Gail Nord

The Free Microsoft Word 2007 Mathematics Add-In

"Technology Tips," which provides a forum for innovative uses of technology in the teaching and learning of mathematics, appears seven times each year in *Mathematics Teacher*. Manuscripts for the department should be submitted via http://mt.msubmit.net. For more background information on the department and guidelines for submission, visit http://www.nctm.org/publications/content.aspx?id=10440#tech.

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The algebraic and symbolic capabilities of the free mathematics add-in provided by Microsoft Word 2007™ can turn Word into a graphing calculator. This article will familiarize teachers with some of the features of this add-in, paying special attention to the power of the Animate command. This computer algebra system (CAS) is available as a free download to any legitimate institutional or individual license holder of Microsoft Word 2007. The add-in is a viable solution for schools that cannot afford lab or site licenses for Mathematica®, Maple®, or graphing calculators. Further, in schools whose students do not have access to graphing calculators outside the classroom, the add-in allows students to engage with these powerful computational tools at home.

Principles and Standards for School Mathematics (NCTM 2000) declares, "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (p. 24). The mathematics classroom should be one in which calculators, computers, courseware, and manipulative materials are readily available and regularly used in instruction (NCTM 1989) and where "every student has access to technology to facilitate his or her mathematics learning" (NCTM 2000, p. 25). If a school has access to this readily available software option, its writing or English language laboratory can be turned into a mathematics laboratory.

The National Research Council (1989) report notes that "calculators and computers make new modes of instruction feasible at the same time that they inject into the learning environment a special sense of wonder which goes with healthy development of mathematical power" (p. 84). An example is Edwards and Özgün-Koca's activity (2009), in which they explore the power of a handheld calculator with a quadratic example; they outline the procedure to create a slider and show the usefulness in providing an inquiry-based lesson. Within Microsoft Word 2007, the Animate command (i.e., the slider command) is set up by default when the user graphs an equation.

