***Taken from the ExamView Newsletter, September 2003* -- http://tinyurl.com/d7ug2n**

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Using Exam*View* to Create Dynamic Questions

I have a confession to make—I love to create dynamic questions using Exam*View*. Why, you ask? Well I know that the time spent creating a good dynamic question is like the time planting a seed from which a lush tree with many branches can grow. That is, you can spend between 5 and 45 minutes to create a simple or complex dynamic question (the seed). Then, just by adding a few conditions, changing a variable definition, or simply changing the value of a constant (watering the seed), you can quickly create additional dynamic questions (the tree branches). From just a few dynamic questions, it's easy to generate many, many copyright-free questions (leaves of the tree).

Once you create your own dynamic questions, you can use them on tests, quizzes, and study guides. It's as if you have an unlimited number of questions. That way, you'll have plenty of questions for students who need extra practice, or you can use the questions with other programs such as the following products that I have used in my classroom.

- MindPoint Quiz Show (see www.mindpoint.com) – Students can learn *and* have fun practicing in class, in the lab, and at home.

- Classroom Performance System (see www.einstruction.com) – With remote control response pads from eInstruction, I can display an Exam*View* question and instantly know whether **all** of my students understand the particular topic.

- Virtual Whiteboard Math Movies – You can create tutorials and/or solutions including audio on a virtual whiteboard that can be delivered over the Internet, LAN, or CD.

Getting Started

If you haven't created a dynamic question or you are not sure what a dynamic question is, let me suggest that you read and follow the steps in my previous article to learn the basics of dynamic question creation. Work through the tutorial using Exam*View* 4.0 and review the online help topics to better understand how to create a dynamic question.

In the following article, you will find three dynamic question examples: Rule of Exponents, Solving a System of Equations Using Substitution or Elimination, and Pythagorean Theorem. Before you begin, click here to download the following question bank (Dynamic Corner-Part I.bnk) *Windows* or (Dynamic Corner-Part I) *Macintosh*. The bank includes the sample questions. (Remember that you will need Exam*View* 4.0 or a more recent version.)

To help you better understand how to create dynamic questions, use the Question Bank Editor to open the question bank and review the algorithms that make up each question. For each example, I have provided a detailed explanation of the algorithms. In addition, I have included several variations of each question.

Example 1: Rule of Exponents

This first example is a bimodal question. That is, you can change its state from a Multiple Choice question to a Short Answer question with a single mouse click. This feature is great for creating problems that work for advanced placement classes.

As you can see, this question includes the question stem, choices, and a rationale. The rationale is an explanation of how to determine the correct answer. You can ask the program to display this information if you create an online test or a study guide. It provides students with the help they need at that "teachable moment." You can provide a little help or step-by-step instructions. It's up to you.

Rule of Exponents (Question #1)

Simplify: d^3d^5

A. d^8 **B.** d^2 **C.** d^{-2} **D.** d^{15}

ANS: A

When multiplying variables with like bases you **add** the exponents.

Here you add the exponents $3 + 5$ which equals 8, therefore $d^3d^5 = d^8$

NOT: Exponents are both positive.

Rule of Exponets-Variables

Question

Simplify: $var1^{exp1}var1^{exp2}$

A. $var1^{Result1}$ **B.** $var1^{Result2}$ **C.** $var1^{Result3}$ **D.** $var1^{Result4}$

Rationale

When multiplying variables with like bases you **add** the exponents.

Here you add the exponents exp1 + exp2 which equals Result1, therefore $var1^{exp1}var1^{exp2} = var1^{Result1}$

Rule of Exponents—Algorithm Definitions

letter	list("a","b","c","d","f","g","h","j","k","m","n","p","q","r","s","w","x","y")
whichLetter	range(1,18)
maxExponent	5
var1	choose(whichLetter,letter)
exp1	range(1,maxExponent)
exp2	range(1,maxExponent)
Result1	exp1+exp2
Result2	exp1-exp2
Result3	exp1*exp2
Result4	exp2-exp1
(condition)	isunique(Result1,Result2,Result3,Result4)

Note: To enter or edit an algorithm, double-click a question and choose Algorithm Definitions from the Edit menu.

