Hands-On Standards®, Common Core Edition

Grade 8

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hands-on learning
for growing minds

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Grade 8

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Introduction

How do we help students find meaning in mathematics? That is, how do we give students more than a rote script for reciting facts and churning out computations? How do we help students develop understanding?

Hands-On Standards®, Common Core Edition Grade 8 is an easy-to-use reference manual for teachers who want to help students discover meaning in mathematics. Each of the manual's 27 lessons demonstrates a hands-on exploration using manipulatives. The goal is to help students get a physical sense of a problem—to help students get their hands on the concepts they need to know and to help them "see" the meaning.

Each lesson in *Hands-On Standards* targets a clearly stated objective. The main part of a lesson offers a story problem that students can relate to and has the students work on the problem using a hands-on approach. Full-color photographs demonstrate the suggested steps. In addition to the main activity, each lesson includes suggested points of discussion, ideas for more exploration, a formative assessment item, and practice pages to help students solidify their understanding. The instructional model is a progression from concrete to abstract.

The book is divided into five sections—The Number System, Expressions and Equations, Functions, Geometry, and Statistics and Probability. These correspond to the five content domains for Grade 8 as cited in the *Common Core State Standards for Mathematics*.

Each lesson in this book features one of the following manipulatives:
Algebra Tiles™ • AngLegs® • Centimeter Cubes • Color Tiles • Folding Number Line • Pattern Blocks • XY Coordinate Pegboard

Read on to find out how *Hands-On Standards, Common Core Edition Grade 8* can help the students in your class find meaning in math and build a foundation for future math success!

A Walk Through a Lesson

Each lesson in *Hands-On Standards*® includes many features, including background information, objectives, pacing and grouping suggestions, discussion questions, and ideas for further activities, all in addition to the step-by-step, hands-on activity instruction. Take a walk through a lesson to see an explanation of each feature.

Objective

The **Objective** summarizes the skill or concept students will learn through the hands-on lesson.

Common Core State Standards

Each lesson has been created to align with one or more of the **Common Core State Standards for Mathematics**.

Talk About It

The **Talk About It** section provides post-activity discussion topics and questions. Discussion reinforces activity concepts and provides the opportunity to make sure students have learned and understood the concepts and skills.

Solve It

Solve It gives students a chance to show what they've learned. Students are asked to return to and solve the original word problem. They might summarize the lesson concept through drawing or writing, or extend the skill through a new variation on the problem.

Lesson Introduction

A brief introduction explores the background of the concepts and skills covered in each lesson. It shows how they fit into the larger context of students' mathematical development.

Try It! Arrow

In order to provide a transition from the introduction to the activity, an arrow draws attention to the Try It! activity on the next page. When the activity has been completed, return to the first page to complete the lesson.

More Ideas

More Ideas provides additional activities and suggestions for teaching about the lesson concept using a variety of manipulatives. These ideas might be suggestions for additional practice with the skill or an extension of the lesson.

Formative Assessment

Formative assessments allow for on-going feedback on students' understanding of the concept.

LESSON 1

The Number System

Approximating Square Roots

By now, students have studied various types of rational and irrational numbers, including square roots. In previous grades, students learned how to find the principal square root of numbers that produce a positive rational number. In this lesson, students will estimate the square roots of numbers that produce positive irrational numbers.

Objective

Estimate the irrational square root of given positive integers.

Common Core State Standards

■ **8.NS.2** Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g., π^2). For example, by truncating the decimal expansion of $\sqrt{2}$, show that $\sqrt{2}$ is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations.

Try It! *Perform the Try It! activity on the next page.*

Talk About It

Discuss the Try It! activity.

■ **Ask:** *Look at a 1 × 1 square. How many squares make up a 1 × 1 square?* Elicit 1. *What is the square root of 1?*

■ **Ask:** *Look at a 2 × 2 square. How many squares make up a 2 × 2 square?* Elicit 4. *What is the square root of 4?* Continue similarly for another example or two.

■ **Ask:** *What is the next square after 16?* (25) *What is the square root of 25?* Continue through 64 and its square root (8), if necessary.

■ **Say:** *Use a calculator to find the square root of 55. Compare it to your estimate. Is it between 7 and 7.5?*

Solve It

Reread the problem with students. Have students build squares to determine between which integers the square of their target number falls. Have students roughly estimate the square root, using the relative distance between the squares of two integers.

More Ideas

For other ways to teach about squares and square roots—

■ Have students create a table of all integers from 1 to 30 and estimate the square roots of the numbers using color tiles.

■ Have students find the approximate location of $\sqrt{3}$ on a Folding Number Line.

Formative Assessment

Have students try the following problem.

Which of the following is the best estimate for the square root of 45?

