

Lesson Plan
Lesson 2: Simplifying Radicals
Mathematics High School Math II

Unit Name: Unit 1: Extending the Number System

Lesson Plan Number & Title: Lesson 2: Simplifying Radicals

Grade Level: High School Math II

Lesson Overview:

Students will be able to explain orally or in written format a working definition of equivalent values using radicals with precision and fluency. Although not directly referenced in this standard, lesson goals are to establish readiness for the unit on the topic of radical simplification. A student must be able to recognize different forms of irrational numbers.

Focus/Driving Question: What is the relationship between a perfect square number and its root? Do you know if a number is considered exact or approximate? When is it appropriate to use an exact answer? Approximate?

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.)

Manage the Lesson:

Step 1- What is the relationship between a perfect square number and its root? Develop the relationship with your students by creating a foldable as can be viewed in either of the following videos Square Root Foldable – http://www.youtube.com/watch?v=9Azs34N_5UU (part one creating the foldable and labeling the foldable) and Square Root Foldable part 2 – <http://www.youtube.com/watch?v=OvMcPpG2S-U> (part two) or adapted to numbers of your own selection. Ask students to consider the relationships between these numbers. As a guide, use their responses to develop a connection to the use of a radical.

Step 2 – Develop vocabulary and create a word wall with your students and develop the following definitions – relate the vocabulary to their foldable (Step 3) on the accompanying vocabulary listed in Vocabulary Development. Ask them to create examples of the vocabulary on the word wall.

Step 3 – Build upon student knowledge by investigating rational roots using the Illuminations activity: Square Roots Go Rational – <http://illuminations.nctm.org/LessonDetail.aspx?id=L854>. You will need to print the accompanying handouts and provide calculators for the activity. This lesson assists students in developing numerical reasoning in considering perfect squares and numbers which are not perfect squares.

Build upon the activity by asking students to explain how to find the square root of a non-perfect square such as 50. Most will suggest using the calculator to generate a solution. This is a perfect time to lead a discussion on rounding (approximate answer) vs. exact answer, where no rounding occurs. Sometimes it is convenient to leave square roots in radical form instead of using a calculator to find approximations (decimal values). Look for perfect squares (i.e., 4, 9, 16, 25, 36, 49 ...) as factors of the number that is

inside the radical sign (radicand) and take the square root of any perfect square factor. Multiply the root of the perfect square times the reduced radical. When there is an existing value that multiplies the radical, multiply any root(s) times that value. An activity on developing prime factorization as a method of providing an exact solution can be found at *Prime Factorization Method for Finding Square Roots* – http://www.ed.gov.nl.ca/edu/k12/curriculum/documents/mathematics/gr8/prime_factorization_method.pdf

Point out that for every pair of prime factors inside the radical, one "comes out" of the radical in its numerical representation. Ask students to consider the square root of 25. Most students will respond that it is 5. Take the opportunity to develop student comprehension that $(-5)^2$ is also 25. Inquire how this could be reflected in a simplified radical.

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. Depending upon access to computers, the use of computer games as student practice can create higher student interest for the reluctant learner or student with attention span issues. All of the materials listed below may not be needed for student mastery of the lesson objective. When planning lesson implementation, select the materials most appropriate for your student's needs.

Instructional Activities:

Illuminations: Visualizing Squares and Square Roots -

<http://illuminations.nctm.org/LessonDetail.aspx?id=U193> (uses geoboards to visualize the geometric meanings of square, square root and irrational numbers)

Simplifying Radical Expressions WS –

<http://www.kutasoftware.com/FreeWorksheets/Alg1Worksheets/Simplifying%20Radicals.pdf>

(Includes numbers and simple variable expressions)

Exponent and Radicals WS – <http://www.math-aids.com/Radicals/Radicals.html> (This website generates radical worksheets for classroom practice. They can also be used for ESL students by selecting a different language option.)

Simplifying Square Roots practice – <http://www.kutasoftware.com/FreeWorksheets/GeoWorksheets/1-Simplifying%20Square%20Roots.pdf> (without variables)

Free Printable Square Root Worksheets from Homeschool Math –

<http://www.homeschoolmath.net/worksheets/square-roots.php> worksheet generator allowing the selection of the types of problems to be used.

[Radical Thinking Graphic Organizer](#) -Students can develop examples of radicals converted into decimals, show radicals being added, subtracted and multiplied, and more. Use this as a "Pair and Share" activity or as sample questions for a test with student created problems.

Computer Practice

Simplifying Radicals – A Complete Course in Algebra – <http://www.themathpage.com/alg/simplify-radicals.htm> (online instruction for individual or use as whole group instruction)

IXL: Simplify Radical Expressions (Algebra Practice) – <http://www.ixl.com/math/algebra-1/simplify-radical-expressions> (online activity which permits students to enter answers and receive immediate feedback)

Quia – Radicals Simplifying – <http://www.quia.com/mc/678599.html> (includes variables in the practice matching problems to answers in a flash card game)

Square Roots Game - <http://www.math-play.com/square-roots-game.html> (online game to practice simplifying radicals)

<http://www.sascurriculumpathways.com/portal/> Activity #1289 video on how to simplify radicals and a quiz

Puzzles and Games

Simplify Expression Connect-the-Dots Puzzle – <http://www.mathnstuff.com/papers/condots/rad1.htm> (printable handout for students to "connect the dot" between problems and answers for a completed image)

Instructional Videos

Simplifying Radicals – <http://www.onlinemathlearning.com/simplify-radicals.html> instructional video for students to review

How to Simplify Radicals (the easy way) – <http://www.youtube.com/watch?v=jXPALrM1bUU> how to simplify a radical

Radical Expressions – Let's Boogie!!! – <http://www.youtube.com/watch?v=GvG0QS-55yw> math video on how to simplify a radical (cartoon)

Understanding Square Roots – <https://www.khanacademy.org/math/arithmetric/exponents-radicals/radical-radicals/v/understanding-square-roots> instructional video

Simplifying Radicals – <http://www.khanacademy.org/math/algebra/exponents-radicals/v/simplifying-radicals> instructional video

Step 5 – Individually, have the students- without using calculators, simplify $3\sqrt{96}$ and write an explanation for simplifying. What is its exact answer? What additional information would they need to know for an approximate answer? Pair and share this activity as a means of summarizing the lesson.