A Closer Look at the Algorithm Definitions

Below is an explanation of the algorithms used in this question. The names you use for the algorithm definitions (or variables) are not critical as long as you do not use function names. As for the functions (e.g., list, range, choose, etc.), you can get a detailed description by reviewing the online help information in the program.

- **letter, whichletter,** and **var1** are *variables* used to generate a random variable from a list of 18 "good" variables. Notice that letters *e, i, l, o, t, u, v,* and *z* are not included for various reasons (e.g., *e* is the base of natural logarithms; *i* is often used to represent the square root of -1; the letters *l, o*, and *z* look like the digits 1, 0, and 2; *t* looks like a +; and *u* and *v* are easily confused with each other).

- **maxExponent** is a *constant* that determines the highest exponent allowed in this question. Change it to a larger value if desired.
- **exp1** and **exp2** are *variables* used to represent the two exponents that are to be added together. *range(1, maxExponent)* generates a random integer between 1 and *maxExponent*
- **Result1** to **Result4** are the exponents for the correct answer and the three distractors (for the multiple-choice version of this bimodal question).
- **isunique(Result1, … Result4)** is a condition that makes sure that none of the four multiple-choice answers are the same. In general you should add this condition to every multiple-choice question you create to prevent duplicate answers unless the distractors are built in such a way that this would never be the case.
- **scramble=TRUE** (not illustrated) causes the program to randomly scramble the answer choices each time you calculate a question

Changing the Algorithm Definitions to Create Variations of the Question
Once you create a dynamic question, you can use it to create one or more variations on the same topic. For example, the first variation shows how you can edit the algorithm to allow for negative exponents.

You can find this variation in the sample question bank that you downloaded. Click the **Edit** menu and choose *Algorithm Definitions* to see the list of variables. Click the **Calculate Values** button to see this question in action, or duplicate the question to create new questions of the same form.

Variation A—Allow for negative exponents (See Question #2 in the question bank.)

- Change the definition of **exp1** and **exp2**.A third parameter may be used to indicate the increment used. If the increment is not included, it is assumed to be 1. If a 1 is included in the increment position, the range will be from the first parameter to the second with an increment of 1 skipping the value of zero. For example:
  range(1,17,2) would generate random odd integers between 1 and 17.
  range (1,18,3) would include every third number between 1 and 18.
  range (-3,5,1) would generate a random integer between –3 and 5 excluding zero.
  range (-3,5) would generate a random integer between –3 and 5 including zero.
- Add two variables **exp1Display** and **exp2Display** (used in the dynamic solution).
- Add a new condition: **exp1+exp2<>0** (this prevents the sum of the exponents from equaling zero).

letter	list("a","b","c","d","f","g","h","j","k","m","n","p","q","r","s","w","x","y")
whichLetter	range(1,18)
var1	choose(whichLetter,letter)
maxExponent	5
exp1	range(-maxExponent,maxExponent,1)
exp1Display	if(exp1<0,"("+str(exp1)+")",str(exp1))
exp2	range(-maxExponent,maxExponent,1)
exp2Display	if(exp2<0,"("+str(exp2)+")",str(exp2))
Result1	exp1+exp2
Result2	exp1-exp2
Result3	exp1*exp2
Result4	exp2-exp1
(condition)	exp1+exp2>0
(condition)	isunique(Result1,Result2,Result3,Result4)
SCRAMBLE	TRUE

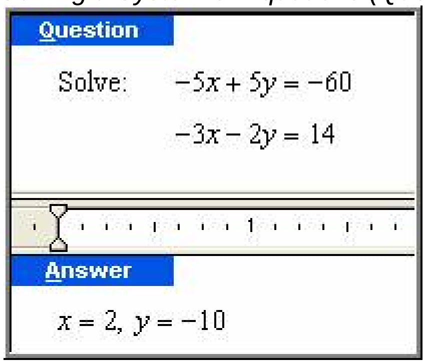
Variation B—Answer is always 1 since the sum of the exponents is zero. (See Question #3.)
You can vary the problem so that the answer is always 1 by changing the condition **exp1+exp2<>0** to **exp1+exp2=0.**
Then change the correct choice to $\mathrm{var1}^{\mathrm{Result1}} = 1$.

