

Model Lesson

Unit Name: Solving Quadratic Equations		Unit Length: 2 Weeks	
Overview: To solve quadratic equations by factoring, geometric modeling, graphing, tables and using quadratic formula			
DESIRED RESULTS			
TEKS and Student Expectations (See Appendix A for detailed description.)			
(A.10) Quadratic and other nonlinear functions. (A), (B)			
<u>Enduring Understandings (Big Ideas)</u> <ul style="list-style-type: none"> The parameters of a quadratic function determine its graph; different quadratic functions represent different relationships; and quadratic functions can be used to solve real world problems Quadratic equations are represented graphically by a parabola (a function with line symmetry, a vertex, and two roots.) Many real world problems can be represented by and solved with quadratic equations. 		<u>Essential Questions</u> <p>Where might you use this formula? Where is it used in art, architecture, agriculture, taxes, and other complex problem-solving contexts? What are the different ways to solve a quadratic equation?</p>	
		<u>Critical Vocabulary</u> <p>Equation, Function, Intercepts, Factoring, Derivation - Completing the Square, Quadratic Formula, Discriminant, Solution, Roots, Coefficients.</p>	
<u>Learning Goals</u> <p>The student will be able to take any quadratic function and determine the best way to solve it. The student will also learn why this formula is so important to learn.</p>		<u>Materials Needed</u> <p>Graph paper, algebra tiles, graphing calculator, LCD panel or Elmo for demonstration.</p>	
ASSESSMENT PLAN			

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<p><u>Performance Tasks</u> Given a unit test, the students will be able to solve a quadratic function using all methods.</p>	<p><u>Other Evidence</u> The student will learn how to determine which method will be most efficient based on the materials available.</p>
<p>GENERAL MELL CONNECTIONS THAT APPLY TO ALL LESSONS</p>	
<p>(MC-01) - To assist the ELLs, the teacher should avoid speaking too rapidly and when possible use basic words rather than unfamiliar ones to introduce new concepts. (MC-02) - Teachers should foster trusting relationships with ELLs through informal conversations and presentation of a culturally rich classroom. (MC-03) - ELLs may need extra opportunities to demonstrate mastery. Grading policies should be flexible enough to provide multiple learning opportunities without severe grade penalties. (MC-04) - ELLs may work at a slower pace than other students because of limited English language skills and should be provided with shortened assignments, or when appropriate, extra time to work on assignments. (MC-05) - ELLs should be scheduled in a math class that has students who have some proficiency in both languages. Teachers may need to work with counselors and others to ensure that this happens. (MC-06) - Teachers should offer tutoring as frequently as possible and encourage ELLs to come in for extra assistance. If possible, the teacher should arrange for an aide or parent volunteer who speaks the language of the ELL to help with translation during the tutoring period on a regular schedule (for example, on Tuesdays and Thursdays, after school).</p>	
<p>LEARNING PLAN</p>	
<p>[Note to teacher: Reproduce a timeline involving the uses of quadratic equations from Babylonians' agricultural needs, to Greeks' geometrical needs, to the golden ratio - aesthetic proportions of beauty, to discovery of Fibonnaci sequences describing arrangement of sunflower seeds & nautilus shells, to rabbit reproduction, to understanding the use of conics to describe the universe. Of course, ballistics will get the students' interest.]</p> <p>Engage</p> <p>The teacher will ask the students to produce</p>	<p><u>MELL Connections</u></p> <p>(MC-13) - Before asking ELLs to speak on a</p>

two numbers, given their sum and their product. The students will have a few minutes to guess and check their results. (This method was developed in elementary school.) (MC-01)

Then the teacher will engage the students in a discussion of other methods of producing the results - thus the quadratic equation. A timeline could be developed to give depth and complexity to the history and use of this equation.

The first introduction for solving the quadratic equation should be with simple factorable equations with integer results. Thus finding the two numbers with a certain sum and product will connect the two ideas. (MC-13)

Explore

To demonstrate the factoring method the student will use Algebra Tiles to set up a geometric representation of this factoring. This will help those students who need the kinesthetic tie. The teacher will model and the students will practice this activity until they can produce the answer without the tiles. (MC-07), (MC-08)

mathematics topic or problem in class, give the student time to practice what they will say with a peer tutor or partner. Without this technique, ELLs may tend to just say "I don't know" when asked a question to avoid possible embarrassment over language deficiencies.

