Simply Radical, Part 2

Manipulating Radical Expressions

Corrie Matchell, Michell Eike
Published by *K20 Center*

Grade Level	8th – 9th Grade	**Time Frame**	90 minutes
Subject	Mathematics	**Duration**	2 class periods
Course	Algebra 1		

Essential Question

What does it mean to simplify a radical expression?

Summary

In this lesson, students investigate patterns within expressions containing operations of square roots of numbers. They will then formalize their understanding of how to manipulate radical expressions and learn how to rationalize the denominator.

Snapshot

Engage

Students use the Question Formulation Technique strategy to form questions about established properties of radical addition and multiplication.

Explore

Students match various addition, subtraction, multiplication, and division problems to their equivalent versions and look for patterns and similarities in the operations.

Explain

Students take notes as they watch a video about simplifying and performing operations on square roots.

Extend

Students watch a video interview with an engineer, then assume the role of an electrical engineer and use radicals to solve a real-world problem.

Evaluate

Students revisit the questions generated at the beginning of the lesson and reflect on what they learned during the lesson and what remaining questions they have.

Standards

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

A509: Work with squares and square roots of numbers

Oklahoma Academic Standards Mathematics (Algebra 1)

A1.N.1.2 : Add, subtract, multiply, divide, and simplify square roots of constants, rationalizing the denominator when necessary.

Attachments

- Electrical Engineering (Sample Responses)—Simply Radical, Part 2.docx
- Electrical Engineering (Sample Responses)—Simply Radical, Part 2.pdf
- Electrical Engineering—Simply Radical, Part 2 - Spanish.docx
- Electrical Engineering—Simply Radical, Part 2 - Spanish.pdf
- Electrical Engineering—Simply Radical, Part 2.docx
- Electrical Engineering—Simply Radical, Part 2.pdf
- Guided Notes (Model Notes)—Simply Radical, Part 2.docx
- Guided Notes (Model Notes)—Simply Radical, Part 2.pdf
- Guided Notes—Simply Radical, Part 2 - Spanish.docx
- Guided Notes—Simply Radical, Part 2 - Spanish.pdf
- Guided Notes—Simply Radical, Part 2.docx
- Guided Notes—Simply Radical, Part 2.pdf
- Lesson Slides—Simply Radical, Part 2.pptx
- Radical Connections (Sample Responses)—Simply Radical, Part 2.docx
- Radical Connections (Sample Responses)—Simply Radical, Part 2.pdf
- Radical Connections—Simply Radical, Part 2 - Spanish.docx
- Radical Connections—Simply Radical, Part 2 - Spanish.pdf
- Radical Connections—Simply Radical, Part 2.docx
- Radical Connections—Simply Radical, Part 2.pdf

Materials

- Lesson Slides (attached)
- Radical Connections handout (attached; one per student; print two-sided)
- Radical Connections (Sample Responses) document (attached)
- Guided Notes handout (attached; one per student; print two-sided)
- Guided Notes (Model Notes) document (attached)
- Electrical Engineering handout (attached; one per pair; print one-sided)
- Electrical Engineering (Sample Responses) document (attached)
- Pencils
- Highlighters (four colors per group)
- Paper
- Chart paper (one per group plus one)
- Scientific calculators (one per student)

15 minutes

Engage

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

Have students get into groups of four or assign groups. Display **slide 5** and introduce the Question Formulation Technique strategy. Give each group one piece of chart paper. Share that they will see two completed math problems on the following slide, and they should generate as many questions as they can about what they see.

Once students understand the assigned task, move to **slide 6** to reveal the problems: the square root of nine **plus** the square root of sixteen equals seven and the square root of nine **times** the square root of sixteen is the square root of the product of nine and sixteen which is twelve. This is written algebraically on the slide.

Have groups begin generating questions, and have them record the questions on their chart papers. Allow approximately 4 minutes for the activity. Use the 4-minute timer on the slide for pacing.

While groups are working, hang one piece of chart paper at the front of the room.

Once time is up, display **slide 7**. Direct groups to read through their list of questions and narrow down their list to their top three questions. The meaning of "top three" is whatever each group decides; these could be their three favorite questions, the three questions they are most unsure of, etc. Tell students they have approximately 3 minutes to finalize their top three, and start the 3-minute timer on the slide.

Invite one volunteer from each group to share their chosen three questions. As they share, record their questions on the chart paper at the front of the room. If a group shares a question that is already on the chart paper, mark that question with a symbol rather than rewriting it.

Leave this chart paper visible for the remainder of the lesson. Students will be asked to reference it again at the end of the lesson.

30 minutes

Explore

Have students get into pairs. Display **slide 8** and give each pair four highlighters of different colors to share. Give each student one copy of the attached **Radical Connections** handout and a scientific calculator.

Direct students' attention to the front of the handout. Explain that there are four sets of equivalent expressions, and they should determine which expressions are equivalent and highlight equivalent expressions with the same color. There are four expressions that are printed larger than the rest (they are also in the first column of the table on the back of the handout) that should all be highlighted a different color, as indicated on the slide.

After students highlight the equivalent expressions, they should use their color-coded expressions to complete the table on the back side of the handout. Give pairs approximately 25 minutes to complete these tasks.

Teacher's Note: Guiding the Activity

Avoid telling the students how to match the equivalent expressions. The expectation is that they compare decimal approximations, but try to get them to come to that conclusion on their own to encourage problem-solving skills.

