

Make Algebra &
PreCalculus Come
Alive Using
Cabri Geometry

Karen Droga Campe
Teachers Teaching with Technology
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Make Algebra & PreCalculus Come Alive Using Cabri Geometry Function Families & the Crosshair Technique

As handheld graphing technology has become more prevalent, our students are not spending significant time graphing functions by pencil and paper techniques. Nevertheless, we still want them to recognize the graphs of key function families, and understand how changing the constants in the equation will affect the graph of the function.

On a TI-82/83/83plus, the students can modify various parameters in the Y= window to explore how these adjustments affect the graph. But this requires the student to switch back and forth between the Y= and graphing windows. Figures and graphs constructed in the Cabri Geometry II program, however, can *dynamically* respond to changes students make in equation parameters. I have been using the power of Cabri on a computer to demonstrate graphs of many function families to my students. An additional advantage of using the computer includes its superior display qualities, with color available and a larger screen area.

The basis for these demonstrations is the “Crosshair” technique taught in the Connecting Algebra & Geometry summer Institute (CAG) developed by Teachers Teaching with Technology (T³). This technique turns the Cabri Geometry screen into a function grapher, by using Cabri’s embedded coordinate geometry environment. Once this technique is mastered, it can be used to create graphs of any function.

Using the “Crosshair” technique to graph any function and explore its properties:

1. On a fresh screen, Show Axes and Define Grid by clicking on the axes.
2. Use the Segment tool to lay a segment on the X-axis. This will put a boundary on your x-value, the dependent variable for the function.
3. Put a Point on the segment, not on the X-axis. Find the Coordinates of this point.
4. Use Numerical Edit to place as many editable numbers on the screen as needed in the equation. For example, the quadratic function $f(x) = ax^2 + bx + c$ requires 3 numbers, for a , b , and c . Use numbers with one decimal place, like 1.1, to easily manipulate later. (see fig.1)

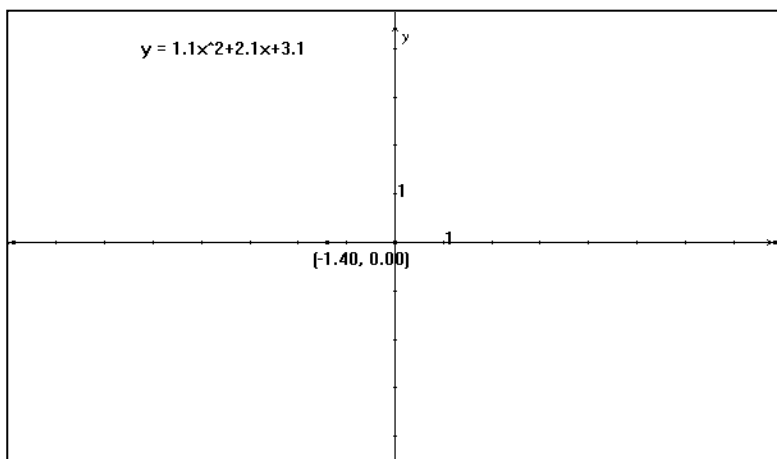


Figure 1

- Use a Comment box to write the general equation. When one of the previously created numbers is needed in the equation, click on it to include it. Then delete the original numbers. The new numbers in the equation are now editable.
- Use the Calculate tool to evaluate the y-value according to the equation. To do this, click on the numbers in the equation and the point's x-value as needed. Click in the result box and drag the result onto the screen. (*see fig. 2*)

