NEW MEXICO
Public Education Department

8.NS. THE NUMBER SYSTEM

Cluster Statement: A: Know that there are numbers that are not rational and approximate them by rational numbers.

Supporting Cluster (Students should spend the large majority of their time (65-85%) on the major work of the grade/course. Supporting work and, where appropriate, additional work should be connected to and engage students in the major work of the grade.)

Standard Text	**Standard for Mathematical Practices**	**Students who demonstrate understanding can:**
8.NS.A.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.	SMP 2: Students Reason abstractly and quantitatively as they explain how to get more precise approximations of irrational numbers. SMP 6: Students attend to precision by using rational approximations of irrational numbers to compare and locate them on a number line. SMP 7: Students will learn specific characteristics of rational and irrational numbers and use their specific structure to classify them. SMP 8: Students explain how to get more precise rational approximations of irrational numbers.	• Classify numbers as rational or irrational. • Understand that every number has a decimal expansion. • Explain that an irrational number is a decimal that does not terminate or repeat, it cannot be written in the form a/b, where b cannot be equal to zero. • Identify and explain that a rational number of repeats or terminates. • Explain what a rational number is and give examples. • Explain what an irrational number is and give examples. **Webb's Depth of Knowledge:** 1-2 **Bloom's Taxonomy:** Understand
Standard Text	**Standard for Mathematical Practices**	**Students who demonstrate understanding can:**
8.NS.A.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 √2, show that √2 is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations.*	SMP 2: Students Reason abstractly and quantitatively as they explain how to get more precise approximations of irrational numbers. SMP 6: Students attend to precision by using rational approximations of irrational numbers to compare and locate them on a number line. SMP 7: Students will learn specific characteristics of rational and	• Approximate square roots • Plot square roots on the number line. • Express thinking in writing about how to approximate values and locations on a number line. **Webb's Depth of Knowledge:** 1-2

	irrational numbers and use their specific structure to classify them. SMP 8: Students explain how to get more precise rational approximations of irrational numbers.	**Bloom's Taxonomy**: Understand, Apply
Previous Learning Connections • In 5th grade, students learned to round decimals to any place value. In 6th grade, students placed rational numbers on a number line and converted rational numbers to decimals using long division. These skills are needed when understanding irrational numbers.	**Current Learning Connections** • During 8th grade, students will use square root and cube root symbols to encounter irrational numbers.	**Future Learning Connections** • In high school students will extend their knowledge of irrational numbers to complex numbers. They will also use rational exponents.

Clarification Statement:
Expand knowledge of numbers to include irrational numbers. Convert decimals to rational numbers. Use a number line to approximate, compare, and order rational and irrational numbers.

Common Misconceptions

- Students struggle with understanding relationships of the subsets of the Real Number System.
- Some students may think some rational numbers in decimal form repeat three or more digits and students mislabel them as irrational because they do not divide far enough to see the pattern or repeating digits.

Multi-Layered System of Supports (MLSS)/Suggested Instructional Strategies

Pre-Teach

Pre-teach (targeted): *What pre-teaching will prepare students to productively struggle with the mathematics for this cluster within your HQIM?*

- For example, some learners may benefit from targeted pre-teaching that provides additional time for confusion to happen with new mathematical ideas when studying 8NSA, knowing that there are numbers that are not rational, and approximating them by rational numbers because some students have difficulty understanding what irrational numbers are, how they compare to rational numbers, and where they fit in the Real Number system. Providing additional time for students to make sense of the concepts and procedures in multiple ways can help them clarify misconceptions, develop a better understanding, and have fluency when solving problems with irrational numbers.

Pre-teach (intensive): *What critical understandings will prepare students to access the mathematics for this cluster?*

- 7NSA2, Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers. This standard provides a foundation for work with 8NSA, knowing that there are numbers that are not rational, and approximating them by rational numbers because students need a firm foundation in operations with rational numbers in order to apply those operational properties to the irrational numbers. They previously extended their knowledge of fractions to include fractions whose numerator or denominator could be an integer and learned to convert fractions to decimals and vice versa, both skills, which are necessary for students to be able to understand the concept of irrational numbers, identify them, and approximate

them in order to solve problems. If students have unfinished learning within this standard, based on assessment data, consider ways to provide intensive pre-teaching support prior to the start of the unit to ensure students are ready to access grade level instruction and assignments.

Core Instruction

Access

Perception: *How will the learning for students provide multiple formats to reduce barriers to learning, such as providing the same information through different modalities (e.g., through vision, hearing, or touch) and providing information in a format that will allow for adjustability by the user?*

- For example, learners engaging with 8NSA, knowing that there are numbers that are not rational, and approximating them by rational numbers, benefits students when learning experiences ensure information is accessible to learners with sensory and perceptual disabilities, but also easier to access and comprehend for many others such as displaying information in a flexible format to vary perceptual features because students will benefit from creating their own visuals in their INBs as well as viewing videos and referring to anchor charts created during class that include color, font size and language that help clarify concepts and vocabulary.

Build

Effort and Persistence: *How will the learning for students provide options for sustaining effort and persistence?*

- For example, learners engaging with 8NSA, knowing that there are numbers that are not rational, and approximating them by rational numbers, benefit when learning experiences attend to students attention and affect to support sustained effort and concentration such as providing feedback that is frequent, timely, and specific because when students are learning about irrational numbers and trying to connect them to what they are familiar with, it is important that they receive constant feedback about misconceptions and errors as well as validation of what they are understanding and applying correctly. Students also need to be able to ask questions that clarify their understanding. The feedback students receive and the questions we ask them need to be specific to prevent miscommunications that lead to other misunderstandings.

