HS: FUNCTIONS – LINEAR, QUADRATIC, & EXPONENTIAL MODELS*

Cluster Statement: B: Interpret expressions for functions in terms of the situation they model.

Standard Text	Standard for Mathematical Practices	Students who demonstrate understanding can:
HSF.LE.B.5: Interpret the parameters in a linear or exponential function in terms of a context. *Note: Algebra 1 focuses on linear and exponential of form $f(x)=b^x+k$.*	SMP 2: Students can reason abstractly and quantitatively by associating parts of a function or graph of a function to its meaning within a given context. SMP 7: Students can look for and make use of structure by understanding and analyzing linear and exponential functions in order to describe their key features in terms of a context.	• Explain the meanings of inputs and outputs of both exponential ($y=b^x+k$) and linear functions in terms of a given context. • Explain the meaning of parts of functions in terms of context (e.g., if x is ice cream cones 5x means 5 times the number of ice cream cones). • Identify the parameters of a linear or exponential equation and know the parameters may be different based on the context (parameters include initial values, rate of change or growth factor/rate, etc.). **Webb's Depth of Knowledge:** 1-2 **Bloom's Taxonomy:** Understand, Apply, Analyze
<u>Previous Learning Connections</u> • Connect to understanding slope is a rate of change expressed as the ratio of rise over run for any two distinct points on the same line. **(8.EE.6)** • Connect to relating the information gathered by the ratio of rise over run to the linear equation and understand that a change in slope will cause the steepness of the line to change. **(8.F.2)** • Connect to simplifying exponential expressions using the Rules of Exponents. **(8.EE.1)**	**<u>Current Learning Connections</u>** • Connect to using paper and pencil, graphing calculators, graphing programs, spreadsheets, or other graphing technologies to model and interpret parameters in linear, quadratic, or exponential functions. Parameters may include slope, y-intercept, base value, and vertical shifts. **(HSF.IF.7, HSF.BF.3)** • Connect to studying functions to develop contextual understanding on parameter changes in linear and exponential function situations. **(HSF.LE.1-3)**	**<u>Future Learning Connections</u>** • Connect to extending analysis to different types of functions and interpreting the key features in modeling situations. **(HSF.IF.4-6, 7)**

Clarification Statement
HSF.LE.B.4: Student should be able to describe parts of **linear** and **exponential functions** in terms of a context. They should be able to describe **slope** and **y-intercepts** or A and B (when in **standard form**) for a linear function and describe and/or differentiate between the **initial value** and **growth factor** for an exponential function. In more complex problems such as exponentials and **polynomials**, it may be useful to break down the problem so that it's clearly understood what is changing by how much for every what. **Translating** the equation into words or vice versa may help understand the equation in terms of the overall **context**. (For instance, every additional packet of gum sold, denoted by x, increases the **revenue** y by 0.95 dollars. That's what the equation y = 0.95x ultimately means.)

Common Misconceptions
- Students often confuse decay factor with the rate of decay.
- Students may be able to identify the slope and y-intercept but not understand their meaning.

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 analyzes common misconceptions when studying Interpreting expressions for functions in terms of the situation they model because this allows students to go over what they previously learned and think about the misconceptions they had about the process and skills needed to construct models of functions. This will benefit students when interpreting expressions.

Pre-teach (intensive): *What critical understandings will prepare students to access the mathematics for this cluster?*
- 8.F.B.4: This standard provides a foundation for work with interpreting expressions for functions in terms of the situation they model because this standard asks students to construct a function to model a linear relationship between two quantities. Students learned to read values from a table or from a graph and interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values. 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 Interpret expressions for functions in terms of the situation they model benefit when learning experiences include ways to recruit interest such as providing contextualized examples to their lives because when students use personal experiences and then model them thru mathematics the students are more interested in doing the task and finding out the outcome. The students become curious about how their personal experience would look thru mathematics.

Build
Effort and Persistence: *How will the learning for students provide options for sustaining effort and persistence?*
- For example, learners engaging with interpreting expressions for functions in terms of the situation they model benefit when learning experiences attend to students attention and affect to support sustained effort and concentration such as prompting or

requiring learners to explicitly formulate or restate learning goals because when students understand the learning goal they will stay on task and work on meeting the goal. Students need a goal so that they can reach it.

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 <Interpret expressions for functions in terms of the situation they model 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 students will need their previous knowledge of functions to be able to interpret the model in terms of the situation.

