



Center City
Public Charter Schools

Character, Excellence, Service

8th Grade Mathematics

Unit #1: Becoming an 8th Grade Mathematician

Working with Exponents, Scientific Notation and Rational Numbers

Pacing: 30 Days

Unit Overview

In this unit, 8th grade students will begin the year concentrating on the Number Sense domain by distinguishing between rational and irrational numbers. This concentration will allow for the review and practice of translating between fractions, decimals and perfects, while still introducing new concepts like perfect and imperfect squares and cubes. Aspects of the Expressions and Equations domain will also be used as scientific notation and exponent laws are explored in this unit too. At the end of this unit, students should be able to answer the question “Why is it helpful to write numbers in different ways?” They should also be ready to begin solving equations with variables on both sides, particularly equations with decimal and fraction coefficients. Finally, the first unit of the year is designed to allow ample time for students to practice until perfect their classroom rules, rituals and procedures, as well as opportunities to apply and reflect on the eight mathematical practices.

Prerequisite Skills

- Long division (converting fractions into decimals)
- Use place value to convert decimals into fractions
- Write exponents in standard and expanded form
- Multiplication/division of integers
- Place rational numbers on a number line
- Calculate the area of a square and the volume of a cube ($A = lw$ or s^2 ; $V = lwh$)
- Perform order of operations

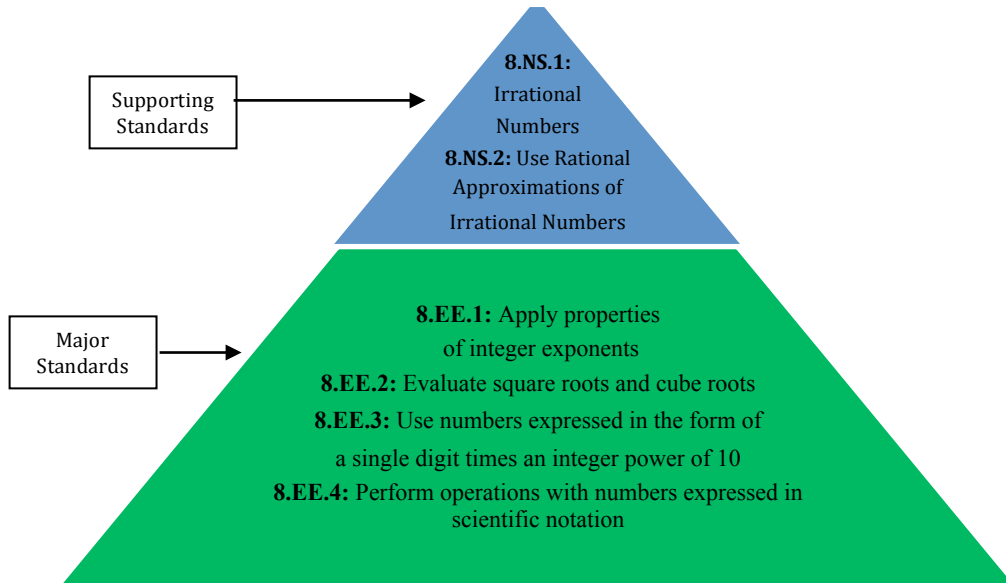
Vocabulary

- Base, exponent, power
- Standard & expanded form
- Perfect square; perfect cube
- Square root; cube root
- Irrational vs. rational vs. real numbers
- Radical sign
- Repeating vs. terminating decimal
- Scientific vs. standard notation;
- Coefficient, product;
- Monomial

Mathematical Practices

- MP.1:** Make sense of problems and persevere in solving them
- MP.2:** Reason abstractly and quantitatively
- MP.3:** Construct viable arguments and critique the reasoning of others
- MP.4:** Model with mathematics
- MP.5:** Use appropriate tools strategically
- MP.6:** Attend to precision
- MP.7:** Look for and make use of structure
- MP.8:** Look for and express regularity in repeated reasoning

Common Core State Standards



According to the PARCC Model Content Framework,

Examples of connecting the mathematical content in this unit to the Mathematical Practices include:

“When students convert a fraction such as $1/7$ to a decimal, they might notice that they are repeating the same calculations and conclude that the decimal repeats. Similarly, by repeatedly checking whether points are on a line through $(1, 2)$ with slope 3, students might abstract the equation of the line in the form $(y - 2)/(x - 1) = 3$. In both examples, students look for and express regularity in repeated reasoning (MP.8).”

