NEW MEXICO
Public Education Department

8.EE: EXPRESSIONS & EQUATIONS

Cluster Statement: A: Expressions and Equations Work with radicals and integer exponents.

Major 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.EE.A.1: Know and apply the properties of integer exponents to generate equivalent numerical expressions. *For example,* $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$.	SMP 2: Students reason abstractly and quantitatively when expressing size comparisons of numbers written in scientific notation. SMP 5: Students use appropriate tools strategically when learning to read and use scientific notation. SMP 6: Students attend to precision by calculating accurately and efficiently, and accurately express number in scientific notation.	• Calculate integer exponents by understanding their properties. • Generate equivalent expressions using the single properties of integer exponents and combinations of the properties. **Webb's Depth of Knowledge:** 1 **Bloom's Taxonomy:** Apply
Standard Text	**Standard for Mathematical Practices**	**Students who demonstrate understanding can:**
8.EE.A.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 √2 is irrational.	SMP 8: Students look for and express regularity in repeated reasoning by using square root and cube root symbols to represent solutions to equations of the form x 2 (x squared)= p and x 3 (x cubed) = p, where p is a positive rational number. Students valuate square roots of small perfect squares and cube roots of small perfect cubes. Students now that √2 is irrational.	• Calculate a square root of a perfect squared number or cube root of a perfect cube root number. • Use the square root and cube root symbol in an equation x2(x squared) =p or x3(x cubed) =p. • Explain square root of 2 is an irrational number. **Webb's Depth of Knowledge:** 1-2 **Bloom's Taxonomy:** Application

<table>
<tr>
<td rowspan="2">Standard Text

8.EE.A.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.</td>
<td rowspan="2">Standard for Mathematical Practices

SMP 2: Students reason abstractly and quantitatively when expressing size comparisons of numbers written in scientific notation.

SMP 5: Students use appropriate tools strategically when learning to read and use scientific notation. Common Core Mathematics Companion: The Standards Decoded, Ruth Harbin Miles and Lois A Williams

SMP 6: Students attend to precision by calculating accurately and efficiently, and accurately express number in scientific notation.</td>
<td>Students who demonstrate understanding can:
• Explain the benefits of scientific notation.
• Write very small or very big numbers in 'scientific notation.
• Understand that some numbers written in scientific notation are estimates.
• Compare very small or very big numbers written in scientific notation to determine which is larger or smaller and by how much.</td>
</tr>
<tr>
<td>Webb’s Depth of Knowledge: 1-2

Bloom’s Taxonomy:
Application, Analysis</td>
</tr>
<tr>
<td>Standard Text

8.EE.A.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.</td>
<td>Standard for Mathematical Practices

SMP2:
Students use numbers and exponents flexibly and interpret their results in context (MP2).

SMP4:
Students practice modeling skills, such as identifying essential features of a problem and gathering the required information (MP4).

SMP.6
Students will calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context.</td>
<td>Students who demonstrate understanding can:
• Add, subtract, multiply or divide numbers written in scientific notation.
• Assess the appropriate size for measurement written in scientific notation.

Webb’s Depth of Knowledge: 1,3

Bloom’s Taxonomy: evaluation, application</td>
</tr>
<tr>
<td><u>Previous Learning Connections</u>
• In 5th grade, students began 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,</td>
<td><u>Current Learning Connections</u>
• In 8th grade, students will connect the properties learned in this cluster to use square and square roots, cube and cube roots, when working with irrational numbers (NS</td>
<td><u>Future Learning Connections</u>
• In high school, learners will use properties of exponents to rewrite expressions and extend their knowledge of integer exponents to rational exponents.</td>
</tr>
</table>

students continued to write and evaluate numerical expressions involving whole-number exponents.	standards) and volume (geometry standards).	

Clarification Statement:
In this cluster, students explore the properties of exponents, radicals, and scientific notation.

Common Misconceptions

- Students may confuse the rules, which usually occurs when they are taught to memorize them rather than understand them. Students may also think that finding a power of a power involves adding exponents.
- Students may confuse the relationship between division and negative exponents or forget about the order or operations.
- Some students may confuse square roots and cubes. Some might divide by 2 or 3 instead of finding the square root or cube respectively Some students fail to recognize the relationship between square numbers and area or between cube numbers and volume.
- Some students may forget that correct scientific notation requires that the first factor be written with only one digit to the left of the decimal. Some may struggle to understand which number should be divided when expressing how many times as much one number is than the other. Students may struggle if they add exponents that should be subtracted. Students can confuse the direction to move the decimal point when the exponent is negative.

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 rehearses prior learning when studying expressions and equations that include radicals and exponents because connections can be formed to prior knowledge of writing and evaluating numerical expressions as students struggle, for example, to determine what a number to the 0 power might be based on what they previously know about powers. Or students may use prior knowledge to determine what 6^3* 6^4might be and explain their thinking. This can be a great lead into showing, in expanded form, WHY the answer is 6^7. This can work as a lead-in to division of powers or into discovery of the rules of exponents rather than just giving students the exponent rules. It is necessary for students to have a grasp of how to write and evaluate powers in order to move on to understanding the concepts behind multiplying and dividing by powers, negative powers, and powers of zero.

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

- 6.EE.A.1 This standard provides a foundation for work with applying and extending previous understanding of arithmetic to algebraic expressions because students must understand how to write and evaluate numerical expressions using exponents. They must understand the difference between multiplying 3 * 4 and evaluating 3^4 in order to write equivalent expressions and evaluate expressions and equations involving powers. Students also need to understand the concept of repeated multiplication applied to powers for that knowledge to be transferred to repeated division being written as powers with negative exponents or as fractions with a numerator of 1 and a power in the denominator. These understandings of repeated multiplication and division and the use of structure in the repeated patterns can help students understand the concept of all numbers to the power of 0 equaling to 1.

