TECHNOLOGY tips

Sliders and Parameters Extend Interactive Software

This department offers a forum where teachers can share innovative classroom activities and ideas related to teaching and learning mathematics using technology. Ideas using all types of classroom technology are welcome. Send tips to the "Technology Tips" editors.

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I write this realizing it is my final "Technology Tip" column as editor. I wish to thank everyone who contributed a tip or "Surfing Note" this year. I would also like to thank Shannon Driskell, my co-editor, Rod Rodrigues and Ruth Casey, our liaisons from the editorial panel, and Albert Goetz, the journal editor, for their collaboration in preparing each column this year.

By the time you read this, Shannon Driskell and I will be making final plans to travel to the NCTM Annual Conference in St. Louis, Missouri. In our conference presentation, we hope to illustrate some of the recently published "Technology Tips" and encourage each of you to submit your ideas about how to use technology effectively in the mathematics classroom. We are looking forward to meeting potential authors for future "Technology Tips" columns. Please continue to support this column by sending your ideas to Shannon, who will be the editor for the 2006–2007 volume year.

This month's "Technology Tips" looks at how Microsoft Excel and The Geometer's Sketchpad can be used in a more interactive way with students. Rod Rodrigues shares some graphing tips using parameters in Microsoft Excel 2003, and in the second tip we explain how to graph a function using sliders in GSP (version 4.06). You can download a free 30-day trial of Microsoft Excel 2003 or purchase a licensed copy from

www.microsoft.com/office/editions/prodinfo/trial.mspx.

Similarly, you can download an instructor evaluation edition (free 60-day trial) of GSP (version 4.0) or purchase a licensed copy from

www.keypress.com/sketchpad.

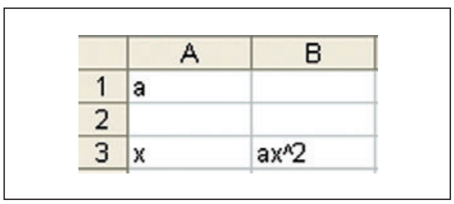
The "Surfing Note" this month contains a link to Interactive Mathematics, a Web site developed by Murray Bourne as a mathematics tutorial. It includes many Flash, Scientific Notebook, and LiveMath Web-based interactive documents.

TIP 1: THE POWER OF PARAMETERS IN EXCEL

Understanding parameters is important in mathematics. Excel has a feature that allows one to name a cell, which permits us to explore the concept of parameters effectively. To illustrate this, prepare a spreadsheet with labels as shown in **figure 1**.

Place the cursor into cell B1 and enter the number 1. With the cursor in cell B1, click on the name box that appears at the top left, just above the spreadsheet (**fig. 2**).

Type "a" and press the Enter button. This names the cell "a." We can now reference that cell by using the letter "a" in any formula. For example, position the cursor into cell A4 and enter the number –3. Enter into cell B4 the formula "= a*A4^2". Enter the formula



	A	B
1	a	
2		
3	x	ax^2

Fig. 1 Basic Excel spreadsheet

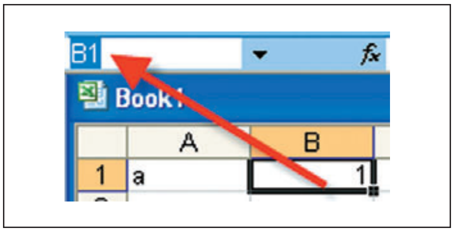
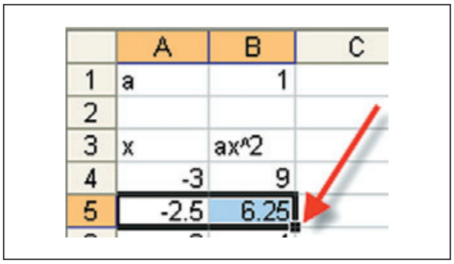
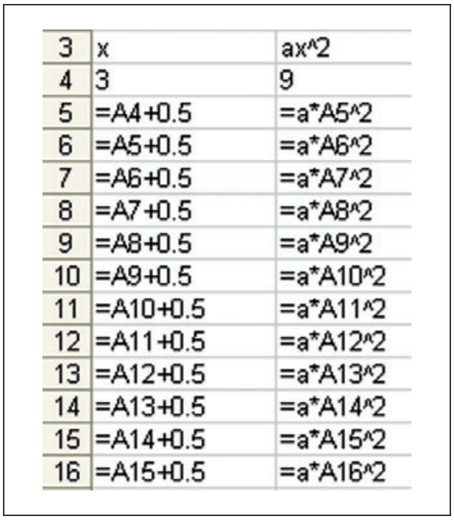