Variation C—Answer always has negative exponent. (See Question #4.)
To create a problem so that the answer always has a negative exponent, change the condition **exp1+exp2>0 to exp1+exp2<0.**

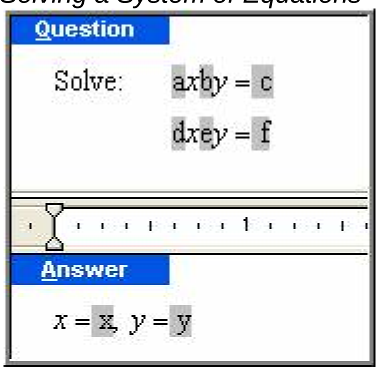
Notice how we've taken a single algorithm and tweaked it just a little to create questions that are similar but different. We could have created a more complex algorithm to start with that did all of these things but I think you'll see the advantages of creating questions that each do one thing well.

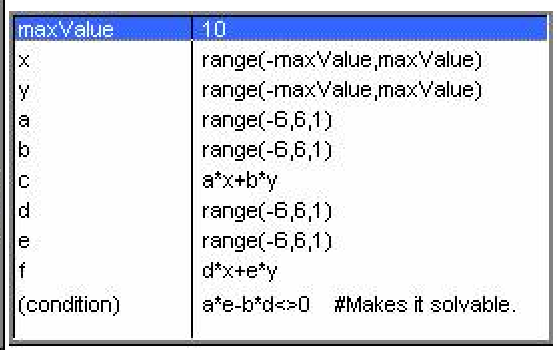
Example 2: Solving System of Equations Using Substitution or Elimination
This problem illustrates a dynamic question with a set of conditions that can be easily changed to generate a variety of types of systems of equations best solved by different methods.

Solving a System of Equations (Question PR #1)



Solving a System of Equations—Variables and Algorithm Definitions





maxValue	10
x	range(-maxValue,maxValue)
y	range(-maxValue,maxValue)
a	range(-6,6,1)
b	range(-6,6,1)
c	a*x+b*y
d	range(-6,6,1)
e	range(-6,6,1)
f	d*x+e*y
(condition)	a*e-b*d<>0 #Makes it solvable.

A Closer Look at the Algorithm Definitions

- **maxValue** is a *constant* which determines the range of values for *x* and *y*.
- **x**, **y**, **a**, **b**, **d**, and **e** are all random integers.
- **c** and **f** are calculated using the values of *a, x, b* and *y* (for *c*) and *d, x, e,* and *y* (for *f*).
- **condition a*e-b*d<>0** is included to make the system of equations solvable. This value is the determinant of the system.

Changing the Algorithm Definitions to Create Variations of the Question
Check the information below to see how you can easily create multiple versions of this problem.

Variation A—(See Question PR #2.) Make it so exactly one of the coefficients of *x* or *y* equals 1. This makes for a system most easily solved by substitution. Include the condition **a=1 xor b=1 xor d=1 xor e=1** *xor* means exclusive *or* – one or the other but not both or in this case only one).

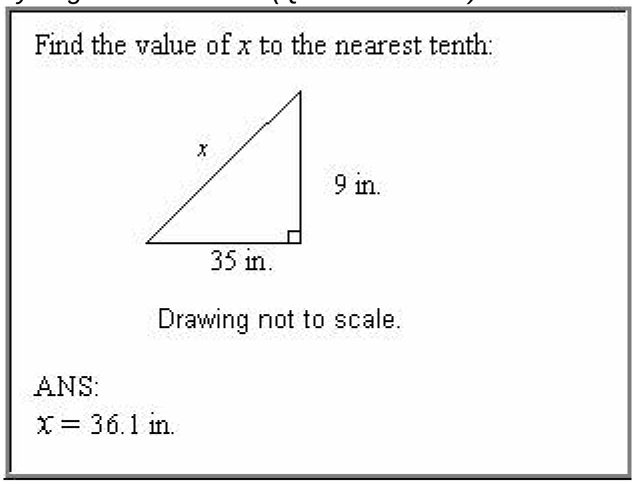
Variation B—(See Question PR #3.) Make it so exactly one of the coefficients of *x* (*a* or *d*) equals 1 and so that neither of the coefficients of *y* (*b* or *e*) equals 1. Include the condition **(a=1 xor d=1) and not(b=1 or e=1).**