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 how expressions and equations work with numbers involving radicals and integer exponents benefit 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 by displaying really small or really large objects in flexible formats to vary perceptual features by providing multiple representations of the information and relationships in tables, graphs, diagrams, videos, and through the use of physical exploration (stacking or counting pennies and using smaller knowns of height or weight to explore relationships with much larger amounts) because students may not grasp the concept with one mode of representation, but may understand another. Further understanding can be reached by forming relationships between and showing connections to other representations.

Build

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

- For example, learners engaging with how expressions and equations work with numbers involving radicals and integer exponents benefit when learning experiences attend to students attention and affect to support sustained effort and concentration such as providing feedback that models how to incorporate evaluation, including identifying patterns of errors and wrong answers, into positive strategies for future success because comprehending and working with very large or small numbers is difficult. Students need constant feedback from peers and teachers. Through collaboration, students will develop a deeper understanding by sharing and analyzing strategies, making connections between errors and correct thinking, will receive validation of thinking and strategies, and increase their overall skills and understanding of how to read and write these numbers, why the various notations are helpful, and how to solve problems using them.

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 how expressions and equations work with numbers involving radicals and integer exponents benefit when learning experiences attend to the linguistic and nonlinguistic representations of mathematics to ensure clarity can comprehensibility for all learners such as presenting key concepts in one form of symbolic representation (e.g., math equation) with an alternative form (e.g., an illustration, diagram, table, photograph, animation, physical or virtual manipulative)because making connections between familiar values and new forms of numerical notation is difficult but necessary. Also, making connections between familiar calculations involving familiar number notations and calculations with values in radical or exponential notation will support students' grasp of the concept and skills involved in working with equations and expressions with these types of numbers. Anchor charts, diagrams, media sources, et al that explicitly show the connections between familiar numerical forms, the new notation, verbal descriptions, and vocabulary terms will

support students development of the concepts and their ability to apply familiar computations when using exponential and radical notations.

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 Expressions and Equations Work with radicals and integer exponents benefit when learning experiences attend to the multiple ways' students can express knowledge, ideas, and concepts such as providing differentiated feedback (e.g., feedback that is accessible because it can be customized to individual learners) because some students need more explicit feedback while others do not. Each individual student progresses differently and by showing them that they are individuals, they are more likely to take the feedback as encouragement than criticism.

Internalize

Self-Regulation: *How will the design of the learning strategically support students to effectively cope and engage with the environment?*

- For example, learners engaging with Expressions and Equations Work with radicals and integer exponents benefit when learning experiences set personal goals that increase ownership of learning goals and support healthy responses and interactions (e.g., learning from mistakes), such as addressing subject specific phobias and judgments of "natural" aptitude (e.g., "how can I improve on the areas I am struggling in?" rather than "I am not good at math") because self-talk is the most powerful downer and upper for any individual. This will boost the students' self-esteem and will have the can-do attitude and persevere not just in Math but also in other content areas.

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 expressions and equations that include radicals and exponents by critiquing student approaches/solutions to make connections through a short mini-lesson because through analysis and sharing of student work on a bell ringer or exit ticket, misconceptions and common errors can be identified, corrected and valued in a safe and meaningful way that strengthens student learning, students will receive validation of their thinking , and students may gain a better understanding through the language and visuals provided by their peers. The mini lesson can be followed up with practice specifically geared toward correction of the misunderstanding or skill.

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 on expressions and equations that include radicals and exponents by offering opportunities to understand and explore different strategies because working with radicals, cubed and square roots, numbers in scientific notation and powers can be complicated. Students need opportunities to compare numbers written differently to gain an understanding of relative sizes written in forms they are unfamiliar with. Students need opportunities to talk about their strategies and thinking and to understand the notations and conversions and how they apply their understanding to solve problems.

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 open-ended tasks linking multiple disciplines when studying expressions and equations work with radical and integer exponents because different exposure to this concept will lead to better appreciation and understanding of the mathematics.

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?

Eliciting and Using Evidence of Student Thinking: Eliciting and using student thinking can promote a classroom culture in which mistakes or errors are viewed as opportunities for learning. When student thinking is at the center of classroom activity, "it is more likely that students who have felt evaluated or judged in their past mathematical experiences will make meaningful contributions to the classroom over time." For example, when studying expression and equations work with radicals and integer exponents eliciting and using student thinking is critical because this standard is foundational to their future math concepts and other core subjects. When students are given an opportunity to present their process/solution with their own way of solving, empowers the students to take risks in the future and move forward with their learning.

Standards Aligned Instructionally Embedded Formative Assessment Resources:
Source: Cognia Formative Item Set for Grade 8 Expressions and Equations

8.EE.A.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. For example, $32 \times 3^{-5} = 3^{-3} = 1/33 = 1/27$.

- Learning Target: I can generate equivalent expressions from whole number and fractions using integer exponents.
- Webb's Depth of Knowledge: 2

Which of the following is equivalent to the expression $\frac{1}{9} \cdot 27$?

Ⓐ $3^{-2} \cdot 3^{-3}$
● $3^{-2} \cdot 3^{3}$
Ⓒ $3^{2} \cdot 3^{-3}$
Ⓓ $3^{2} \cdot 3^{3}$

Relevance to families and communities:

During a unit focused on working with radicals and integer exponents, 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 by having students learn about the mathematics used within the different careers of their

Cross-Curricular Connections:

Science - Distance of planets from the sun

family members and community. Students can also research careers, mathematicians, or people influential in their culture and the ways they use math or have contributed to the field.	