Fig. 2 Accessing name box in an Excel spreadsheet



	A	B	C
1	a	1	
2			
3	x	ax^2	
4	-3	9	
5	-2.5	6.25	

Fig. 3 Highlighted cells A5 and B5



3	x	ax^2
4	3	9
5	=A4+0.5	=a*A5^2
6	=A5+0.5	=a*A6^2
7	=A6+0.5	=a*A7^2
8	=A7+0.5	=a*A8^2
9	=A8+0.5	=a*A9^2
10	=A9+0.5	=a*A10^2
11	=A10+0.5	=a*A11^2
12	=A11+0.5	=a*A12^2
13	=A12+0.5	=a*A13^2
14	=A13+0.5	=a*A14^2
15	=A14+0.5	=a*A15^2
16	=A15+0.5	=a*A16^2

Fig. 4 Showing "Formula Auditing" mode in an Excel spreadsheet

"=A4 + 0.5" into cell A5. Enter the formula "= a*A5^2" into cell B5. Note that Excel recognizes the reference "a" and uses whatever you have in the cell by that name. This feature will become even more evident shortly. Highlight cells A5 and B5; note the black square in the lower right corner of the selection box (**fig. 3**).

Click on the square and drag it down, say to row 16. Then, using Ctrl + ` (accent grave), you can inspect the formulas that you just copied into these cells. This mode is called "Formula Auditing" mode. As below, you see that all of the formulas show the letter "a" in them, just as they should were "a" a parameter (**fig. 4**).