“Scientific notation (8.EE.4) presents opportunities for strategically using appropriate tools (MP.5). For example, the computation $(1.73 \times 10^{-4}) \times (1.73 \times 10^{-5})$ can be done quickly with a calculator by squaring 1.73 and then using properties of exponents to determine the exponent of the product by inspection.”

Progression of Skills

7 th Grade	8 th Grade	9 th Grade
N/A	8.EE.1: Know and apply the properties of integer exponents to generate equivalent numerical expressions.	HSN.RN.2: Rewrite expressions involving radicals and rational exponents using the properties of exponents.
N/A	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 a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational.	HSN.RN.1: Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. <i>For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5$ to hold, so $(5^{1/3})^3$ must equal 5.</i>
N/A	8.EE.3: Use numbers expressed in the form of a 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.	
N/A	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. Interpret scientific notation that has been generated by technology	
7.NS.2d: Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats.	8.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.	HSN.RN.3: Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

Big Ideas	Students Will...	
	Know/Understand	Be Able To...
<ul style="list-style-type: none"> • What are the eight mathematical practices and how do mathematicians leverage these practices to better represent and understand mathematical content? • Why is it helpful to write (rational) numbers in different ways? • How and why do we approximate irrational numbers? • How are mathematic laws/properties created? • Why would you want to write a number expressed as a single digit times an integer power of 10 and how might this be useful in real-world situations? In what type of situation would it be easy to compare two numbers written in scientific notation? 	<ul style="list-style-type: none"> • Rational numbers can be written as ratios (fractions, decimals & percents); • Numbers that are not rational are call irrational and can be approximated by rational numbers; • All numbers have a decimal expansion; some are repeating and some terminate (end); • The properties of integer exponents are derived from the patterns made when exponents are used; • There is more than one way to use exponent properties to create equivalent expressions; • Perfect squares and cubes represent the amount of space (area and volume, respectively) inside that shape; • A square root and cube root represent the side lengths of those shapes; • Imperfect squares and cubes are areas/volumes that no whole number can be multiplied by itself $2x$ or $3x$ to get to; • Square roots can be positive or negative, whereas cube roots can only be positive based on integer rules; • Squaring/cubing a number and finding a square/cube root are inverse operations; • Exponent properties can be used to make operations with numbers in scientific notation more efficient; 	<ul style="list-style-type: none"> • Distinguishing between rational and irrational numbers; • Convert fractions into decimals using long division to determine if the number is rational or irrational; • Approximate irrational numbers in order to estimate their value, compare them and locate them on a number line; • Apply the properties of integer exponents to generate equivalent numerical expressions; • Use square/cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$; • Evaluate square roots of small perfect squares and cube roots of mall perfect cubes (integers 1-20); • Use scientific notation to estimate very large or small quantities, and express how many times as much one is than the other; • Perform operations with numbers expressed in scientific notation;