Variation C—(See Question PR #4.) Make it so that *a* = -*d* or *b* = -*e* so that the system is most easily solved by just adding the two equations together using the method of elimination. Include the condition **a+d=0 xor b+e=0.**

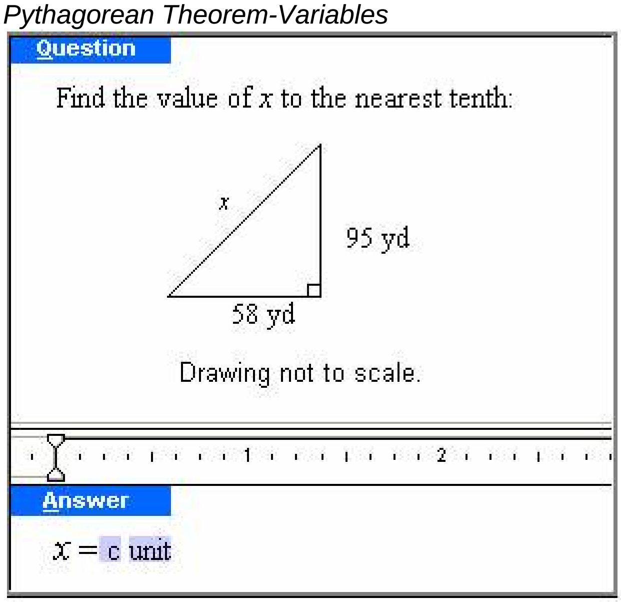
Variation D—(See Question PR #5.) Make it so that the system of equations is most easily solved by elimination but so that each equation will need to be multiplied by a constant in order for elimination to occur. Include the condition **a+d<>0 and b+e<>0**

Example 3: **Pythagorean Theorem**
While this problem shows you how to create a question to test your students' knowledge of the Pythagorean Theorem, it also shows how to create a dynamic question using a picture.

Pythagorean Theorem (Question PR #6)



Pythagorean Theorem-Variables

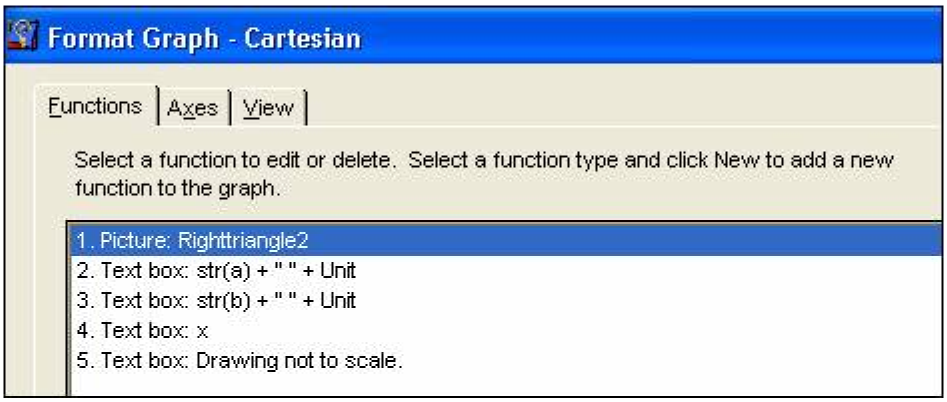


The algorithm below shows one constant (**maxLength**), and nine variables. Most of these are used "behind the scenes" to label a Cartesian Graph that includes a picture of a right triangle (see below). The variables *a* and *b* are defined (using the **range** function) as random integers between 1 and 100 (the value of **maxLength**). The variables **aSquared, bSquared,** and **aSquaredPlusbSquared** are longer variable names but self-explanatory. The variables are not used in the algorithm itself but in the display of the complete dynamic solution. The variable *c* is calculated using the Pythagorean Theorem. To make this problem more interesting, three variables were added to put English units next to the lengths of the sides.

