NEW MEXICO
Public Education Department

8.G: GEOMETRY

Cluster Statement: B: Understand and apply the Pythagorean Theorem.

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.G.B.6: Explain a proof of the Pythagorean Theorem and its converse.	SMP 3: Students construct viable arguments and critique the reasoning of others by explaining a proof of the Pythagorean Theorem. SMP 4: Students use modeling to understand the meaning of the Pythagorean Theorem and prove it.	• Model a proof of the Pythagorean Theorem and verbally or in written form explain the proof. • Understand the converse of the Pythagorean Theorem and be able to apply it to any triangle to prove it is or is not a right triangle. **Webb's Depth of Knowledge:** 2-4 **Bloom's Taxonomy:** Apply, Evaluate
Standard Text	**Standard for Mathematical Practices**	**Students who demonstrate understanding can:**
8.G.B.7: Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.	SMP 7: Students look for and make use of structure by discovering how the Pythagorean Theorem can be used to solve for any side of a right triangle.	• Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions. • Solve problems where they must apply the Pythagorean Theorem. **Webb's Depth of Knowledge:** 1-2 **Bloom's Taxonomy:** Understand, Apply

<table>
<tr>
<td>Standard Text

8.G.B.8: Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.</td>
<td>Standard for Mathematical Practices

SMP 7: Students use the structure of the coordinate plane to draw a right triangle, an example of looking for and making use of structure in the coordinate plane.

SMP 6: Students attend to precision when substituting the correct values into the Pythagorean Theorem, calculating correctly, and using academic vocabulary correctly in explanations.</td>
<td>Students who demonstrate understanding can:
Apply the Pythagorean Theorem to find the distance between two points on a coordinate system.
Recognize the diagonal line is the hypotenuse and the vertical and horizontal legs that connect are the legs.
Solve real-world problems using the Theorem as a strategy.
Explain solution strategies using correct mathematical vocabulary.
Webb's Depth of Knowledge: 1-2

Bloom's Taxonomy:
Understand, Apply</td>
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<td><u>Previous Learning Connections</u>
In 6th grade, students graph points in a coordinate system and find the horizontal or vertical distance between two points in a coordinate system. Students draw polygons in a coordinate system when given vertices. In 7th grade, students expand these skills to find the area of squares.</td>
<td><u>Current Learning Connections</u>
In 8th grade, students will use square root symbols to represent solutions and approximate square root values.</td>
<td><u>Future Learning Connections</u>
In high school, students prove theorems about triangles. Students use Pythagorean Theorem to solve problems and discover other mathematical relationships.</td>
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<tr>
<td colspan="3">Clarification Statement:
Students explore the relationships between sides of a right triangle to understand the formula $a^2 + b^2 = c^2$. They solve problems applying the Pythagorean Theorem.</td>
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<td colspan="3">Common Misconceptions
Some students might calculate the length of the triangle leg instead of the hypotenuse. Confuse the leg for the hypotenuse.
Students may forget to find the square root.
Students try to find missing side lengths for triangles that are not right triangles and need experiences reconstructing the proof by drawing squares on the sides of the triangle to see that the areas do not add up.</td>
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<tr>
<td colspan="3">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 uses images/resources (especially those being used the first time) when studying to understand and apply the Pythagorean Theorem because students are already very</td>
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familiar with triangles and to revisit the type of triangles, angles of a triangle and know that this theorem is only applicable to a right triangle. They will also benefit from reviewing exponents, squares and square roots.

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

- 7.G.B.6 : This standard provides a foundation for work to understand and apply the Pythagorean Theorem- because reviewing what they learned about triangles from the previous year will help them connect to the 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.

Core Instruction

Access

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

- For example, learners engaging with understanding and application of the Pythagorean Theorem benefit when learning experiences include ways to recruit interest such as providing novel and relevant problems to make sense of complex ideas in creative ways because students can see real-world use of the theorem and make connections. The Pythagorean Theorem is used in football, baseball, in construction and architecture. GPS coordinates use the Pythagorean Theorem as well. When students solve problems that they can relate to, it makes the math more meaningful and relevant.

