New Mexico Instructional Scope

Similarity, Right Triangles, and Trigonometry 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

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Similarity, Right Triangles, and Trigonometry 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

- Understand similarity in terms of similarity transformation
  - HSG.SRT.A.1
  - HSG.SRT.A.2
  - HSG.SRT.A.3
- Prove theorems involving similarity
  - HSG.SRT.B.4
  - HSG.SRT.B.5
- Define trigonometric ratios and solve problems involving right triangles
  - HSG.SRT.C.6
  - HSG.SRT.C.7
  - HSG.SRT.C.8

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Similarity, Right Triangles, and Trigonometry Guide

Grade	*CCSS Domain*	*CCSS Cluster*
G	**Similarity, Right Triangles, & Trigonometry**	**Understand similarity in terms of similarity transformations**

Cluster Standard: HSG.SRT.A.1

Standard	**Standards for Mathematical Practice**
Verify experimentally the properties of dilations given by a center and a scale factor: • HSG.SRT.A.1.A: A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged. • HSG.SRT.A.1.B: The dilation of a line segment is longer or shorter in the ratio given by the scale factor.	• **SMP2:** Reason abstractly and quantitatively. • **SMP3:** Construct viable arguments and critique the reasoning of others. • **SMP5:**
Clarification Statement	**Students Who Demonstrate Understanding Can...**
This cluster establishes the basic criteria of similarity through an analysis of dilation transformations. Students formalize the similarity theorems and use the theorems to prove pairs of triangles are similar.	• Determine the properties of dilation. Dilate when the center of dilation is in, on and out of the shape. Dilate when given a center of dilation and a scale factor. Determine the center of dilation and the scale factor from a diagram. Dilate using both positive and negative scale factors. • Construct a dilation. • Determine coordinate rules for dilations using any center of dilation. • Construct a dilated image which has corresponding line segments and is transformed along the same line from the center of the dilation. • Verify experimentally that a dilated image is similar to its pre-image by showing congruent, corresponding angles, and proportional sides. • Determine and apply the properties of dilation.
DOK	**Blooms**

1-2	Understand, Apply

Grade	*CCSS Domain*	*CCSS Cluster*
G	**Similarity, Right Triangles, & Trigonometry**	**Understand similarity in terms of similarity transformations**

Cluster Standard: HSG.SRT.A.2

Standard	**Standards for Mathematical Practice**
Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.	• **SMP3:** Construct viable arguments and critique the reasoning of others. • **SMP5:** Use appropriate tools strategically.
Clarification Statement	**Students Who Demonstrate Understanding Can...**
This cluster establishes the basic criteria of similarity through an analysis of dilation transformations. Students formalize the similarity theorems and use the theorems to prove pairs of triangles are similar.	• Dilate figures using both positive and negative scale factors. • Identify corresponding angles and sides based on similarity statements. • Develop and write similarity statements for two polygons. • Determine if two triangles are similar based on their corresponding parts. • Establish a sequence of similarity transformations between two similar polygons.
DOK	**Blooms**
1-2	Understand, Apply

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Similarity, Right Triangles, and Trigonometry Guide

Grade	*CCSS Domain*	*CCSS Cluster*
G	**Similarity, Right Triangles, & Trigonometry**	**Understand similarity in terms of similarity transformations**

Cluster Standard: HSG.SRT.A.3

Standard	Standards for Mathematical Practice
Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.	• **SMP7:** Look for and make use of structure.
Clarification Statement	**Students Who Demonstrate Understanding Can...**
This cluster establishes the basic criteria of similarity through an analysis of dilation transformations. Students formalize the similarity theorems and use the theorems to prove pairs of triangles are similar.	• Develop the Angle-Angle criteria of similarity by expanding on previously learn properties of angles of Triangles • Use transformations as a tool to discover how AA similarity is derived and to make the process more efficient. • Express the properties of similarity transformations to explain the justification of AA similarity.
DOK	**Blooms**
1-2	Understand, Apply

Common Misconceptions

- A common misconception is thinking that the comparison of any pair of angles will be sufficient, when the comparison must be made using corresponding pairs.
- Students may incorrectly apply the scale factor. Some students often do not list the vertices of similar triangles in order. However, the order in which vertices are listed is preferred and especially important for similar triangles so that proportional sides can be correctly identified.