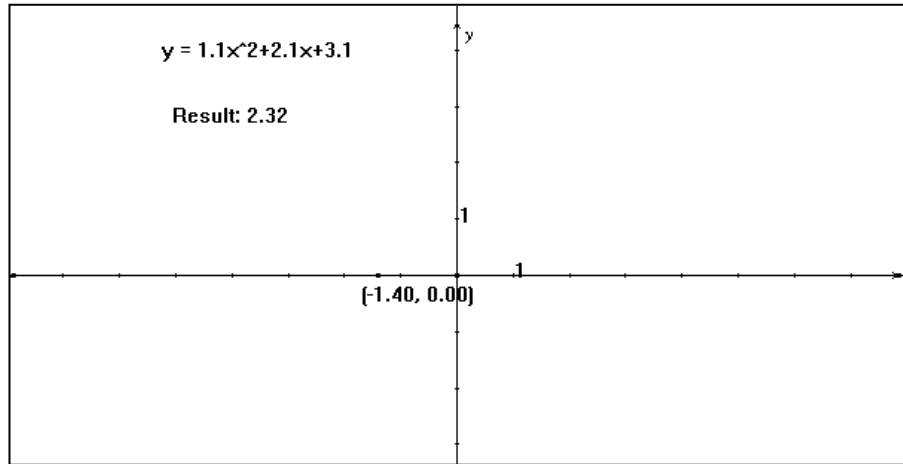


Figure 2

- Use Measurement Transfer: click on the result of the calculation, then on the Y-axis. A new point appears at that y-value.
- Create the crosshairs: construct Perpendicular Lines through the x and y points perpendicular to the appropriate axis. Then place a Point at the intersection of these. (*see fig. 3*)

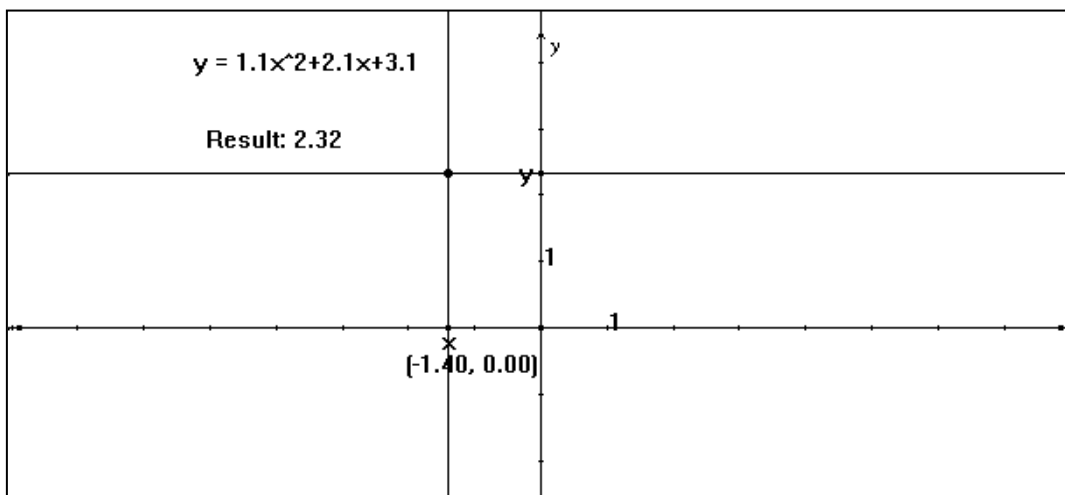
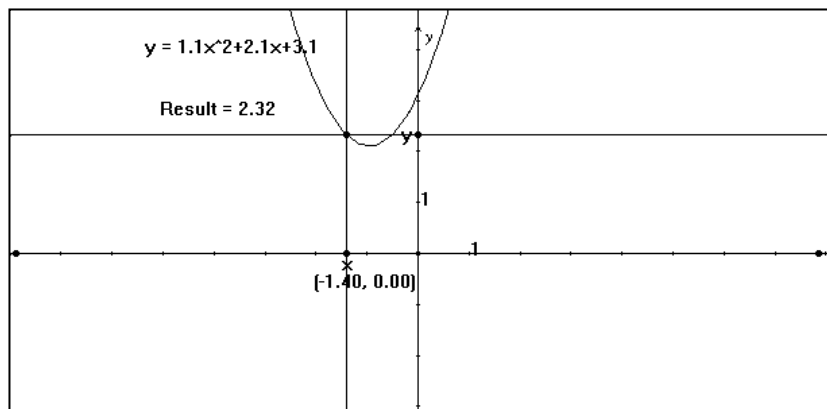


