NEW MEXICO
Public Education Department

HS: STATISTICS & PROBABILITY — INTERPRETING CATEGORICAL & QUANTITATIVE DATA

Cluster Statement: C: Interpret linear models

Standard Text	Standard for Mathematical Practices	Students who demonstrate understanding can:
HSS.ID.C.7: Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. *Widely Applicable as Prerequisite for a Range of College Majors, Postsecondary Programs and Careers.*	SMP 2: Students can reason abstractly and quantitatively by describing the meaning of a slope and y-intercept related to linear (or nearly linear) bivariate set of data. SMP 7: Students can use the structure of the equation for a line of best fit or a graph of the data to describe its rate of change and intercept in context of the data.	• Explain the slope and intercept of a linear model in the context of data from a visual model. • Explain the slope and intercept of a linear model in the context of data from written notation. **Webb's Depth of Knowledge:** 1-2 **Bloom's Taxonomy:** Understand, Apply, Analyze

Standard Text	Standard for Mathematical Practices	Students who demonstrate understanding can:
HSS.ID.C.8: Compute (using technology) and interpret the correlation coefficient of a linear fit.	SMP 2: Students reason abstractly and quantitatively by making sense of correlation coefficients and their relationship to different situations. SMP 5: Students can use e tools strategically by using technology to calculate correlation coefficients to determine the strength of a model.	• Find the correlation coefficient using technology. • Describe the meaning of the correlation coefficient of a given set of data in the context of the problem **Webb's Depth of Knowledge:** 1-2 **Bloom's Taxonomy:** Understand, Apply, Analyze

Standard Text	Standard for Mathematical Practices	Students who demonstrate understanding can:
HSS.ID.C.9: Distinguish between correlation and causation.	SMP 2: Students can reason abstractly and quantitatively by determining when a situation has correlation without causation, correlation with causation or correlation with possible causation. SMP 3: Students can construct viable arguments by verbally justifying whether two variables show causation.	• Explain the difference between correlation and causation. • Give examples of variables that are correlated, but have no logical causal connection (e.g., number of bee stings and ice cream sales both go up in the summer but there isn't a causal link between the two). • Give examples of variables that have both correlation and a high likelihood of causation (e.g., the amount of time spent studying for an exam and the score on the exam). • Give examples of variables that are neither correlated nor have a causal link (e.g., the number of shoes you own and how many students are in your third period class). **Webb's Depth of Knowledge:** 1-2 **Bloom's Taxonomy:** Understand, Apply, Analyze
<u>Previous Learning Connections</u> • Connect to plotting points in a coordinate grid and constructing an equation or a function to model the linear relationship. **(5.G.1-2)** • Connect to constructing and interpreting scatterplots. **(8.SP.1)** • Connect to constructing an equation or a function to model a linear relationship and determining/interpreting the slope and y-intercept. **(8.F.4)**	**<u>Current Learning Connections</u>** • Connect to explaining the slope and y-intercept as they relate to the context of the original problem. **(HSF.IF.4)** • Connect to creating linear functions and using them to solve problems. **(HSA.CED.1-3)** • Connect to interpreting key features of graphs and functions. **(HSF.IF.4)**	**<u>Future Learning Connections</u>** • Connect to determining which function fits the data. (linear, exponential, quadratic).

Clarification Statement

- HSS.ID.C.7: Students interpret the **slope (rate of change)** and the **y-intercept (constant term)** of a **linear model** in the context of the **data**. Students may use **graphing calculators or software** to create **representations of data sets**, create linear models, and to assist student them in interpreting the data. Students should know that all linear models take the form **y = mx + b** where m is the slope and b is the y-intercept.

- HSS.ID.C.8: Students should compute (using technology) and interpret the **correlation coefficient** of a **linear fi**t and use it to understand the strength of a **linear relationship**. Students should match the correlation coefficient to its appropriate **scatter plot** and linear model.

  Students should use the correlation coefficient to determine the **goodness of fit** for a linear model. Students should know that it has the symbol r and that it ranges from -1 to 1. A coefficient equal to 1.0 suggests a **positive correlation** between the data. This means that as the **independent variable** (x) **increases** so does the **dependent variable** (y).

  A correlation coefficient equal to -1.0 suggests a **negative correlation** between the data, or as the independent variable (x) increases, the dependent variable **decreases**.

  If the coefficient equals 0, there is no **linear correlation**. However, just because the linear correlation coefficient equals 0 doesn't mean there is not another type of correlation between the data. Students should also know that in addition to being positive or negative, the correlation coefficient can be **weak** or **strong**. The closer the correlation is to -1 or 1, the stronger the correlation.

- HSS.ID.C.9: Students should be able to do more than just give the definition of correlation and **causation**. This should be developed as a skill of critical thinking where students are expected to first look at every set of data to determine if it is appropriate to be making comparisons between them. Students need to remember that correlation does not imply causation. For example, let's say we find that there's a strong positive linear correlation between the age of a tree and how many apples it produces. In fact, this correlation is so strong that r = 0.99. Does that mean the age of the tree causes more apples to grow? Can there be other factors? (e.g., What about rainfall? Did the farmer use fertilizer? Did he prune the trees? What were the summer and winter temperatures? Any one of these factors may have influenced the number of apples.)

Common Misconceptions

- Students do not always know that slope, rate of change, and steepness are interchangeable.
- Students may try to determine the appropriateness of a line of best fit based only on the value of r.