Unit Sequence

	Student Friendly Objective SWBAT...	Key Points/ Teaching Tips	Exit Ticket	Instructional Resources
1	Learn the expectations and practices of an 8 th grade mathematician.	I. Classroom Rituals, Rules, and Procedures <ul style="list-style-type: none"> • Class structure –DO NOW, Fluency Drills, Material Distribution, Organizing binders, notes, etc • Explain how the class vision relates to my personal goals; • Execute classroom procedures and explain their purpose 		Perseverance Activity: http://scienceblogs.com/startswithabang/2009/08/31/paper-folding-to-the-moon/
2		II. Pre-Assessments & Goal Setting <ul style="list-style-type: none"> • Review previous year’s data (strengths/weaknesses) • Fluency pre-assessment • Set individual and class goals 		
3		III. Classroom Culture <ul style="list-style-type: none"> • Get to know your fellow mathematicians • Survey the class (Personality Types, Learning Modality, etc.) • Collect & display survey data 		
4		IV. Writing and Speaking like a Mathematician <ul style="list-style-type: none"> • Accountable talk protocols • Writing mathematical arguments 		
5		V. Investigating and Applying the 8 Mathematical Practices <ul style="list-style-type: none"> • Discuss the power of perseverance (in life and in math) <ul style="list-style-type: none"> ○ “Perseverance activity”: How many folds would it take for this paper to reach the moon? ○ Socratic Discussion: What’s the answer, what were different methods you used to find the answer? <p><i>*Note: Goals IV and V should be accomplished through and with content (i.e. critical 6th/7th grade skills or pre-requisites for this unit, such as converting fractions to decimals)</i></p>		

<p>6 - 7</p>	<p>Use powers and exponents to write large and small numbers; Translate between expressions in expanded and exponential form; Evaluate exponential expressions with variables.</p>	<ul style="list-style-type: none"> • Hook: “What’s the Best Choice? – Genie Task” <ul style="list-style-type: none"> ○ Allow students to struggle through the problem, as they will most likely rely on modeling based on the pattern. After a few minutes of struggling through, allow them to discuss their strategies with peers. ○ Hook them in today’s lesson by explaining that the skills we will learn today will help us tackle problems like this in a more efficient way • Pacing: 2 days • Lesson: Use part I from “A Few Folds” to connect the concept in the hook problem to today’s lesson and to provide students a hands on opportunity to see the resulting patterns of exponents. • Special Case: a number raised to the 0th power = 1 • Closing/Reflection: Revisit Genie Task – allow students to work independently and then with partners/groups as necessary to complete the problem and then explain in writing or through socratic discussion how today’s lesson helped them approach this task 	<p>1) a. Rewrite using exponents: (y) (7) (7) (7) (y)</p> <p>b. Evaluate your expression if $y = \frac{1}{2}$</p> <p>2) Evaluate the expression: $(-\frac{3}{4})^4$</p> <p>3) Tim wrote 16 as $(-2)^4$. Is he correct? Explain</p>	<p>“What’s the Best Choice? – Genie Task” (Appendix C)</p> <p>“A Few Folds” (Appendix C)</p> <p>My Math Chapter 1, Lesson 2 <i>*Provide explicit, procedural instruction as necessary after the Few Folds activity before students use My Math for independent practice</i></p>
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8	Observe patterns in exponent operations to create of laws (shortcuts) to creating equivalent exponential expressions.	<ul style="list-style-type: none"> • Exploratory lesson designed to allow students an opportunity to practice applying MP7 (look for and make use of structure) and MP8 (look for and express regularity in repeated reasoning) • Explicit instruction and practice to follow in tomorrow’s lesson 	Alien Attack Task Socratic Seminar Written Reflection	“Alien Attack” (Appendix C)
9	Write monomials in expanded form and use the associative property to simplify exponential expressions;		<p>1) Simplify: $\frac{5}{x^3} (-4x^6) =$</p> <p>2) Can the following expression be simplified? If so, write an equivalent expression. If not, explain why: $(-4)^2 \cdot 17^5 \cdot (-4)^3 \cdot 17^7 =$</p> <p>3) A rectangular area of land is being sold off in smaller pieces. The total area of the land is 2^{15} square miles. The pieces being sold are 8^3 square miles in size. How many smaller pieces of land can be sold at the stated size? Compute the actual number of pieces.</p>	My Math Chapter 1, Lesson 3