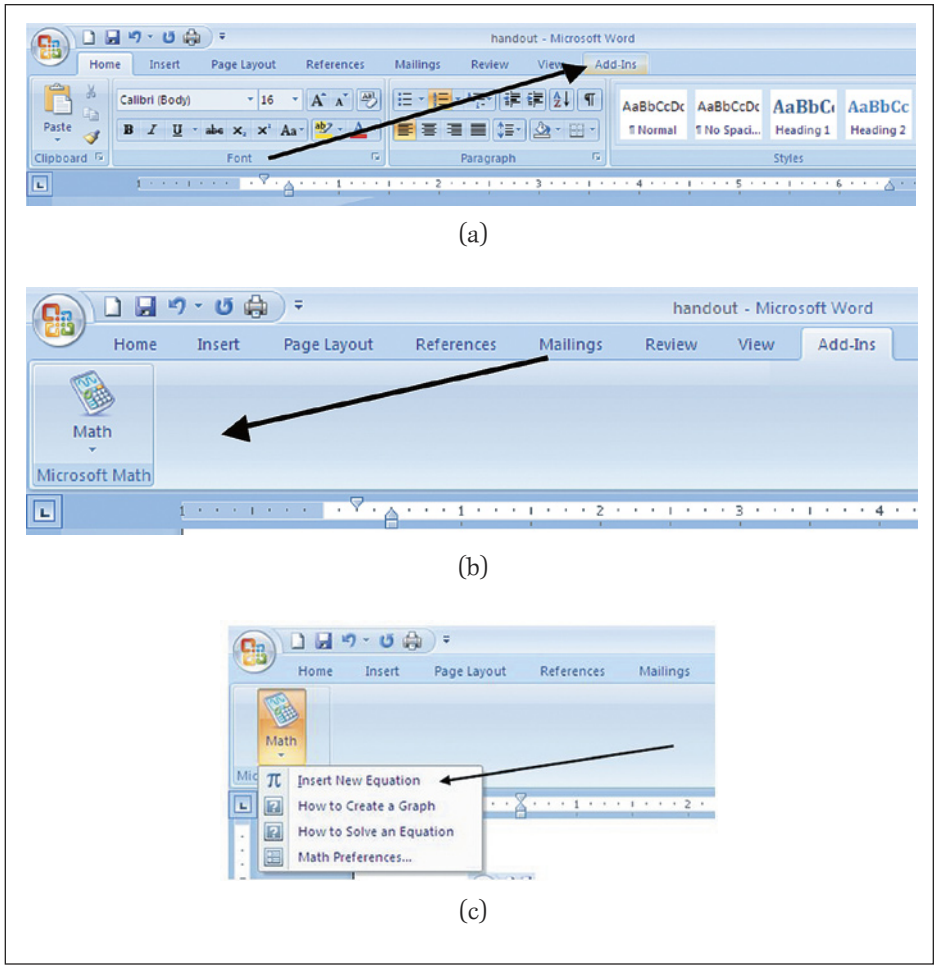
GETTING STARTED

Download the free Microsoft Word 2007 Math Add-In (Microsoft 2007). Users who have MathType™ installed on their computers will need to turn it off before

they will be able to run the add-in successfully. To close down MathType, open a Word document and click on the button in the upper-left corner of the screen. Choose Word Options at the bottom of the drop-down menu and then go to Add-Ins in the left column. At the bottom of the next screen will be a Manage button associated with a drop-down menu. From the drop-down menu, choose Templates and click on Go. Then uncheck the MathType commands and click on OK. The MathType commands will reactivate once you close and then reopen Word. Alternatively, you can retrace these steps and manually turn the commands back on by checking the box.

You are now ready to run the add-in. Select the Add-Ins tab on the ribbon (see **fig. 1a**). Then click on the Microsoft Math button on the new ribbon (see **fig. 1b)**. A drop-down menu will appear; choose Insert New Equation (**fig. 1c**). (If the option to insert an equation is ghosted, select the menu button in the upper-left corner of the screen and then the Convert option.)

Equations can now be entered in the pop-up box. To begin, have students create the graph of a quadratic equation (see **fig. 2**). Right-clicking on the equation brings up a content-sensitive menu of mathematical options, and selecting Plot in 2D will produce the graph shown in **figure 3**. The graph thus obtained can be copied and pasted into other documents or saved with the current document.



(a) (b) (c)

Fig. 1 Once the add-in software is downloaded, Microsoft Word Mathematics can be accessed by first selecting Add-Ins (**a**) and then Mathematics (**b**) to produce the drop-down menu of choices (**c**).

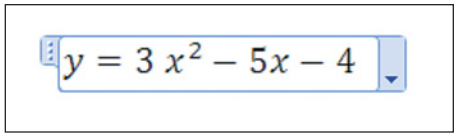


Fig. 2 A good place for students to start is with a quadratic equation.

USING THE ANIMATE FEATURE

Enter the equation $y = b\sin(x)$ in the equation box and select Plot 2D. The Animate option will appear at the lower left of the screen (see **fig. 4**). Click on the arrow key to watch b increase from 0 to 2. As b increases, the amplitude of the sinusoid increases, and the graph on the screen changes. To pause the animation midway, click on the arrow again. The default range for b can be changed by highlighting either end value with the cursor and typing in the desired value. Similarly, additional parameters can be introduced, as in $y = a \cdot \sin(b \cdot x)$. Pressing the down arrow key will bring up both parameters, and the user can then select either a or b (see **fig. 5**).

Using technological tools, as *Principles and Standards* (NCTM 2000) points out, supports students' reasoning about broader issues, including parameter changes, allowing students to "model and solve complex problems that were heretofore inaccessible to them" (p. 26). An example such as

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

can help students quickly develop concepts and make conjectures about the properties of the conic sections with minimal directions while using Animate (see **fig. 6**). Further, "technology also provides a focus as students discuss with one another and with their teacher the objects on the screen and the effects of the various dynamic transformations that technology allows (NCTM 2000, p. 25). In both curricular content and instructional style, there "should be a renewed effort to focus on exploring patterns, not just learning formulas" (National Research Council 1989, p. 84).

The next example is for the calculus classroom and will involve a function and its derivative. Enter $y = a \cdot x^2 + b \cdot x$ and $y = 2 \cdot a \cdot x + b$. Left-click to highlight both equations and then right-click and select Plot 2D. Animate either a or b (see **fig. 7**). The graph of the line has an x-intercept where the parabola has a critical value.

