JAVA APPLETS FOR TRIGONOMETRY

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Abstract: Laboratory activities and classroom demonstrations built using Geometer's Sketchpad and the Mathematical Java Toolkit are demonstrated. All have been used in trigonometry classes at West Virginia University.

The recently formed Institute for Math Learning at West Virginia University is charged "To significantly enhance the mathematics learning environment for the students of West Virginia University, with specific expectations that student performance in mathematics will improve in measurable and definable ways." The Institute's mission is to develop, create, and extend innovative approaches to instruction in undergraduate mathematics courses, initially with a focus on courses before calculus, such as college algebra and trigonometry.

This has been leveraged by the historically strong connection of the WVU Department of Mathematics with K-12 education statewide, with distance education dual-credit courses in College Algebra and Trigonometry (the "WvEB math" courses, with more information available at http://wvebmath.ws/). The Institute has the long term goal of improving the quality of math instruction throughout the state by finding ways to ensure that standards are kept high, that secondary schools are aware of collegiate expectations, and that teachers have the tools they need to help students to meet the standards. The goals of the courses are focused on increasing student awareness of applications of mathematics to science, engineering, and technology. This has been recognized as a high priority in several recent national reports. Students are targeted for the course that might otherwise not enroll in a mathematics course during their senior year. Such students find out too late that their choice selection limits their ability to major in STEM areas. More information about the WvEB mathematics classes is available in (Pyzdrowski and Pyzdrowski 2002).

The instructional model being developed for IML courses on campus includes (of necessity) relatively large lecture sections, coupled with integrated computer laboratories. Faculty members serve as course coordinators and lead developers of applets, lecture materials, and class activities. Lecturers provide some of the classroom presentations and manage records. The laboratories are expected to carry their share of the instructional burden of the courses. They include a writing component, graphing utilities, and virtual models for word problems. Currently the College Algebra labs in Mathwright have all of their responses turned in on paper. The Trigonometry course the laboratories have their primary exposition written in html, posted on the web. Questions are answered using the

classroom management system WebCT, both for short answer determinant questions and for more reflective essay answers (which are automatically emailed to a dedicated course email address and thereafter graded on line).

An existing initiative at West Virginia University, using the Windows based scripting language Mathwright to develop laboratories in College Algebra, has been somewhat successful in working towards this goal. There were stability issues in running Mathwright executables under Windows 2000, so one goal has been to implement some of the ideas developed in the Mathwright labs as Java applets, which are platform independent and robust.

The novel experience of taking a class with a substantial computer component has the potential to impact positively student commitment and performance (Blum-Anderson 1992, Fey and Heid 1984), and indeed that has been our experience. The discipline, structure, and active participation that the computer laboratories provide produce better student performance on tests and class activities than traditional courses can provide.

The interactive portions of the trig labs use two main tools:

1) Applets written using the Geometer's Sketchpad and converted to Java Sketchpad (NSF awards DMI-9561674 & 9623018). These applications are interactive and full of animations and the potential for experimentation. For example, the shot below is for a laboratory that considers the famous ladder problem of navigating a long ladder around the corner between two corridors that intersect at right angles. In this applet the corridor widths, the ladder length, and the ladder position can all be adjusted. When the ladder gouges the corridor walls it disappears.

