NEW MEXICO
Public Education Department

8.EE: EXPRESSIONS & EQUATIONS

Cluster Statement: B: Understand the connections between proportional relationships, lines, and linear equations.

Major Cluster (Students should spend the large majority of their time (65-85%) on the major work of the grade/course. Supporting work and, where appropriate, additional work should be connected to and engage students in the major work of the grade.)

Standard Text	**Standard for Mathematical Practices**	**Students who demonstrate understanding can:**
8.EE.B.5: Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.	SMP 2: Students reason abstractly and quantitatively by explaining what the slope and y-intercept represent on a graph and in context with the proportional relationship. SMP 3: Students construct viable arguments and critique the reasoning of others by justifying that similar right triangles provide the same slope for the same non-vertical line. SMP 4: Students model with mathematics by modeling a contextual proportional relationship by graphing and writing equations. SMP 5: Students use appropriate tools strategically by utilizing the coordinate plane (graph paper) to graph lines and analyzing graphs modeled by calculators.	• Graph proportional relationships. • Interpret the unit rate as the slope of the graph. • Compare two proportional relationships whether it is table, graph or equation. **Webb's Depth of Knowledge:** 1, 2 **Bloom's Taxonomy:** Understand, Apply
Standard Text	**Standard for Mathematical Practices**	**Students who demonstrate understanding can:**
8.EE.B.6: Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation *y* = *mx* for a line through the origin and the equation *y* = *mx* + *b* for a line intercepting the vertical axis at *b*.	SMP 2: Students reason abstractly and quantitatively by explaining what the slope and y-intercept represent on a graph and in context with the proportional relationship. SMP 3: Students construct viable arguments and critique the reasoning of others by justifying that similar right triangles provide the same slope for the same non-vertical line. SMP 4: Students model with mathematics by modeling a contextual proportional relationship by graphing and writing equations.	• Identify the Y-intercept of the graph and understand the meaning of the y-intercept in a real-world problem situation. • Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane. • Graph a line from an equation in the form of y=mx+b, understand what m is (slope) and the b (y-intercept).

	SMP 5: Students use appropriate tools strategically by utilizing the coordinate plane (graph paper) to graph lines and analyzing graphs modeled by calculators.	• Discover the equation y = mx for a line through the origin (proportional) and the equation y = mx + b for a line intercepting the vertical axis at b. **Webb's Depth of Knowledge:** 3 **Bloom's Taxonomy:** Analyze, Evaluate
Previous Learning Connections • In 6th grade, students used ratio, rate reasoning, and unit rate. In 7th grade, students made connections to the 6th grade skills to compute unit rates and recognize and represent proportional relationships	**Current Learning Connections** • In 8th grade, learners will use these skills to compare properties of functions given a table, a graph, or an equation.	**Future Learning Connections** • In future courses, students will understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

Clarification Statement:
Students connect slope to unit rates, tables, lines, and equations. Students will also connect similar triangles to slope.

Common Misconceptions

- Students may make errors if they estimate unit rate from a graph instead of calculating the rate from data or an equation. Errors may occur if they find a single unit rate instead of comparing unit rates, compare unit rates from one relationship with the unit rate in the other relationship or forget to divide to calculate the unit rate
- Some errors may occur if students divide the differences between x-coordinates by the difference between y-coordinates. If students apply the slope formula incorrectly errors will arise. Students will make errors if they confuse the x-axis and the y-axis.

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 new mathematical language in connection with prior learning when studying the connections between proportional relationships, lines, and linear equations because the language of the 8th grade cluster is completely new, but the skills needed for success began in 6th grade. Previously to 8th grade, slope is referred to as rate, unit rate, and constant of proportionality. Constant proportionality is structured in the y=kx form, so shifting students from y=kx to y=bx or even y=mx+b will take a shift in language and terminology, yet the skills of finding slope have already been developed.

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

- 6.RP.A.2: This standard provides a foundation for work with understanding ratio relationships and calculating rate which would support finding slope because it introduces a relationship between two values. This standard also introduces ratios written as a fraction which supports dividing values to produce a rate. 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 creating connections between proportional relationships, lines, and linear equations will benefit when learning experiences include ways to recruit interest such as providing contextualized examples to their lives because students will need to interpret values from graphs, lines, tables, and equations that represent real world variables given the context of a problem, and, in order to show mastery of this cluster, explain the relationship of these values to one another, to the context of the problem, and to mathematical practice. Choosing applicable, contextualized tasks related to students' lives, for example, comparing a distance-time graph in the context of running the mile in P.E. class to a distance-time equation with realistic values, can generate interest, engagement, and access for students who may have learning gaps in their mathematical understanding

Build

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

- For example, learners engaging with creating connections between proportional relationships, lines, and linear equations will benefit when learning experiences attend to students attention and affect to support sustained effort and concentration such as providing feedback that models how to incorporate evaluation, including identifying patterns of errors and wrong answers, into positive strategies for future success because the most common student misconception in this cluster takes place when students reverse X and Y values when analyzing lines, graphs, tables, and ordered pairs. Using effective error analysis, for example providing students with a word problem and graph drawn with an incorrect slope (possible error: unit rate- x divided by y instead of y divided by x) and asking students to examine both the graph and the word problem for an error can clarify the misconception, connect visual associations to positive and negative slope and aid learner self-reflection to promote future success.

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 creating connections between proportional relationships, lines, and linear equations will 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 vocabulary such as slope, y intercept, equation of a line, hypotenuse, etc. are all brand new to 8th grade content. Students have worked with x and y variables and graph reading to find unit rate or constant of proportionality in 6th and 7th grade standards. although the skills are deeply connected and related, the language does not overlap. For example, connecting the language, showing the shift in language, not shift in skill, between y = kx (constant of proportionality equation) and y = mx (slope equation) to the previously learned structure in 6th and 7th grade will access foundational skills and understanding within these new concepts.