Animate works in three-dimensional plots as well. One choice might be the following:

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$$

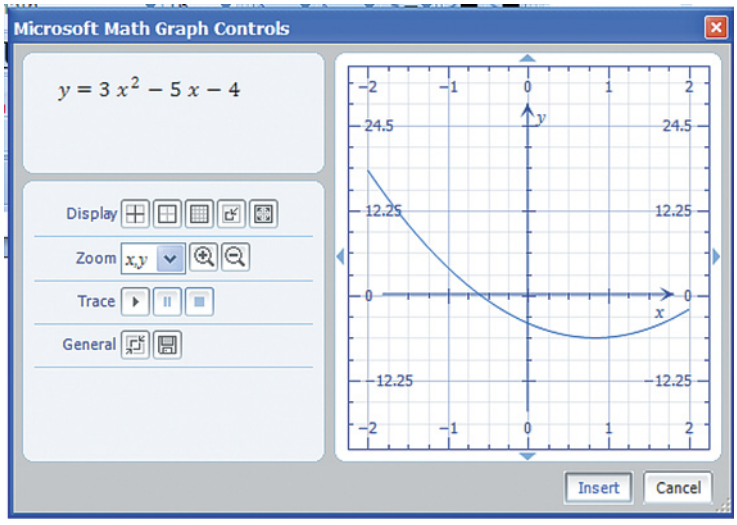


Fig. 3 The graph of the quadratic appears in this window.

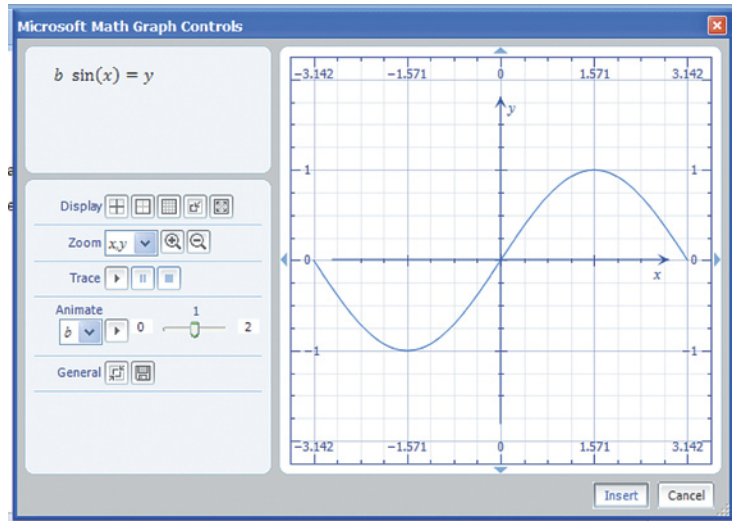


Fig. 4 Once a parameter is introduced into the equation, the Animate option appears automatically.

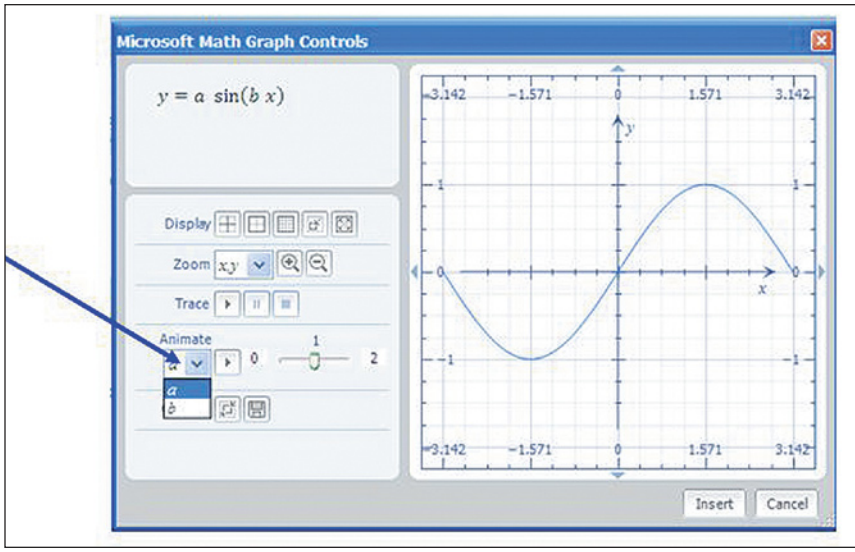


Fig. 5 The Animate command can also be used with two parameters.