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Grade	*CCSS Domain*	*CCSS Cluster*
G	**Similarity, Right Triangles, & Trigonometry**	**Prove theorems involving similarity**

Cluster Standard: HSG.SRT.B.4

Standard	Standards for Mathematical Practice
Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.	• **SMP3:** Construct viable arguments and critique the reasoning of others. • **SMP5:** Use appropriate tools strategically.
Clarification Statement	**Students Who Demonstrate Understanding Can...**
Students continue to develop their ability to create proofs while incorporating similarity. They will prove the Pythagorean Theorem based on similar triangles. They will then apply similarity to a variety of real world situations.	• Prove two triangles are similar using AA (could extend to SAS or SSS) similarity theorem. • Use proportion to understand and justify logical claims. • Analyze a proof that two triangles are similar to determine if the argument is valid. • Prove various theorems about a triangle's properties. • Determine if two lines are parallel. • Set up and solve a proportion. • Apply the Pythagorean Theorem. • Organize and write a mathematical proof, including justification of my argument.
DOK	**Blooms**
1-3	Understand, Apply, Analyze

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Grade	*CCSS Domain*	*CCSS Cluster*
G	**Similarity, Right Triangles, & Trigonometry**	**Prove theorems involving similarity**

Cluster Standard: HSG.SRT.B.5

Standard	Standards for Mathematical Practice
Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.	• **SMP3:** Construct viable arguments and critique the reasoning of others. • **SMP5:** Use appropriate tools strategically.
Clarification Statement	**Students Who Demonstrate Understanding Can...**
Students continue to develop their ability to create proofs while incorporating similarity. They will prove the Pythagorean Theorem based on similar triangles. They will then apply similarity to a variety of real world situations.	• Apply Theorems and postulates of triangle similarity to solve problems and prove relationships within and between geometric figures. • Use similar figures to find missing side lengths and missing angle measures. • Use congruent figures to find missing side lengths and missing angle measures. • Determine if two geometric figures are congruent or similar. • Justify why two figures are congruent or similar using theorems from Geometry.
DOK	**Blooms**
1-3	Understand, Apply, Analyze

Common Misconceptions

- Students may forget the importance of the order of vertices when making similarity statements.

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Similarity, Right Triangles, and Trigonometry Guide

Grade	*CCSS Domain*	*CCSS Cluster*
G	**Similarity, Right Triangles, & Trigonometry**	**Define trigonometric ratios and solve problems involving right triangles**

Cluster Standard: HSG.SRT.C.6

Standard	Standards for Mathematical Practice
Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.	• **SMP3:** Construct viable arguments and critique the reasoning of others. • **SMP4:** Model with mathematics. • **SMP6:** Attend to precision. • **SMP7:** Look for and make use of structure.
Clarification Statement	**Students Who Demonstrate Understanding Can...**
This cluster builds on the concepts of similarity to define the trigonometric ratios. Using Pythagorean Theorem and trigonometric ratios, students solve for unknown side lengths and angle measures in right triangles.	• Use similarity, side ratios, and angles in right triangles to develop and define trigonometric ratios to help in completion of triangles • Identify the side opposite to and adjacent to an acute angle in a right triangle. • Write and simplify ratios using the sides of a right triangle. • Compare side ratios of similar right triangles and identify if they are equivalent. • Use the definition of sine, cosine, tangent, secant, cosecant, and cotangent to write those trigonometric ratios for a given triangle.
DOK	**Blooms**
1-2	Understand, Apply

Grade	*CCSS Domain*	*CCSS Cluster*

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Similarity, Right Triangles, and Trigonometry Guide

G	Similarity, Right Triangles, & Trigonometry	Define trigonometric ratios and solve problems involving right triangles

Cluster Standard: HSG.SRT.C.7

Standard	Standards for Mathematical Practice
Explain and use the relationship between the sine and cosine of complementary angles.	• **SMP3:** Construct viable arguments and critique the reasoning of others. • **SMP4**: Model with mathematics. • **SMP6**: Attend to precision. • **SMP7**: Look for and make use of structure.
Clarification Statement	**Students Who Demonstrate Understanding Can...**
This cluster builds on the concepts of similarity to define the trigonometric ratios. Using Pythagorean Theorem and trigonometric ratios, students solve for unknown side lengths and angle measures in right triangles.	• Use the concept of complementary angles to show how sine and cosine are related • Identify the opposite leg, adjacent leg, and hypotenuse with respect to an angle in a right triangle. • Explain the relationship between sine and cosine of complementary angles of right triangles.
DOK	**Blooms**
1	Understand

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Similarity, Right Triangles, and Trigonometry Guide

