

Simplifying Square Roots of Whole Numbers

Strand:	Expressions and Operations
Topic:	Simplifying square roots of whole numbers
Primary SOL:	A.3 The student will simplify a) square roots of whole numbers and monomial algebraic expressions;
Related SOL:	5.3, 6.4, 7.1d, 8.3, 8.14a

Materials

- Grid paper
- Simplifying Square Roots of Whole Numbers activity sheet

Vocabulary

factor, perfect square, prime factorization, radical expression, radicand, square root, whole numbers

Student/Teacher Actions: What should students be doing? What should teachers be doing?

1. Using the grid paper squares provided in the table in Part I of the activity, as well as the questions that follow, students should work with a partner or in a small group to review the concepts of a perfect square and its principal square root. Upon completion of Part I of the activity, one representative from the group or partnership should check their answers. While students are working, the teacher should be circulating to answer questions and ensure that students have strong background knowledge on this concept.
2. Part II should be primarily a teacher-led section; however, scaffold this information and allow students to participate and claim ownership to the new idea. For instance, ask students to approximate the length of the side for a square with an area of 8 square units. Their Mathematics 8 background should enable them to reason that the side would be between two and three units in length. It may also help to provide an extra example, like $\sqrt{27}$, that would allow for more student participation.
3. With their partners or small groups, students should be given an opportunity to simplify square roots with the help of a pictorial image in Part III. Circulate to monitor progress, answer questions, and select student work to display demonstration tool (e.g., document camera, digital display).
4. Part IV is again primarily teacher-led; however, scaffold the new information again so that students can be active participants through questioning. They should also fill in missing information toward the end of the section.
5. The final section gives students an opportunity to simplify square roots individually. The teacher should circulate to answer questions. Upon completion of this section, students can compare responses with another student and discuss discrepancies before submitting their work.

Assessment

- **Questions**
 - You simplified $\sqrt{98}$ to $7\sqrt{2}$. Determine the decimal approximation for $7\sqrt{2}$. Explain why this decimal approximation makes sense, based on your knowledge of the two consecutive integers between which $\sqrt{98}$ lies.
 - How do you know whether a square root is fully simplified?
- **Journal/writing prompts**
 - Your classmate simplified $\sqrt{300}$ to $10\sqrt{3}$. His partner simplified the same radical expression to $5\sqrt{12}$. In complete sentences, explain whose response is preferred and how you would help the other student revise their response to match the preferred one.
 - In your own words, explain the relationship(s) between the numbers 80, $\sqrt{80}$, and $4\sqrt{5}$.
- **Other Assessments**
 - Exit tickets could be issued asking students to simplify an expression like $\sqrt{288}$.

Extensions and Connections

- Questions that apply the Pythagorean Theorem (taught in Mathematics 8) could be posed with the expectation that solutions be expressed in simplest radical form rather than rounding a decimal answer.
- This lesson could extend into one where Algebra I students simplify the square root of a monomial expression. Questions could be asked where students are given the area of a square and are asked to determine a side length.
- Students have background knowledge concerning prime factorization, perfect squares, and square roots. Instruction on this content begins in Grade 5 and continues through Grade 8, where students learn to determine the two consecutive integers between which a square root lies. Algebra I students can apply the simplification of a square root when solving quadratic equations later in the course.
- Square roots are applied in many formulas used in high school science courses. Teachers may prefer exact, simplified values rather than rounded decimal approximations.

Strategies for Differentiation

- Have students create a flow chart showing the steps of their strategy for simplifying a square root.
- Have students record a list of perfect squares down the side of their paper before working on examples.
- Provide students with graph paper.
- Use of a graphing utility to check their simplified radical against its equivalent value.
- Allow for collaboration on “individual practice” portion of the activity sheet.

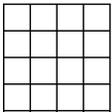
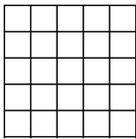
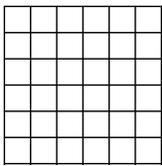
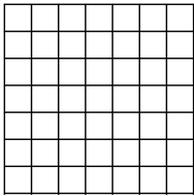
Note: The following pages are intended for classroom use for students as a visual aid to learning.

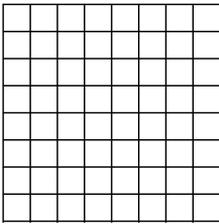
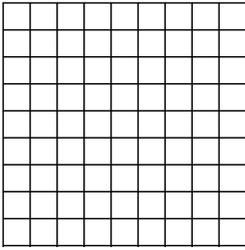
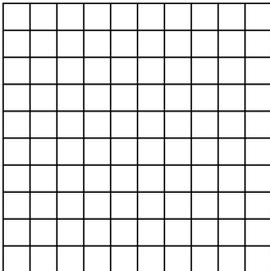
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Simplifying Square Roots of Whole Numbers

I. Review/Background Information

Perfect Squares – Use the grid squares provided to complete the table below:

Grid Square	Dimensions	Area
		
		
		
		
		
		

Grid Square	Dimensions	Area
		
		
		

The numbers that are listed in the **Area** column of the chart above represent some of the perfect squares.

The square root of a perfect square matches the length of a side for a square with the given area.

Fill in each square root listed.