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 representation of linear function because students need to understand the features of the linear model and the meaning of the features. Students need to rehearse different ways of writing the linear model.

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

- 8.F.8.4: This standard provides a foundation for work with constructing a function to model a linear relationship between 2 quantities because students need to know the information needed to model the linear function. 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 interpreting the linear model in the context of the data benefit when learning experiences include ways to recruit interest such as providing contextualized examples to their lives because students make meaningful connections to real-life data sets. By using real-life examples, students understand and interpret the linear model in the context of the problems based on their prior experience and make implication of the data sets.

Build

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

- For example, learners engaging with interpreting the slope (rate of change) and the intercept (the constant term) of a linear model in the context of the data benefit when learning experiences attend to students attention and affect to support sustained effort and concentration such as generating relevant examples with students that connect to their cultural background and interests because students use examples relevant to their interest to interpret the meaning of slope and intercept in the context of the data. Students expand their understanding of slope and intercept to describe the implication of the linear model in the context of the data.

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 interpreting the meaning of slope and intercept of a linear model in the context of the data benefit when learning experiences attend to the linguistic and nonlinguistic representations of mathematics to ensure clarity can comprehensibility for all learners such as pre-teaching vocabulary and symbols, especially in ways that promote connection to the learners' experience and prior knowledge because students make connection of their prior knowledge of slope and intercept of linear model in the context of the data. Students interpret the features of the linear model in the context of the problems verbally and symbolically.

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 computing (using technology and interpreting the correlation coefficient of a linear fit benefit when learning experiences attend to the multiple ways students can express knowledge, ideas, and concepts such as providing calculators, graphing calculators, geometric sketchpads, or pre-formatted graph paper because students use graphing calculators and graph paper to calculate and validate the correlation coefficient of a linear fit. Students use the correlation coefficient to explain the relationship of the two quantities of the data set.

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 the linear model in the context of the data and distinguishing between correlation and causation 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 because students use their understanding of the rate of change and constant of the linear model to describe the correlation coefficient of the data set. Students interpret the trend of the data using the correlation coefficient. Students distinguish between correlation and causation by plotting analyzing the data.

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 modeling the scatter plot with a linear function by clarifying mathematical ideas and/or concepts through a short mini-lesson because students need to use the appropriate information to model the scatter plot with linear function. Students understand the connection of rate of change and intercept of the linear function in context of the data.

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 representing the scatter plot with linear function by addressing conceptual understanding because students explain the implication of rate of change and intercepts of the linear function in the context of the data. Students use the rate of change and intercepts to predict the trend of the behavior and describe the correlation.

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 application of and development of abstract thinking skills when studying modeling with linear function and calculating the correlation because students explain the similarities and differences of correlation and causation. Students describe and compare real-life data that has a correlation and real-life data that has causation.

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?

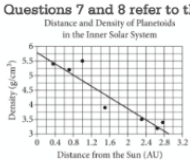
Facilitating Meaningful Mathematical Discourse: Mathematics discourse requires intentional planning to ensure all students feel comfortable to share, consider, build upon and critique the mathematical ideas under consideration. When student ideas serve as the basis for discussion we position them as knowers and doers of mathematics by using equitable talk moves students and attending to the ways students talk about who is and isn't capable of mathematics we can disrupt the negative images and stereotypes around mathematics of marginalized cultures and languages. "A discourse-based mathematics classroom provides stronger access for every student — those who have an immediate answer or approach to share, those who have begun to formulate a mathematical approach to a task but have not fully developed their thoughts, and those who may not have an approach but can provide feedback to others.” For example, when studying interpreting linear models for data facilitating meaningful mathematical discourse is critical because students might use different linear models to represent the data sets. Students interpret and summarize the data differently using their linear models. Students compare the conclusion and defend the solution by constructing viable arguments.

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

Question ID 423228

Assessment	Test	Cross-Test and Subscore	Difficulty	Primary Dimension	Secondary Dimension	Tertiary Dimension	Calculator
SAT	Math	Problem Solving and Data Analysis	■□□	Problem Solving and Data Analysis	Two-variable data: Models and scatterplots	1. Using a model that fits the data in a scatterplot, compare values predicted by the model to values given in the data set.	Calculator

Questions 7 and 8 refer to the following information.



The scatterplot above shows the densities of 7 planetoids, in grams per cubic centimeter, with respect to their average distances from the Sun in astronomical units (AU). The line of best fit is also shown.

An astronomer has discovered a new planetoid about 1.2 AU from the Sun. According to the line of best fit, which of the following best approximates the density of the planetoid, in grams per cubic centimeter?

A. 3.6

B. 4.1

C. 4.6

D. 5.5

Rationale

Choice C is correct. According to the line of best fit, a planetoid with a distance from the Sun of 1.2 AU has a predicted density between $4.5\ g/cm^3$ and $4.75\ g/cm^3$. The only choice in this range is 4.6.

Choices A, B, and D are incorrect and may result from misreading the information in the scatterplot.

https://tasks.illustrativemathematics.org/content-standards/tasks/1888

Relevance to families and communities:

During a unit focused on interpreting linear models of the data, 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, relating the mathematical models used to real-life data to interpret and predict the trend of data in order to provide useful information for decision-making in the community.

Cross-Curricular Connections:

Science: In high school the NNSS state students should “use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.” Consider providing a connection based where students must analyze data and consider the relationship among various factors including boundaries, resources, climate, and competition.

https://www.nextgenscience.org/topic-arrangement/hsinterdependent-relationships-ecosystems