Grade	*CCSS Domain*	*CCSS Cluster*
G	**Similarity, Right Triangles, & Trigonometry**	**Define trigonometric ratios and solve problems involving right triangles**

Cluster Standard: HSG.SRT.C.8

Standard	Standards for Mathematical Practice
Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.	• **SMP3:** Construct viable arguments and critique the reasoning of others. • **SMP4:** Model with mathematics. • **SMP6:** Attend to precision. • **SMP7:** Look for and make use of structure.
Clarification Statement	**Students Who Demonstrate Understanding Can...**
This cluster builds on the concepts of similarity to define the trigonometric ratios. Using Pythagorean Theorem and trigonometric ratios, students solve for unknown side lengths and angle measures in right triangles.	• Apply the trig ratios and the Pythagorean theorem to solve right triangle models • Identify the unknown parts of a right triangle using the sine/cosine/tangent ratios. • Solve for the unknown angle measures of a right triangle using inverse sine, inverse cosine, and inverse tangent. • Solve for the unknown parts of a right triangle using Pythagorean Theorem. • Solve real world problems using trigonometric ratios and the Pythagorean Theorem.
DOK	**Blooms**
1-2	Understand, Apply

Common Misconceptions

- Students may confuse the alternate interior angle theorem and its converse as well as the Pythagorean Theorem and its converse.
- Students may confuse side lengths with angle measurements and will place values as the wrong substitutions in the ratios.
- Students may think that right triangles must be oriented a particular way. They may not realize that opposite and adjacent sides need to be identified with reference to a particular acute angle in a right triangle.

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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: **Similarity, Right Triangles, & Trigonometry**	Strand: **Understand similarity in terms of similarity transformations**

Suggested Student Discourse Questions

• Examine your partner's sequence of transformations. Would you make changes to their sequence? Why? • Can you identify sequences like these in what you see around you? In architecture? In nature?	• Compare your sequence of transformations with another group. Which sequence seems to be more complete? Why? • How would proving two triangles are similar help us prove that corresponding angles of the triangles have the same measure?

Domain: **Similarity, Right Triangles, & Trigonometry**	Strand: **Prove theorems involving similarity**

Suggested Student Discourse Questions

• Share the steps you used to prove the triangles in the diagram are similar right triangles. What feedback can you give to others about the steps they used? • Where can you find similar right triangles in real life? Why do you believe they are there?	• After you share the steps you used to prove the triangles in the diagram are similar right triangles, did you think of any other steps you could use? Come up with as many as you can. • How could you use similarity of triangles with other shapes, such as trapezoids and

	hexagons?

Domain: **Similarity, Right Triangles, & Trigonometry**	Strand: **Define trigonometric ratios and solve problems involving right triangles**
Suggested Student Discourse Questions	
• Share the ratios you created to solve the problem. Give feedback to other students- is the ratio correct? If not, what should be changed? • If you know one dimension of an object, how could you use trigonometric ratios to find other dimensions of that object without using a ruler?	• What is the easiest way to decide upon a trigonometric ratio for a given situation? • How do trigonometric ratios use similar shapes to find measures of the legs and hypotenuse of right triangles?

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Similarity, Right Triangles, and Trigonometry Guide

ASSESSMENT GUIDE

- Understand similarity in terms of similarity transformations
- Prove theorems involving similarity
- Define trigonometric ratios and solve problems involving right triangles

Grade	*CCSS Domain*	*CCSS Strand*
G	**Similarity, Right Triangles, & Trigonometry**	**Understand similarity in terms of similarity transformations**
	Sample Task #1 (Constructed Response)	

CollegeBoard	Question ID 421874						
SAT	Math	Additional Topics in Math	Medium	Additional Topics in Math	Right triangles and trigonometry	1. Solve problems in a variety of contexts using b. right triangle trigonometry;	Calculator

Triangles ABC and DEF are shown above. Which of the following is equal to the ratio $\frac{BC}{AB}$?

Question Difficulty: Medium

A. $\frac{DE}{DF}$

B. $\frac{DF}{DE}$

C. $\frac{DF}{EF}$

D. $\frac{EF}{DE}$

Choice B is correct. In right triangle ABC, the measure of angle B must be 58° because the sum of the measure of angle A, which is 32°, and the measure of angle B is 90°. Angle D in the right triangle DEF has measure 58°. Hence, triangles ABC and DEF are similar (by angle-angle similarity). Since $\overline{BC}$ is the side opposite to the angle with measure 32° and AB is the hypotenuse in right triangle ABC, the ratio $\frac{BC}{AB}$ is equal to $\frac{DF}{DE}$.