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 creating connections between proportional relationships, lines, and linear equations will 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) solving problems using a variety of strategies because integrated technology can help solidify the connections between lines, equations, graphs and tables by creating visual illustrations with labels, graphing animations that demonstrate a line ascending or descending at a constant rate, and/or animations of similar triangles illustrating same slope concept when deriving the y= mx and y = mx +b formulas.

Internalize

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

- For example, learners engaging with creating connections between proportional relationships, lines, and linear equations will 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 embedding new ideas in familiar ideas and contexts (e.g., use of analogy, metaphor, drama, music, film, etc.) because the concept of dependent and independent relationships is relatively understood by students when considering context. For example, students understand the connection between speed and time when placed in the context of driving- i.e. the fast your drive, the sooner you arrive at your destination. However, the mathematical vocabulary, terminology and equation portion of this cluster clouds student's ability to draw the connections, and ultimately, that is the goal of this standard. Using familiar ideas and contexts allows students to logically draw connections between variables and then use mathematical language to formalize their understanding versus using unfamiliar context where the whole process is brand new to student understanding.

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 understanding the connections between proportional relationships, lines, and linear equations by critiquing student approaches/solutions to make connections through a short mini-lesson because there are several components and representations of

information in this cluster. Students will be presented with tables, graphs, ordered pairs, equations, and triangles. Students may be able to recognize a relationship between values when presented in a table, but struggle with reading graphs. Taking the time to critique approaches/ make connections with the way other students arrived at an answer will model successful ways to approach a task or problem.

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 understanding the connections between proportional relationships, lines, and linear equations by helping students move from specific answers to generalizations for certain types of problems because when placed in real world context, students can often draw the correct connections between variables based on experience and not mathematical computation. For students struggling with the mathematical recognition, it may be valuable to focus on generalizations involving proportional relationships to boost confidence and understanding before addressing misconceptions within the process of finding slope or using similar triangles to show slope is the same.

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 open-ended tasks linking multiple disciplines when studying the connections between proportional relationships, lines, and linear equations because value relationships cross over into many disciplines. For example, students could develop an equation and model to determine cost/profit of items in a school store to guarantee enough funding for a field trip/class party.

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?

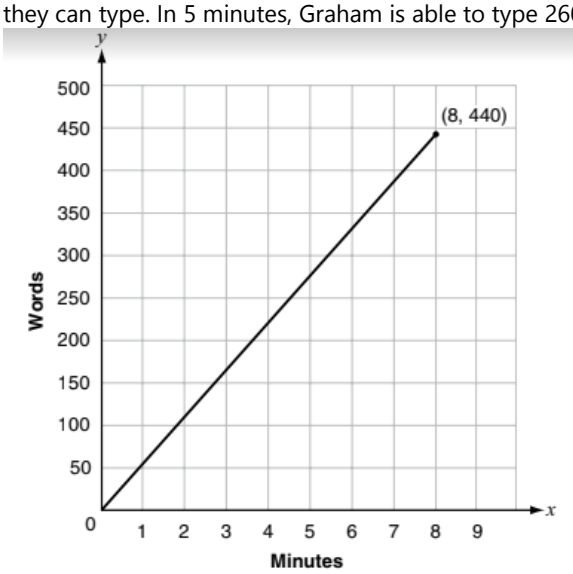
Posing Purposeful Questions: CLRI requires intentional planning around the questions posed in a mathematics classroom. It is critical to consider "who is being positioned as competent, and whose ideas are featured and privileged" within the classroom through both the types of questioning and who is being questioned. Mathematics classrooms traditionally ask short answer questions and reward students that can respond quickly and correctly. When questioning seeks to understand students' thinking by taking their ideas seriously and asking the community to build upon one another's ideas a greater sense of belonging in mathematics is created for students from marginalized cultures and languages. For example, when studying the connections between proportional relationships, lines, and linear equations the pattern of questions within the classroom is critical because it allows students to communicate mathematically. It allows them to answer questions about rate of change, linear and proportional relationships. They can communicate their method of understanding the difference between linear and proportional relationships, while making a connection between them. This allows the teacher to formatively assess them while checking for understanding. The questions can be oral, on paper (exit tickets) or group questions that allow students to discuss different strategies in a safe classroom environment (It is important that the teacher create an environment where students feel safe to share).

Standards Aligned Instructionally Embedded Formative Assessment Resources:
Source: Cognia Formative Item Set for Grade 8 Expressions and Equations

8.EE.B.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.

- Learning Target: I can compare the unit rate given in a statement and slope from a graph.
- Webb's Depth of Knowledge: 3

As part of applying for a job, Graham and Claire each completes a keyboarding skills test to determine how fast they can type. In 5 minutes, Graham is able to type 260 words. Claire's results are shown in the graph.



a) How much faster, in words per minute, is Claire than Graham? Show your work or explain your reasoning.
b) Claire estimates that it will take her about 36 minutes to complete the document. What error did Claire make and what's the actual time it will take her to complete the document? Show your work or explain your reasoning.

Relevance to families and communities:	**Cross-Curricular Connections:**
During a unit focused on the connections between proportional relationships, lines, and linear equations , 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, by having students examine proportional relationships in different recipes. Having students make their favorite recipe that requires them to double or triple the ingredients based on the number of servings the recipe yields vs. the number of servings needed.	Science: Compare rates and relationships in scientific data.