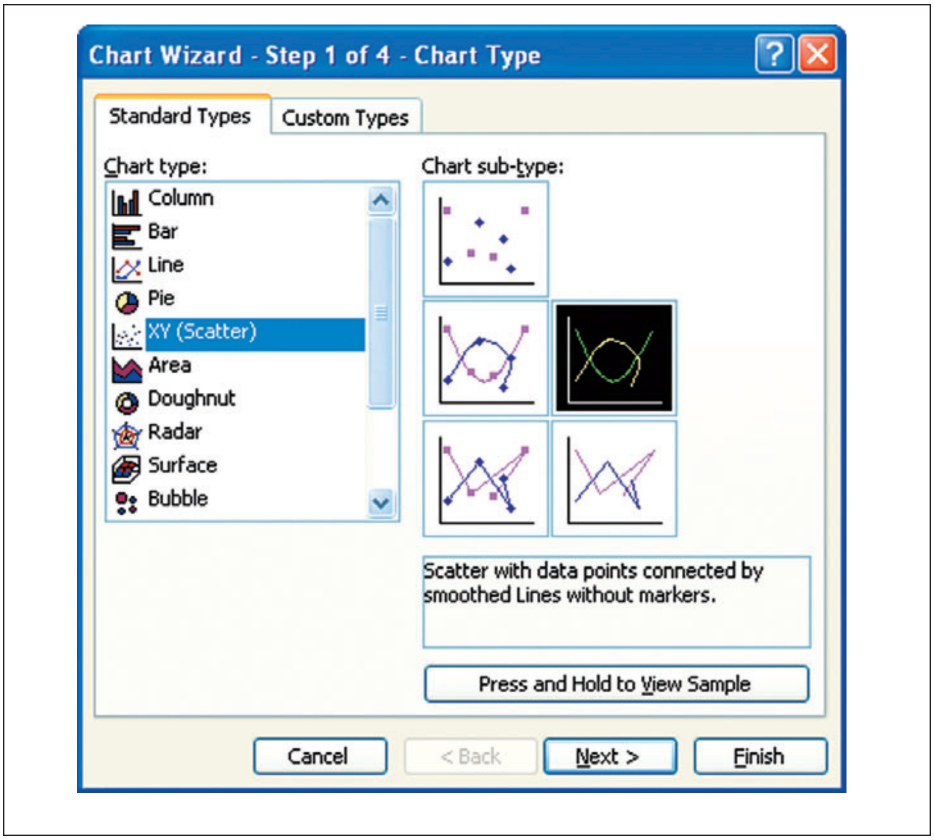
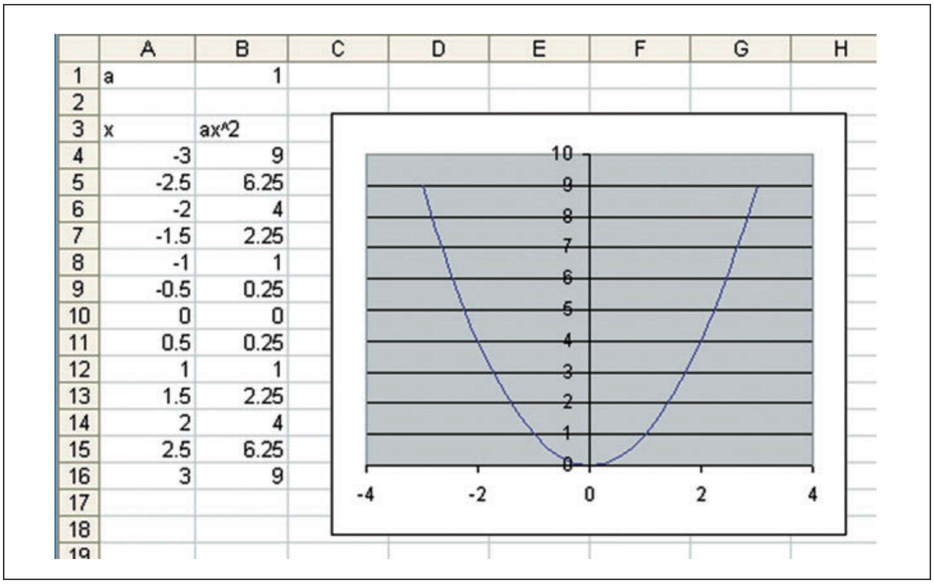


Fig. 5 Selecting a graph type using the Chart Wizard



	A	B
1	a	1
2		
3	x	ax^2
4	-3	9
5	-2.5	6.25
6	-2	4
7	-1.5	2.25
8	-1	1
9	-0.5	0.25
10	0	0
11	0.5	0.25
12	1	1
13	1.5	2.25
14	2	4
15	2.5	6.25
16	3	9

Fig. 6 Equation and graph of $f(x) = ax^2$

Use Ctrl + ` to exit the Formula Auditing mode. Highlight the cell range A4:B16. From the menu, click on Insert/Chart/XY (Scatter), selecting the type as shown in **figure 5**.

Continue stepping through the Chart Wizard windows by clicking the Next button. The connected scatter plot will be inserted into your spreadsheet. Deleting the legend and positioning the graph, we have a good look at the whole situation, complete with table and corresponding graph of the function (**fig. 6**).

Manually change the value in cell B1, and both the table and the graph will change instantly in response. You now have an interactive way to view changes

