New Mexico Instructional Scope

Algebra 2 Linear, Quadratic, and Exponential Models Guide

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

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

- Construct and compare linear, quadratic, and exponential models and solve problems.
  - HSF.LE.A.4

Grade	CCSS Domain	CCSS Cluster
A2	Linear, Quadratic, & Exponential Models	Construct and compare linear, quadratic, and exponential models and solve problems

Cluster Standard: HSF.LE.A.4

Standard	Standards for Mathematical Practice
For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.	• **SMP 4:** Model with mathematics. • **SMP 7:** Look for and make use of structure.
Clarification Statement	**Students Who Demonstrate Understanding Can...**
• Students will be able to go back and forth between an exponential model and logarithmic model and know when one model may be more useful than another one to solve problems in context.	• Use the properties of logs. • Describe the key features of logs. • Use logarithmic form to solve exponential models.
DOK	**Blooms**
1-2	Understand, Apply

Common Misconceptions

- Students may mix-up direction of term with value of exponents.

Student Discourse Guide

- **Purposeful, rich classroom discourse offers students the opportunity to express their ideas, thinking, and to critique the reasoning of others in a variety of ways (writing, drawing, verbal). Purposeful implementation of 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 paths to solutions and reveal knowledge or misunderstandings to educators. The process also allows educators to honor students' culture, lived experiences and evolving math identities.**
- **Discourse that focuses on tasks that promote reasoning and problem solving is a primary mechanism for developing conceptual understanding and meaningful learning of mathematics (Michaels, O'Connor, and Resnick, 2008)**

Domain: **Linear, Quadratic & Exponential Models**	Strand: **Construct and compare linear, quadratic, and exponential models and solve problems**

Suggested Student Discourse Questions

- How are rates of change different in linear, quadratic and exponential models?
- Talk to your peer about which math tool (TI calculator, Desmos, etc.) works best for them. How does their strategy compare to yours?
- In what ways can we use technology (TI calculators, Desmos, etc.) to solve this logarithmic equation?
- Which model (linear, quadratic, exponential) would be best used to model _____?

ASSESSMENT GUIDE

- Construct and compare linear, quadratic, and exponential models and solve problems

Grade	*CCSS Domain*	*CCSS Strand*
A2	Linear, Quadratic, & Exponential Models	Construct and compare linear, quadratic, and exponential models and solve problems
	Sample Task #1 (Constructed Response)	
	Standards Aligned Instructionally Embedded Formative Assessment Resources: http://tasks.illustrativemathematics.org/content-standards/HSF/LE/A/tasks/213 This type of assessment question requires students to analyze and compare two exponential functions. Students will engage with SMP7 as they use the structure of the exponential function to analyze a scenario and, if allowed use of technology, SMP5 as they use graphs to reason their solutions.	

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MLSS AND CLR GUIDE

- Construct and compare linear, quadratic, and exponential models and solve problems

CCSS Domain	*CCSS Cluster*
Linear, Quadratic, and Exponential Models	Construct and compare linear, quadratic, and exponential models and solve problems

Culturally and Linguistically Responsive Instruction

Relevance to Families and Communities	During a unit focused on constructing and comparing linear, quadratic and exponential models and using them to solve problems, 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, collecting/researching a socially relevant data set to fit with a mathematical model. This context allows students to reason with and discuss mathematics but also provides a purpose and drives engagement.	
Cross-Curricular Connections	Many of the Navajo rug designs you will discover by following the project will be good examples of symmetrical balance. Symmetrical balance is a type of visual balance where the overall composition is arranged to look like it is the same on both sides of the center of the design. In other words, it is a design which could be folded in half, and as the design folds, each part of the design would match up with its symmetrical counterpart on the opposite side of the center. The rug design on the right is symmetrical left-to-right. If a line was drawn vertically down the center of the rug, the arrangement of shapes and colors would appear to be exactly the opposite of each other on both sides of that line. http://web.archive.org/web/20080130134231/http:/www.mpsaz.org/arts/elements/balance/page1.html	
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*	• Task: When planning with your HQIM consider how to modify tasks to represent the prior experiences, culture, language and interests of your students to "portray mathematics as useful and important in students' lives and promote students' lived experiences as important in mathematics class." Tasks can also be designed to "promote social justice [to] engage students in using mathematics to understand and eradicate social inequities (Gutstein 2006)." For example, when constructing and comparing linear, quadratic and exponential models

	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 creating mathematical identities as capable mathematicians that can use mathematics within school and society?*	and using them to solve problems, the types of mathematical tasks are critical because this is a golden opportunity to show the relevance and usefulness of mathematics, whether it relates to sports, careers, social data, etc. Every student can find a use for this mathematics given the proper context.