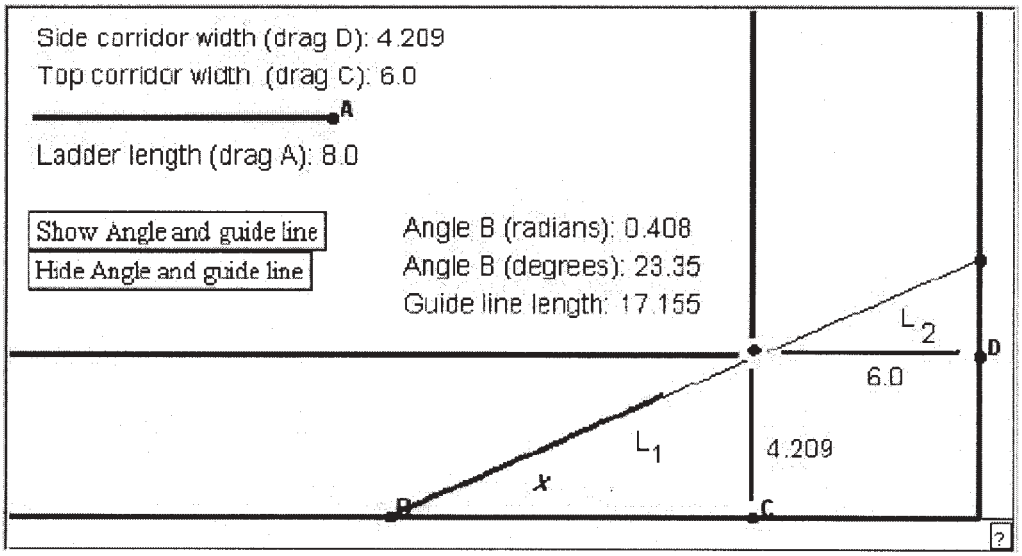

Figure 1: The ladder problem applet

The link is live at
`http://math.wvu.edu/~mays/AVdemo/Labs/Lab07/Lab07-02.htm`

Another Java Sketchpad applet, this one incorporating animation, illustrates Lissajous curves, parameterized in the plane with x and y coordinates that are sinusoidal curves.

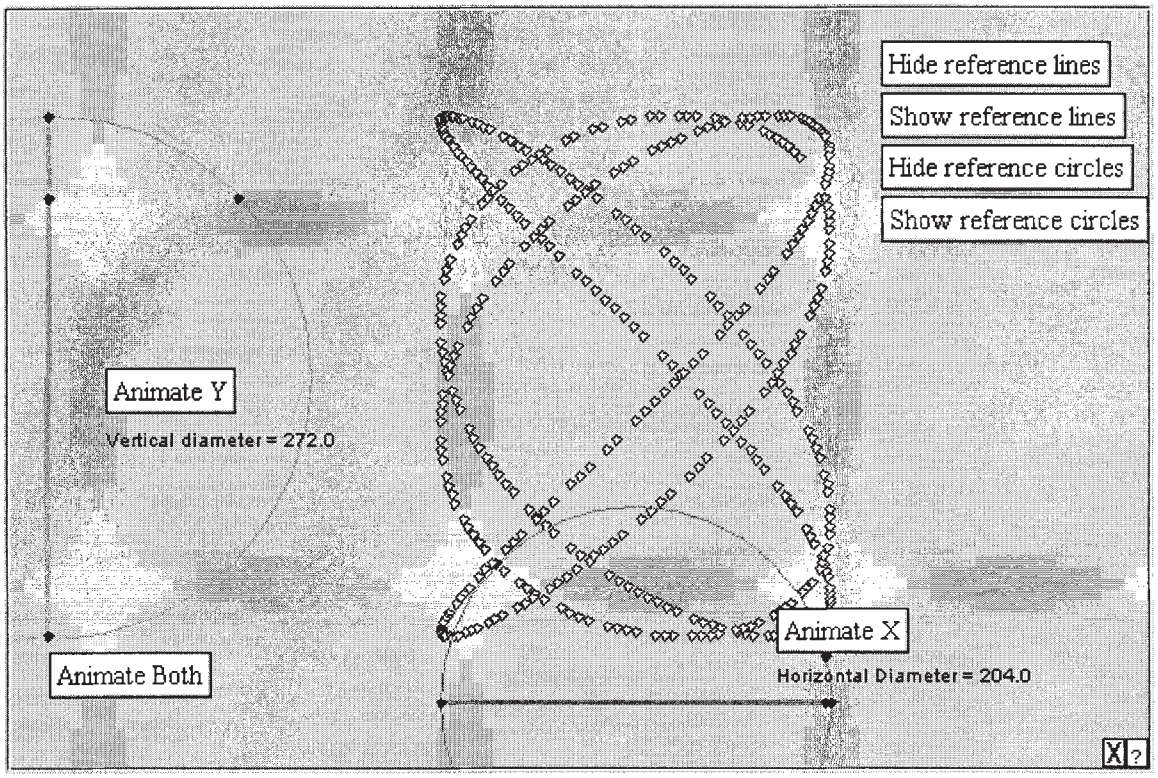

Figure 2: The Lissajous animated applet

This applet allows students to adjust the diameters of the circles to change the period of the curves and to turn on or off the circles themselves and the reference lines that intersect to determine the point being plotted. This applet is available at
`http://math.wvu.edu/~mays/AVdemo/Labs/Lab10/Lab10-02.htm`

2) Applets written using the Mathematical Java Toolkit developed by Joe Yanik at Emporia State University (NSF award DMI-9950714). These can be more mathematically sophisticated, but they still provide the opportunity for experimentation and developing insights. For example, the screen below is for a parametric function plotter adapted to investigate the equations representing Lissajous curves, with convenient slide controls to vary coefficients. This applet is live at
`http://math.wvu.edu/~mays/AVdemo/Labs/Lab10/Lab10-03.htm`