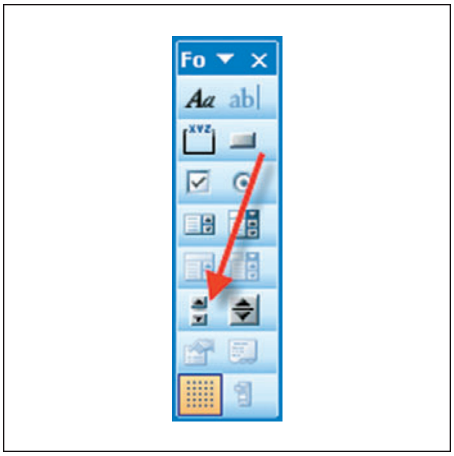


Fig. 7 Scroll bar option on the Forms toolbar

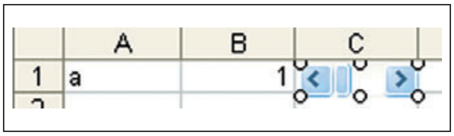


Fig. 8 Creating a scroll bar in an Excel spreadsheet

instantly, thanks to the use of the parameter. You can quickly see the effects changing *a* has on the graph by simply changing the contents of cell B1. But it gets better. From the menu, select View/Toolbars/Forms. Click on the Scroll Bar option (**fig. 7**). Then click in cell C1 and drag the mouse to position the scroll bar in your spreadsheet (**fig. 8**). To format the scroll bar, double-click on it and select the Control tab. We will use the default minimum and maximum values, but we want to enter B1 as the Cell Link, as shown in **figure 9**. Then click on the OK button. Click away from the scroll bar.

Cell B1 will change to 0. Click on the scroll bar, however, and cell B1 will change dynamically in response, without a new number being entered. The impact will be more dramatic if the scale along the graph's axes is fixed. To do this, click on the *x*-axis. Then choose Format/Selected Axis from the menu and select the Scale tab. Uncheck the Minimum and Maximum boxes, and manually set minimum and maximum values as you would like. Repeat this process with the *y*-axis.

You now have a dynamic interactive spreadsheet that allows you to explore trends and dynamic changes. You can look at the parameter's impact not only by investigating several static examples but also by sliding through many examples. The many variations of this procedure contribute to making Excel into a calculator on steroids.

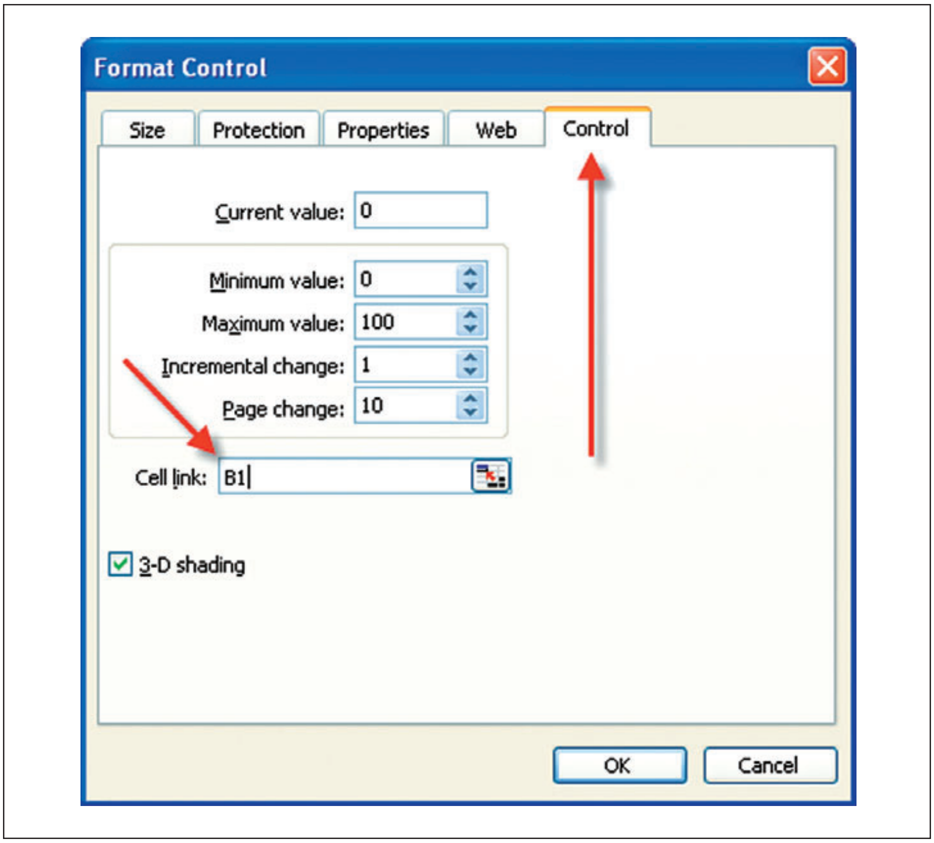


Fig. 9 Formatting a scroll bar in an Excel spreadsheet

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TIP 2: USING SLIDERS THAT ACT AS PARAMETERS WITH GEOMETER'S SKETCHPAD

The latest version of GSP (version 4.06) allows users to graph various kinds of functions, including polynomial, trigonometric, logarithmic, square root, and absolute value. [*For more details of how to graph functions with GSP, please refer to the "Technology Tip" in the September 2004* Mathematics Teacher.*—Ed.*] In this tip, we will show you how to construct a slider to represent the numerical coefficient of a function. As the user changes the value of the slider, the graph of the function will change dynamically.