Alternate approach: The trigonometric ratios can be used to answer this question. In right triangle ABC, the ratio $\frac{BC}{AB} = \sin(32°)$. The angle E in triangle DEF has measure 32° because $m(\angle D) + m(\angle E) = 90°$. In triangle DEF, the ratio $\frac{DF}{DE} = \sin(32°)$. Therefore, $\frac{DF}{DE} = \frac{BC}{AB}$.

Choice A is incorrect because $\frac{DE}{DF}$ is the reciprocal of the ratio $\frac{BC}{AB}$. Choice C is incorrect because $\frac{DF}{EF} = \frac{BC}{AC}$, not $\frac{BC}{AB}$. Choice D is incorrect because $\frac{EF}{DE} = \frac{AC}{AB}$, not $\frac{BC}{AB}$.

Additional Assessment: Similar Triangles:

https://achievethecore.org/coherence-map/HS/G/116/611/611

The linked assessment question addresses G-SRT.A, specifically the question requires students to look at two triangles with a given pair of congruent angles and state a series of transformations to map one onto the other. Students will apply rotation, translation and a generic dilation in this example. This assessment

	should be given to students after they've had time to work with concrete examples of dilations as this more complicated example requires abstract algebra in terms of the scale factor. Students will engage in SMP1, SMP2, and potentially SMP3 depending on if students work in groups to share their solutions.

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Grade	*CCSS Domain*	*CCSS Strand*
G	**Similarity, Right Triangles, & Trigonometry**	**Prove theorems involving similarity**

Sample Task #1 (Constructed Response)

Standards Aligned Instructionally Embedded Formative Assessment Resources:
SAT Item #: 422453 The linked assessment question addresses G-SRT.B, specifically the question requires students to solve for a side length in a series of composed right triangles.

CollegeBoard	Question ID 422453						
Assessment **SAT**	Test **Math**	Cross-Test and Subscore **Additional Topics in Math**	Difficulty **Hard**	Primary Dimension **Additional Topics in Math**	Secondary Dimension **Right triangles and trigonometry**	Tertiary Dimension **1. Solve problems in a variety of contexts using c. properties of special right triangles.**	Calculator **No Calculator**

In the figure above, $\overline{BD}$ is parallel to $\overline{AE}$. What is the length of $\overline{CE}$?

Sample Task #2

Question Difficulty: Hard

The correct answer is 30. In the figure given, since $\overline{BD}$ is parallel to $\overline{AE}$ and both segments are intersected by $\overline{CE}$, then angle BDC and angle AEC are corresponding angles and therefore congruent. Angle BCD and angle ACE are also congruent because they are the same angle. Triangle BCD and triangle ACE are similar because if two angles of one triangle are congruent to two angles of another triangle, the triangles are similar. Since triangle BCD and triangle ACE are similar, their corresponding sides are proportional. So in triangle BCD and triangle ACE, $\overline{BD}$ corresponds to $\overline{AE}$ and $\overline{CD}$ corresponds to $\overline{CE}$. Therefore, $\frac{BD}{CD} = \frac{AE}{CE}$. Since triangle BCD is a right triangle, the Pythagorean theorem can be used to give the value of CD: $6^2 + 8^2 = CD^2$. Taking the square root of each side gives $CD = 10$. Substituting the values in the proportion $\frac{BD}{CD} = \frac{AE}{CE}$ yields $\frac{6}{10} = \frac{18}{CE}$. Multiplying each side by CE, and then multiplying by $\frac{10}{6}$ yields $CE = 30$. Therefore, the length of $\overline{CE}$ is 30.

http://tasks.illustrativemathematics.org/content-standards/HSG/SRT/B/4/tasks/1568

The linked assessment question addresses G-SRT.B, specifically the question requires students to show two triangles are similar and then use ratios of side lengths to derive the Pythagorean theorem. This assessment should be given to students after they've worked with setting up ratios for similar triangles. Students will engage in SMP3, SMP6 and, if asked to share and critique work of peers, SMP3.

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Grade	*CCSS Domain*	*CCSS Strand*
G	**Similarity, Right Triangles, & Trigonometry**	**Define trigonometric ratios and solve problems involving right triangles**

Sample Task #1 (Constructed Response)

CollegeBoard Question ID 4169029

SAT	Math	Additional Topics in Math	Medium	Additional Topics in Math	Right triangles and trigonometry	4. Solve problems using the relationship between sine and cosine of complementary angles.	Calculator

In a right triangle, the tangent of one of the two acute angles is $\frac{\sqrt{3}}{3}$. What is the tangent of the other acute angle?

