8th Grade Math; Unit 2 Lesson 2

Key Standards addressed in this Lesson: CC8.NS.1, CC8.NS.2

Time allotted for this Lesson: 3 to 4 days

Key Concepts in Standards:

MCC8.NS.1 Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually, and convert a decimal expansion which repeats eventually into a rational number.

MCC8.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., $\pi 2$). For example, by truncating the decimal expansion of $\sqrt{2}$ (square root of 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.

Evidence of Learning:

By the conclusion of this unit, students should be able to demonstrate the following competencies:

- explain the difference between a rational and an irrational number;
- convert either a repeating or a terminating decimal into a fraction;
- write a decimal approximation for an irrational number to a given decimal place;
- place rational and irrational numbers on a number line;

ENDURING UNDERSTANDINGS

- Square roots can be rational or irrational.
- An irrational number is a real number that cannot be written as a ratio of two integers.
- Every number has a decimal expansion, for rational numbers it repeats eventually, and can be converted into a rational number.
- All real numbers can be plotted on a number line.
- Rational approximations of irrational numbers can be used to compare the size of irrational numbers, locate them approximately on a number line, and estimate the value of expressions.
- $\sqrt{2}$ is irrational.

Essential Question(s):

- Why is it useful for me to know the square root of a number?
- What is the difference between rational and irrational numbers?
- When are rational approximations appropriate?
- Why do we approximate irrational numbers?

Vocabulary: (Tier)

- **Decimal Expansion:** The decimal expansion of a number is its representation in base 10 (i.e., the decimal system). For example, the decimal expansion of 25^2 is 625, of π is 3.14159..., and of $\frac{1}{9}$ is 0.1111....
- **Integer:** The set of whole numbers and their opposites.
- **Irrational:** A real number whose decimal form is non-terminating and non-repeating that cannot be written as the ratio of two integers.
- **Perfect Square:** A number that has a rational number as its square root.
- **Radical:** A symbol $\sqrt{}$ that is used to indicate square roots.
- **Rational:** A number that can be written as the ratio of two integers with a nonzero denominator
- **Square Root:** One of two equal factors of a nonnegative number. For example, 5 is a square root of 25 because 5 • 5 = 25. Another square root of 25 is -5 because (-5) • (-5) = 25. The +5 is called the principle square root of 25 and is always assumed when the radical symbol is used.

Concepts/Skills to Maintain:

- computation with whole numbers and decimals, including application of order of operations

Opening:

- Graphic Organizer of The Number System: Provide students with a list of about 15 numbers and have them place them in the chart where they think they belong. Discuss and make corrections as needed.
- **http://www.slideshare.net/kbrach/classifying-numbers**
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- **http://www.scribd.com/doc/13289036/Rational-Numbers-Skit (This is a rational number skit. It will help students to understand the difference between rational and irrational numbers.)**
- www.youtube.com/watch?v=KKfoORhiSA0 (Math Rap on Rational & Irrational Numbers)

Work Session:

Day One:

- **Graphic Organizer: Rational vs. Irrational** Take a piece of copy paper and fold the shorter sides in so that they meet in the middle. This will create two doors. Label one door Rational and the other door Irrational. Open the appropriate door to write notes and examples of each. Make sure to include how to convert a repeating decimal to a fraction.
- **Or** open the file that says Square Root Graphic Organizer and use this GO (won't attach right, sorry!)

Example 1:
Change $0.\overline{4}$ to a fraction.

- Let $x = 0.444444\ldots$.
- Multiply both sides so that the repeating digits will be in front of the decimal. In this example, one digit repeats so both sides are multiplied by 10, giving $10x = 4.4444444\ldots$.
- Subtract the original equation from the new equation.

$$\begin{array}{r} 10x = 4.4444444\ldots \\ -\ x = 0.444444\ldots \\ \hline 9x = 4 \end{array}$$

- Solve the equation to determine the equivalent fraction.

$$\frac{9x}{9} = \frac{4}{9}$$

$$x = \frac{4}{9}$$

Additionally, students can investigate repeating patterns that occur when fractions have denominators of 9, 99, or 11.