Before you start graphing with GSP, you will want to define a coordinate system. Under the Graph menu, select Define Coordinate System (**fig. 10**).

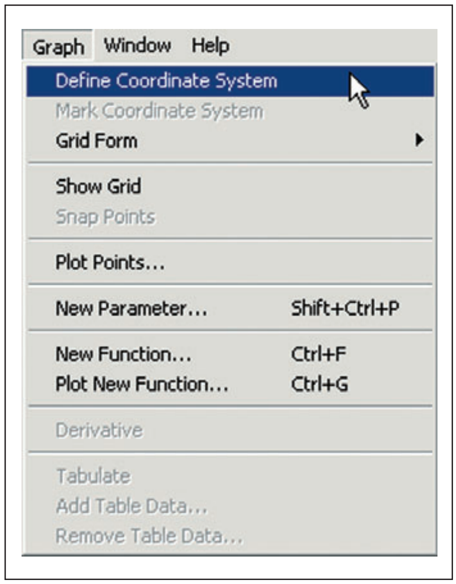


Fig. 10 Defining a Coordinate System under the Graph menu

To construct a slider in our sketch window, we need to access a built-in Custom Tool. Custom Tools are advanced versions of what were called scripts in version 3.0. You must open the file called Sliders.gsp to access one of the Slider Tools. This file is located in the Custom Tools folder within the Sam-

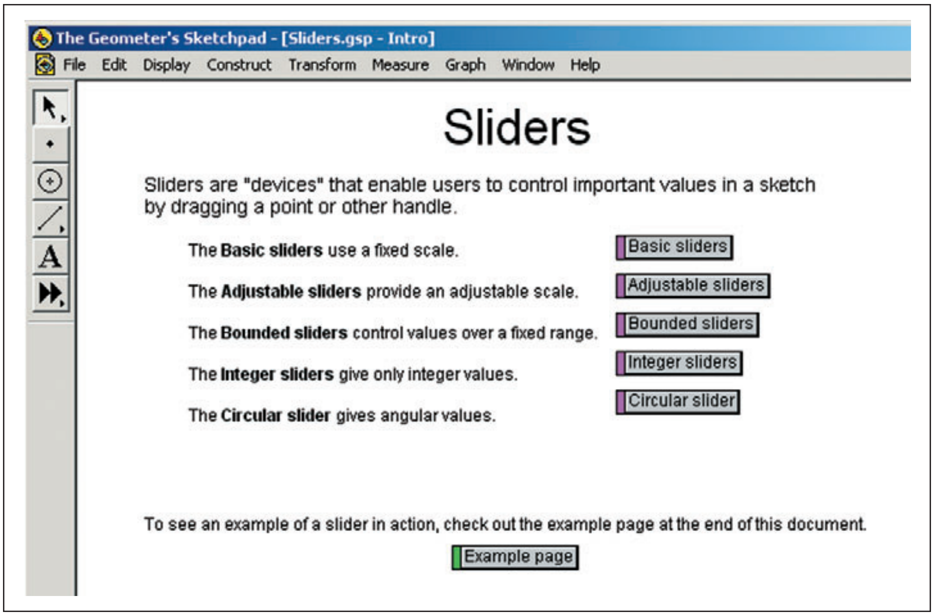


Fig. 11 Sliders Custom Tools file in GSP

ples folder that is installed with Sketchpad. On a PC, this file is usually on the hard drive at

C:\ProgramFiles\Sketchpad\Samples\CustomTools\Sliders.gsp.

On a Mac, the file is located at

Applications\Sketchpad\Samples\Custom Tools\Sliders.gsp.

This file contains several sliders useful for defining parameters (**fig. 11**).

