New Mexico Instructional S
Algebra 1 Arithmetic with Polynomial
Rational Expressions G

The purpose of this tool is to help educators understand each of the grade level standards and how those standards connect to the students' overall preparation for college and career readiness.

The NMIS is a teacher-influenced tool, designed to provide instructional planning support at the programmatic level for districts and instructional level for teachers. Its foundation stems from the vision and mission of the PED and came into existence to assure that students in NM will be engaged in a culturally and linguistically responsive educational system that meets the social, emotional, and academic needs of ALL students. This is also rooted in the belief that all students must have access to on-grade-level standards, focusing on acceleration. The purpose of this tool is to help educators understand each of the grade level standards and how those standards connect to the students' overall preparation for college and career readiness.

Standards are defined as the most critical prerequisite skills and knowledge. This document is color-coded to reflect both anchor and priority standards. Though previous emphasis was placed on priority standards to address lost learning due to COVID-19, New Mexico teachers should note that moving forward, while priority standards allow for acceleration of learning, **all** standards should be addressed in instruction throughout the school year.

In this guide you will find:

- A breakdown of each of the grade level standards within the cluster, including:
  - Standards of Mathematical Practice
  - Common Misconceptions
  - Identification of Priority Standards, as identified by NMPED.
  - Level of Rigor Identification
- Sample aligned assessment items
- Suggested Student Discourse Guide
- A multilayered system of supports (MLSS) and culturally and linguistically responsive instruction (CLR) guide

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Key		
	Priority Standard	Priority standards, as identified by NMPED, are denoted with red highlighting. Priority standards are the most critical prerequisite skills and knowledge a student needs. This does not mean that these are only standards required to be taught, just these are the standards that will allow for the acceleration the students of New Mexico need during this time.
	*Conceptual Understanding*	Conceptual Understanding standards help students build a deep understanding of the **how** and **why** of mathematics.
	*Application*	Application standards help students identify the appropriate concepts and skills to tackle **novel real-world problems.**
	*Procedural Skill and Fluency*	Procedural standards help students develop **efficiency** and **accuracy** in computations.

Standards Breakdown

- Perform arithmetic operations on polynomials.
  - HSA.APR.A.1

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Grade	*CCSS Domain*	*CCSS Cluster*
A1	Arithmetic with Polynomials Rational Expressions	Perform arithmetic operations on polynomia

Cluster Standard: HSA.APR.A.1

Standard	Standards for Mathematical Practice
Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.	• **SMP5**: Use appropriate tools strategically.. • **SMP7**: Look for and make use of structure.

Clarification Statement	Students Who Demonstrate Understanding Can...
• The development of polynomials and rational expressions in high school parallels the development of numbers in elementary and middle grades. In elementary school, students might initially see expressions for the same numbers 8 + 3 and 11, or 3/4 and 0.75, as referring to different entities: 8 + 3 might be seen as describing a calculation and 11 is its answer; 3/4 is a fraction and 0.75 is a decimal. They come to understand that these different expressions are different names for the same numbers, that properties of operations allow numbers to be written in different but equivalent forms, and that all of these numbers can be represented as points on the number line. In middle grades, they come to see numbers as forming a unified system, the number system, still represented by points on the number line. The whole numbers expand to the integers—with extensions of addition, subtraction, multiplication, and division, and their properties. Fractions expand to the rational numbers—and the four operations and their properties are extended. A similar evolution takes place in algebra. At first algebraic expressions are simply numbers in which one or more letters are used to stand for a number which is either unspecified or unknown. Students learn to use the properties of operations to write expressions in different but	• Define ‘closure’ in terms of mathematical properties and operations. • Identify that the sum, difference, or product of two polynomials will always be a polynomial, which means polynomials are closed under addition, subtraction, and multiplication (but not division). • Apply arithmetic operations of add, subtract, and multiply multi-variable polynomials of any degree.

equivalent forms. At some point they see equivalent expressions, particularly polynomial and rational expressions, as naming some underlying thing.	
DOK	**Blooms**
1	Remember, Understand

Common Misconceptions

- Students might think polynomials are only monomial, binomial, or trinomial.
- Students may confuse the impact of adding and subtracting polynomials on the degree of the variable.
- Students may not fully distribute the multiplication of polynomials when applying the distributive property or squaring a binomial, and only multiply like terms.
- When adding and multiplying like terms, students may initially confuse $x + x$ as x^2 instead of $2x$, or $x \cdot x$ as $2x$ instead of x^2.
- Students may not think $x^2 \bullet x = x^3$ is not an example of closure for polynomial multiplication since the result has a different exponent than the factors.