Pythagorean Theorem—Variables and Algorithm Definitions

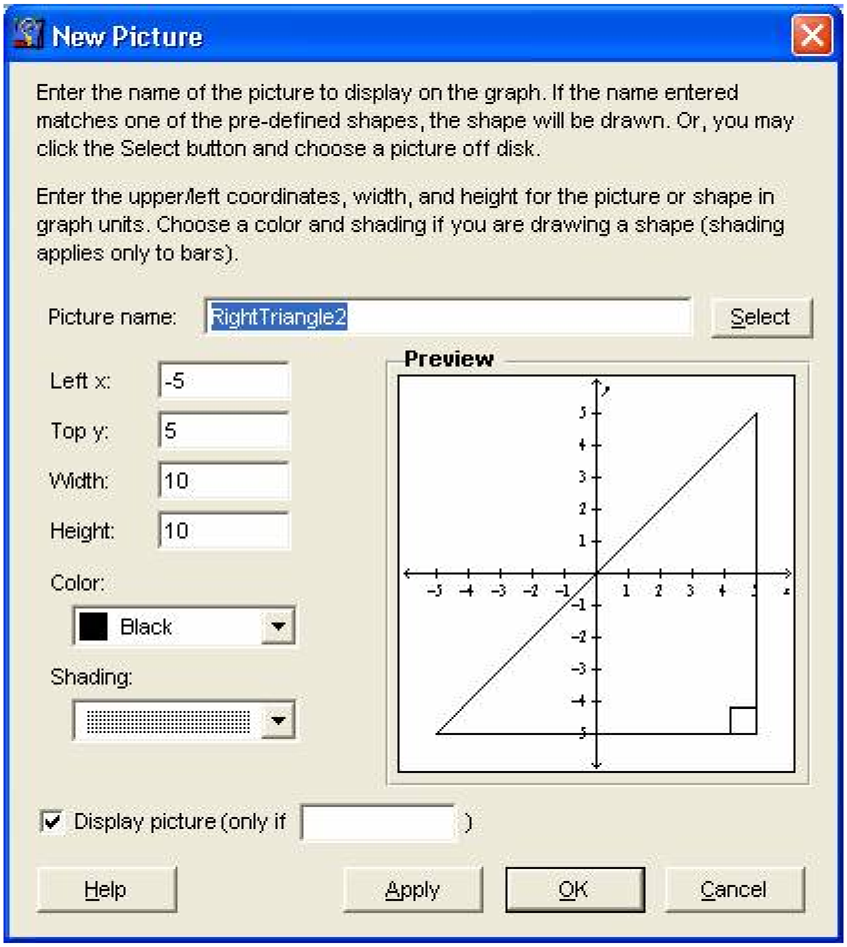
maxLength	100
a	range(1,maxLength,1)
aSquared	a^2
b	range(1,maxLength,1)
bSquared	b^2
aSquaredPlusbSquared	a^2+b^2
c	sqr(a^2+b^2)
whichUnit	range(1,4)
EnglishLengthUnits	list("in.","ft","yd","mi")
unit	choose(whichUnit,EnglishLengthUnits)

It turns out that creating the algorithm for this dynamic question is only half the work since we still need to use variables defined in the algorithm to label a right triangle. Try clicking and then double-clicking on the picture of the right triangle in the sample question bank (Question #6) to see the format (pieces of) the Cartesian Graph shown below:

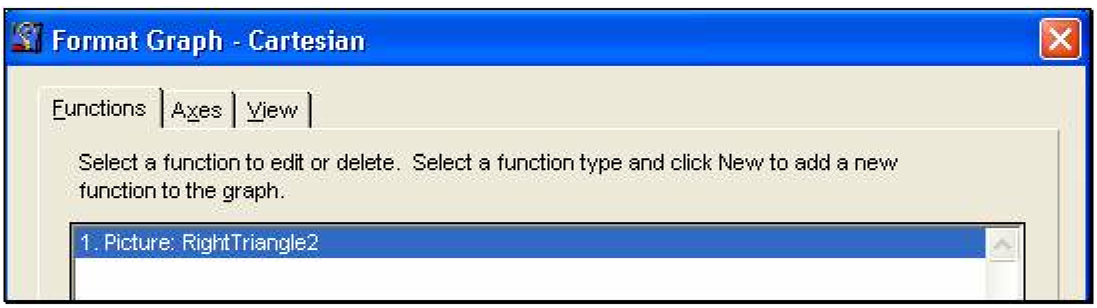


In order to include a picture of a right triangle (or another picture), do the following:

- Click **Insert-Graph-Cartesian**.
- In the **Format Graph – Cartesian** window, click the drop-down box next to *f(x)* and choose *Picture*.
- Click **New**. The New Picture window should appear.
- Type **RightTriangle2** next to *Picture name:* and the following image should appear.

