 \cdot 5 \cdot 5 \cdot a \cdot a \cdot b \cdot b \cdot b \cdot c = 2^3 \cdot 5^2 a^2 b^3 c$

20 minutes

Explain

Show **slide 14** and give each student a copy of the attached **Guided Notes** handout. Introduce the vocabulary: *radical*, *radicand*, and *index*.

Move to **slide 15** and share how to read aloud radical notation. Share that if they do not see anything written for the index that it is an index of 2. Ask volunteers to share why they think that is the case. If needed, ask guiding questions to help students see that a square root, which they have seen before, relates to "square," which is a power of 2.

Display **slide 16** and use the slide to explain to students how to simplify radicals.

Transition through **slides 17–22** to walk through the first example, which finds the square root of 24. Then walk through the second example using **slides 23–26**, which finds the cube root of 24. Emphasize to students the similarities and differences between these two problems.

Show **slide 27** and ask students to try the first step on their own. Here students are asked to find the square root of x^4y^3. Depending on your class needs, either transition through **slides 28–33** to help walk students through the problem or to allow them to check their work as they work ahead.

Display **slide 34** and ask students to try the fourth example on their own. Once students are done, move to **slide 35** so that students can check their work.

Repeat this using **slides 36–37** for Example 5 and **slides 38–39** for Example 6.

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

20 minutes

Extend

Teacher's Note: Communicating Expectations

During this phase of the lesson, students are going to practice simplifying radical expressions through a game of Bingo. Before beginning this activity determine how you would like students to show their work and how you would like them to mark their Bingo Cards.

Showing Your Work: Do you want them to turn in their scratch work? If you want them to turn in this work after the activity, give them instructions for numbering the problems and labeling the answers so you can quickly check the work. Where do you want students to show their work? If you do not want students to write on the class set of Bingo Cards, then have students use notebook paper. If you plan for students to write on the Bingo Cards, then consider having students show their work on the back of their Bingo Cards.

Marking Your Bingo Card: Do you want students to write on their Bingo Cards? If so, consider giving students pens, markers, or other coloring tools. If you do not want students to write on the class set of Bingo Cards, then consider giving students approximately a dozen Bingo Chips, tokens, or coins to place on their Bingo Cards. Keep in mind that if you laminated your Bingo Cards, students could use dry-erase markers.

Show **slide 40** and introduce the Radical Bingo activity. Allow students to choose their own **Radical Bingo Card** to avoid any suspicions of bias. Each card has all 24 possible simplified expressions.

Clearly communicate your expectations for this activity, especially regarding how you would like students to show their work and how you would like them to mark their Bingo Card.

Teacher's Note: Guiding the Activity

The radical expressions are on the odd-numbered slides of the attached **Radical Bingo Slides**, and the corresponding simplified expressions are on the following even-numbered slides, which are hidden. You may choose to unhide all the slides if your students need more help with these problems or you may keep them hidden.

The slides have been randomized to give students practice with both square roots and cube roots. The difficulty of the problems has been dispersed throughout the slides as well. If you would prefer to call the problems in a different order, you can rearrange the slides or simply keep track using the attached **Radical Bingo Tracking Sheet**.

Use the attached **Radical Bingo Slides** to facilitate this activity. Display and read aloud **slide 3**, which is the first radical expression they are to simplify: the square root of $9a^6$. The simplified expression is on the hidden **slide 4**. As students are simplifying the expression and looking for the result on their Radical Bingo Card, mark that problem in the first row of the attached **Radical Bingo Tracking Sheet**. This paper is to help you keep track of which expressions have been called, and make it easier to check when a student calls Bingo.

5 minutes

Evaluate

Display **slide 41** and give each student a half-page of the attached **Radical Thinking** handout. Here students are asked to simplify the fourth root of 81 and then reflect on their learning using the Muddiest Point strategy.

After students have a couple minutes to simplify the given radical, move to **slide 42** and have students write their responses to the prompts on the slide:

- **Crystal Clear:** What do you think is the easiest (clearest) part of simplifying radicals?
- **Muddiest Point:** What do you think is the most confusing (muddiest) part of simplifying radicals?

Resources

- K20Center. (n.d.). Card sort. Strategies. https://learn.k20center.ou.edu/strategy/147
- K20Center. (n.d.). Muddiest point. Strategies. https://learn.k20center.ou.edu/strategy/109
- K20Center. (n.d.). Pass the problem. Strategies. https://learn.k20center.ou.edu/strategy/151