A. Between 4 and 5 but closer to 4

B. Between 4 and 5 but closer to 5

C. Between 6 and 7 but closer to 6

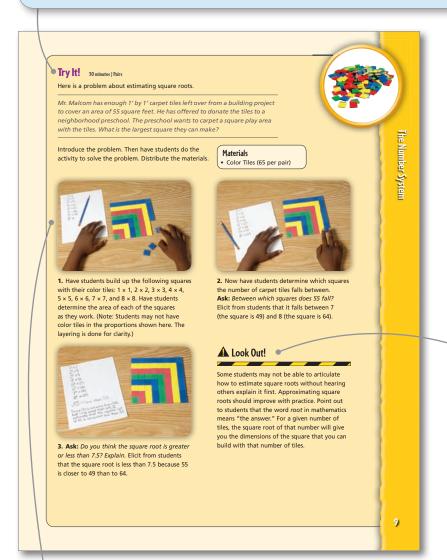**D.** Between 6 and 7 but closer to 7

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Try It!

The **Try It!** activity opens with **Pacing** and **Grouping** guides. The **Pacing** guide indicates about how much time it will take for students to complete the activity, including the post-activity discussion. The **Grouping** guide recommends whether students should work independently, in pairs, or in small groups.

Next, the **Try It!** activity is introduced with a real-world story problem. Students will "solve" the problem by performing the hands-on activity. The word problem provides a context for the hands-on work and the lesson skill.

The **Materials** box lists the type and quantity of materials that students will use to complete the activity, including manipulatives such as Color Tiles and Pattern Blocks.

This section of the page also includes any instruction that students may benefit from before starting the activity, such as a review of foundational mathematical concepts or an introduction to new ones.

Try It! 30 minutes | Pairs

Here is a problem about estimating square roots.

Mr. Malcom has enough 1' by 1' carpet tiles left over from a building project to cover an area of 55 square feet. He has offered to donate the tiles to a neighborhood preschool. The preschool wants to carpet a square play area with the tiles. What is the largest square they can make?

Introduce the problem. Then have students do the activity to solve the problem. Distribute the materials.

Materials
• Color Tiles (65 per pair)

1. Have students build up the following squares with their color tiles: 1 × 1, 2 × 2, 3 × 3, 4 × 4, 5 × 5, 6 × 6, 7 × 7, and 8 × 8. Have students determine the area of each of the squares as they work. (Note: Students may not have color tiles in the proportions shown here. The layering is done for clarity.)

2. Now have students determine which squares the number of carpet tiles falls between. **Ask:** *Between which squares does 55 fall?* Elicit from students that it falls between 7 (the square is 49) and 8 (the square is 64).

⚠ **Look Out!**

Some students may not be able to articulate how to estimate square roots without hearing others explain it first. Approximating square roots should improve with practice. Point out to students that the word *root* in mathematics means "the answer." For a given number of tiles, the square root of that number will give you the dimensions of the square that you can build with that number of tiles.

3. Ask: *Do you think the square root is greater or less than 7.5? Explain.* Elicit from students that the square root is less than 7.5 because 55 is closer to 49 than to 64.

The Number System

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Look Out!

Look Out! describes common errors or misconceptions likely to be exhibited by students at this age dealing with each skill or concept and offers troubleshooting suggestions.

Step-by-Step Activity Procedure

The hands-on activity itself is the core of each lesson. It is presented in three—or sometimes four—steps, each of which includes instruction in how students should use manipulatives and other materials to address the introductory word problem and master the lesson's skill or concept. An accompanying photograph illustrates each step.

A Walk Through a Student Page

Each lesson is followed by a corresponding set of student pages. These pages take the student from the concrete to the abstract, completing the instructional cycle. Students begin by using manipulatives, move to creating visual representations, and then complete the cycle by working with abstract mathematical symbols.

Exercise

Concrete and **Representational** exercises (pictorial representations of the featured manipulative) help students bridge conceptual learning to symbolic mathematics.

Standards-Based Math Practice

Abstract exercises provide standards-based math practice to allow students to deepen their understanding of the featured skill.

Answer Key

Use Color Tiles to estimate the square root of the given number. Fill in the blanks. Write a sentence about the estimate of the square root.

1. $\sqrt{28}$

(Check students' work.)

28 is between the square numbers of 25 and 36
$\sqrt{28}$ is between 5 and 6 .
It is closer to 5 .

Using Color Tiles, model square numbers to help you estimate the given square root. Sketch the model. Write the estimate and justify it.

2. $\sqrt{76}$

76 is between the square numbers of 64 and 81
$\sqrt{76}$ is between 8 and 9 .
It is closer to 9 .

Estimate each square root. Write the two numbers the square root is between and circle the number it is closer to.

3. $\sqrt{15}$
between 3 and 4, but closer to 4

4. $\sqrt{45}$
between 6 and 7, but closer to 7

5. $\sqrt{33}$
between 5 and 6, but closer to 6

6. $\sqrt{65}$
between 8 and 9, but closer to 8

7. $\sqrt{20}$
between 4 and 5, but closer to 4

8. $\sqrt{50}$
between 7 and 8, but closer to 7

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Answer Key

Challenge! Explain how you decide which two numbers the value of a square root is between.

Challenge: (Sample) Find the greatest square number that is less than the number under the radical symbol. Find the least square number that is greater than the number under the radical symbol. Decide which square number is closer to the number under the radical symbol.

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