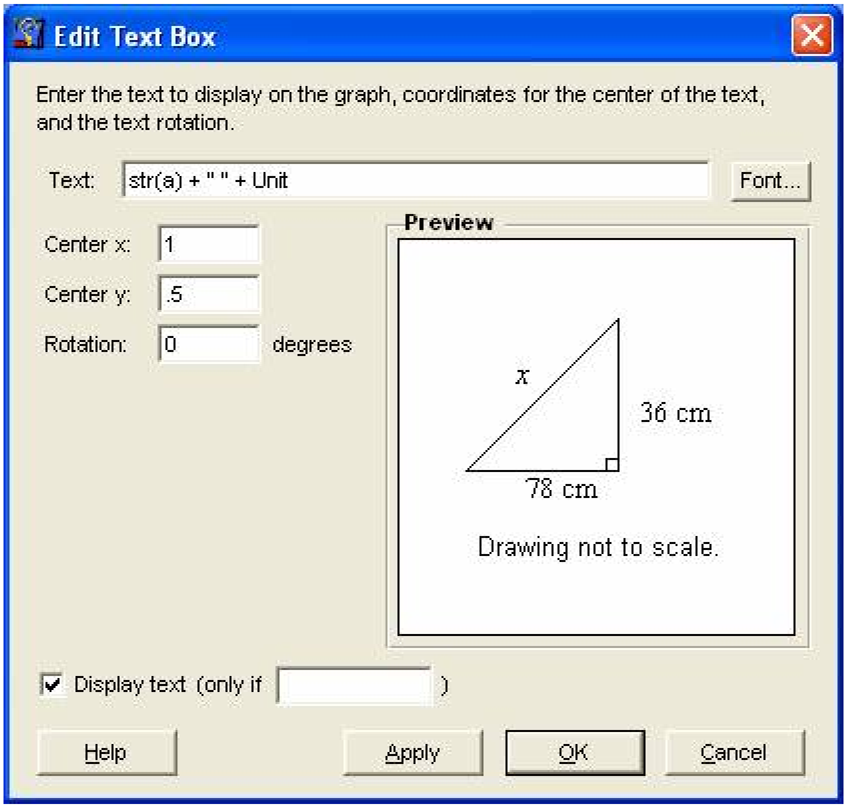


- Click **OK** to see the following window.