10	Extend the product rule to find powers of monomials; Explain the connection between the Product of Powers law and the Power of Powers law.	<ul style="list-style-type: none"> • For written and discussion-based closing: How does the Product of Powers law apply to finding the power of a power? 	<p>1) $(3^2 \times 7^4)^5 =$</p> <p>2) Show and explain/prove in detail why: $(2 \cdot 3 \cdot 4)^4 = 2^4 3^4 4^4$.</p> <p>3) Sarah wrote that $(3^5)^7 = 3^{12}$. Explain Sarah's mistake and then correct it. Write an exponential expression using a base of 3 and exponents of 5, 7, and 12 that would make her answer correct.</p>	My Math Chapter 1, Lesson 4
11	Write and evaluate expressions using negative exponents; Demonstrate the relationship between positive/negative exponents and very large/small numbers using a graphing calculator.	<ul style="list-style-type: none"> • Exploring Powers of 10: Use graphing calculators to notice patterns from positive to negative exponents (GA Supp. Tasks, p. 47) • For written and discussion-based closing: How are negative exponents and positive exponents related? 	<p>1) What is the value of (3×10^{-5})?</p> <p>2) Write the complete expanded form of the decimal 4.728 in exponential notation.</p> <p>3) Prove that $\left(\frac{7}{5}\right)^{-4} = \frac{7^{-4}}{5^{-4}}$.</p>	My Math Chapter 1, Lesson 5
12	Make sense of and persevere in solving a real world problem. Create viable mathematical arguments and critique the reasoning of others.	<ul style="list-style-type: none"> • Teaching Tip: emphasize MP1 (make sense of problems and persevere in solving them) and MP 3 (create mathematical arguments and critique the reasoning of others); the focus is on student-led problem solving instead of teacher-led modeling • Teaching Tip: Structure the lesson in a way that allows for an appropriate balance between independent and group think time 	<p>Nesting Dolls Task Socratic Seminar Individual Written Reflection</p> <p>Teaching Tip: Debrief the problem through a socratic seminar; after which all students should have an opportunity to solve the problem independently and reflect on their process in writing</p>	"Nesting Dolls" (Appendix C)

13	<p style="text-align: center;">Flex Days (Instruction Based on Data) Recommended Resources:</p> <p style="text-align: center;">My Math Chapter 1 Inquiry Lab (Pages 79 – 80) My Math “Estimate Roots” (Chapter 1 Lesson 9) “Week by Week Essentials – Review Packets:”</p>			
14	<p style="text-align: center;">http://mathlearnnc.sharpschool.com/cms/One.aspx?portalId=4507283&pageId=5149151 “Got Cubes?” (Appendix C) “Engage NY Mid-Module Assessment” (Appendix C) Engage NY Lesson 6 (Appendix C)</p>			
15	Combine different exponent laws to simplify exponential expressions; Create exponential expressions that all simplify to the same monomial		Written Reflection	“Exponential Exponents Performance Task” (Appendix C)
16	Demonstrate and explain how all rational numbers represent division; Determine if a number is a rational number by converting fractions into repeating and terminating decimals.	For written and discussion-based closing: <i>How can you determine if a number is a rational number?</i>	1) Write as a decimal: $\frac{3}{8}$ 2) Write in fraction form: -8.02 3. Explain why any rational number is either a terminating or repeating decimals. Provide examples to support your thinking.	My Math Chapter 1, Lesson 1 https://learnzillion.com/lessons/219-understand-and-apply-the-definition-of-rational-numbers On Level: Enrich A Triangular Line Design (Under Differentiated Tab in My Math)