Build

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

- For example, learners engaging with understanding and application of the Pythagorean Theorem 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 when students see that the math standard connects to their cultural background, they see it as relevant to them. The Pythagorean Theorem has ancient proofs that span the Earth, over many continents and countries. The ancient uses, by our ancestors are relevant to our understanding the modern uses of the Theorem.

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 understanding and application of the Pythagorean Theorem benefit when learning experiences attend to the linguistic and nonlinguistic representations of mathematics to ensure clarity can comprehensibility for all learners such as embedding visual, non-linguistic supports for vocabulary clarification (pictures, videos, etc.)m because a visual model of the Pythagorean Theorem, with key vocabulary highlighted will help students makes connections to the key components of the theorem (a,b are legs and c is the hypotenuse). Videos can model uses of the Pythagorean Theorem, the components and key vocabulary of the theorem and show students how to apply it to real world problems.

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 understanding and application of the Pythagorean Theorem 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 these math tools will help students work efficiently on the task. Using calculators is an efficient way for students to square numbers and to get the square root of numbers. Using graph paper can help students find the distance between two points in a coordinate system. Geometric software can also be helpful for this standard.

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 understanding and application of the Pythagorean Theorem 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 using outlines, graphic organizers, unit organizer routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships because graphic organizers can be powerful visual aids that help students review the key components of the Pythagorean Theorem. They can use them to visualize the proofs, the converse of the theorem and the application of the theorem. They can also include concept mastery routines that emphasize the key concepts (ex. How to solve for a missing leg? How to solve for a missing hypotenuse? How to apply the converse to prove a triangle is a right triangle or not?).

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 how to understand and apply the Pythagorean Theorem by clarifying mathematical ideas and/or concepts through a short mini-lesson because a clear understanding of a right triangle and the part of a right triangle will make the application of the Pythagorean Theorem clearer.

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 to understand and apply the Pythagorean Theorem-insert language of cluster by addressing conceptual understanding because application of the theorem is a multi-layer approach and students will have a better learning path if concepts underlying the theorem is clear to them.

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 to understand and apply the Pythagorean

	Theorem because students will have a better appreciation of the mathematics around them and know that the presence of mathematics is beyond math class.

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?

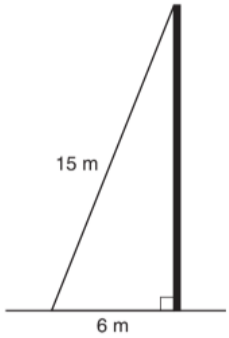
Facilitating Meaningful Mathematical Discourse: Mathematics discourse requires intentional planning to ensure all students feel comfortable to share, consider, build upon and critique the mathematical ideas under consideration. When student ideas serve as the basis for discussion we position them as 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 to understand and apply Pythagorean Theorem facilitating meaningful mathematical discourse is critical because when students can articulate what they understand or are confused about helps them validate what they currently know/not know. In some instances, students share what they know about triangles based on their cultural background.

Standards Aligned Instructionally Embedded Formative Assessment Resources:
Source: Cognia Formative Item Set for Grade 8 Geometry

8.G.B.7 Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

- Learning Target: I can use the Pythagorean Theorem to find the length of one leg of a right triangle.
- Webb's Depth of Knowledge: 2

This diagram shows a 15-meter wire attached to the top of a telephone pole. The wire is attached to the ground at a point 6 meters from the base of the pole.



What is the height of the pole?

Ⓐ $\sqrt{189}$ meters
Ⓑ $\sqrt{219}$ meters
Ⓒ $\sqrt{231}$ meters
Ⓓ $\sqrt{261}$ meters

Relevance to families and communities:	**Cross-Curricular Connections:**
During a unit focused on to understand and apply Pythagorean Theorem, 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, learning about the mathematics used within the different careers of your family and community can provide a strong connections between school and careers.	Language Arts: Students can do research on a famous mathematician that has a known proof of the Pythagorean Theorem and write an essay about the proof.