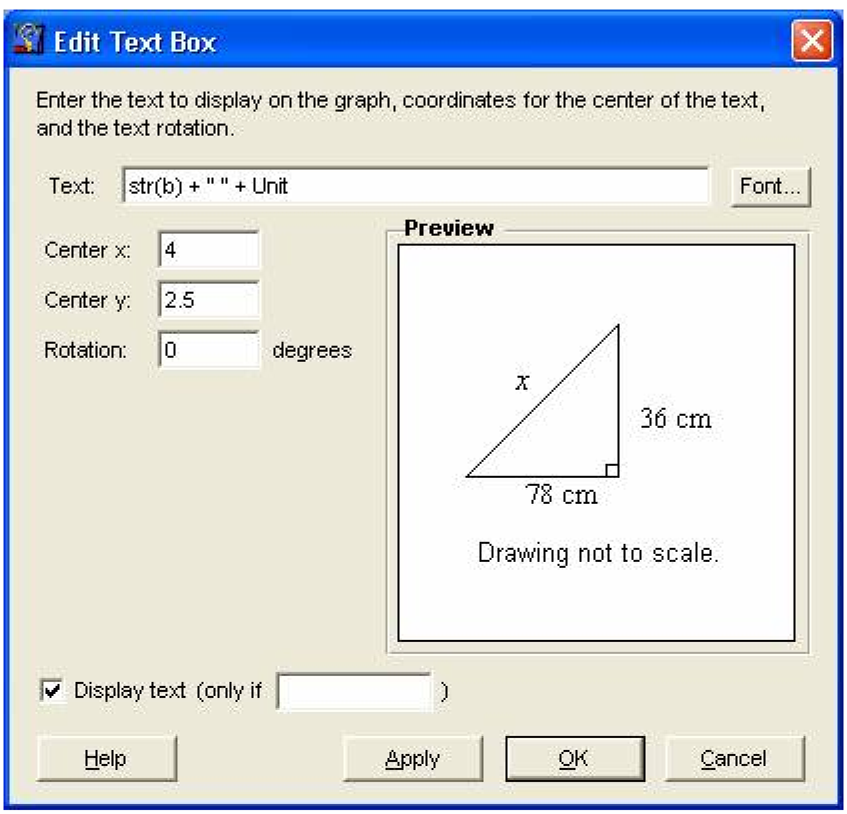


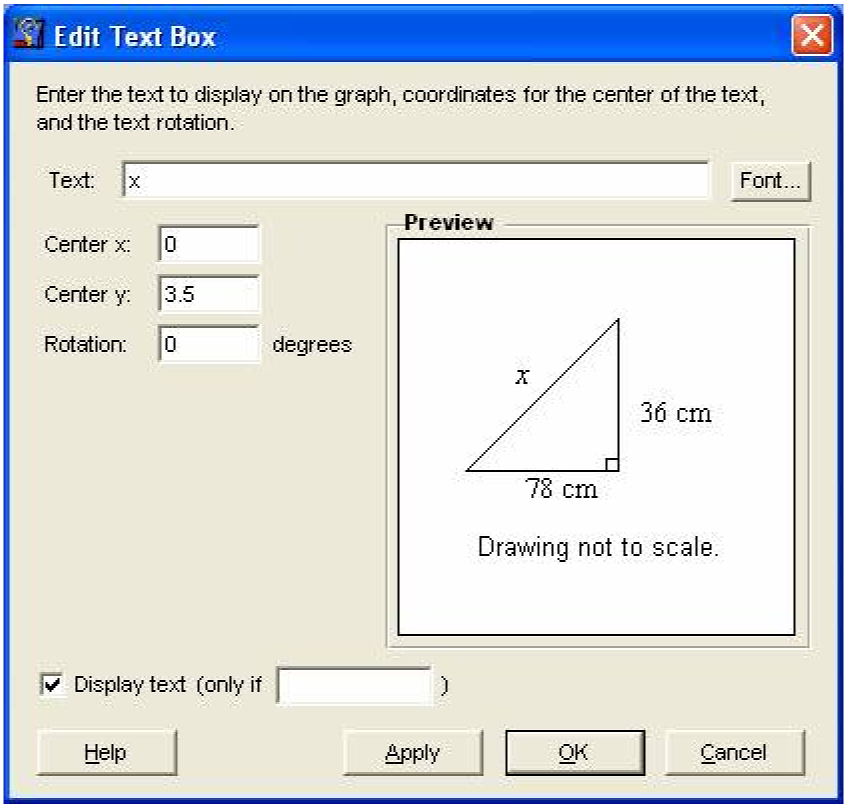
- Try changing the *Left x, Top y, Width,* and *Height* values of the picture to make it a reasonable size in a good location.
- Now add text boxes used to display the attributes of the triangle. See the question, figures, and instructions below for details about these.