Planning for Multi-Layered System of Supports

Vertical Alignment

Previous Learning	*Current Learning*	*Future Learning*
• In 8th grade and Algebra 1, students learned about exponential models.	• Students will use this knowledge to solve more complex logarithmic problems that include the use of logarithmic properties	• Students will build on this knowledge of exponents and logarithms in future math courses.

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 that addresses constructing and comparing linear, quadratic and exponential models and using them to solve problems because these are all function families that should have been previously studied. Students,

		therefore, may be able to spark each other's memory about the shapes of graphs, patterns in numbers and/or forms of equations.
Intensive	*What critical understandings will prepare students to access the mathematics for this cluster?*	8.F.B4/F.BF.A2: This standard provides a foundation for work with constructing and comparing linear, quadratic and exponential models and using them to solve problem because the 8th grade standard addresses students modeling linear data with linear functions and the high school standard addresses when students build a function to model arithmetic and geometric sequences. 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***

• What the domain of a function represents in terms of the function and what values are appropriate (i.e. discrete v. continuous values and other restrictions based on the type of function and the given context).
• In functions there is an underlying structure that determines the transformation of any function, regardless of its type.
• How to use trigonometric ratios, reference angles, and symmetry to find patterns on the unit circle.
	• Find and interpret key features of a graph or table of a function, including extreme values, end behavior, and intervals of increase and decrease.
	• identify and graph parent functions and their transformations (i.e. vertical translation, horizontal translation, vertical stretch/shrink, reflect over x-axis, etc.).
	• Calculate values of sine, cosine, and tangent for given
		• Build on students' experience with the following skills:
		  ○ Graphing on the coordinate plane (6.NS.C.8)
		  ○ Building and solving proportional relationships (7.RP.A.2)
		  ○ Recognize and use function notation (HSF.IF.A)
		  ○ Recognizing inverse functions (HSF.BF.B.4)
		  ○ Graphing, solving and modeling quadratic, linear, exponential and absolute value functions (HSF.LE.A, HSF.LE.B)
		  ○ Recognize, build and solve trigonometric ratios (HSG.CRT.C)
		• Cognitive Strategies
		  ○ Repeatedly model the strategies
		  ○ Monitor the students' use of the strategies
		  ○ Provide feedback to students
		  ○ Teach self-questioning and self-monitoring strategies

● Inverse trigonometric functions have restricted domains and ranges and are one to one.	angles. ● Solve trigonometric equations, including those written in quadratic form and equations containing more than one angle.	○ Introduce multiple means of representation for mathematical ideas ● Encourage students to use alternative tools to better access the grade level content. Examples include: ○ Desmos.com ○ Graphing calculator ○ Sketch a graph ○ Create a table of values ○ Algebra tiles ○ Graphic organizers ○ SOH CAH TOA

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 constructing and comparing linear, quadratic and exponential models and using them to solve problems by critiquing student approaches/solutions to make connections through a short mini lesson because explanations may arise using tables, graphs and function algebra. Building connections between these approaches can illuminate errors as well as push students beyond estimations and toward exact answers.
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 constructing and comparing linear, quadratic and exponential models and using them to solve problems by addressing conceptual understanding because the basis of this cluster is in strategically selecting a model based on characteristics provided. If students do not have a firm understanding of the characteristics of linear, quadratic and exponential functions, they will not be able to select or therefore use an appropriate model to solve problems.

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 such as in-depth, self-directed exploration of self-selected topics when constructing and comparing linear, quadratic and exponential models and using them to solve problems. Challenging students to select a data set to model requires them to reason with the different types of data sets available, strategically explore models and interpret their findings in context. This can also serve to reach the interest of these students on a deeper level.