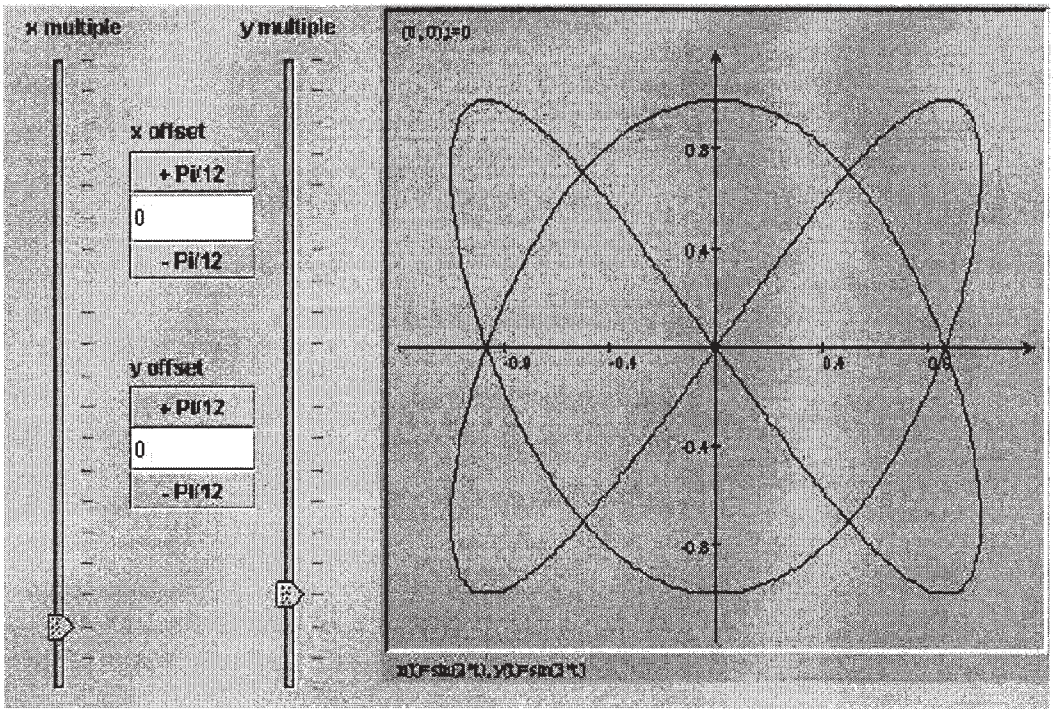

Figure 3: The Lissajous coefficient applet

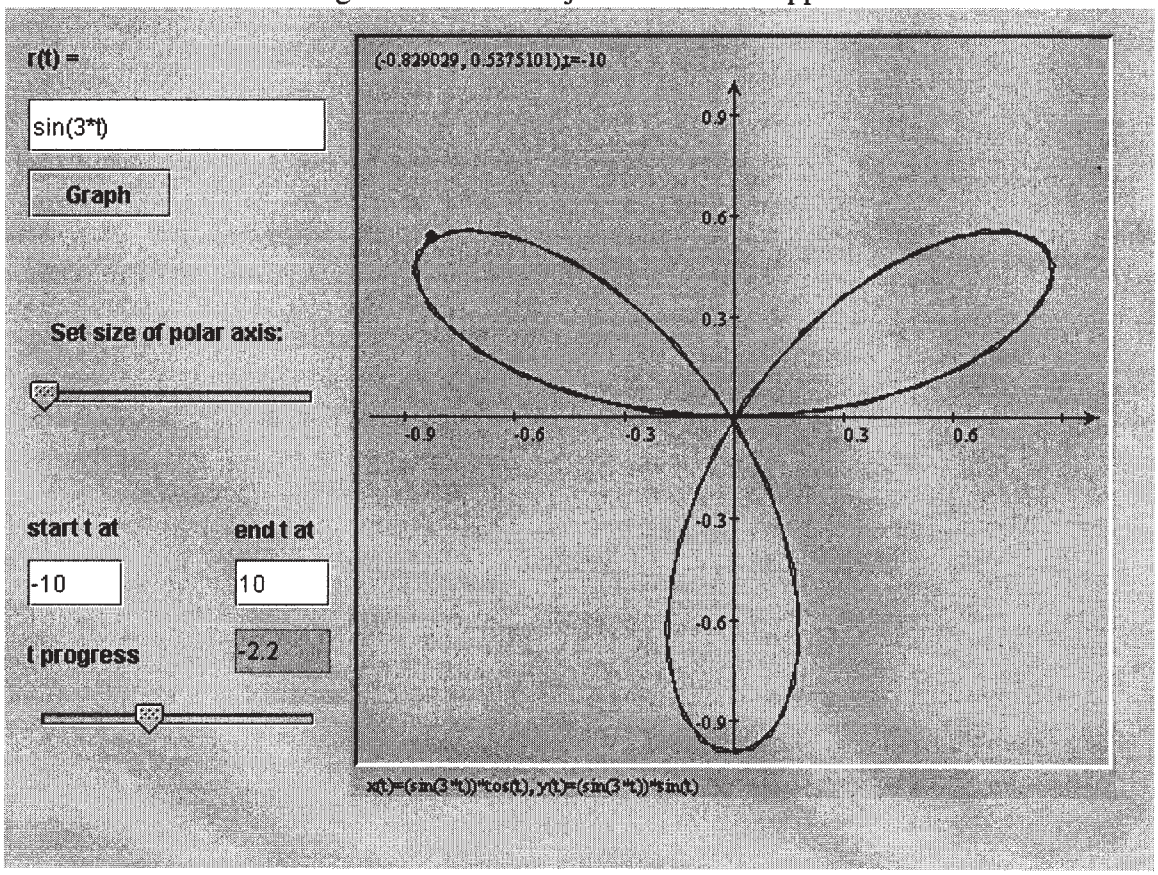

Figure 4: The polar function grapher applet

This polar function grapher has a slider at the bottom which lets the curve be generated dynamically, so that the effect of symmetry and period on the graph can be displayed more clearly. It is on line at
`http://math.wvu.edu/~mays/AVdemo/Labs/Lab09/Lab09-02.htm`

A generic grapher was written, in which parameters can be passed to provide a labeling for specific labs along with initial functions to plot. The grapher has an integrated algebraic, graphic, and