Theme: The Number Concepts **Suggested Days of Instruction: 40 days**

Ohio's Learning Standards

NUMBER SYSTEMS (NS)

Know that there are numbers that are not rational, and approximate them by rational numbers

8.NS.1 Know that real numbers are either rational or irrational. Understand informally that every number has a decimal expansion which is repeating, terminating, or is non-repeating and non-terminating.

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.

EXPRESSIONS AND EQUATIONS (EE)

Work with radicals and integer exponents.

8.EE.1 Understand, explain, and apply the properties of integer exponents to generate equivalent numerical expressions. *For example,* $3^2 \times 3^{-5} = 3^{-3} = {}^{1}/_{3^3} = {}^{1}/_{27}$

8.EE.2 Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational.

8.EE.3 Use numbers expressed in the form of single digit times an integer power of 10 to estimate very large or very small quantities and to express how many times as much one is than the other. *For example, estimate the population of the United States as* 3×10^8*; and the population of the world as* 7×10^9*; and determine that the world population is more than 20 times larger.*

8.EE.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

Commentary

Eighth graders learn to distinguish between rational and irrational numbers. Building on seventh grade understanding, students recognize that the decimal equivalent of a fraction will either terminate or repeat and they convert repeating decimals into their fraction equivalents. Finally, eighth graders use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line, and estimate the value of expressions.

Eighth grades learn how to compute with integer exponents. Students build on what they have learned about square roots to solve equations in the form of $x^2 = p$ and $x^3 = p$, where p is a positive rational number, evaluating perfect square and perfect cube roots. Students learn how to express very large and very small numbers in scientific notation and express how many times larger or smaller one number written in scientific notation is than another. Students use the properties of integer exponents to perform operations with numbers written in scientific notation. Students interpret numbers written in scientific notation using technology.

Resources:
SpringBoard: Unit 1 (Lessons 1-1 to 8 -2) Unit 2 (Lessons 9-1 to 10-2)
Note: Lessons 1-1 to 2-1 provide a review of Grade 7 skills.
Manipulatives: Number lines, square tiles, Unifix or Linking cubes

Formative Assessments
SpringBoard Digital: Short-Cycle Assessment for each lesson

Summative Assessments
SpringBoard Digital: End of Unit or Customized Assessment

OST Released Items:

Embedded Assessments
Unit 1
EA1: Patterns and Quantitative Reasoning, ***Game On***
EA2: Representing Rational and Irrational Numbers, ***Weather or Not?***
EA3: Exponents and Scientific Notation, ***Contagious Mathematics***

Unit 2
EA1: Expressions and Equations, ***What a Good Idea!***

Addressing Student Misconceptions and Common Errors
8.NS.1
Some students have difficulty understanding the relationship of the subsets of the Real Number System with a Venn diagram. Try a hands-on approach using boxes that fit inside one another to represent the subsets.

Some students need more practice than others converting repeating decimals to equivalent fractions. This can be done over time with mini-practice sessions weekly.

8.NS.2
When rational numbers written in decimal form have more than three digits that repeat, some students stop the division process and call it an irrational number. These students need to be encouraged to persevere with the division until they are convinced there is no repeat. These students may not have a clear understanding of rational numbers as numbers that can be written in fraction form. This fact should be made explicit during instruction.

Addressing Student Misconceptions and Common Errors - Continued

8.NS.2 Continued

To help students who become overwhelmed with the process to approximate irrational numbers, suggest an organized format. For example, set up three columns with questions that need to be answered for each. Some students may need the template at first.

____ falls between which two whole numbers?	Is _____closer to ____ or ____?	Is _____ closer to ____ or ____?

8.EE.1

Students often confuse the rules. This occurs primarily when students are taught to memorize the rules rather than understand what is happening in the properties by working with numerical expressions as in the suggestions above. It is important to present examples and let students discover what the rules are. Then students should be encouraged to write their reasoning so they can clarify the explanations for themselves.

8.EE.2

It is important for students to have multiple opportunities and exposures with perfect cubes. This is a new concept in the curriculum and many students struggle with finding cube roots. A common misconception for cube roots is that any number times 3 is a perfect cube. Building larger cubes from smaller ones gives students a visual that they can rely on.

8.EE.3

Students often confuse a very large number for a small number when written in scientific notation such as 4,000,000 for 4×10^{-6}. This usually is a result of students trying to memorize a rule about moving a decimal point to the left or the right. Instead of teaching a rule, rely on students' background knowledge of negative exponents. Before rewriting a number in standard form, look to the exponent to determine whether it is a small or large number. This can be used as a check.

Students who do not understand the properties of exponents also make errors in computation with scientific notation. Teachers may need to review these properties.

8.EE.4

When performing operations with numbers in scientific notation, such as $(7 \times 10^5) \times (18 \times 10^9)$, some students will be overwhelmed with keeping track of what they should do. Encourage these students to color code the numbers such as highlighting the numbers in exponential form in the given example so students remember to work them together.

Source: The Common Core Mathematics Companion: The Standards Decoded (What They Say, What They Mean, How to Teach Them)
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