Model Lesson

Unit Name: Pythagorean Theorem	Unit Length: 45 minutes
Overview: Squaring numbers vs. areas of squares	

DESIRED RESULTS

TEKS and Student Expectations (See Appendix A for detailed description.)

(G.8) **Congruence and the geometry of size. (C)**

Enduring Understandings (Big Ideas)	Essential Questions	Critical Vocabulary
The operation of squaring a number can be modeled using the area of a square There is a relationship between the legs and hypotenuse of a right triangle.	Is there a relationship between the lengths of the legs and hypotenuse of a right triangle? Is there a connection between squaring a number and the area of a square?	Triangle (triangulo) Angle Measure (la medida del angulo) Legs (piernas) Hypotenuse (hipotenusa) Length (longitud) Squares (cuadrados) Area (area) Conjecture (conjetura) Relationship (relacion)

Learning Goals	Materials Needed
Content objective: The student will determine that, in a right triangle, the sum of the squares of the lengths of the legs is equal to the square of the length of the hypotenuse Language objective: The student will use the appropriate vocabulary for discussing the Pythagorean Theorem.	Interactive geometry software such as Geometer's Sketchpad

ASSESSMENT PLAN

Performance Tasks	Other Evidence
Quiz The students will use the Pythagorean Theorem to find missing measures in right triangles as shown in sketches	During the guided discovery lesson, the teacher will observe the students to determine understanding and participation in the lesson. The students

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Edited by:	Pat Curtin & John Beck, MELL Staff		Date:	March, 2008

(all measures for the first quiz will be Pythagorean Triples to provide whole number solutions).
Examples: 3, 4, __
               __, 8, 10
              5, __, 13
              8, 15, __
	will write a conjecture based on the investigation:
	$a^2 + b^2 = c^2$
	
	The students will explain the Pythagorean Theorem orally or in writing.

LEARNING PLAN

It is assumed that students are comfortable with the operation of squaring a number and finding the area of a square.

The teacher will review the concept of and vocabulary associated with right triangles, angle measure, and length measure. Most students will have heard of the Pythagorean Theorem and it's famous algorithm:
$a^2 + b^2 = c^2$

Place the students in groups. The size of each group will be determined by the number of computers vs. the number of students. Using a dynamic geometry software package (such as Geometer's Sketchpad), the teacher will provide a right triangle for each group. [Depending on the time available and computer skills of the students, the teacher may provide the completed sketch or guide the students to complete the sketch.] Students will use the software to determine the measure of each interior angle and the sum of the three angles; then drag a vertex about to notice that the right angle is fixed and the sum is always 180 degrees and that the right angle is always 90 degrees. (MC-12), (MC-15), (MC-16)

Next, students will determine the lengths of the two legs and the hypotenuse. The square of each length

MELL Connections

(MC-08) – Hands-on activities involving math manipulatives are typically helpful to ELLs because the lesson involves multiple learning modalities and does not require the student to rely solely upon his/her ability to understand verbal instruction.

(MC-12) – ELLs should be given numerous opportunities to write about the mathematics concepts they are learning. Journal entries, for example, provide opportunities for the students to crystallize their thinking about concepts and for the teacher to check for understanding. Students who have limited English language skills

will be computed and the squares of the lengths of the legs will be added. This sum will be the square of the length of the hypotenuse. (MC-08)

Students will then construct squares on the three sides of the triangle, construct the interiors of the squares, and measure the areas of the squares. They will add the areas on the legs and compare the sum to the area on the hypotenuse. (MC-12), (MC-16)

Students will compare the results obtained by squaring the lengths with the results obtained using the area of the squares constructed on the sides. By dragging a vertex, students will confirm the result for multiple triangles.

Students will write their conjecture in a journal, explain what they learned, and use the formula to confirm Pythagorean Triples. A brief quiz will be administered to confirm that the students can use the Pythagorean Theorem to determine missing measures. (MC-12), (MC-16)

A sample created in Geometer's Sketchpad® is attached.

should be allowed to write in their first language initially and should not be penalized for spelling or grammar errors.

