Unpacked South Dakota State Mathematics Standards

Purpose: *In order for students to have the best chance of success, standards, assessment, curriculum resources, and instruction must be aligned in focus, coherence, and rigor. Unpacked standards documents are intended to help align instruction to the focus, coherence, and rigor of the South Dakota State Mathematics Standards. The standards have been organized in clusters as they are not so much built from topics, but rather woven out of progressions. Not all content in a given grade is emphasized equally in the mathematics standards. Some clusters require greater emphasis than others based on the depth of the ideas, the time that they take to master, and/or their importance to future mathematics or the demands of college and career readiness. To say that some things have greater emphasis is not to say that anything in the standards can safely be neglected in instruction. Neglecting standards will leave gaps in student skill and understanding and may leave students unprepared for the challenges of a later grade.*

Domain: Expressions and Equations	**Grade Level: 8**

8.EE.A Cluster: Work with radicals and integer exponents.

Explore the properties of exponents, radicals, and scientific notation.

****This is a MAJOR cluster.** *Students should spend the large majority of their time (65-85%) on the major work of the grade. Supporting work and, where appropriate, additional work should be connected to and engage students in the major work of the grade.*

8.EE.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. For example, 3^2× 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 a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes.

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. For example, estimate the population of the United States as 3 times 10^8 and the population of the world as 7 times 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.

Aspects of Rigor: (Conceptual, Procedural, and/or Application)

Conceptual Understanding	***Procedural Fluency***	***Application***
Understand the properties of integer exponents. **(8.EE.1)** **Product of Powers** $a^m \cdot a^n = a^{m+n}$ **Power of a Power** $(a^m)^n = a^{mn}$ **Power of a Product** $(ab)^m = a^m b^m$ **Negative Exponent** $a^{-m} = \frac{1}{a^m}, a \neq 0$ **Zero Exponent** $a^0 = 1, a \neq 0$ **Quotient of Powers** $\frac{a^m}{a^n} = a^{m-n}, a \neq 0$ **Power of a Quotient** $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}, b \neq 0$	Generate equivalent expressions using the single properties of integer exponents and combinations of the properties. **(8.EE.1)**	
Understand that finding a square and	Compute the square root and	

a square root are inverse operations. **(8.EE.2)** Understand that finding a cube and a cube root are inverse operations. (8.EE.A.2) Relate the square and cube root to the geometric shape of a square and cube. (Ex: a square root represents the length of the side of a square). **(8.EE.2)**	the cube root of expressions and equations. **(8.EE.2)**	
Understand that a single digit times an integer power of 10 is the format of scientific notation. **(8.EE.3)** Know how to estimate powers of 10. **(8.EE.3)**	Write large and small numbers in scientific notation. **(8.EE.3)**	Compare the estimations of the powers of 10. **(8.EE.3)**
Understand how to convert between decimal notation (standard form) and scientific notation. **(8.EE.4)** Know how to read scientific notation on a calculator. **(8.EE.4)** Answer: $= 3.564 \times 10^{-5}$ *(scientific notation)* = 3.564e-5 *(scientific e notation)* = 0.00003564 *(real number)*	Add, subtract, multiply, and divide numbers in scientific notation. **(8.EE.4)**	Calculate and choose an appropriate unit of measure when working with decimal notation (standard form) and scientific notation. **(8.EE.4)** Ex: A certain swimming pool contains about 3 x 10^7 teaspoons of water. Choose a more appropriate unit for reporting the volume of water in this swimming pool and convert from teaspoons to your chosen units. **(8.EE.4)**

Enacting the Mathematical Practices - Evidence of Students Engaging in the Practices

1. **Make sense of problems and persevere in solving them.**
2. **Reason abstractly and quantitatively.**
    - Reason the meaning and the magnitude of values expressed with exponents or scientific notation by convincing each other.
3. **Construct viable arguments and critique the reasoning of others.**
    - Justify the properties of exponents (ex: students can explain why they are adding the exponents)
4. **Model with mathematics.**
5. **Use appropriate tools strategically.**
    - Use calculators to read scientific notation correctly.
6. **Attend to precision.**
    - Apply the correct units of measurements. Use appropriate degree of precision (rounding accurately) when computing square and cube roots.
7. **Look for and make use of structure.**
    - Recognize when and how to use each property of exponents and simplify the expression.
8. **Look for and express regularity in repeated reasoning.**
    - Utilize the properties of exponents as a shortcut for repeated multiplication.

Vertical and Horizontal Coherence and Learning Progressions

Previous Learning Connections	***Current Learning Connections***	***Future Learning Connections***
In 5th grade, learners 1. begin to develop and understand the powers of 10 and the placement of the decimal when multiplying or dividing by powers of 10. In 6th grade, learners 1. write and evaluate numerical expressions involving whole-number exponents.	In 8th grade, learners 1. will use square and square roots, cube and cube roots, when working with irrational numbers (number sense) and volume (geometry).	In high school, learners 1. will use properties of exponents to rewrite expressions 2. extend their knowledge of integer exponents to rational exponents.

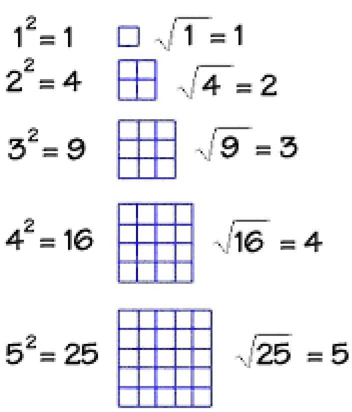
Vocabulary (key terms and definitions)

- Exponent
- Base
- Power
- Radical
- Square
- Square Root
- Cube
- Cube Root
- Scientific Notation
- Standard Form
- Decimal Notation

Relevance, Explanations, and Examples:

8.EE.1: Introduce properties of integer exponents one at a time and let the students discover the properties instead of making them memorize the rules.

8.EE.2: Use geometric representations to understand the connections between squares (area) and square roots (side length).



8.EE.3: Correlate positive exponents to large numbers and negative exponents to small numbers.

8.EE.4: Explore scientific notation on a variety of calculators (ex: scientific calculator, graphing calculator, phone calculator, online calculators). The testing calculator used on the smarter balanced testing as of June 2018: https://www.desmos.com/testing/southdakota/scientific

Achievement Level Descriptors	
Cluster: **Work with radicals and integer exponents.**	
Concepts and Procedures	***Level 1:*** Students should be able to calculate the square of integers and identify and calculate square roots of familiar perfect squares. They should be able to translate between standard form and scientific notation.
	Level 2:. Students should be able to work with and apply the properties of integer exponents of degree 2 or less in order to produce or identify equivalent numerical expressions. They should be able to calculate the cube of integers and identify and calculate the cube root of familiar perfect cubes. They should be able to use appropriate tools (e.g., calculator, pencil and paper) to translate large or small numbers between scientific notation and standard form.
	Level 3: Students should be able to apply the properties of integer exponents in order to produce or identify equivalent numerical expressions to any integer degree. They should be able to identify that the square root of 2 is irrational, calculate or approximate to an appropriate degree of precision the square root or cube root of a rational number, solve quadratic and cubic monomial equations (ex: $x^2 = 25$), and represent the solution as a square or cube root, respectively. They should be able to work with and perform operations with scientific notation.
	Level 4: Students should be able to use scientific notation and choose units of appropriate size for realistic measurements, solve binomial quadratic (ex: $x^2 + 1 = 10$) and cubic equations, and represent the solution as a square or cube root, respectively.