Once you have this file open, return to your original window by selecting it under the Window menu. The last tool in your toolbox along the left side of your sketch window is called the Custom Tool. Click on this and hold down the mouse button to access the Sliders custom tools. Select the "basic horizontal" custom tool (**fig. 12**).

With this tool selected, you can draw a basic horizontal slider in the way that the Compass Tool allows you to draw a circle. In your sketch window, click your mouse to obtain a single horizontal slider. You will need to create as many sliders as you have coefficients in your function. For example, you would need three sliders for the general form of a parabola $ax^2 + bx + c$. To deactivate the Slider Custom Tool, simply click the Selection Arrow in your toolbox.

When I created sliders in my sketch window, they all were labeled with the same letter. Depending on the sliders in your sketch window, you might also need to rename them. Select the Text Tool in your toolbox and double-click on the slider's endpoint to rename each

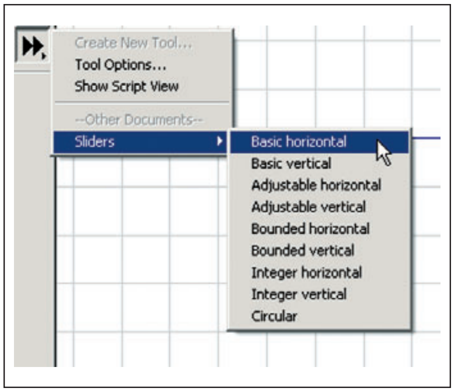


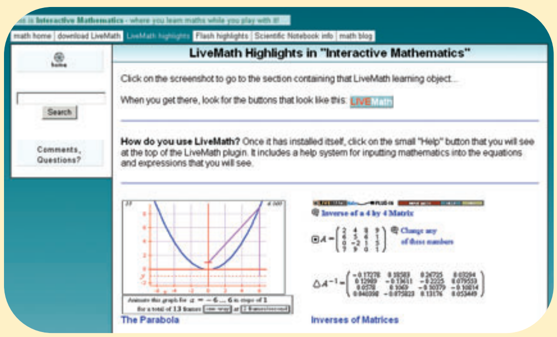
Fig. 12 Basic horizontal slider custom tool

slider. You will also want to rename each slider's corresponding measurement in the same manner. Notice that as you change the length of each slider, its corresponding measurement also changes.

To graph a function using the sliders as coefficient values, select Plot New Function under the Graph menu. A window, similar to the built-in calculator, will appear. By default, GSP uses similar input for a function as a graphing calculator where the function must be in "$y =$" or "$f(x) =$" format. [*This format*

Surfing Note

www.intmath.com



Interactive Mathematics is a Web site created by Murray Bourne while he was lecturing at Ngee Ann Polytechnic in Singapore. This tutorial Web site was created for high school students, undergraduate level students, adult learners, and teachers who want to learn about a wide range of mathematical topics, including algebra, trigonometry, graphs, complex numbers, statistics, and calculus. Accompanying many of the tutorials are Flash, Scientific Notebook, or LiveMath Web-based interactive documents that allow the user to explore the mathematics being addressed. The Flash interactive examples include the golden ratio, linear velocity, complex numbers, trigonometric functions, matrices, pulleys, and sine and cosine graphs. The LiveMath documents allow the user to experiment interactively with the equation of a parabola and an ellipse, polar coordinates, matrices, the volume of a solid of revolution, trigonometric graphs and their applications, and geometric sequences. The LiveMath plug-in is needed to view these documents and can be downloaded at

www.livemath.com/lmplugin/.

Six tutorial or demonstration videos on calculus concepts are also available at this Web site.

can be changed under the Equation menu in this pop-up window to an "x = " format or polar notation.—Ed.] Enter an expression using either the keypad or keyboard in the window, clicking on the sliders' measurements in your sketch window when entering coefficient values (**fig. 13**).

Click OK once you have finished entering your function. Notice that GSP sometimes adds extraneous sets of parentheses in your expression. Both the function's equation and its graph will be displayed in your sketch window (**fig. 14**). Depending on the function you entered, you might need to zoom in or out to see portions of your graph.