Rotate the image about the *x*-, *y*-, or *z*-axis for a moving picture (see **fig. 8**). *Professional Standards for Teaching Mathematics* (NCTM 1991) notes, "Mathematical power includes the ability to explore, conjecture, and reason logically" (p. 1).

Challenge your students to grasp extended concepts with a family of graphs such as this one:

$$\frac{x^a}{4} + \frac{y^b}{9} + \frac{z^c}{25} = 1$$

The Plot Range dialogue box can be activated by clicking on the last, right icon on the Display line within the Microsoft Math Graph Controls dialogue box to control viewable octants.

Animate can be used to increase students' understanding of parametric equations as well. Notice that in **figure 1c**, the drop-down menu also includes the option Math Preferences. Select this option and then change the setting to Radians and Complex Numbers and close the box by clicking on OK. A standard example of a graph of a helix (see **fig. 9**) can be entered in the Equation box:

```
plotParamLine3d(at,sin(t),
                        cos(t),{t,–10,10})
```

Note that the command will be executed whether or not spaces have been introduced between expressions; for example, *a t* will be interpreted in the same way as *at*. After entering this command, right-click in the equation box to activate the drop-down menu and select Simplify.

The graph of the helix uses the Animate command; click on the Animate slider bar and watch in real time as the helix acts like a spring undergoing compression and expansion (see **fig. 10**). Use the following command in the Equation box:

```
plotParamLine3d(at,sin(t),
                        cos(t),{t,–10,10})
```

Select Simplify in the drop-down menu and then choose, as in **figure 10**, the Animate slider (right arrow) by *a*. Animate even works while plotting multiple simultaneous parametric equations in three dimensions. These images were

generated (see **fig. 11**) using the following command:

```
Show3D(plotParamLine3d(at,bsin(t),
                                c cos(t),
{t,–20,20}),plotParamLine3d(t,sin(t),
                        cos(t),{t,–20,20}))
```

The Display command (which shows options) also allows the user to rotate and turn off the grids.

CONCLUSION

The more specific reasoning habit of seeking patterns and relationships often receives limited attention in the classroom. Whatever topics are taught, students must learn them in a way that deepens their mathematical thinking and reasoning (Martin 2009). "Technology can help students learn mathematics," as *Principles and Standards* notes:

> For example, with calculators and computers students can examine more examples or representational forms than are feasible by hand, so they can make and explore conjectures easily. The graphic power of technological tools affords access to visual models that are powerful but that many students are unable or unwilling to generate independently. The computational capacity of technological tools extends the range of problems accessible to students and also enables them to execute routine procedures quickly and accurately, thus allowing more time for conceptualizing and modeling. (NCTM 2000, p. 25)

Graphing packages that allow for user-defined interactions have opened the door for mathematics teachers to extend inquiry and discovery lessons greatly. Teachers can opt for the Animate command in Word 2007, the slider on a TI-Inspire, or the Manipulate command in Mathematica. Students' understanding of concepts such as amplitude and period are enhanced by the use of these tools.

But why stop there? The Animate feature can be used to aid students' understanding of many topics throughout mathematics. Certainly it increases the number of concepts that students can readily discover for themselves. Further information, including extended

