Simplifying Square Roots

Reporting Category Expressions and Operations

Topic Simplifying square roots

Primary SOL A.3 The student will express the square roots and cube roots of whole numbers and the square root of a monomial algebraic expression in simplest radical form.

Related SOL A.2, A.4

Materials

- Graphing calculators

Vocabulary

square root, perfect square, squaring (earlier grades)

simplest radical form, radicand (A.3)

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

1. Ask students what they remember about square roots, and list responses on the board. Ideas that may come up include such things as the radical symbol, that they are the inverse of squaring a number, and perfect squares. (Note: This should enable you to know whether your students have enough knowledge to determine the square root of a perfect square.)
2. Ask students to simplify $\sqrt{4}$ and to be able to explain their reasoning. Have students share their ideas. Continue with $\sqrt{9}, \sqrt{16}, \sqrt{25}$. In the conversation, bring out the ideas of $2 \cdot 2 = 4$, $2^2 = 4$, and that finding a square root and squaring are inverse operations.
3. Display the following expressions. Group students in pairs, and have each partner take one column. Instruct each partner to find the decimal equivalent of his/her expression and compare it with his/her partner's decimal.

Partner A	**Partner B**
$\sqrt{3 \cdot 5}$	$\sqrt{3} \cdot \sqrt{5}$
$\sqrt{6 \cdot 4}$	$\sqrt{6} \cdot \sqrt{4}$
$\sqrt{7} \cdot \sqrt{5}$	$\sqrt{7 \cdot 5}$
$\sqrt{18}$	$3\sqrt{2}$

   Note: You may need to review order of operations and explain the steps so that the calculator will perform the desired operations.

4. After students have had time to calculate, ask them what they noticed. (Each row has the same decimal equivalent.) Now, ask them to go back and look at each row. Knowing that they are equivalent, what other observations can be made? Have students share their observations. (Note: Students may not see how $\sqrt{18} = 3\sqrt{2}$ just yet, but that is okay for now.)

5. Tell students that in mathematics, we often represent an expression in different ways but that the different representations do not change the value of the expression. For example, 7 + 6 is the same as 10 + 3, or $\frac{4}{8}$ is the same as $\frac{1}{2}$. They just learned that the each pair of expressions in the two columns represents the same number in two different ways and that this number can also be written as a decimal.
6. Give students the expression $\sqrt{4 \cdot 2}$, and ask them to work with partners to represent this expression in as many ways as they can without changing its value. Have students share their ideas, which will definitely include the decimal representation and $\sqrt{4} \cdot \sqrt{2}$, given the work already done in this lesson. Encourage other ideas to emerge as well, including $\sqrt{8}, 2\sqrt{2}, \sqrt{2} + \sqrt{2}$, and $\sqrt{2^2} \cdot \sqrt{2}$. Some students may suggest similar representations eliminating only the symbol for multiplication. If $\sqrt{8}$, and $2\sqrt{2}$ do not emerge, suggest them, ask students whether they agree or disagree with them, and ask why.
7. Ask students to work with partners to represent the two numbers $\sqrt{12}$ and $\sqrt{15}$ in as many ways as possible. Have students share their ideas. Ask why they were able to represent $\sqrt{12}$ using a whole number (outside of the radical) but not $\sqrt{15}$.
8. Tell students that just as we have a simplified way of expressing fractions, we also have a simplified way of expressing square roots. Post the following: "A square root in simplest form is one in which the radicand (argument) has no perfect square factors other than one." Ask which representation of $\sqrt{12}$ is in simplest form and how they know it is in simplest form.
9. Have students work with partners to represent the following square roots in simplest form: $\sqrt{20}, \sqrt{45}, \sqrt{72}, \sqrt{75}$. (Note: There may be several different strategies for simplifying these square roots. Some students may use prime factorization to get the square factors, and others may use their knowledge of perfect squares. It is important that you accept these strategies and any other mathematically sound strategies that students offer.)
10. When students have finished, have them share their strategies for simplifying these square roots. Before you move on, ask whether there are other strategies for finding the simplest forms of these square roots. If you have students who did not fully simplify $\sqrt{72}$, be sure this idea comes out in the discussion.
11. Summarize the lesson by using the questions and/or journal prompts below.

Assessment

- **Questions**
  - How do you know whether a square root is fully simplified?
  - Why do you think we simplify square roots into their simplest forms?
- **Journal/Writing Prompts**
  - Explain how you would simplify a square root into its simplest form.
  - Compare and contrast simplifying fractions and simplifying square roots.
- **Other**
  - Provide opportunities for students to practice expressing square roots in simplest form.

Extensions and Connections (for all students)

- Have students also simplify cube roots of whole numbers and square roots of monomial algebraic expressions (see the “Simply Radical” lesson).
- Provide students with real-life problems using the Pythagorean Theorem, and ask them to express their solutions in simplest form.

Strategies for Differentiation

- Have students create a flow chart showing the steps of their strategy for simplifying a square root.
- Suggest students expand out radicand expressions, using prime factorization, and have them circle pairs when simplifying square roots.