Question Difficulty: Medium

A. $-\frac{\sqrt{3}}{3}$

B. $-\frac{3}{\sqrt{3}}$

C. $\frac{\sqrt{3}}{3}$

D. $\frac{3}{\sqrt{3}}$

Choice D is correct. The tangent of a nonright angle in a right triangle is defined as the ratio of the length of the leg opposite the angle to the length of the leg adjacent to the angle. Using that definition for tangent, in a right triangle with legs that have lengths a and b, the tangent of one acute angle is $\frac{a}{b}$ and the tangent for the other acute angle is $\frac{b}{a}$. It follows that the tangents of the acute angles in a right triangle are reciprocals of each other. Therefore, the tangent of the other acute angle in the given triangle is the reciprocal of $\frac{\sqrt{3}}{3}$ or $\frac{3}{\sqrt{3}}$.

Choice A is incorrect and may result from assuming that the tangent of the other acute angle is the negative of the tangent of the angle described. Choice B is incorrect and may result from assuming that the tangent of the other acute angle is the negative of the reciprocal of the tangent of the angle described. Choice C is incorrect and may result from interpreting the tangent of the other acute angle as equal to the tangent of the angle described.

Additional Assessment:

http://tasks.illustrativemathematics.org/content-standards/HSG/SRT/C/tasks/1316

The linked assessment question addresses G-SRT.C, specifically the question requires students to apply right

	triangle geometry to the context of points on a map. Students will need to visualize points on a map forming a right triangle and then apply formulas and concepts they are familiar with to solve contextual problems. This assessment should be given to students after they've been introduced to the formal definition of trigonometric ratios and applications of Pythagorean theorem and similar triangles. Students will engage in SMP1, SM 4, and potentially SMP5 if students are required to generate their own maps using tools.

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MLSS AND CLR GUIDE

- Understand similarity in terms of similarity transformations
- Prove theorems involving similarity
- Define trigonometric ratios and solve problems involving right triangle

CCSS Domain	*CCSS Cluster*
Similarity, Right Triangles, and Trigonometry	**Understand similarity in terms of similarity transformations**

Culturally and Linguistically Responsive Instruction

Relevance to Families and Communities	During a unit focused on understanding similarity in terms of similarity transformation, 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, when looking at ancient pottery pattern samples, how can Mesopotamian pottery patterns relate to Native American or African pottery patterns displayed throughout various cultures.	
Cross-Curricular Connections	Drafting/Architecture: Connect to trusses, shadow lengths	
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 of students of marginalized cultures and languages?* • *How can you create connections between the cultural and linguistic behaviors of your students' home*	• 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. Using equitable talk moves students in the ways they talk about who is and isn't capable of mathematics. As a result, 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 understanding similarity

	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?	in terms of similarity transformation, facilitating meaningful mathematical discourse is critical because instructors should be able to draw from student misconceptions and translate these into learning pieces which will engage students in building on each other's ideas and deepen understanding of similarity transformation.

Planning for Multi-Layered System of Supports

Vertical Alignment

Previous Learning	*Current Learning*	*Future Learning*
• In 8th grade, students perform transformations, including dilations, in a coordinate plane. They also identify a sequence of transformations that highlights the similarity of two figures.	• In later clusters within the Geometry course, students connect their conceptual understanding of similarity to explore trigonometric relationships including special right triangles and trigonometric ratios.	• Students will continue their work with similar figures in later courses when working with trigonometric ratios and the unit circle. They will use their understanding of dilations when working with functions to determine a stretch/shrink transformation.

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 uses images/resources (especially those being used the first time) when understanding similarity in terms of similarity transformation SRT.A. cluster because it is important for students to understand prior knowledge vocabularies as they are introduced to more complex ones.