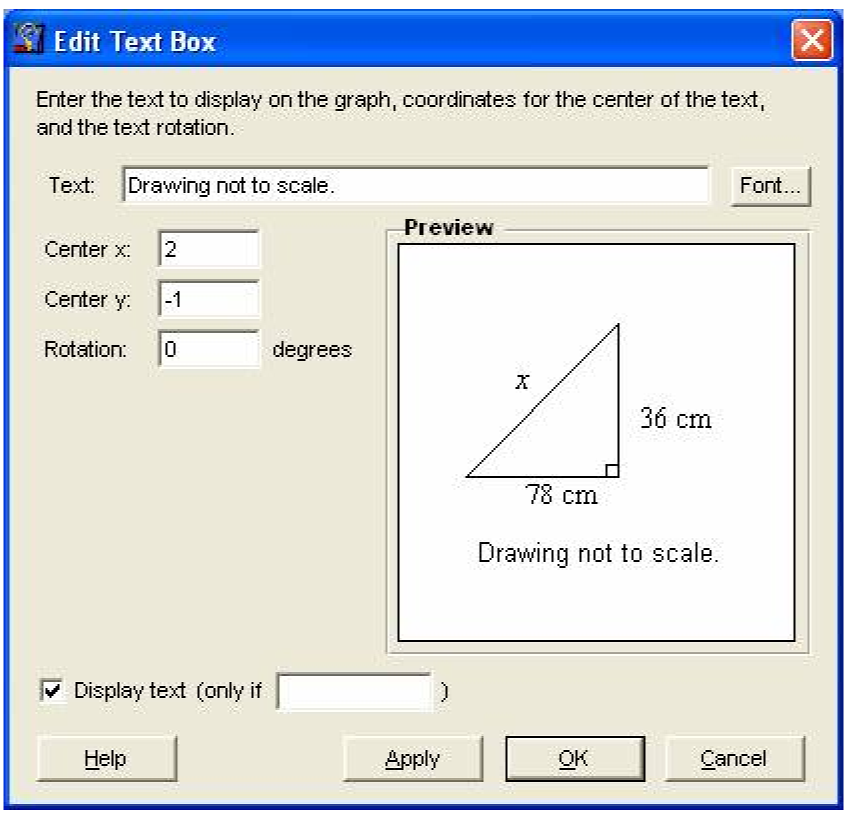
To add a text box like the one shown below, click on the drop-down arrow next to ***f(x)***, choose **Text Box,** and then click **New**. Then change the options to match the following window.



Repeat this procedure two more times to add three additional text boxes for the other leg, hypotenuse, and "Drawing not to scale" legend:







- Hide the *x* and *y* axes by clicking the *Axes* tab and then clicking the **Clear** button and then **OK**.

Changing the Algorithm Definitions to Create Variations of the Question
Variation A—(See Question PR #7.) Make it so that the values of *a* and *b* (the two legs) are never equal. Include the **condition**: **a <> b** **(**Spaces before and after the not equal sign are optional.)

Variation B—(See Question PR #8.) Make *a, b* smaller (or larger) values by changing the constant **MaxLength** to values less than (or greater than) 100.

Variation C—(See Question PR #9.) Make *a, b* non-integer values by changing *a* and *b* to **range(1,maxLength,0.1)**.

Variation D—(See Question #10.) Make it so *x* (the hypotenuse) comes out even (is an integer) by including the condition **c=int(c)**

Variation E—(See Question #11.) include metric_units by changing **WhichUnit** to **range(1,8)**, including **MetricLengthUnits** = **list("mm","cm","m","km"),** and including **LengthUnits** =**list(EnglishLengthUnits,MetricLengthUnits).** Change the definition of the variable **Unit** to **choose(whichUnit,LengthUnits).**

Variation F—(See Question #12.) Include a complete dynamic solution. Use the variables **a**, **b**, **c**, **unit**, **aSquared**, **bSquared**, and **aSquaredPlusbSquared** to add a solution which changes to match each newly generated dynamic question. Such a solution is particularly useful for a test key that you print or study guide that you make available online or in printed form.

Dynamic Solution to Pythagorean Theorem (Showing Variables in Gray)

Answer

$x =$ c unit

Solution:

$a^2 + b^2 = c^2$ where $a =$ a unit and $b =$ b unit

$\mathrm{a}^2 + \mathrm{b}^2 = x^2$

$\mathrm{aSquared} + \mathrm{bSquared} = x^2$ or $x^2 = \mathrm{aSquared} + \mathrm{bSquared}$

So $x^2 = \mathrm{aSquaredPlusbSquared} \Rightarrow x = \sqrt{\mathrm{aSquaredPlusbSquared}}$

$x =$ c unit

Dynamic Solution (with Variables Replaced by Values)

Answer

$x = 92.4\ cm$

Solution:

$a^2 + b^2 = c^2$ where $a = 27.8\ cm$ and $b = 88.1\ cm$

$27.8^2 + 88.1^2 = x^2$

$772.84 + 7{,}761.61 = x^2$ or $x^2 = 772.84 + 7{,}761.61$

So $x^2 = 8534.45 \Rightarrow x = \sqrt{8534.45}$

$x = 92.4\ cm$

Now plant your own dynamic question "seeds" and enjoy the "fruits" of the trees that grow from them!

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