(MC-15) –   In forming groups, the teacher should make sure that ELLs are assigned with a peer tutor, that ELLS are distributed   among groups, and that no group   is predominantly comprised of ELLs.

(MC-16) –   When monitoring ELLs during instruction, the teacher should make a special effort to assist, re-explain and demonstrate again, if necessary. Encouragement and reinforcement should be used frequently.

Pythagorean Theorem   Teorema Pitagórico
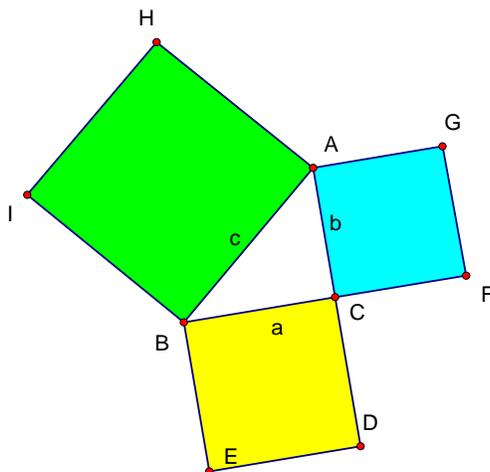
Measure Angle A = 49.25°   La medida del ángulo A = 49.25°

Measure Angle B = 40.75°   La medida del ángulo B = 40.75°

Measure Angle C = 90.00°   La medida del ángulo C = 90.00°

(Measure Angle A)+(Measure Angle B)+(Measure Angle C) = 180.00°

(La medida del ángulo A)+(La medida del ángulo B)+(La medida del ángulo C) = 180.00°

Sides a and b are legs of the 90 degree triangle

Toma partido a y b es piernas del 90 triángulo del grado

Side c is the hypotenuse   El lado c es la hipotenusa

Length of side a = 2.23 cm   la longitud del lado a = 2.23 cm

Length of side b = 1.92 cm   la longitud del lado b = 1.92 cm

Length of side c = 2.94 cm   la longitud del lado c = 2.94 cm

$(\text{Length of side a})^2+(\text{Length of side b})^2 = 8.64 \text{ cm}^2$

$(\text{la longitud del lado a})^2+(\text{la longitud del lado b})^2 = 8.64 \text{ cm}^2$

$(\text{Length of side c})^2 = 8.64 \text{ cm}^2$ $(\text{la longitud del lado c})^2 = 8.64 \text{ cm}^2$

Now look at the squares that are built on the three sides of the right triangle.

Ahora mire los cuadrados que son construidos en los tres lados del 90 triángulo del grado.

Area of the square on side a = 4.96 cm^2 el área del cuadrado en el lado a = 4.96 cm^2

Area of the square on side b = 3.68 cm^2 el área del cuadrado en el lado b = 3.68 cm^2

(Area of the square on side a)+(Area of the square on side b) = 8.64 cm^2

(el área del cuadrado en el lado a)+(el área del cuadrado en el lado b) = 8.64 cm^2

Area of the square on side c = 8.64 cm^2 el área del cuadrado en el lado c = 8.64 cm^2

Use point A, B, or C to change the size of the triangle.

Utilice el punto A, B, o C para cambiar el tamaño del triángulo.

