NEW MEXICO
Public Education Department

HS: FUNCTIONS- LINEAR, QUADRATIC, & EXPONENTIAL MODELS

Cluster Statement: A: Construct and compare linear, quadratic, and exponential models and solve problems.

Standard Text	**Standard for Mathematical Practices**	**Students who demonstrate understanding can:**
HSF.LE.A.4 **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 Students model with mathematics.by applying concepts of logarithms to problems in context. SMP 7. Students look for and make use of structure by writing a logarithmic model given an exponential model and vice versa.	• Use the properties of logs. • Describe the key features of logs. • Use logarithmic form to solve exponential models.
		Webb's Depth Of Knowledge: 1-2
		Bloom's Taxonomy: understand, apply

Previous Learning Connections	**Current Learning Connections**	**Future Learning Connections**
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.

Clarification Statement
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.

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

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 constructing and comparing linear, quadratic and exponential models and using them so solve problem 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.

Pre-teach (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 so solve problem because the 8th grade standard is when students modeled linear data with linear functions and the high school standard is 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.

Core Instruction

Access

Interest: How will the learning for students provide multiple options for recruiting student interest?

- For example, learners engaging with constructing and comparing linear, quadratic and exponential models and using them to solve problems benefit when learning experiences include ways to recruit interest such as providing contextualized examples to their lives because a variety of relevant concepts can be modeled with these functions, allowing a teacher to tailor this learning to fit the social, cultural and/or career interests of their students.

Build

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

- For example, learners engaging with constructing and comparing linear, quadratic and exponential models and using them so solve problems benefit when learning experiences attend to students attention and affect to support sustained effort and concentration such as providing alternatives in the mathematics representations and scaffolds because students may see these models better through a table, graph or equation. Allowing multiple representations gives opportunity to draw connections between the representations and reasoning of others.

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 constructing and comparing linear, quadratic and exponential models and using them so solve problems benefit when learning experiences attend to the linguistic and nonlinguistic representations of mathematics to ensure clarity can comprehensibility for all learners such as making connections to previously learned structures because these functions are not always discussed at the same time. Linear functions are a prior grade skill while quadratics and exponentials are explored in depth, often independently. Reviewing the key characteristics of these structures allows students to wrestle with which function type best fits a given scenario.

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 constructing and comparing linear, quadratic and exponential models and using them so solve problems benefit when learning experiences attend to the multiple ways students can express knowledge, ideas, and concepts such as solving problems using a variety of strategies because student reasoning may stem from a table, graph and/or work with a function rule. All strategies may lead to correct solutions and provide opportunity to build connections across representations and critique reasoning.

Internalize

Executive Functions: How will the learning for students support the development of executive functions to allow them to take advantage of their environment?

- For example, learners engaging with constructing and comparing linear, quadratic and exponential models and using them so solve problems benefit when learning experiences provide opportunities for students to set goals; formulate plans; use tool and processes to support organization and memory; and analyze their growth in learning and how to build from it such as embedding prompts to "show and explain your work" (e.g., portfolio review, art critiques) because understanding student thinking provides insight into their level of understanding as well as their ability to use a variety of representations to support their solutions. This allows for specific feedback, clarification and opportunities to push students beyond their comfort zone.

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 constructing and comparing linear, quadratic and exponential models and using them so solve problem 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.

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 constructing and comparing linear, quadratic and exponential models and using them to solve problem 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

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 in-depth, self-directed exploration of self-selected topics when studying constructing and comparing linear,

	quadratic and exponential models and using them to solve problems because 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.

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?

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 studying constructing and comparing linear, quadratic and exponential models and using them so solve problems, the types of mathematical tasks are critical because this is a golden opportunity to show the relevancy 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.

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 SMP 7 as they use the structure of the exponential function to analyze a scenario and, if allowed use of technology, SMP 5 as they use graphs to reason their solutions.

Relevance to families and communities:	**Cross-Curricular Connections:**
During a unit focused on constructing and comparing linear, quadratic and exponential models and using them so solve problems, 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, for example collecting/researching a socially relevant data set to fit with a mathematical model. This context allows students to reason with and discuss the mathematics but also provides a purpose and drives engagement.	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. Design a Navajo Rug