

Lesson Plan
Lesson 4: Rational Exponents
Mathematics High School Math II

Unit Name: Unit 1: Extending the Number System

Lesson Plan Number & Title: Lesson 4: Rational Exponents

Grade Level: High School Math II

Lesson Overview: Students will be able to explain orally or in written format a working definition of radicals using rational exponents with precision and fluency. They will be able to apply the properties of integer exponents to rational exponents developing the notation appropriate to radicals. Students should be able to rewrite expressions containing radicals in terms of exponents and reverse the concept by rewriting exponents in terms of radicals, keeping fluency of equivalent expressions as a necessary understanding.

Focus/Driving Question: How can radical notation be used to express equivalency in terms of rational exponents?

West Virginia College- and Career-Readiness Standards:

M.2HS.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. (e.g., We define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.)

M.2HS.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Manage the Lesson:

Step 1: Launch the lesson using the video *Roots and Unit Fraction Exponents* – <http://www.youtube.com/watch?v=zKE46XeJGZU>. You can pause the video to periodically assess student comprehension of exponential relationships from previous learning.

Step 2: Develop vocabulary and create a word wall with your students and develop the following definitions. Relate the vocabulary to their foldable on the exponential rules. Students create the Foldable for Rational Exponents by reviewing the laws of exponents and developing the law of rational exponents. Show the relationship between the index and radicand powers when creating examples for the foldable. Ask students for their own examples of each law and share them in class by either writing on the board or presenting students' foldable displayed under a document camera. Ask students to identify the vocabulary contained within their foldable examples and to label accordingly. Ask them to place their examples of the vocabulary on the word wall.

Step 3: Investigate and explore using Mathisfun.com to develop rational exponent relationships. – <http://www.mathisfun.com/algebra/exponent-fractional.html>

Step 4: Students will demonstrate their knowledge through the incorporation of student practice utilizing a variety of materials. The combination of materials listed can be adapted to your students learning styles and abilities. For example, breaking the assignment into shorter tasks can guide your instruction and provide informal assessment on student mastery. Not all of these materials may be needed for student mastery of the objectives. When planning lesson implementation, select the materials most appropriate for your student's needs.

Instructional Videos

Rational Exponents and Exponent Laws – <http://www.khanacademy.org/math/algebra/exponent-equations/exponent-properties-algebra/v/rational-exponents-and-exponent-laws> (Introduction to simplifying radicals in terms of fractional exponents)

Fractional Exponents Calculator 1 TI 84 Calculator Fractional Exponents –

<http://www.youtube.com/watch?v=Mcg5s-aiLpQ&feature=relmfu>

Fractional Exponents Calculator 2 TI 84 Calculator Fractional Exponents –

<http://www.youtube.com/watch?v=pt2za0MoyKg>

Roots and Unit Fraction Exponents – <http://www.youtube.com/watch?v=zKE46XejGZU>

Instructional Activities

Simplifying Rational Exponents Printable –

<http://www.kutasoftware.com/FreeWorksheets/Alg2Worksheets/Simplifying%20Rational%20Exponents.pdf>

Radicals and Rational Exponents Printable –

<http://www.kutasoftware.com/FreeWorksheets/Alg2Worksheets/Radicals%20and%20Rational%20Exponents.pdf>

<http://www.sascurrículumpathways.com/portal/> (Activity #285 radical and exponent rules are used in research to find the practical applications)

Computer Practice

A Visual Approach to Simplifying Radicals – <http://www.wisc-online.com/Objects/ViewObject.aspx?ID=TMH5706>
(Interactive applet to demonstrate the simplifying of radicals containing variables may be used for instruction or review. Note: powers higher than 3 are explained and these may be used for an extension lesson)

Can You Spot the Error? Activity for Exponents -

<http://www.regentsprep.org/Regents/math/algtrig/ATO1/teacherevalfractpower.htm> (Can you spot the error in simplifying the equivalent expression between radical and fractional exponent expressions)

Discovering the Laws of Rational Exponents –

<http://www.regentsprep.org/Regents/math/algtrig/ATO1/RatPowersTeacher.HTM> (Students use a calculator to discover the laws of rational exponents by developing a table to discover the rule)

