K20 L•E•A•R•N

Radical Yet Rational, Part 1

Rewriting Rational Exponents and Radicals

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Grade Level	10th – 11th Grade	**Time Frame**	80-90 minutes
Subject	Mathematics	**Duration**	2 class periods
Course	Algebra 2		

Essential Question

Why do we use rational exponents to represent radicals?

Summary

In this lesson, students will recall properties of exponents and how to simplify square roots and cube roots. Then, students will learn how to write radical expressions as expressions with rational exponents and vice versa. Students will use this knowledge to simplify expressions using either approach. This is the first lesson of three in the "Radical Yet Rational" lesson series.

Snapshot

Engage

Students recall properties of exponents through a Card Matching activity.

Explore

Students simplify square roots and cube roots to solve a square puzzle.

Explain

Students complete guided notes with the class and formalize their understanding of why and how radical expressions can be written as expressions with rational exponents and vice versa.

Extend

Students apply what they have learned to simplify expressions using rational exponents and radicals.

Evaluate

Students demonstrate and reflect on how to select an approach when simplifying expressions that contain radicals or rational exponents.

Standards

Oklahoma Academic Standards Mathematics (Algebra 2)

A2.A.2.5: Rewrite algebraic expressions involving radicals and rational exponents using the properties of exponents.

Attachments

- Card Matching—Radical Yet Rational Part 1 - Spanish.docx
- Card Matching—Radical Yet Rational Part 1 - Spanish.pdf
- Card Matching—Radical Yet Rational Part 1.docx
- Card Matching—Radical Yet Rational Part 1.pdf
- Different Methods Same Result—Radical Yet Rational Part 1 - Spanish.docx
- Different Methods Same Result—Radical Yet Rational Part 1 - Spanish.pdf
- Different Methods Same Result—Radical Yet Rational Part 1.docx
- Different Methods Same Result—Radical Yet Rational Part 1.pdf
- Guided Notes—Radical Yet Rational Part 1 - Spanish.docx
- Guided Notes—Radical Yet Rational Part 1 - Spanish.pdf
- Guided Notes—Radical Yet Rational Part 1.docx
- Guided Notes—Radical Yet Rational Part 1.pdf
- Lesson Slides—Radical Yet Rational Part 1.pptx
- Pass the Problem—Radical Yet Rational Part 1 - Spanish.docx
- Pass the Problem—Radical Yet Rational Part 1 - Spanish.pdf
- Pass the Problem—Radical Yet Rational Part 1.docx
- Pass the Problem—Radical Yet Rational Part 1.pdf
- Square Puzzle—Radical Yet Rational Part 1 - Spanish.docx
- Square Puzzle—Radical Yet Rational Part 1 - Spanish.pdf
- Square Puzzle—Radical Yet Rational Part 1.docx
- Square Puzzle—Radical Yet Rational Part 1.pdf

Materials

- Lesson Slides (attached)
- Square Puzzle handout (attached; one per pair; printed front only)
- Guided Notes handout (attached; one per student; printed front/back)
- Different Methods, Same Result handout (attached; one per student; printed front only)
- Pass the Problem handout (attached; one per pair; printed front only)
- Card Matching handout (optional; attached; one per pair; printed front only)
- Desmos account
- Pencils
- Scissors
- Student devices with internet access

15 minutes

Engage

Teacher's Note: Desmos Activity Preparation

To use Desmos Classroom for the following Card Matching activity, select the following link: "Radical Yet Rational, Part 1." 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/.

Alternative Card Matching Activity

If you prefer not to use the Desmos activity, you may print the attached **Card Matching** handout and cut out one set of cards for each pair of students. The square cards contain properties of exponents and examples of those properties. The small rectangular cards contain equivalent expressions that match with the property cards as well. Students are expected to arrange the cards into seven groups of four cards.

Introduce the lesson using the attached **Lesson Slides**. Display **slide 3** to share the lesson’s essential question with students. Go to **slide 4** to share the lesson’s learning objectives. Review each of these with students to the extent you feel necessary.