Figure 3

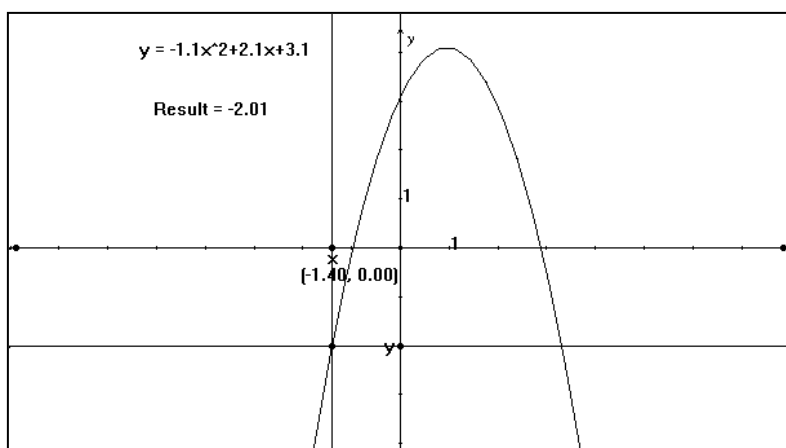
- Find the Locus of this point with respect to the point on the X-axis (*see fig. 4*). Do this by clicking first on the intersection point (the object for which to construct the locus) then on the X-axis point (the object that moves with respect to some path, in this case the original segment placed on the X-axis).

10. To edit a number in the equation, double-click on it and use the scroll arrows that appear. Explore what happens to the graph as the numbers change. Since the graph updates automatically, students see the graph “come alive.”



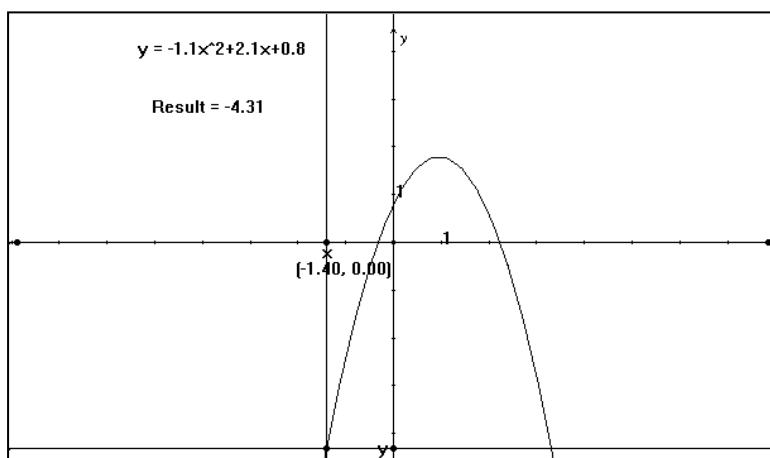
Positive “a” value (Fig. 4)

Figure 4



Negative “a” value (Fig. 5)

Figure 5



Changing the value of “c” (Fig. 6)

Figure 6

My personal favorite is the basic power function, $y = x^n$. By letting n equal any integer or a fraction between one and zero, students can see patterns in graphs of power functions, inverse variation, and radical functions ($y = \sqrt[n]{x}$).