Fractional Exponents – http://www.khanacademy.org/math/algebra/exponents-radicals/e/exponents_3 (Online practice including negative fractional exponents, may be used for extension discussion)

Puzzles and Games

Rational Exponent Block - http://busynessgirl.com/files/pdf/rational_exponent_block.pdf (Printable puzzle where students can cut up the squares and match to the answer sheet. Note: these are stated in the same order on both pages; give the 1st sheet to cut and have them mix the squares up thoroughly, then provide the answer sheet for matching)

Integral and Rational Exponent Jeopardy Game –

<http://www.superteachertools.com/jeopardy/usergames/Jan201103/game1295461809.php>

Step 5: After the students complete practice of rational exponents; discuss the rules for rational exponents and the relationship to exponential rules and radicals. End the class with the Find Someone Who Can Activity – Rational Exponents. The goal of the activity is for each student to sign off on each square to demonstrate knowledge. The twist is they may only do this for one person per square. They need to try to get their signature and solution in all of the different squares.

Step 6: Reflect with your students regarding equivalency and rewriting between exponential and radical forms? It is important for them to understand that these expressions are equivalent to one another. Have your students draw a triangle on a paper. Ask them to list the points they want to remember from today's lesson upon the triangle vertices. Lead a discussion with students sharing what is written on their triangle regarding rational exponents.

Academic Vocabulary Development:

Establish a word wall with your students and develop the following definitions-relate the vocabulary to their foldable on the rational exponents. Ask them to create examples of the vocabulary on the word wall.

index - In the expression $\sqrt[n]{k}$, the index is n

power - exponential expressions such as 3^2 and 3^5 are powers of 3. The nth power of b is defined as $b^n = b \cdot b \cdot b \cdot \dots$ b where there are n factors of b.

radical - An expression of the form \sqrt{a}

radicand - An expression beneath a radical sign

rational exponent – An exponent having both an integer numerator and denominator

Launch/Introduction:

Launch the lesson using the video Roots and Unit Fraction Exponents –

<http://www.youtube.com/watch?v=zKE46XejGZU> . Pause the video to periodically assess student comprehension of exponential relationships from previous learning and begin to discuss fractional exponents.

Investigate/Explore:

Investigate and explore using TI to develop rational exponent relationships with students with an activity using a graphing calculator. Students should be able to develop fluency in recognizing equivalent expressions between radicals and exponential forms of a number.

Students will demonstrate their knowledge through the incorporation of student practice utilizing a variety of materials. Instructors combine materials listed by adapting to your students learning styles and abilities for investigation and practice of the objectives. For example, breaking the assignment into shorter tasks can guide your instruction and provide informal assessment on student mastery. Some materials may be used as online practice by the instructor for individualized remediation. Not all of these materials may be needed for student mastery of the objectives.

Summarize/Debrief:

End the class with the Find Someone Who Can Activity – Rational Exponents. The goal of the activity is for each student to sign off on each square to demonstrate knowledge.

Materials:

Graphing Calculator, Word Wall Materials (construction paper, markers), foldable (white copy paper or notebook paper, markers or colored pencils, scissors), optional-computers, printables

Career Connection:

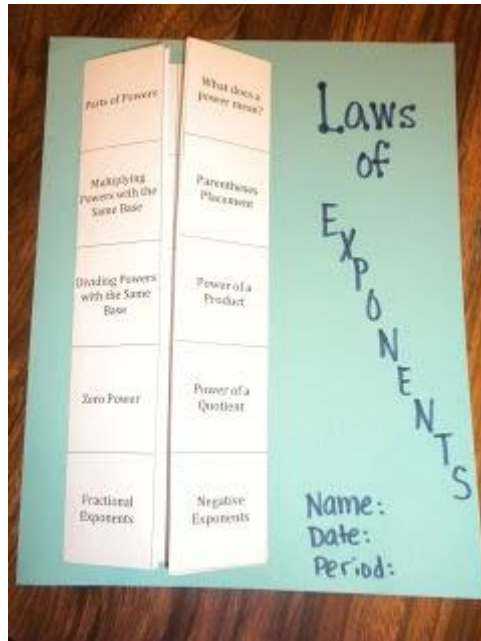
Engineering and Technical Cluster and Science and Natural Resources Cluster use rational exponents and radicals in solving formulas. Physicists solve for unknowns such as calculating the time t that a freely falling object is dropped or using it in a pre-determined formula.