Student Discourse Guide

- Purposeful, rich classroom discourse offers students the opportunity to express their ideas, thi critique the reasoning of others in a variety of ways (writing, drawing, verbal). Purposeful imple classroom discourse allows students to activate funds of knowledge and to refine their mathematical understanding. When students have frequent opportunities for discourse they find various path and reveal knowledge or misunderstandings to educators. The process also allows educators to see students' culture, lived experiences and evolving math identities.
- Discourse that focuses on tasks that promote reasoning, and problem solving is a primary mec developing conceptual understanding and meaningful learning across (Michaels, O'Connor, and Resnick, 2008)

Domain: Arithmetic with Polynomials & Rationa Expressions	Strand: Perform arithmetic operations on polynom

Suggested Student Discourse Questions

• What is the name of a polynomial with two • When you multiply polynomials what do yo with the exponents?	• Have students critique each other's work. (Approaches/Strategies) • A new bakery offers decorated sheet cakes children's birthday parties and other special occasions. The bakery wants the volume of cake to be 351 cubic inches. The cake is in shape of a rectangular solid. They want the of the cake to be four inches longer than th width of the cake and the height of the cake to b one-third of the width. What should the dimensions of the cake pan be?

ASSESSMENT GUIDE

- Perform arithmetic operations on polynomials.

Grade	*CCSS Domain*	*CCSS Strand*
A1	Arithmetic with Polynomials & Rational Expressions	Perform arithmetic operations on polynomia

Sample Task #1 (Constructed Response)

$$(x^2y-3y^2+5xy^2)-(-x^2y+3xy^2-3y^2)$$

Write an equivalent expression to the one above.

SAT, #18093 (Modified)

Sample Task #2 (Multiple Choice)

$(ax+3)(5x^2-bx+4)=20x^3-9x^2-2x+12$

The equation above is true for all x, where a and b are constants. What is the value of ab ?

A. 18

B. 20

C. 24

D. 40

Rationale

Choice C is correct. If the equation is true for all x, then the expressions on both sides of the equation will be equivalent. Multiplying the polynomials on the left-hand side of the equation gives $5ax^3-abx^2+4ax+15x^2-3bx+12$. On the right-hand side of the equation, the only x^2-term is $-9x^2$. Since the expressions on both sides of the equation are equivalent, it follows that $-abx^2+15x^2=-9x^2$, which can be rewritten as $(-ab+15)x^2=-9x^2$. Therefore, $-ab+15=-9$, which gives $ab=24$.

Choice A is incorrect. If $ab=18$, then the coefficient of x^2 on the left-hand side of the equation would be $-18+15=-3$, which doesn't equal the coefficient of x^2, -9, on the right-hand side. Choice B is incorrect. If $ab=20$, then the coefficient of x^2 on the left-hand side of the equation would be $-20+15=-5$, which doesn't equal the coefficient of x^2, -9, on the right-hand side. Choice D is incorrect. If $ab=40$, then the coefficient of x^2 on the left-hand side of the equation would be $-40+15=-25$, which doesn't equal the coefficient of x^2, -9, on the right-hand side.

SAT, #5207088

MLSS AND CLR GUIDE

- Perform arithmetic operations on polynomials

CCSS Domain	*CCSS Cluster*
Arithmetic with Polynomials and Ratio Expressions	Perform arithmetic operations on polynomials

Culturally and Linguistically Responsive Instruction

Relevance to Families and Communities	During a unit focused on understanding that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication, consider options for learning from your families and communities the cultural and linguistic ways mathematics exists outside of school

	to create stronger home to school connections for students. For example, discuss how their family culture celebrates an event. Use that event to show some elements of each families' celebration may be similar and different but each is valid and link it to learning. Some students may need to use area models, some may need colored pencils, some students may prefer to add horizontally, and some will prefer to add vertically. Although we learn in different ways, our learning is valid.	
Cross-Curricular Connections	Industrial Arts: Often construction makes use of multiplying polynomials in deciding how to design various aspects of a house or office to fit a predetermined area. Consider providing a connection for students to design something like a sliding door given a specific frame to height ratio and surrounding framework and then substituting in to find the total area for different input values. Art: Often students like to "play" with manipulatives. Consider having students make a work of art using algebra tiles and then create a polynomial expression to represent their artwork.	
Validate/Affirm/Build/Bridge	• *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?* • *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*	• Building Procedural Fluency from Conceptual Understanding: Instruction should build from conceptual understanding to allow students opportunities to make meaning of mathematics before focusing on procedures. When new learning begins with procedures it hinders those with strong prior familiarity with school mathematics procedures for solving problems and does not allow learning to build for more methods for solving tasks that occur outside of school mathematics. For example, when understanding that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; adding, subtracting, and multiplying polynomials. These types of mathematical tasks are critical because students need to build procedural fluency and their conceptual understanding. Students need to understand conceptually like terms, how and why the result of adding and multiplying polynomials is different, how multiplying polynomials is connected to an area model, and how adding polynomials connects to a linear model like perimeter. Algebra tiles, area models, and tasks involving perimeter and area will help students build conceptual understanding while improving their procedural fluency.

	creating mathematical identities as capable mathematicians that can use mathematics within school and society?	