Step 6 - Reflect with your students regarding radicals. Are there any questions regarding radicals? Consider your teaching practices and how the lesson organization worked with your students. Ask the students to write 3 statements regarding exponents and square roots. Students should reflect upon the skills that were needed to generate their solutions in simplifying an exponent and simplifying a radical. Ask them to respond in their reflection on any connection between the two concepts.

Academic Vocabulary Development:

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

radical - an expression of the form $\sqrt{}$ a radicand - an expression beneath the radical sign

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radical sign - the symbol $\sqrt{}$

rational number - a real number that is written as the quotient of two integers

irrational number -real numbers that cannot be expressed in the form $\frac{a}{b}$ where a and b are integers

terminating decimal - a decimal in which the division process stops because a remainder of 0 has been reached (finite or ending)

repeating decimal - a non-terminating decimal in which the same digit or block of digits repeats unendingly

square root - the number a is a square root of the number b if $a^2 = b$

simplest form of a radical (nth root)- the radical contains no integral radicand with a factor that repeats n or more times, no fractions under the radical sign, and no radicals in the denominator

Launch/Introduction:

What is the relationship between a perfect square number and its root? Ask students to consider the relationships between these numbers.

Investigate/Explore:

Develop the relationship with your students by creating a foldable as viewed in either of the following videos Square Root Foldable - http://www.youtube.com/watch?v=9Azs34N_5UU (part one creating the foldable and part two labeling the foldable) and Square Root Foldable Part two – <http://www.youtube.com/watch?v=OvMcPpG2S-U> or adapted to numbers of your own selection.

The purpose of the lesson is to scaffold necessary skills for the unit by the review of perfect squares, square roots and simplifying a radical. The launch activity encourages instructional discovery of the patterns of perfect squares and the development of vocabulary guided by the instructor through the creation of a word wall. Students prepare a foldable of perfect squares and develop their knowledge in the creation of corresponding square roots. The instructor can choose to do this portion (create an example) as individual, small group or whole group instruction depending on student abilities or necessary modifications. The process of instructional practice by students can be flexible instruction by the assignment of handouts, games, or online computer practice according to instructional resources and differentiation determined by the instructor. Assessment of the lesson is a ongoing part of the instructional process, whether informal or formal and should guide the instructor's instruction. A short assessment in Step 5 of Manage the Lesson is provided for students to use justification in their applications for simplifying. Both students and instructor are encouraged to reflect upon the lesson and knowledge gained in whole group discussion.

Summarize/Debrief:

Students can use a 3-2-1 chart to process their learning and identify misconceptions.

3	Things I Learned Today ...
2	Things I Found Interesting ...
1	Question I Still Have ...

Materials:

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

Suggested websites for instructional information and student use:

http://www.youtube.com/watch?v=9Azs34N_5UU
<http://www.youtube.com/watch?v=OvMcPpG2S-U>
<http://illuminations.nctm.org/LessonDetail.aspx?id=L854>
http://www.ed.gov.nl.ca/edu/k12/curriculum/documents/mathematics/gr8/prime_factorization_method.pdf
<http://illuminations.nctm.org/LessonDetail.aspx?id=U193>
<http://www.kutasoftware.com/FreeWorksheets/Alg1Worksheets/Simplifying%20Radicals.pdf>
<http://www.math-aids.com/Radicals/Radicals.html>
<http://www.kutasoftware.com/FreeWorksheets/GeoWorksheets/1-Simplifying%20Square%20Roots.pdf>
<http://www.homeschoolmath.net/worksheets/square-roots.php>
<http://www.themathpage.com/alg/simplify-radicals.htm>
<http://www.ixl.com/math/algebra-1/simplify-radical-expressions>
<http://www.quia.com/mc/678599.html>
<http://www.mathnstuff.com/papers/condots/rad1.htm>
<http://www.onlinemathlearning.com/simplify-radicals.html>
<http://www.youtube.com/watch?v=jXPALrM1bUU>
<http://www.youtube.com/watch?v=GvG0QS-55yw>
<https://www.khanacademy.org/math/arithmetric/exponents-radicals/radical-radicals/v/understanding-square-roots>
<http://www.khanacademy.org/math/algebra/exponents-radicals/v/simplifying-radicals>
<http://www.sascurriculumpathways.com/portal/>

Career Connection:

Skills developed in this unit can be related to formulas for velocity and gravity (Engineering and Technical Cluster, Science and Natural Resources Cluster).

Lesson Reflection:

In Step 6 of Manage the Lesson, students and the instructor (model the reflection process) individually write 3 statements regarding exponents and square roots. Students should reflect upon the skills that were needed to generate their solutions in simplifying an exponent and simplifying a radical. In a whole group format, the instructor can lead a discussion on making connections between the concepts.

Consider your teaching practices and how the lesson organization worked with your students. What would you do again in this lesson? What parts of the lesson need improvement?