(MC-07) - New concepts should first be presented to ELLs in a concrete manner, followed by a semi-concrete manner, and finally an abstract manner.

(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

The following methods will help with factors which are not integers:

Using the graphing calculator to solve for the x intercepts, thus revealing the solution to the equation, is very helpful for reinforcing the concept. The student will need a review of using the appropriate function keys. The teacher can model with an LCD panel or "Elmo" device. After modeling, the teacher should monitor individual student performance. Using the tracing key will help find the result and also variations of time. (MC-16)

Using the table from the graphing calculator will also reinforce the use of calculators as a tool. The table is a way of scrolling for the information from a list instead of the graph and is often more accurate. Using the completing-the-square method will reinforce the tie to the Pythagorean theorem. The teacher will demonstrate, and the students will practice. (Since the advent of calculators, this method has become almost archaic.)

Introducing the Quadratic Formula will help students solve any quadratic function no matter what materials they have available. This formula has been used for centuries as developed in the introduction. The student should have an ability to determine the a, b, c values after the equation has been solved for zero (solving literal equations should be a prerequisite). The student should also be able to use the substitution method and order of operations at this point. If not, the teacher will have to use guided practice to help the students. (MC-04)

It will be important to develop this equation with a deep understanding of the discriminant, and how it can be used to predict the

verbal instruction.

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

(MC-10) - ELLs should be provided with or assisted in developing a learning aid

outcomes.

Explain

For each of the above methods, the teacher will have to reinforce a grasp of when and how these methods may be applied efficiently. Very basic algebra skills are needed and reinforced or retaught during this process. The student will produce results using each different method and explain why the chosen method was used. (MC-10)

Elaborate

Elaboration on relevant concepts should be included throughout the learning process, beginning for example, with the introduction of the timeline illustrating the historical development and application of formulas, to current uses in the present. This deep backgrounding should better enable the student to determine which methods best apply to solving newly introduced problems. Many opportunities for further enhancement readily suggest themselves: for instance, if a ballistics expert is in the area, a guest speaker appearance might offer powerful enrichment. (MC-08)

Evaluate (MC-03), (MC-15)

The student will be able to successfully solve a quadratic equation by simple factoring, graphing and properly applying the quadratic formula.

The teacher will check the development of each student and assess accordingly.

Peer grouping will help with identifying and filling in individual gaps in knowledge acquisition, and will enable the teacher to proceed with all levels of development

that shows math vocabulary in both English and their native language and should be allowed to use this tool when working on assignments. Student-made glossaries, word walls, and compare and contrast charts may help ELLs learn mathematics vocabulary.

(MC-08) - To assist the ELLs, the teacher should model the expected task and use visual representations to reinforce concepts and/or steps in the problem-solving process. Critical concepts should be clearly emphasized and repeated.

(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.
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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.

<p><i>Cross-curricular second language acquisition/listening.</i> 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</p>	<p>[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; [X] (c)(2)(C) - learn new language structures, expressions, and basic and academic vocabulary heard during classroom instruction and interactions; [X] (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; [X] (c)(2)(H) - understand implicit ideas and information in increasingly complex spoken language commensurate with grade-</p>
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<p>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:</p>	<p>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.</p>
<p>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</p>	<p>[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; X[(c)(3)(D) - speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency; X[(c)(3)(E) - share information in cooperative learning interactions; [X] (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;</p>

<p>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:</p>	<p>(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.</p>
<p><i>Cross-curricular second language acquisition/reading.</i> 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 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,</p>	<p>(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 reading such as left to right and top to bottom; X[(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</p>

<p>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:</p>	<p>increasingly challenging language; [X] (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; [X] (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.</p>
<p><i>Cross-curricular second language acquisition/writing.</i> 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</p>	<p>(c)(5)(A) - learn relationships between sounds and letters of the English language to represent sounds when writing in English; (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; (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</p>

<p>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 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:</p>	<p>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 (apostrophes) 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 (c)(5)(G) - narrate, describe, and explain with increasing specificity and detail to fulfill content area writing needs as more English is acquired.</p>
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Appendix 1
TEKS and Student Expectations

(A.10) **Quadratic and other nonlinear functions.**

The student understands there is more than one way to solve a quadratic equation and solves them using appropriate methods.

The student is expected to:

(A) solve quadratic equations using concrete models, tables, graphs, and algebraic methods; and

(B) make connections among the solutions (roots) of quadratic equations, the zeros of their related functions, and the horizontal intercepts (x-intercepts) of the graph of the function.