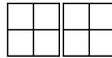
$$\sqrt{4} = 2, \quad \sqrt{9} = \underline{\hspace{2cm}}, \quad \sqrt{16} = \underline{\hspace{2cm}}, \quad \sqrt{25} = \underline{\hspace{2cm}},$$

$$\sqrt{36} = \underline{\hspace{2cm}}, \quad \sqrt{49} = \underline{\hspace{2cm}}, \quad \sqrt{64} = \underline{\hspace{2cm}}, \quad \sqrt{81} = \underline{\hspace{2cm}},$$

$$\sqrt{100} = \underline{\hspace{2cm}}, \quad \sqrt{144} = \underline{\hspace{2cm}}, \quad \sqrt{289} = \underline{\hspace{2cm}}, \quad \sqrt{361} = \underline{\hspace{2cm}}$$

II. Simplifying the Square Root of a Whole Number that is not a Perfect Square

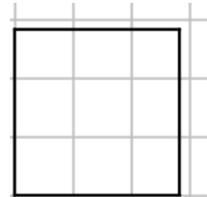
There are other whole numbers, such as 8, that are not perfect square numbers. It would be difficult to make a grid square with an area of 8 square units. We can represent an area of 8 by laying grid squares with an area of 4 square units down twice.



We can use this thinking to simplify square roots of numbers that are not perfect squares:

$$\sqrt{8} = \sqrt{4 * 2} = \sqrt{4} * \sqrt{2} = 2\sqrt{2}$$

Therefore, if we created one grid square with an area of 8 square units, it would have sides that are $2\sqrt{2}$ units in length.



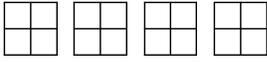
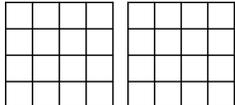
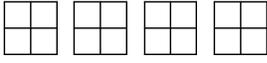
III. Practice – Pictorial Representations to Simplify Square Roots

Draw a picture of each radicand as multiple perfect grid squares and show work to simplify each in the table below:

Square Root	Pictorial Representation of the Radicand as Multiple Perfect Squares	Simplified Square Root
$\sqrt{12}$		
$\sqrt{18}$		
$\sqrt{75}$		

IV. Ensuring Square Roots are Expressed in Simplest Form

Two students have provided their work to simplify $\sqrt{32}$ in the space below:

Student A	Student B
 $\sqrt{4 * 8}$	 $\sqrt{16 * 2}$
$\sqrt{4} * \sqrt{8}$	$\sqrt{16} * \sqrt{2}$
 $2\sqrt{8}$	$4\sqrt{2}$

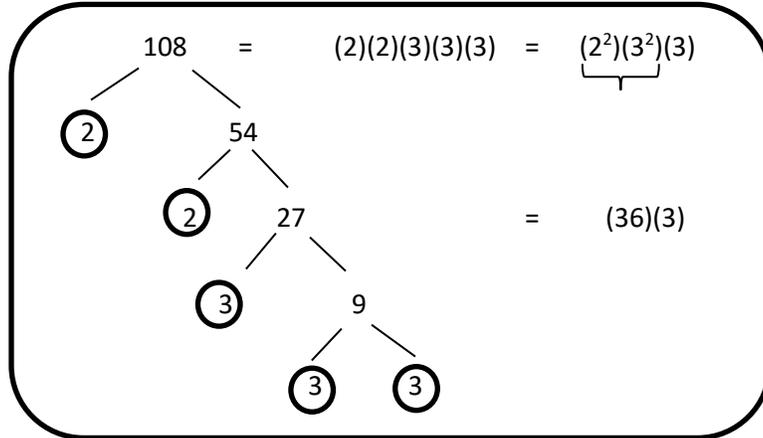
Although both students' work produces a radical expression that is equivalent to $\sqrt{32}$, Student B's is the most simplified because the remaining radicand does not contain any other perfect square factors. Student A would need to repeat the process to simplify $\sqrt{8}$.

$$[2\sqrt{8} = 2\sqrt{4 * 2} = 2 * \sqrt{4} * \sqrt{2} = 2 * 2 * \sqrt{2} = 4\sqrt{2}]$$

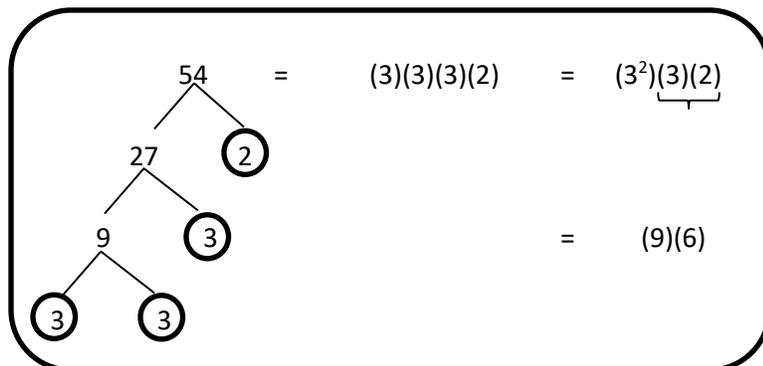
Because the goal is to simplify a radical expression to its simplest form, it is important to visualize the radicand as the fewest number of perfect squares possible.

Prime factorization of a radicand can assist in finding the largest possible perfect square factor.

$$\begin{aligned} &\sqrt{108} \\ &\sqrt{36 * 3} \\ &\sqrt{36} * \sqrt{3} \\ &6\sqrt{3} \end{aligned}$$



$$\begin{aligned} &\sqrt{54} \\ &\underline{\hspace{2cm}} \\ &\underline{\hspace{2cm}} \\ &\underline{\hspace{2cm}} \end{aligned}$$



V. Individual Practice

Simplify each square root to its simplest form using the method of your choice.

1.) $\sqrt{150} =$ _____

2.) $\sqrt{162} =$ _____

3.) $\sqrt{600} =$ _____

4.) $\sqrt{432} =$ _____

5.) $\sqrt{360} =$ _____