Assign student pairs or ask students to find their own partners. Inform students they are going to complete a Card Matching activity in Desmos.

Display **slide 5** and 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.

On **screen 1** of the Desmos activity, students work in pairs to match cards that contain equivalent expressions and examples with the exponent property they demonstrate. On **screen 2**, students receive feedback on how many cards they matched correctly.

15 minutes

Explore

Display **slide 6**. Pass out scissors and the attached **Square Puzzle** handout to each pair of students. Have students cut out the nine square tiles and rearrange them into one large square by matching each side with an equivalent value. Inform students that when they finish, every pair of touching sides should be equivalent.

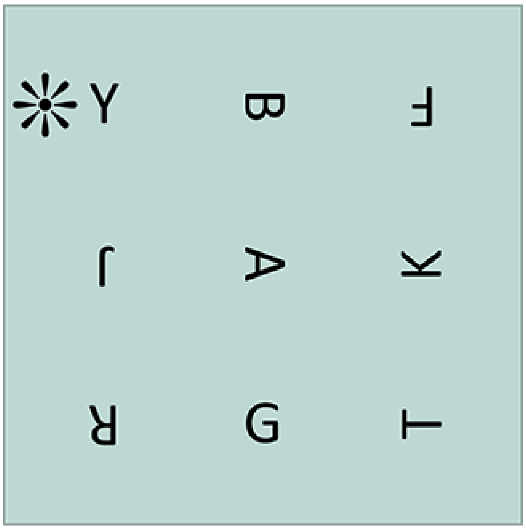
Alternative Focus: Absolute Value Symbols

The expressions in this lesson are understood to be positive. If you would prefer that students also practice using absolute value symbols when needed, consider reviewing when absolute value symbols are needed by showing students the following optional video, titled "Pre-Algebra 31 - Simplifying Radical Expressions," starting at 5:37.

Embedded video

https://youtube.com/watch?v=Ef2gOQbDv7M?t=336

As students work together to solve the puzzle, use the image below as a quick way to check students' work. The symbol in the top-left corner matches one of the tiles; once that symbol is oriented the same way on students' puzzles, the letters on their tiles will be oriented as shown below if placed correctly.



After students have completed their puzzles, display **slide 7**. Have students use the I Notice, I Wonder strategy to examine their finished puzzles. Ask for volunteers to share what they notice and what they wonder.

Teacher's Note: Purpose

The purpose of this activity is for students to notice that the square root of x must be the same as x to the one-half power and that the cube root of x must equal x to the power of one-third, since that is the only way the pieces fit together. Inform wondering students that they are going to learn why this is true and what to do with this information during the next part of the lesson.

25 minutes

Explain

Teacher's Note: Pacing the Lesson

If you have a traditional 45-minute class period, it is recommended that you finish the first day by having students reflect on the puzzle and begin the Guided Notes. Consider working through example 1 together before sending students home to think about example 2. Then, you can begin the next class period by inviting students to share their ideas for example 2.

After students have had time to discuss what they notice and wonder from the Square Puzzle activity, display **slide 8**. Walk students through the question posed on the slide: "If we know that the square root of x squared is x, then x to what power squared would also equal x?"

Give students a few minutes to discuss what they think that exponent is and why. Ask students to share their thoughts. Then, go to **slide 9** to demonstrate why those expressions with rational exponents are equivalent to the radical expressions.

Display **slide 10** and pass out the attached **Guided Notes** handout to each student. You may have students add this handout to their math notebooks if that is a classroom norm.

Complete the handout as a class.

Teacher's Note: Guiding the Activity

A common mistake students make when rewriting radical expressions into expressions with rational exponents is writing the index in the numerator of the exponent. To help students remember that the index goes in the denominator of the exponent, use the word "root" to refer to both the index of the radical and a plant. Students know the roots of a plant are in the soil at the bottom of the plant—so the root goes at the bottom of the fraction. Use the graphic in the Guided Notes to illustrate this idea. For example, the nth root of a^m is a to the power of m over n, since the root goes in the denominator/dirt. Another example: The third root of x^2 is x to the two-thirds power, since 3 is the root and the root goes in the denominator/dirt.