Language and Symbols: *How will the learning for students provide alternative representations to ensure accessibility, clarity and comprehensibility for all learners? (e.g., a graph illustrating the relationship between two variables may be informative to one learner and inaccessible or puzzling to another; picture or image may carry very different meanings for learners from differing cultural or familial backgrounds)*

- For example, learners engaging with 8NSA, knowing that there are numbers that are not rational, and approximating them by rational numbers, benefit when learning experiences attend to the linguistic and nonlinguistic representations of mathematics to ensure clarity can comprehensibility for all learners such as providing graphic symbols with alternative text descriptions because the symbolism in this content is specific, but can be complicated for students. Anchor charts, notes, and other visuals that include the correct symbols and numeric examples along with verbal descriptions can support students with connecting the mathematical language to their everyday language and experiences. Students would also benefit from working with peers to use language, diagrams, numbers and other representations to help them make sense of the connections between the language and vocabulary, the concepts and the symbolic representations. For example, discussing a rational number, what it is explained using decimals, and a numerical example can help students grasp the concept.

Expression and Communication: *How will the learning provide multiple modalities for students to easily express knowledge, ideas, and concepts in the learning environment?*

- For example, learners engaging with 8NSA, knowing that there are numbers that are not rational, and approximating them by rational numbers, benefit when learning experiences attend to the multiple ways students can express knowledge, ideas, and concepts such as providing calculators, graphing calculators, graph paper, or number lines because using these tools help students explore irrational numbers and their approximations and compare them to rational numbers.

Internalize

Comprehension: *How will the learning for student's support transforming accessible information into usable knowledge, knowledge that is accessible for future learning and decision-making?*

- For example, learners engaging with 8NSA, knowing that there are numbers that are not rational, and approximating them by rational numbers, benefit when learning experiences attend to students by intentionally building connections to prior understandings and experiences; relating important information to the learning goals; providing a process for meaning making of new learning; and, applying learning to new contexts such as incorporating explicit opportunities for review and practice because the concept of irrational numbers is hard to grasp initially. Students will benefit from opportunities to explore values such as the square root of 2 as well as practice identifying irrational numbers and approximating them using number lines and other tools.

Re-teach

Re-teach (targeted): *What formative assessment data (e.g., tasks, exit tickets, observations) will help identify content needing to be revisiting during a unit?*

- For example, students may benefit from re-engaging with content during a unit on 8NSA, knowing that there are numbers that are not rational, and approximating them by rational numbers by providing specific feedback to students on their work through a short mini-lesson because providing students specific feedback about what is correct thinking and incorrect thinking based on exit tickets, bell ringer, classwork, etc. will help confirm what they know and provide them feedback and support for areas of struggle.

Re-teach (intensive): *What assessment data will help identify content needing to be revisited for intensive interventions?*

- For example, some students may benefit from intensive extra time during and after a unit 8NSA, knowing that there are numbers that are not rational, and approximating them by rational numbers by addressing conceptual understanding because some students struggle to understand the subsets of the Real Number System displayed in a Venn Diagram and may need to use manipulatives such as boxes that fit inside one another to represent the subsets. Adding examples of numbers in the subsets to the boxes can further help with the concept.

Extension

What type of extension will offer additional challenges to 'broaden' your student's knowledge of the mathematics developed within your HQIM?

- For example, some learners may benefit from an extension such as the application of and development of abstract thinking skills when studying 8NSA, knowing that there are numbers that are not rational, and approximating them by rational numbers because asking them, for example, how many irrational numbers they think are

between 1.4 and 1.5 causes them to apply their new learning to something abstract and think more deeply about the concepts in order to find and explain their solution.

Culturally and Linguistically Responsive Instruction:

Validate/Affirm: How can you design your mathematics classroom to intentionally and purposefully legitimize the home culture and languages of students and reverse the negative stereotypes regarding the mathematical abilities of students of marginalized cultures and languages?
Build/Bridge: How can you create connections between the cultural and linguistic behaviors of your students' home culture and language the culture and language of school mathematics to support students in creating mathematical identities as capable mathematicians that can use mathematics within school and society?

Goal Setting: Setting challenging but attainable goals with students can communicate the belief and expectation that all students can engage with interesting and rigorous mathematical content and achieve in mathematics. Unfortunately, the reverse is also true, when students encounter low expectations through their interactions with adults and the media, they may see little reason to persist in mathematics, which can create a vicious cycle of low expectations and low achievement. For example, when studying to know that there are numbers that are not rational, and approximate them by rational numbers, goal setting is critical because when students know that the expectation for them to learn this standard that it will connect to their future and encourage them to look forward to higher math classes.

Standards Aligned Instructionally Embedded Formative Assessment Resources:

Source:
http://s3.amazonaws.com/illustrativemathematics/attachments/000/008/657/original/public_task_334.pdf?1462388138

8.NS.A.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.

- Learning Target: I can identify rational and irrational numbers.
- Webb's Depth of Knowledge: 1
- The task assumes that students are able to express a given repeating decimal as a fraction.

Task

Decide whether each of the following numbers is rational or irrational. If it is rational, explain how you know.

a. $0.33\overline{3}$

b. $\sqrt{4}$

c. $\sqrt{2} = 1.414213\ldots$

d. 1.414213

e. $\pi = 3.141592\ldots$

f. 11

g. $\frac{1}{7} = 0.\overline{142857}$

h. $12.3456565\overline{656}$

Relevance to families and communities:	**Cross-Curricular Connections:**
During a unit focused on rational and rational numbers, consider options for learning from your families and communities the cultural and linguistic ways this mathematics exists outside of school to create stronger home to school connections for students, for example, learning about the mathematics used within the different careers of your family and community can provide a strong connections between school and careers.	Science: Students can represent their collected data in different forms of rational and irrational numbers.