17	<p>Model perfect squares and cubes and connect the term “perfect square/cube” to a shape’s area/volume and “square/cube root” to the shape’s side length.</p> <p>Calculate the roots of integers and rational numbers.</p>	<ul style="list-style-type: none"> • Discovery Hook: Give students 16 post-its and have them form squares; have them take away a post-it and try to make a square again; have them track which numbers they can make perfect squares with; do the same with building blocks for perfect cube • Fluency: Build students’ familiarity with squares 1-20 and cubes 1-20 • Closing/Reflection: When would I need to use square roots and cube roots? 		My Math Chapter 1, Lesson 8
18	<p>Approximate (estimate) the roots of imperfect squares and cubes using number lines, fractions and calculators.</p>	<ul style="list-style-type: none"> • Below Level: Place imperfect squares on a double-sided number line • On Level/Alg. 1 Extension: Simplify radicals ($\sqrt{32} \rightarrow \sqrt{16 \times 2} \rightarrow 4\sqrt{2}$) • Above Level: Students may estimate square roots to the nearest tenth by applying the following technique: <p><i>Example:</i> Find $\sqrt{27}$. We know that $\sqrt{27}$ falls between 5 and 6 because $\sqrt{27}$ falls between 25 and 36. The difference between 25 and 36 is 11. The difference between 25 and 27 is 2. The fraction two-elevenths is a good approximation for the distance between 5 and $\sqrt{27}$. Since two-elevenths is approximately 0.2, 5.2 is a good approximation for 27. A more precise value is 5.196, but 5.2 is correct to the nearest tenth.</p>	<ol style="list-style-type: none"> 1. Estimate $\sqrt{135}$ to the nearest integer. 2. Approximate $\sqrt{28}$ using a number line and/or the fraction technique 3. Approximate the cube $\sqrt[3]{51}$ using a number line and/or the fraction technique. 4. Simplify $\sqrt{40}$ <p>How can you estimate the square root of a non-perfect square?</p>	My Math Chapter 1, Lesson 9

19	Distinguish between rational and irrational numbers; Explain why the roots of imperfect squares and cubes are irrational; Judge another person's reasoning for strengths and misconceptions about rational and irrational numbers.		<p>Which of the numbers in the list below are irrational?</p> <div style="border: 1px solid black; padding: 5px; display: inline-block;"> $\sqrt{9}, 4\pi, 2.8, -5, 0.1245\dots, \sqrt{8}$ </div>	<p>https://learnzillion.com/lessons/221-distinguish-between-rational-and-irrational-numbers</p> <p>“Real Number Hexagon Chart” (Appendix C)</p> <p>“Real Number Race” (Appendix C)</p> <p>“Robin’s Response” (Appendix C)</p>
20	Compare and order real numbers; Organize the system of real numbers into different Venn diagram configurations.	<ul style="list-style-type: none"> • Guided Practice Activities: Class Number Line & Individualized # Strips • Closing questions for written reflection and discussion: <i>How are real numbers different from irrational numbers?</i> 		<p>My Math Chapter 1, Lesson 10</p> <p>“NC 8th Number Sense Activities” (Appendix C)</p> <p>Resource for Remediation: Repeating Decimals Activity Lab http://map.mathshel1.org/materials/download.php?fileid=1237</p>

21	<p>Make sense of and persevere in solving a real world task that requires me to compare and order real numbers</p>	<ul style="list-style-type: none"> • Teaching Tip: Structure the lesson in a way that allows for an appropriate balance between independent think time and group think time; provide opportunities throughout the lesson for students to stop and reflect on their approach and to share strategies with other groups. Intervene only as necessary to scaffold or address misconceptions 	“Award Show Task”	<p>“Award Show Task” (Appendix C)</p> <p>Resource for Reteach: “Compare Real Numbers” (Differentiation Tab under Chapter 1, Lesson 10)</p>
22	<p>Develop a conceptual understanding of scientific notation through calculator exploration</p> <p>Compare and estimate quantities in the form of a single digit times a power of 10; Explain why it is helpful to write numbers in different ways.</p>	<ul style="list-style-type: none"> • Hook: YouTube video “Power of 10” (highlights different powers of 10) and “Exploring Powers of 10” • This lesson is mostly about building conceptual knowledge; use the EXPONENT LAWS FLUENCY DRILLS at the end of the lesson to bridge previous week’s exponent laws to this week’s work with scientific notation 	Engage NY Exit Ticket	<p>“Exploring Powers of 10” (Appendix C)</p> <p>Engage NY Lesson 8</p>
23	<p>Convert between standard and scientific notation; Describe real-life examples of when scientific notation is more useful than standard form; Make comparisons of the size of numbers expressed in both decimal and scientific notation using the lengths of everyday objects.</p>	<ul style="list-style-type: none"> • Closing reflection question: How is scientific notation useful in the real world? 	<ol style="list-style-type: none"> 1) Write the number 68,127,000,000,000,000 in scientific notation. 2) Convert to standard form: 7.99×10^{32} 	My Math Chapter 1, Lesson 6