Lesson Reflection:

Students use the Triangle Review to consider the information from the rational exponents lesson. It is a means of student reflection upon the important points from the lesson as well as a way for the instructor to identify student misunderstandings. Teachers can participate with the students, drawing their own Triangle Review and reflecting upon the lesson.

Foldable for Rational Exponents

Although this is not the content of the foldable the students are creating, here is an illustration of the style of the foldable. It is not necessary to glue the foldable to a separate sheet.



- Have each students take a sheet of paper (consider using colorful paper so that the foldable is more easily identified by the student) and fold it half “hamburger” style.
- Fold it again to create quarter sections.

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- Then have students fold it again lengthwise to create quarter sections horizontally. Each student should now

- Each student should now have a total of 16 sections. The section on the far left and right should be folded in. These sections will be the titles on the “outside”, which will hide the middle sections until the students lifts the tab.

Have the student cut as indicated.

(cut here – only to vertical fold)			(cut here – only to vertical fold)
(cut here – only to vertical fold)			(cut here – only to vertical fold)
			(cut here – only to vertical fold)

➤ Complete the foldable as shown. Remember the 1st and 4th columns are written on the “outside” of the tabs.

<h2 style="text-align: center;">Rational Exponents</h2>	Written by and for: Student Name	$(\sqrt[4]{16})^2 = 16^{\frac{2}{4}} = 16^{\frac{1}{2}} = (\sqrt{16})^1 = \sqrt{16} = 4$	Example 1
Definition	A rational exponent has the form $a^{\frac{m}{n}}$ where m and n are both integers. It can be rewritten as $\sqrt[n]{a^m}$. (n ≠ 0)	$8^{\frac{2}{3}} \cdot 8^{-\frac{1}{3}} = 8^{\frac{2}{3} - \frac{1}{3}} = 8^{\frac{1}{3}} = \sqrt[3]{8} = 2$	Example 2
Laws of Exponents	$x^1 = x$ $x^0 = 1$ $x^m \cdot x^n = x^{m+n}$	$4^{\frac{3}{2}} = (\sqrt[2]{4})^3 = 2^3 = 8$	Example 3
	$\frac{x^m}{x^n} = x^{m-n}$ $(x^m)^n = x^{mn}$	$\frac{27^{\frac{5}{6}}}{27^{\frac{1}{2}}} = 27^{\frac{5}{6} - \frac{1}{2}} = 27^{\frac{5}{6} - \frac{3}{6}} = 27^{\frac{2}{6}} = 27^{\frac{1}{3}} = \sqrt[3]{27} = 3$	Example 4

Find Some Who Can...

Your mission is to find a different person among your classmates to simplify each expression in the table below. Your teammates must write the correct answer in the square and then sign the square. You may not have a person sign/answer more than one square.

Simplify $8^{\frac{2}{3}}$. _____	Simplify $81^{-\frac{1}{2}}$. _____	Simplify $64^{\frac{2}{3}}$. _____	Simplify $25^{\frac{3}{5}}$. _____
Rewrite $(37)^{\frac{5}{3}}$ as a radical. _____	Rewrite $(13)^{\frac{4}{3}}$ as a radical. _____	Rewrite $(9)^{\frac{1}{6}}$ as a radical. _____	Rewrite $(16)^{\frac{2}{5}}$ as a radical. _____
Rewrite $\sqrt[5]{17^3}$ using exponents. _____	Rewrite $\sqrt[3]{8^4}$ using exponents. _____	Rewrite $\sqrt[2]{2^{-1}}$ using exponents. _____	Rewrite $\sqrt[6]{48^4}$ using exponents. _____
Simplify $(16x^3y)^{\frac{1}{2}}$. _____	Simplify $(9ab^2y^8)^{\frac{3}{2}}$. _____	Simplify $(27m^3n^5)^{\frac{1}{3}}$. _____	Simplify $(49x^8z^2)^{-\frac{1}{2}}$. _____