Planning for Multi-Layered System of Supports

Vertical Alignment

Previous Learning	*Current Learning*	*Future Learning*
• Connect to combining like terms and simplifying expressions using the distributive property **(6.EE.3)**	• Connect to using the properties of operations to write expressions in different but equivalent forms. **(HSA.SSE.A.2)**	• Connect to dividing polynomials. **(HSA.APR.2-3)** • Connect to performing operations with rational expressions. **(HSA.APR.7)**

Suggested Instructional Strategies

Pre-Teach

Level of Intensity	*Essential Question*	*Examples*
Targeted	*What pre-teaching will prepare students to productively struggle with the mathematics for this cluster within your HQIM?*	Some learners may benefit from targeted pre-teaching when performing arithmetic operations on polynomials, understanding the relationship between zeros and factors of polynomials, using polynomial identities to solve problems and rewriting rational expressions. Students may have unfinished learning when identifying and combining like terms, understanding the relationship between a zero and a factor, and division of numerical expressions. Students need to understand the connection between numerical and variable expressions. Also, students may have unfinished learning on identifying the parts, such as, coefficient, variable, constant of a variable expression and would benefit from targeted pre-teaching.
Intensive	*What critical understandings will*	6.EE.A.4 provides a foundation for work with performing arithmetic operations of polynomials because students

	prepare students to access the mathematics for this cluster?	learned to identify two expressions as equivalent written in the form y + y + y and 3y by substituting a fixed value for y. Students should use this same reasoning to add and subtract polynomials. 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.

Universal Support Framework

A student should know/understand...	A student should be able to do...	***Potential Scaffolds***

• Different forms of an expression can be equivalent and are useful in different contexts.
• The addition, subtraction, or multiplication of polynomials results in another polynomial.
• When a situation and its potential constraints will be represented by a linear or quadratic, or exponential equation/inequality or a system of those equations/inequalities.
• The relationship between solutions of equations/ inequalities and their graphical representations.
	• Use the structure of an expression and the properties of mathematics to rewrite it in a different form.
	• Perform the operations of addition, subtraction, and multiplication with polynomials.
	• Determine reasonable solutions based on the context of real-world problems from graphs of equations/inequalities and systems of equations/inequalities.
	• Use the properties of mathematics to solve linear and quadratic
		• Build on students' experience with the following skills:
		  ○ Connect to identifying and interpreting slope and *y*-intercept for linear representations. (8.F.3-4)
		  ○ Connect to rewriting standard linear equation to slope intercept form for systems of equations. (8.EE.8)
		  ○ Connect to knowing and apply the properties of integer exponents to generate equivalent, simplified numerical expressions using the properties of exponents. (8.A.1)
		  ○ Connect to combining like terms and simplifying expressions using the distributive property (6.EE.3)
		  ○ Connect to creating and solving equations in one variable. (7.EE.4)
		  ○ Connect to reasoning with inequalities. (7.EE.4)
		  ○ Connect to solving real world problems involving two linear equations in two variables. (8.EE.8)
		• Cognitive Strategies
		  ○ Repeatedly model the strategies
		  ○ Monitor the students' use of the strategies
		  ○ Provide feedback to students
		  ○ Teach self-questioning and self-monitoring strategies

	equations/inequalities and systems of those equations/inequalities.	○ Introduce multiple means of representation for mathematical ideas ● Encourage students to use alternative tools to better access the grade level content. Examples include: ⊄ Desmos graphing calculator ⊄ Algebra tiles ⊄ Graphic Organizers ⊄ Sketch graph ⊄ Create table of values

Re-Teach		
Level of Intensity	***Essential Question***	***Examples***
Targeted	What formative assessment data (e.g., tasks, exit tickets, observations) will help identify content needing to be revisited during a unit?	For example, students may benefit from re-engaging with content during a unit on performing arithmetic operations on polynomials, by examining tasks from a different perspective through a short mini-lesson because students need to understand the parts of the expression that are related to the outcome (i.e. Sum, difference, product, quotient). Given the outcome and one of its parts, students can find the other part. Example: (4x + 6) + ? = 8x -10
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 performing arithmetic operations on polynomials by offering opportunities to understand and explore different strategies because some students may need support strategies, such as using colored pencils to color code like terms, using algebra tiles to perform operations on polynomials, or the use of calculators to assist in the adding or subtracting of integers.

Extension	
Essential Question	***Examples***

What type of extension will offer additional challenges to 'broaden' your student's knowledge of the mathematics developed within your HQIM?	Some learners may benefit from an extension performing arithmetic operations on polynomials because students need to expand their algebraic thinking to gain a deeper understanding of polynomials by generating their own equivalent expressions. Students' understanding of integer sums, differences, products and quotients will be reinforced when students are asked to use reasoning to generate their own equivalent expressions.