As I adjust the exponent, I ask the students to predict the effect on the graph. I also ask them to explain what happens to the graph when the exponent equals one or zero. The interactive computer display stimulates a fruitful class discussion about the properties of the graphs of power functions, the patterns exhibited as the exponent changes, and the connection between $f(x) = \sqrt[n]{x}$ and fractional exponents. It is a great opportunity to bring together several topics from Advanced Algebra or Pre-Calculus in one animated lesson. (see figs. 7-10)

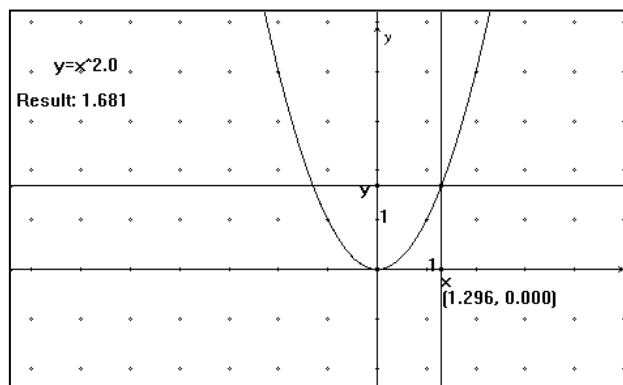


Figure 7: positive even integer exponent

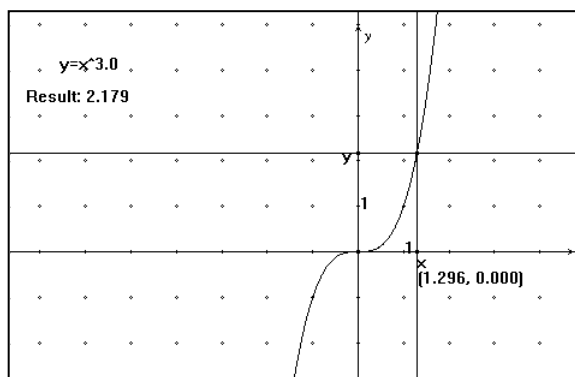


Figure 8: positive odd integer exponent

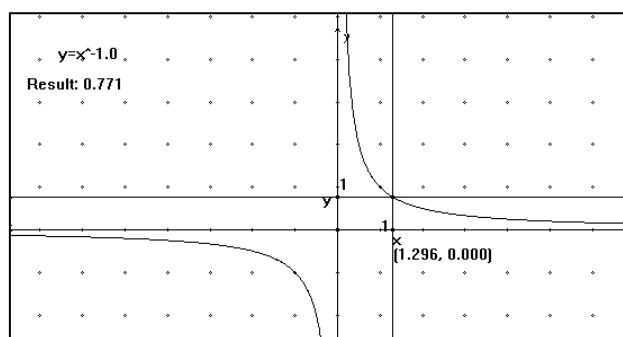


Figure 9: inverse variation

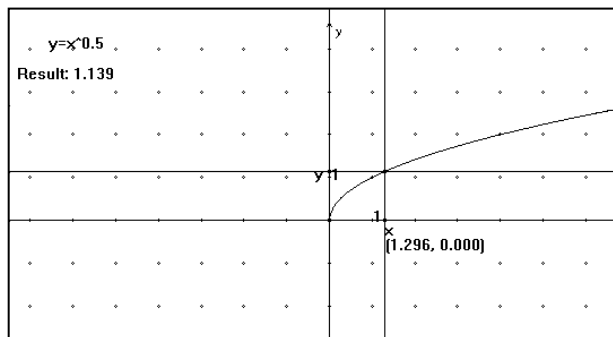


Figure 10: square root function

The Crosshair technique works for any type of function. Try to build linear, polynomial, trigonometric, exponential or logarithmic functions using this method. It can even be used to build conic sections in a piecewise manner. These lessons are successful as classroom demonstrations in which students take notes on the graphs and discussion, or as lab activities for individuals or pairs of students. I create the Cabri file in advance, so class time is focused on the dynamic view of function behavior.

Reference: T³ Connecting Algebra & Geometry Institute course materials; Charles Vonder Embse, Gene Olmstead, Gayle Garrison, Jane Wortman, Michael Keyton, Arne Engebretsen, & Judy Hicks; Teachers Teaching with Technology & Texas Instruments © 1998.