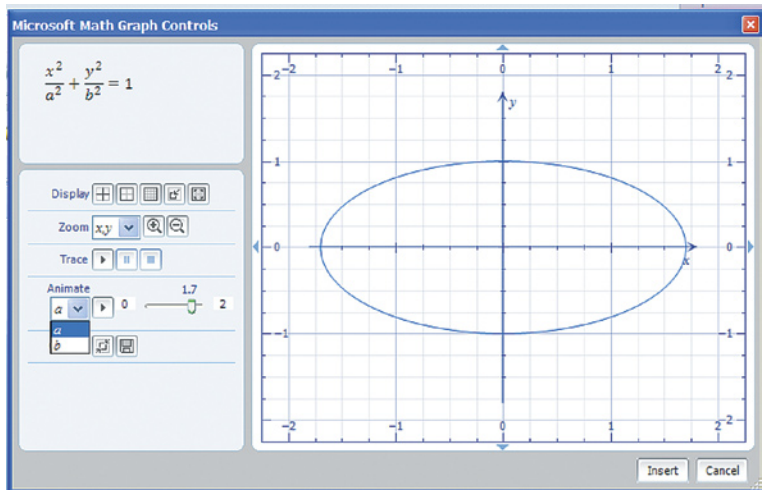


Fig. 6 Animating *a* or *b* to form ellipses or a circle can help students make conjectures about the eccentricity of an ellipse.

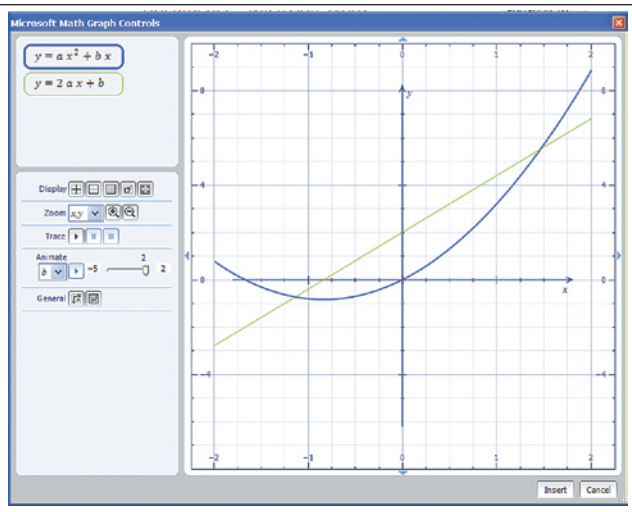


Fig. 7 Animating the values of *a* and *b* will demonstrate that the *x*-intercept of the derivative has the same abscissa as the critical point of the parabola.

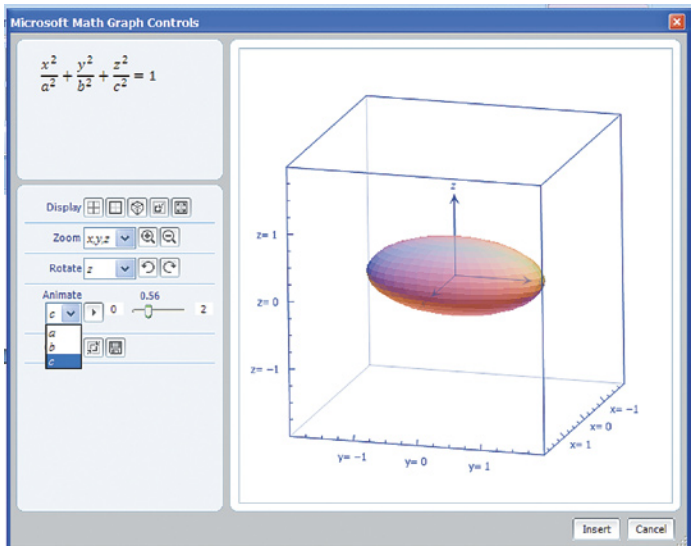


Fig. 8 Animate works well with three-dimensional images also.

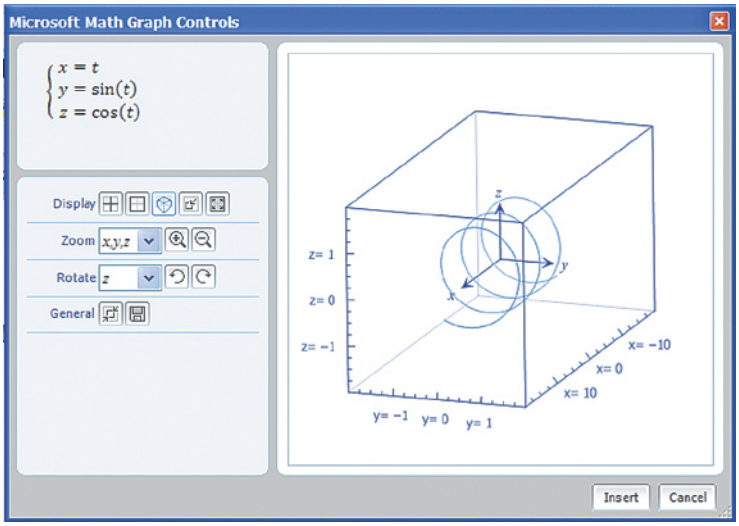


Fig. 9 A helix can be animated in a springlike fashion.