Example 2:
$\frac{4}{9}$ is equivalent to $0.\overline{4}$, $\frac{5}{9}$ is equivalent to $0.\overline{5}$, etc.

- Practice Identifying Rational vs. Irrational

Day Two:
- Graphic Organizer: Estimating Square Roots (see below)
- Practice

Day Three:
- GA Dept of Education **Task "Rational or Irrational Reasoning?"** which may be found in the GA frameworks at www.georgiastands.org

Other Possible Resources:

The Outstanding Math Guide: 8th Grade Supplement
- Radical page 19
- Rational/Irrational Numbers page 23

Holt Course 3 Text:
- Rational Numbers Section 2-1
- Comparing and Ordering Rational Numbers Section 2-2
- Exponents Section 4-1
- Look for a Pattern in Integer Exponents Section 4-2
- Properties of Exponents Section 4-3
- Squares and Square Roots Section 4-5
- Estimating Square Roots Section 4-6
- The Real Numbers Section 4-7

Coach Grade 8 (GPS)
- Lesson 4: Rational and Irrational Numbers

Crosswalk Coach

- Lesson 1: Rational numbers
- Lesson 2: Irrational numbers
- Lesson 3: Compare and order rational numbers
- Lesson 4: Estimate the value of expressions
- Lesson 5: Exponents
- Lesson 6: Square roots and cubic roots

Common Core Coach

- Lesson 1: Understanding rational and irrational numbers
- Lesson 2: Estimating the value of irrational expressions
- Lesson 3: Applying properties of exponents
- Lesson 4: Understanding square and cube roots

On Core Mathematics:

- Lesson 1-5: Rational Numbers
- Lesson 1-6: Irrational Numbers

Closing:

Number line activity (Line up card attachment)
http://www.regentsprep.org/regents/math/algebra/AOP1/Tcards.htm

TOD: Relevant Problem from http://www.kutasoftware.com or similar software

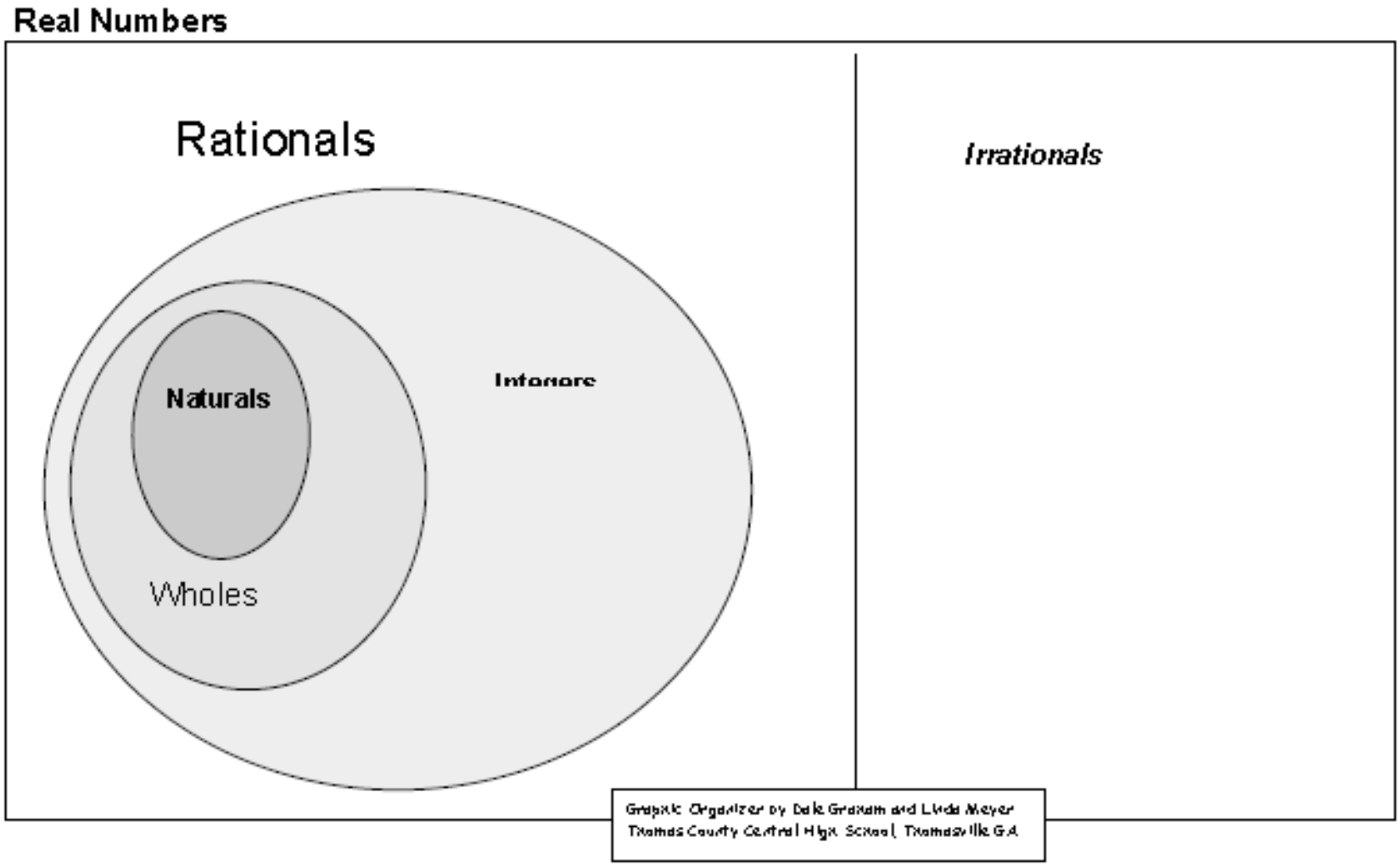
Corresponding Task(s)