tabular presentation of the function. It is available for inspection at `http://math.wvu.edu/~mays/AVdemo/Labs/Grapher/GraphingUtility.html`

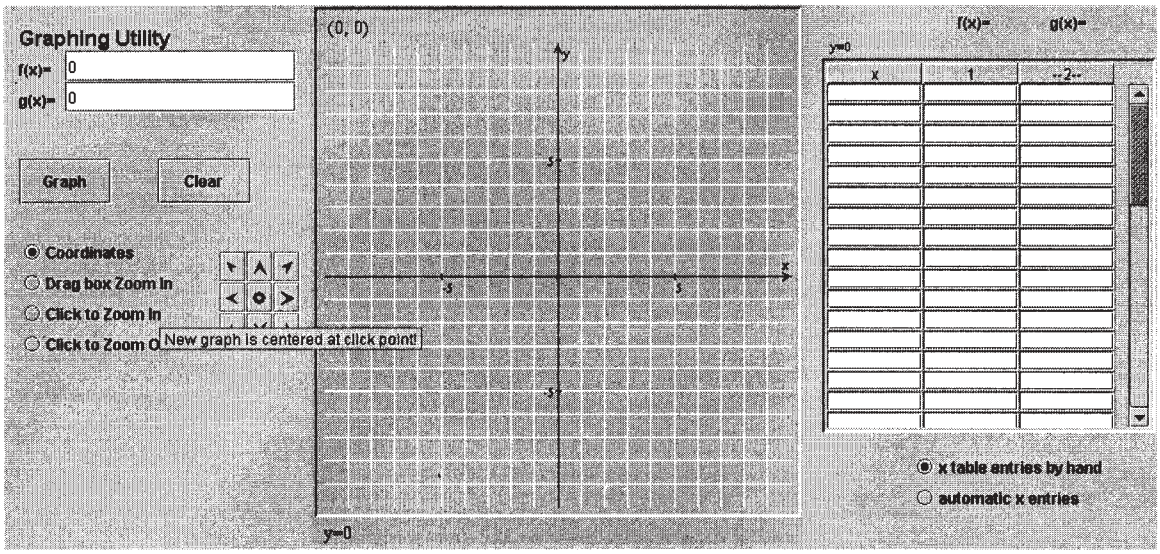

Figure 5: The generic graphing utility applet

References Cited

Blum-Anderson, J. (1992). Increasing enrollment in higher-level mathematics classes through the affective domain. School Science & Mathematics 8, p. 433-436.

Fey, J. T. & Heid, M. K. (1984). Imperatives and possibilities for new curricula in secondary school mathematics. Computers in Mathematics Education: 1984

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