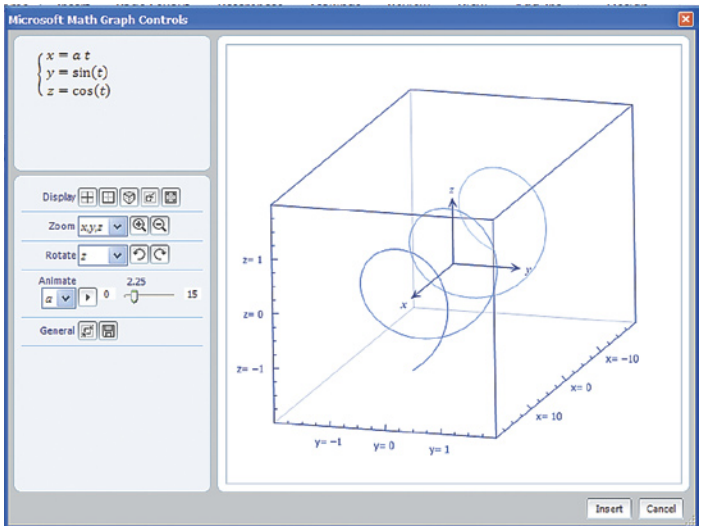


Fig. 10 Use the Animate command to see the spring in action.

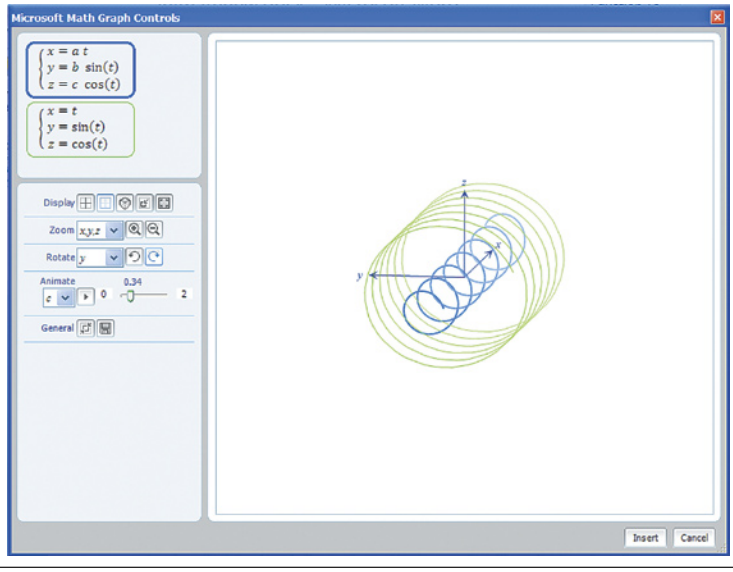


Fig. 11 Two parametric equations can be graphed simultaneously.

examples, directions, and worksheets, can be found at http://web02.gonzaga.edu/faculty/nord/links.htm.

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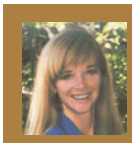

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Surfing Note

Need more information about the Microsoft Word 2007 Mathematics Add-in? Gail Nord has compiled a useful user manual for persons interested in using or exploring this free software. She provides important information about commands as well as examples for topics in college algebra, precalculus, single- and multi-variable calculus, linear algebra, logic, statistics and probability, and number theory. Go to http://web02.gonzaga.edu/faculty/nord/word%20users%20manual/tableofcontentsmanual.htm.

A work in progress, the Web site is constantly updated with new tutorials on and examples of built-in functions and trouble shooting. We encourage you to use the Microsoft Word 2007 Mathematics Add-In and let us know what you think.