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Intensive	*What critical understandings will prepare students to access the mathematics for this cluster?*	Standard 8.G.A.4- Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them. This standard provides a foundation for working with understanding similarity in terms of similarity transformation SRT.A. cluster because when students are not clear on the language structure of the mathematical problem at hand, it allows for a lot of misconceptions when the language has been presented in an advanced manner. 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***

• Transformations as functions and symmetry in terms of transformations.
• Two figures are congruent if there is a sequence of transformations that maps one onto another.
• Two figures are similar if they have the same shape with congruent angles and proportional side lengths.
• The formal language for relationships between angles including vertical angles, angles created when a transversal intersects parallel
	• Carry out rotations, reflections, translations, and dilations using a variety of tools and compare and contrast their effects.
	• Prove two triangles are congruent using ASA, SAS, and SSS or two triangles are similar using AA, SAS, and SSS.
	• Build formal justifications (proofs) for the theorems about lines and angles, triangles, and parallelograms.
		• Build on students' experience with the following skills:
		  ○ Understand and use the coordinate axis
		  ○ Write and solve linear equations, especially proportions
		  ○ Recognize and draw geomteric shapes (square, triangle, trapezoid, etc.)
		  ○ Understand and use the formulas of geometric shapes (Perimeter, Area, Volume, etc.)
		• Cognitive Strategies
		  ○ Repeatedly model the strategies
		  ○ Monitor the students' use of the strategies
		  ○ Provide feedback to students
		  ○ Teach self-questioning and self-monitoring strategies
		  ○ Introduce multiple means of representation for mathematical ideas
		• Encourage students to use alternative tools to better access the grade level content. Examples

lines, angles and sides of triangles, the segments and angles of parallelograms, and the trigonometric ratios sine, cosine, and tangent.	• Find unknown side lengths and angle measures of right triangles using trigonometric ratios and the Pythagorean Theorem.	include: ○ Desmos graphing calculator ○ Desmos scientific calculator ○ Desmos geometry tool ○ GeoGebra ○ **Graphing or scientific calculator** ○ **Google Drawing** ○ **Geometric tools (ruler, protractor, compass, etc.)** ○ **Tracing paper** ○ **Graph paper and mirror/string/etc.** ○ **Craft tools (scissors, string, construction paper, etc.)** ○ **Paper folding**

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 with content during a unit on understanding similarity in terms of similarity transformation SRT. A. cluster by examining tasks from a different perspective through a short mini-lesson because allowing students to connect their knowledge of scale and transitions into more complex thought processes such as dilations can help re-shift the reason why this standard is important in this context.
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 on understanding similarity in terms of similarity transformation SRT. A. cluster by offering opportunities to understand and explore different strategies because students might be able to explore the concept of “same shape” much easier than the concept of congruence.

Extension	
Essential Question	***Examples***
What type of extension will offer additional challenges to	Some learners may benefit from an extension to explore

'broaden' your student's knowledge of the mathematics developed within your HQIM?	links between various topics when understanding similarity in terms of similarity transformation SRT.A. cluster. Introducing students to angle measurements and how they aid in the process of transformation as well as congruence will help students avoid any misconceptions in the similarity cluster.

CCSS Domain	*CCSS Cluster*
Similarity, Right Triangles, and Trigonometry	**Prove theorems involving similarity**

Culturally and Linguistically Responsive Instruction

Relevance to Families and Communities	During a unit focused on proving theorems involving similarity, 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, in the field of forensics, being able to determine the height of an individual contrasted with a fixed object in a video frame.	
Cross-Curricular Connections	Physics- Connect to Vectors, particularly in resultants and to Dimensional Kinematics Art – Connect to drafting/architecture and to shapes and reflection within works of art	
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 of students of marginalized cultures and languages?* • *How can you create connections between the cultural and linguistic behaviors of*	• Building Procedural Fluency from Conceptual Understanding: Instruction should build from conceptual understanding to allow students opportunities to make meaning of mathematics before focusing on procedures. When new learning begins with procedures it hinders students with strong prior familiarity from learning more methods for solving tasks that occur outside of school mathematics. For example, when proving theorems involving similarity, the types of mathematical tasks are critical because the connections that can be utilized from an ELA standpoint (argumentative critical thinking) towards proving theorems in a mathematical world can be of instrumental value prior to introducing the procedural fluency (e.g. the Pythagorean theorem).

	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?	

Planning for Multi-Layered System of Supports

Vertical Alignment

Previous Learning	*Current Learning*	*Future Learning*
• In 8th grade, students developed the idea of "same shape" and "scale factor" as a definition of similarity. They will develop and connect these ideas when proving theorems within this cluster.	• Having previously studied dilations, students expand their definition of similarity to include congruence and dilation. These concepts lead to the criteria for triangle similarity. Students use proportional reasoning to approach problems involving similar figures. Trigonometric ratios will be developed using similar right triangles in connection to the work within this cluster.	• The trigonometric ratios (sine, cosine, tangent) will be founded on right triangles and similarity in subsequent learning. The Pythagorean theorem is generalized to non-right triangles by the Law of Cosines and Law of Sines.