English Language Proficiency Standards Quick Reference. (Chapter 74. Curriculum Requirements Subchapter A. Required Curriculum, §74.4. English Language Proficiency Standards). *The standards checked here are merely examples for the teacher's consideration for inclusion in this lesson.*	
Cross-curricular second language acquisition/listening. The ELL listens to a variety of speakers including teachers, peers, and electronic media to gain an increasing level of comprehension of newly acquired language in all content areas. ELLs may be at the beginning, intermediate, advanced, or advanced high stage of English language acquisition in listening. In order for the ELL to meet grade-level learning expectations across the foundation and enrichment curriculum, all instruction delivered in English must be linguistically accommodated (communicated, sequenced, and scaffolded) commensurate with the student's level of English language proficiency. The student is expected to:	[X] (c)(2)(A) - distinguish sounds and intonation patterns of English with increasing ease; (c)(2)(B) - recognize elements of the English sound system in newly acquired vocabulary such as long and short vowels, silent letters, and consonant clusters; (c)(2)(C) - learn new language structures, expressions, and basic and academic vocabulary heard during classroom instruction and interactions; (c)(2)(D) - monitor understanding of spoken language during classroom instruction and interactions and seek clarification as needed; (c)(2)(AE - use visual, contextual, and linguistic support to enhance and confirm understanding of increasingly complex and elaborated spoken language; (c)(2)(F) - listen to and derive meaning from a variety of media such as audio tape, video, DVD, and CD ROM to build and reinforce concept and language attainment; (c)(2)(G) - understand the general meaning, main points, and important details of spoken language ranging from situations in which topics, language, and contexts are familiar to unfamiliar; (c)(2)(H) - understand implicit ideas and information in increasingly complex spoken

	language commensurate with grade-level learning expectations; and (c)(2)(I) - demonstrate listening comprehension of increasingly complex spoken English by following directions, retelling or summarizing spoken messages, responding to questions and requests, collaborating with peers, and taking notes commensurate with content and grade-level needs.
Cross-curricular second language acquisition/speaking. The ELL speaks in a variety of modes for a variety of purposes with an awareness of different language registers (formal/informal) using vocabulary with increasing fluency and accuracy in language arts and all content areas. ELLs may be at the beginning, intermediate, advanced, or advanced high stage of English language acquisition in speaking. In order for the ELL to meet grade-level learning expectations across the foundation and enrichment curriculum, all instruction delivered in English must be linguistically accommodated (communicated, sequenced, and scaffolded) commensurate with the student's level of English language proficiency. The student is expected to:	[X] (c)(3)(A) - practice producing sounds of newly acquired vocabulary such as long and short vowels, silent letters, and consonant clusters to pronounce English words in a manner that is increasingly comprehensible; (c)(3)(B) - expand and internalize initial English vocabulary by learning and using high-frequency English words necessary for identifying and describing people, places, and objects, by retelling simple stories and basic information represented or supported by pictures, and by learning and using routine language needed for classroom communication; (c)(3)(C) - speak using a variety of grammatical structures, sentence lengths, sentence types, and connecting words with increasing accuracy and ease as more English is acquired; (c)(3)(D) - speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency; (c)(3)(E) - share information

	in cooperative learning interactions; (c)(3)(F) - ask and give information ranging from using a very limited bank of high-frequency, high- need, concrete vocabulary, including key words and expressions needed for basic communication in academic and social contexts, to using abstract and content-based vocabulary during extended speaking assignments; (c)(3)(G) - express opinions, ideas, and feelings ranging from communicating single words and short phrases to participating in extended discussions on a variety of social and grade- appropriate academic topics; (c)(3)(H) - narrate, describe, and explain with increasing specificity and detail as more English is acquired; (c)(3)(I) - adapt spoken language appropriately for formal and informal purposes; and (c)(3)(J) - respond orally to information presented in a wide variety of print, electronic, audio, and visual media to build and reinforce concept and language attainment.
Cross-curricular second language acquisition/reading. The ELL reads a variety of texts for a variety of purposes with an increasing level of comprehension in all content areas. ELLs may be at the beginning, intermediate, advanced, or advanced high stage of English language acquisition in reading. In	(c)(4)(A) - learn relationships between sounds and letters of the English language and decode (sound out) words using a combination of skills such as recognizing sound-letter relationships and identifying cognates, affixes, roots, and base words; (c)(4)(B) - recognize directionality of English

order for the ELL to meet grade-level learning expectations across the foundation and enrichment curriculum, all instruction delivered in English must be linguistically accommodated (communicated, sequenced, and scaffolded) commensurate with the student's level of English language proficiency. For Kindergarten and Grade 1, certain of these student expectations apply to text read aloud for students not yet at the stage of decoding written text. The student is expected to:

reading such as left to right and top to bottom;