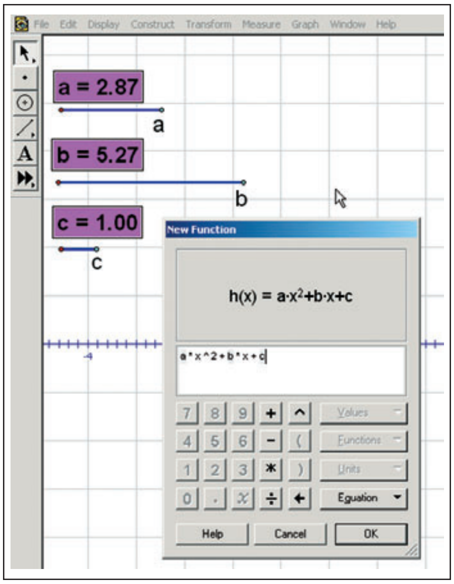


Fig. 13 Defining a New Function using sliders as coefficient values

You can have your students investigate and reflect on how each of the coefficients relates to the function's graph. The graphing features of GSP expand the use of this software beyond the typical geometry applications. We encourage readers to explore these features further and share what you have discovered or how you have used the tools in your classroom.

[*For more ideas on using GSP to explore functions, see Todd Moyer's article "Non-Geometry Mathematics and The Geometer's Sketchpad,"* Mathematics Teacher *99 (March 2006): 490–95.—Ed.*] ∞

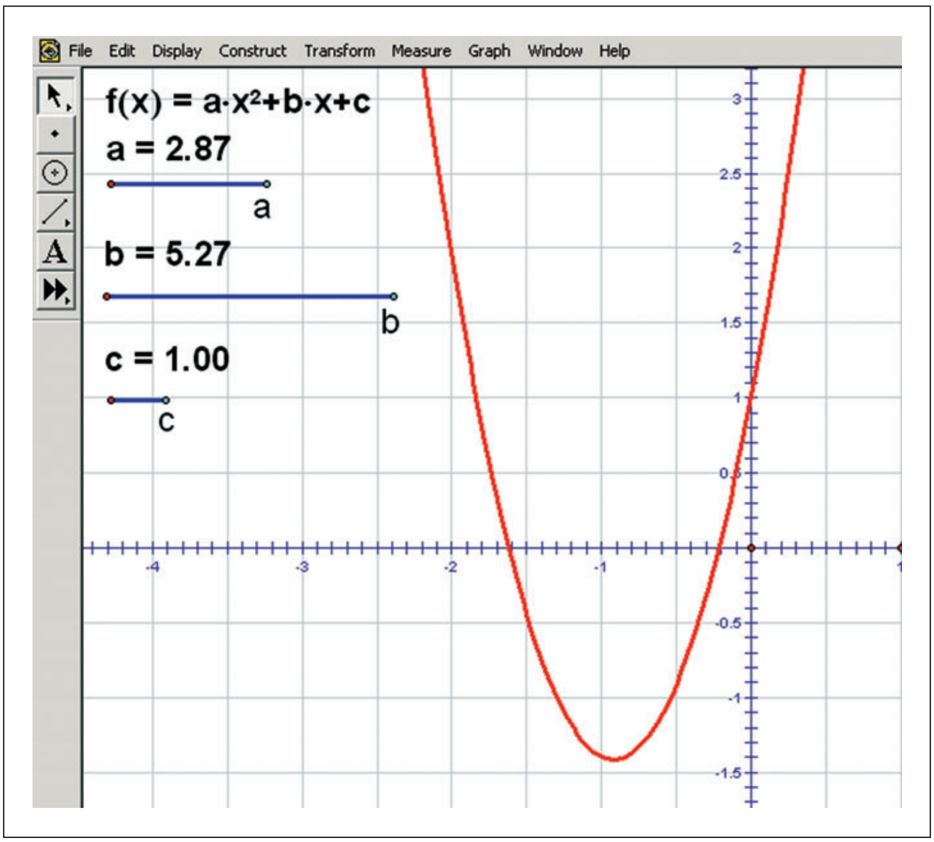


Fig. 14 Equation and graph of $f(x) = ax^2 + bx + c$