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*	Some learners may benefit from targeted pre-teaching that uses images/resources (especially those being used the first time) when proving theorems involving similarity because students can make connections between right

	cluster within your HQIM?	triangles by drawing a perpendicular line to bisect a bigger right triangle to form two smaller ones.
Intensive	*What critical understandings will prepare students to access the mathematics for this cluster?*	8.G.B.6- Explain a proof of the Pythagorean Theorem and its converse**.** This standard provides a foundation for work with proving theorems involving similarity because when students understand the similarity between right triangles and the Pythagorean theorem, they will be able to make trigonometric connections between the two. 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***

• Transformations as functions and symmetry in terms of transformations.
• Two figures are congruent if there is a sequence of transformations that maps one onto another.
• Two figures are similar if they have the same shape with congruent angles and proportional side lengths.
• The formal language for relationships between angles including vertical angles, angles created when a transversal intersects parallel lines, angles
	• Carry out rotations, reflections, translations, and dilations using a variety of tools and compare and contrast their effects.
	• Prove two triangles are congruent using ASA, SAS, and SSS or two triangles are similar using AA, SAS, and SSS.
	• Build formal justifications (proofs) for the theorems about lines and angles, triangles, and parallelograms.
	• Find unknown side lengths and angle measures of right
		• Build on students' experience with the following skills:
		  ○ Understand and use the coordinate axis
		  ○ Write and solve linear equations, especially proportions
		  ○ Recognize and draw geomteric shapes (square, triangle, trapezoid, etc.)
		  ○ Understand and use the formulas of geometric shapes (Perimeter, Area, Volume, etc.)
		• Cognitive Strategies
		  ○ Repeatedly model the strategies
		  ○ Monitor the students' use of the strategies
		  ○ Provide feedback to students
		  ○ Teach self-questioning and self-monitoring strategies
		  ○ Introduce multiple means of representation for mathematical ideas
		• Encourage students to use alternative tools to better access the grade level content. Examples include:

and sides of triangles, the segments and angles of parallelograms, and the trigonometric ratios sine, cosine, and tangent.	triangles using trigonometric ratios and the Pythagorean Theorem.	○ Desmos graphing calculator ○ Desmos scientific calculator ○ Desmos geometry tool ○ GeoGebra ○ **Graphing or scientific calculator** ○ **Google Drawing** ○ **Geometric tools (ruler, protractor, compass, etc.)** ○ **Tracing paper** ○ **Graph paper and mirror/string/etc.** ○ **Craft tools (scissors, string, construction paper, etc.)** ○ **Paper folding**

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 with content during a unit on proving theorems involving similarity by revisiting student thinking through a short mini-lesson because it is important to understand where students are in terms of vocabulary such as similar and scale factors, so that when tackling the proofs students are not intimidated by the mathematical language expected.
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 on proving theorems involving similarity by offering opportunities to understand and explore different strategies because it might help clear up different misconceptions when students are allowed to display understanding in different ways. For example: with EL students one strategy would be to pair up individuals with native English-speaking classmates as they explore the task.

Extension	
Essential Question	***Examples***
What type of extension will offer additional challenges to	For example, some learners may benefit from an

'broaden' your student's knowledge of the mathematics developed within your HQIM?	extension such as the opportunity to explore links between various topics when studying proving theorems involving similarity because students might be able to broaden their knowledge of similarity into real world scenarios such as in the architectural field.

CCSS Domain	*CCSS Cluster*
Similarity, Right Triangles, and Trigonometry	**Define trigonometric ratios and solve problems involving right triangles**

Culturally and Linguistically Responsive Instruction

Relevance to Families and Communities	During a unit focused on trigonometric ratios and solving problems involving right triangles, 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, when looking at trigonometric ratios of right triangles, students can relate the ratios of the triangle if we focus on sports. Shooting a basketball from 5 feet away vs. shooting a basketball from 10 ft away will show you congruence. Scaling down the basket by ½ the height can provide a transition into trigonometric ratios.	
Cross-Curricular Connections	STEM: Connect to engineering and construction use of trigonometry to determine accurate angles and/or missing lengths.	
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 of students of marginalized cultures and languages?* • *How can you create connections between the cultural and*	• Using and Connecting Mathematical Representations: The standard for mathematical practice, use appropriate tools strategically, provides a strong foundation to validate and bridge concepts for students. Mathematical representations are mathematical tools. The linguistic and cultural experiences of students provide different and varied types of representations for solving mathematical problems. By explicitly encouraging students to use multiple mathematical representations students can draw on their "mathematical, social, and cultural competence". By valuing these representations and discussing them we can connect student representations to the representations of school mathematics and build a bridge for students to position them as competent and capable mathematicians. For example, when studying

	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?	trigonometric ratios and solving problems involving right triangles the use of mathematical representations within the classroom is critical because students will relate the background knowledge within cross-curricular activities and relate it to the different mathematical representations needed for this cluster.