(c)(4)(C) - develop basic sight vocabulary, derive meaning of environmental print, and comprehend English vocabulary and language structures used routinely in written classroom materials;

(c)(4)(D) - use prereading supports such as graphic organizers, illustrations, and pretaught topic- related vocabulary and other prereading activities to enhance comprehension of written text;

(c)(4)(E) - read linguistically accommodated content area material with a decreasing need for linguistic accommodations as more English is learned;

(c)(4)(F) - use visual and contextual support and support from peers and teachers to read grade- appropriate content area text, enhance and confirm understanding, and develop vocabulary, grasp of language structures, and background knowledge needed to comprehend increasingly challenging language;

(c)(4)(G) - demonstrate comprehension of increasingly complex English by participating in shared reading, retelling or summarizing material, responding to questions, and taking notes commensurate with content area and grade level needs;

(c)(4)(H) - read silently with increasing ease and comprehension for longer periods;

	(c)(4)(I) - demonstrate English comprehension and expand reading skills by employing basic reading skills such as demonstrating understanding of supporting ideas and details in text and graphic sources, summarizing text, and distinguishing main ideas from details commensurate with content area needs; (c)(4)(J) - demonstrate English comprehension and expand reading skills by employing inferential skills such as predicting, making connections between ideas, drawing inferences and conclusions from text and graphic sources, and finding supporting text evidence commensurate with content area needs; and (c)(4)(K) - demonstrate English comprehension and expand reading skills by employing analytical skills such as evaluating written information and performing critical analyses commensurate with content area and grade-level needs.
Cross-curricular second language acquisition/writing. The ELL writes in a variety of forms with increasing accuracy to effectively address a specific purpose and audience in all content areas. ELLs may be at the beginning, intermediate, advanced, or advanced high stage of English language acquisition in writing. In order for the ELL to meet grade-level learning expectations across foundation and enrichment curriculum, all	(c)(5)(A) - learn relationships between sounds and letters of the English language to represent sounds when writing in English; [x] (c)(5)(B) - write using newly acquired basic vocabulary and content-based grade-level vocabulary; (c)(5)(C) - spell familiar English words with increasing accuracy, and employ English spelling patterns and rules with increasing accuracy as more English is acquired;

| instruction delivered in English must be linguistically accommodated (communicated, sequenced, and scaffolded) commensurate with the student's level of English language proficiency. For Kindergarten and Grade 1, certain of these student expectations do not apply until the student has reached the stage of generating original written text using a standard writing system. The student is expected to: | (c)(5)(D) - edit writing for standard grammar and usage, including subject-verb agreement, pronoun agreement, and appropriate verb tenses commensurate with grade-level expectations as more English is acquired;
 e(c)(5)(E) - employ increasingly complex grammatical structures in content area writing commensurate with grade-level expectations, such as:
 (i)   using correct verbs, tenses, and pronouns/antecedents;
 (ii)   using possessive case (apostrophe *s*) correctly; and
 (iii) using negatives and contractions correctly;
 (c)(5)(F) - write using a variety of grade-appropriate sentence lengths, patterns, and connecting words to combine phrases, clauses, and sentences in increasingly accurate ways as more English is acquired; and
 [x] (c)(5)(G) - narrate, describe, and explain with increasing specificity and detail to fulfill content area writing needs as more English is acquired. |

Appendix A
TEKS and Student Expectations

(G.8) **Congruence and the geometry of size.** The student uses tools to determine measurements of geometric figures and extends measurement concepts to find perimeter, area, and volume in problem situations.

The student is expected to:
 (C) derive, extend, and use the Pythagorean Theorem.