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 interpreting expressions for functions in terms of the situation they model benefit when learning experiences attend to the multiple ways, students can express knowledge, ideas, and concepts such as using social media and interactive web tools (e.g., discussion forums, chats, web design, annotation tools, storyboards, comic strips, animation presentations) because this will support the interest of the students by allowing them to use different media to represent their model and interpretation of the functions.

Internalize

Comprehension: *How will the learning for students support transforming accessible information into usable knowledge, knowledge that is accessible for future learning and decision-making?*

- For example, learners engaging with interpreting expressions for functions in terms of the situation they model benefit when learning experiences attend to students by intentionally building connections to prior understandings and experiences; relating important information to the learning goals; providing a process for meaning making of new learning; and, applying learning to new contexts such as providing explicit, supported opportunities to generalize learning to new situations (e.g., different types of problems that can be solved with linear equations) because when students are able to connect a model of a function relation to any situation then they have created an understanding of how mathematics can be connected to real life.

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 interpreting expressions for functions in terms of the situation they model. By providing specific feedback to students on their work through a short mini-lesson, misconceptions can be addressed immediately.

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 interpreting expressions for functions in terms of the situation they model by confronting student misconceptions because students will be aware of them and avoid them next time they are exposed to the same task.

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 the opportunity to explore links between various topics when studying interpreting expressions for functions in terms of the situation they model because this allows students to make connections not only with the mathematics but notice how this unit is related to other topics.

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 interpreting expressions for functions in terms of the situation they model, eliciting and using student thinking is critical because students need to feel comfortable that their peers will validate their thinking so they can share what they did. Sharing is an opportunity to learn from our mistakes and from others.

Standards Aligned Instructionally Embedded Formative Assessment Resources:
Source: https://satsuitequestionbank.collegeboard.org/

NEW MEXICO
Public Education Department

Question ID 19789

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Assessment	Test	Cross-Test and Subscore	Difficulty	Primary Dimension	Secondary Dimension	Tertiary Dimension	Calculator
SAT	Math	Heart of Algebra	■■□	Heart of Algebra	Linear functions	3. For a linear function that represents a context a. interpret the meaning of an input/output pair, constant, variable, factor, term, or graph based on the context, including situations where seeing structure provides an advantage;	Calculator

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The average number of students per classroom at Central High School from 2000 to 2010 can be modeled by the equation $y = 0.56x + 27.2$, where x represents the number of years since 2000, and y represents the average number of students per classroom. Which of the following best describes the meaning of the number 0.56 in the equation?

A. The total number of students at the school in 2000

B. The average number of students per classroom in 2000

C. The estimated increase in the average number of students per classroom each year

D. The estimated difference between the average number of students per classroom in 2010 and in 2000

Rationale

Choice C is correct. In the equation $y = 0.56x + 27.2$, the value of x increases by 1 for each year that passes. Each time x increases by 1, y increases by 0.56 since 0.56 is the slope of the graph of this equation. Since y represents the average number of students per classroom in the year represented by x, it follows that, according to the model, the estimated increase each year in the average number of students per classroom at Central High School is 0.56. Choice A is incorrect because the total number of students in the school in 2000 is the product of the average number of students per classroom and the total number of classrooms, which would appropriately be approximated by the y-intercept (27.2) times the total number of classrooms, which is not given. Choice B is incorrect because the average number of students per classroom in 2000 is given by the y-intercept of the graph of the equation, but the question is asking for the meaning of the number 0.56, which is the slope. Choice D is incorrect because 0.56 represents the estimated yearly change in the average number of students per classroom. The estimated difference between the average number of students per classroom in 2010 and 2000 is 0.56 times the number of years that have passed between 2000 and 2010, that is, $0.56 \times 10 = 5.6$.

https://www.map.mathshell.org/tasks.php?unit=HN08&collection=9&redir=1
https://docs.google.com/a/hobbsschools.net/viewer?a=v&pid=sites&srcid=c2pjaXNkLm9yZ3xjb21tb24tY29yZS1tYXRoZW1hdGljcy1hc3Nlc3NtZW50LWZpZWxkLXRlc3Rpbmctc2l0ZXxneDo3NTkzOTczZTJhN2M1MjJk

Relevance to families and communities:	Cross-Curricular Connections:
During a unit focused on interpreting expressions for functions in terms of the situation they model, 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, think of a special event or activity that you have done. How would you represent it as a function and how would it model the	Science: Colony Collapse Disorder refers to the drastic loss of honeybees and honeybee colonies, such as what has been observed around the world in recent decades. Consider providing a connection where students construct models based on the data and then use those models to describe factors affecting the bee colony populations.

event or activity? Using the mathematics, you will create a stronger connection between your personal life and mathematics.	