Example 4 is a commonly missed question. Consider having students try it on their own. After giving the class a few minutes to work, write the final answer on the board without any work. Now, ask students to compare the answer on the board with their work. Ask students to think quietly about why the answer on the board is correct. After a minute of quiet thinking—allowing all students to have that time to compare and potentially reconsider their own work and solutions—ask for volunteers to explain why the answer on the board is correct.

Here's another way to emphasize the correct answer, 2 times the third root of x to the power of 4, as opposed to the common mistake, the third root of the quantity of 2x to the power of 4: Start the problem by writing 2 to the power of 1 times x to the power of four-thirds. The misconception comes from not seeing the difference between a base of 2x and a base of 2 times another base of x. If students are struggling to understand, show students the difference between having parentheses around the 2x compared with the given example.

Teacher's Note: Remediation

If students do not have a strong background in simplifying radicals, consider having students add a list of perfect square numbers and a list of perfect cubes to their notes for later reference.

15 minutes

Extend

Teacher's Note: Preparation

Before beginning this portion of the lesson, decide whether you want the Different Methods, Same Result handout to be guided practice or independent practice.

The sample responses to the handout are included in the Lesson Slides, but they are hidden by default. If you would like students to check their work as they go, unhide slides 12–15 ahead of time. You can do so by right-clicking on each slide in the left-hand navigation panel and deselecting "Hide Slide" in the dropdown menu.

Display **slide 11** and inform students it’s time for them to apply what they have learned.

Pass out the attached **Different Methods, Same Result** handout to each student. Have students work in pairs to simplify each expression using different methods.

After finishing each problem, students should check their final answers with their partners. If their answers match, have students move on to the next question. If their answers do not match, have partners trade papers to check each other’s work and find any mistakes made.

Optional Slides

To review the possible approaches, unhide and transition through **slides 12–15**. Remind students that these are just possible methods of simplifying, and that there are many correct ways to simplify these expressions. Ask for volunteers to explain their work for each solution.

10 minutes

Evaluate

To assess students' flexibility in working with both methods, use the Pass the Problem strategy. Display **slide 16** and pass out the attached **Pass the Problem** handout to each pair of students.

Explain the procedure to students as follows: For question 1, student A writes the first step in the simplifying process, then passes the paper to student B, who writes the next step; students should continue taking turns until the expression is completely simplified. For question 2, student B starts instead.

The goal is for students to demonstrate their flexibility between methods, as they do not have control over how their partners start the simplifying process.

Once students finish simplifying, go to **slide 17** and ask students to reflect on how they started each question and why.

Sample Student Responses

Students are likely to respond with having a preferred method or choosing to work with the given format, which are both valid reasons to start a problem in a particular way. The key is for students to understand they can decide how to start simplifying, as they are going to need this skill in the next lesson: "Radical Yet Rational, Part 2."

After students have submitted their work, unhide and show **slides 18–19**. Give students time to reflect on their thought processes and solutions. Use student responses to see which misconceptions persist.

Resources

- ElisaRiva. (2017, February 13). Brain, mind, psychology [Illustration]. Pixabay. https://pixabay.com/illustrations/brain-mind-psychology-idea-drawing-2062057/
- K20 Center. (n.d.). Card matching. Strategies. https://learn.k20center.ou.edu/strategy/1837
- K20 Center. (n.d.). I notice, I wonder. Strategies. https://learn.k20center.ou.edu/strategy/180
- K20 Center. (n.d.). Pass the problem. Strategies. https://learn.k20center.ou.edu/strategy/151
- MyWhyU. (2011, December 16). Pre-Algebra 31 - Simplifying Radical Expressions [Video]. YouTube. https://www.youtube.com/watch?v=Ef2gOQbDv7M
- K20 Center. (n.d.). Desmos classroom. Tech tools. https://learn.k20center.ou.edu/tech-tool/1081