Task: Rational or Irrational Reasoning from the State at www.georgiastandards.org

Highlight the Mathematical Practices that this lesson incorporates:

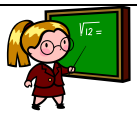
Make sense of problems and persevere in solving them	**Reason abstractly and quantitatively**	**Construct viable arguments and critique the reasoning of others**	**Model with mathematics**	**Use appropriate tools strategically**	**Attend to precision**	**Look for and make sure of structure**	**Look for and express regularity in repeated reasoning**

What are the different types of numbers?



Integers

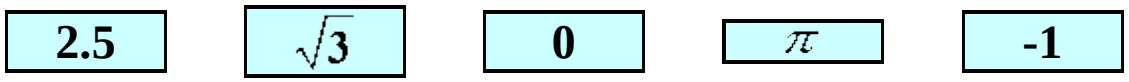
Foldable: Estimating Square Roots

Radicals 

Steps	Estimate	Number Line
	Example #1 $\sqrt{71}$ $\sqrt{64}$ = $\sqrt{71}$ = $\sqrt{81}$ =	
	Example #2 $\sqrt{23}$	
	Example #4 $\sqrt{6}$	
	Example #5 $\sqrt{13}$	
	Example :6 $\sqrt{113}$	

Line Up Cards

Prepare 3x5 cards with a variety of numbers, both rational and irrational.
For example,



Give each student a card and ask the class to arrange themselves around the room in numerical order.
(You may wish to allow students to use their calculators when determining their place in the number line.)

This very quick activity will help students obtain a feeling of how numbers are related to one another. It is particularly valuable in allowing students to see how rational and irrational numbers compare.

There are many additional activities which also utilize these cards:

- Ask all of the students holding "irrational" numbers to move to one side of the room, and all students holding "rational" numbers to move to the opposite side of the room.
- Ask 5 students to stand in the front of the room in numerical order. You, the teacher, holding a card, position yourself in the number line. Ask the class if you are standing in the correct numerical location. This could also be a small quiz or extra credit activity.
- Ask 2 students to stand in the front of the room. Ask the class to determine the size of the interval between the two numerical values.
- Shuffle the cards and ask the students to place themselves in numerical order a second time.
- When the students are lined up in numerical order, ask all of the students to step forward whose number:
  -- is a multiple of 2.
  -- is an irrational number.
  -- is an odd number.
  -- can be expressed as a fraction.
  -- etc.

There are many possibilities -
let your imagination guide you