Planning for Multi-Layered System of Supports

Vertical Alignment

Previous Learning	*Current Learning*	*Future Learning*
• In 8th grade, students applied the Pythagorean Theorem to find unknown side length in right triangles and distance between two points. They will make connections between Pythagorean Theorem and trigonometric ratios to continue solving right triangles in this cluster.	• Students will continue to use trigonometric ratios throughout the remainder of the course. A strong procedural fluency is necessary for individuals to apply these ratios to items within future clusters. Pythagorean Theorem and the trigonometric ratios are used to find lengths necessary for finding surface areas and volumes. Students use similarity concepts when defining properties of circles, arc lengths, and sector areas.	• In future courses, trigonometric ratios are used to develop more complex concepts such as relationships within the unit circle. Students will graph the trigonometric functions and observe the cyclic patterns that arise from the trigonometric ratio relationships.

Suggested Instructional Strategies

Pre-Teach

Level of Intensity	*Essential Question*	*Examples*
Targeted	*What pre-teaching will prepare students to*	Some learners may benefit from targeted pre-teaching that introduces new representations when studying

	productively struggle with the mathematics for this cluster within your HQIM?	trigonometric ratios because students will be able to draw on prior knowledge of trigonometric ratios by representing proportional relationships between quantities learned prior to this cluster.
Intensive	*What critical understandings will prepare students to access the mathematics for this cluster?*	7.RP.A.2- Recognize and represent proportional relationships between quantities: This standard provides a foundation for work with trigonometric ratios because the ratios explored in graphing linear relationships can now be explored by exposing students to trigonometric ratios within a right triangle. 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

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• The formal language for relationships between angles including vertical angles, angles created when a transversal intersects parallel
	• Carry out rotations, reflections, translations, and dilations using a variety of tools and compare and contrast their effects.
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	• Build formal justifications (proofs) for the theorems about lines and angles, triangles, and parallelograms.
		• Build on students' experience with the following skills:
		  ○ Understand and use the coordinate axis
		  ○ Write and solve linear equations, especially proportions
		  ○ Recognize and draw geomteric shapes (square, triangle, trapezoid, etc.)
		  ○ Understand and use the formulas of geometric shapes (Perimeter, Area, Volume, etc.)
		• Cognitive Strategies
		  ○ Repeatedly model the strategies
		  ○ Monitor the students' use of the strategies
		  ○ Provide feedback to students
		  ○ Teach self-questioning and self-monitoring strategies
		  ○ Introduce multiple means of representation for mathematical ideas
		• Encourage students to use alternative tools to better access the grade level content. Examples

lines, angles and sides of triangles, the segments and angles of parallelograms, and the trigonometric ratios sine, cosine, and tangent.	• Find unknown side lengths and angle measures of right triangles using trigonometric ratios and the Pythagorean Theorem.	include: ○ Desmos graphing calculator ○ Desmos scientific calculator ○ Desmos geometry tool ○ GeoGebra ○ **Graphing or scientific calculator** ○ **Google Drawing** ○ **Geometric tools (ruler, protractor, compass, etc.)** ○ **Tracing paper** ○ **Graph paper and mirror/string/etc.** ○ **Craft tools (scissors, string, construction paper, etc.)** ○ **Paper folding**

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 with content during a unit on solving problems involving right triangles by clarifying mathematical ideas and/or concepts through a short mini-lesson because polygons other than triangles are not necessarily similar if each pair of corresponding angles is congruent. For example, all rectangles have congruent corresponding angles, but the corresponding sides of all rectangles do not have the same ratio.
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 on solving problems involving right triangles by offering opportunities to understand and explore different strategies because by investigating patterns of association in bivariate data students can use scatter plots and linear models.

Extension	
Essential Question	***Examples***
What type of extension will offer additional challenges to 'broaden' your student's knowledge of the mathematics	For example, some learners may benefit from an extension such as open-ended tasks linking multiple

developed within your HQIM?	disciplines when studying to define trigonometric ratios because students can make connections between engineering practices such as building electronics such as TVs. Understanding how trigonometric ratios an intricate part of the development of tv screens are will create a real-life extension for students.