Show **slide 9** and introduce the I Notice, I Wonder strategy. Direct students to look for patterns in their completed table and record what they notice and wonder on their handouts. Allow approximately 5 minutes for this activity.

Move to **slide 10** and use the prompts on the slide to guide a whole-class discussion:

- What did you notice about each row?
- What did you notice about each column?
- What do you still wonder?

Teacher's Note: Guiding the Discussion

If needed, try to drive the discussion toward the similarities in the rows. If students do not recognize the patterns, ask them to compare the addition problems to their simplified answers. Students should realize that the coefficients are being added and the radicals remain unchanged.

20 minutes

Explain

Give each student one copy of the attached **Guided Notes** handout. Explain that they are about to watch a video, and they should complete the handout with observations from the video.

Show **slide 11** and play the video, *Traditional Algebra 1: Adding and Subtraction of Square Roots (Radicals)*.

Embedded video
https://youtube.com/watch?v=YP7L62Kx2v8

As the video plays, monitor students' progress and pause the video as needed, especially to answer students' questions. Use the attached **Guided Notes (Model Notes)** document as needed.

Stop the video at 13:00, which is when the last example on the handout is completed.

Display **slide 12** and use the questions on the slide to summarize what students have just learned. Ask for volunteers or call on students to answer the following questions about:

Adding and Subtracting Radicals

- What must be true to add or subtract square roots?
- How do you add or subtract square roots?

Multiplying and Dividing Radicals

- How do you multiply or divide square roots?
- When do you need to rationalize a denominator?
- How do you rationalize a denominator?

20 minutes

Extend

Show **slide 13** and remind students that there are many careers that need people to use their mathematical skills. Let students know that they are about to watch a video of an electronics engineer talking about his career and how he uses math.

Play the video, *Electronics - A.J. Adeleye*, on the slide.

Embedded video
https://youtube.com/watch?v=S38tfPRzAxk

Stop the video at the 9:05 minute mark. Display **slide 14** and lead a whole-class discussion using the following questions from the slide:

- What is one part of the job that sounds interesting?
- What is one part of the job that sounds challenging?
- What can you do now if you're interested in becoming an electronics engineer?

Show **slide 15** and tell students that they should now assume the role of an engineer in the field of electrical engineering. Have students continue working with their partners from earlier, or have students find a new partner. Give each pair one copy of the attached **Electrical Engineering** handout. Read the scenario on the slide:

- "You are testing a new hair dryer that will be sold in different countries. You know that wall outlets provide alternating current, or AC, which means the voltage changes in a repeating wave pattern instead of staying constant. Because AC voltage changes, engineers use RMS voltage to describe the effective voltage that powers a device."

Transition to **slide 16** and continue reading from the slide deck or from the handout. Share the peak voltage of the hair dryer and the formula that students should use. Have pairs use the formula and given peak voltage to find the RMS voltage, then represent it as both a simplified expression by rationalizing the denominator and as a decimal approximation to draw a conclusion. Then, pairs are challenged to find the peak voltage, given the RMS voltage. Give pairs approximately 10 minutes to complete their real-world scenario problem.

Use the attached **Electrical Engineering (Sample Responses)** document as needed.

5 minutes

Evaluate

Show **slide 17** and refer back to the list of questions generated at the beginning of the lesson. Display the list and ask students to silently reflect on the questions. To prompt students' reflection, use the slide and ask prompting questions like the following:

- Which questions do you feel have been answered?
- Which ones have not been answered?
- Do you have new questions?

Begin the 1-minute timer on the slide and allow for silent reflection.

Display **slide 18** and introduce the Quick Write strategy. Then, ask students to complete a 2-minute Quick Write, either on computers or by hand, responding to the prompts on the previous slide. Share that students should write continuously for the entire two minutes without stopping or finishing early. Begin the 2-minute timer on the slide and have students begin writing.

When the timer expires, have students turn in their writings. Read students' responses to gain an understanding of what they learned and what points should be addressed or re-taught.

Resources

- The Algebros. (2020, November 29). *Traditional Algebra 1: Adding and subtraction of square roots (radicals) Flippedmath* [Video]. YouTube. https://www.youtube.com/watch?v=YP7L62Kx2v8
- K20 Center. (n.d.). I notice, I wonder. Strategies. https://learn.k20center.ou.edu/strategy/180
- K20 Center. (n.d.). Question formulation technique. Strategies. https://learn.k20center.ou.edu/strategy/5188
- K20 Center. (n.d.). Quick write. Strategies. https://learn.k20center.ou.edu/strategy/1127
- K20 Center. (2021, September 21). *K20 Center 1 minute timer* [Video]. YouTube. https://www.youtube.com/watch?v=6ilD555O_RE
- K20 Center. (2021, September 21). *K20 Center 2 minute timer* [Video]. YouTube. https://www.youtube.com/watch?v=HcEEAnwOt2c
- K20 Center. (2021, September 21). *K20 Center 3 minute timer* [Video]. YouTube. https://www.youtube.com/watch?v=ilSP02KPau0
- K20 Center. (2021, September 21). *K20 Center 4 minute timer* [Video]. YouTube. https://www.youtube.com/watch?v=kpCsfuvzQeY
- K20 Center. (2021, December 13). *ICAP- Electronics - A.J. Adeleye* [Video]. YouTube. https://www.youtube.com/watch?v=S38tfPRzAxk