

# CONNECTING GEOMETRY, ALGEBRA, STATISTICS, TRIGONOMETRY, AND CALCULUS WITH THE TI-89/VOYAGE 200

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The following images illustrate how the TI 89/Voyage 200 can be used to connect geometry, algebra, statistics, and trigonometry. The unit circle is constructed in the *Cabri* Geometry editor (Figure 1) with its equation displayed. The central angle is created and measured. The coordinates of the points on the circle and the measures of the central angles are displayed (Figure 2).

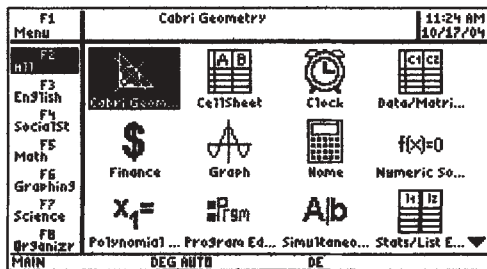


Figure 1

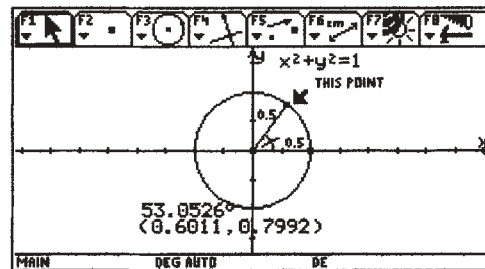


Figure 2

The values of the coordinates and the measures of the corresponding central angles are collected and stored in the Data Matrix Editor (Figures 3 and 4).

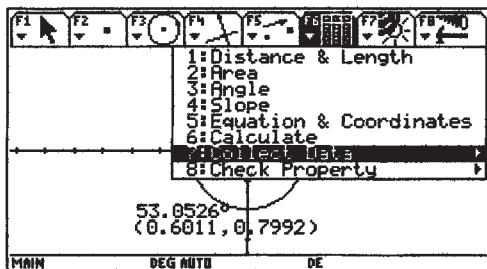


Figure 3

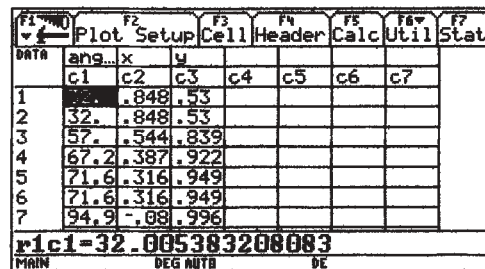


Figure 4

The unit circle and data are displayed simultaneously on a split screen (Figures 5 and 6).

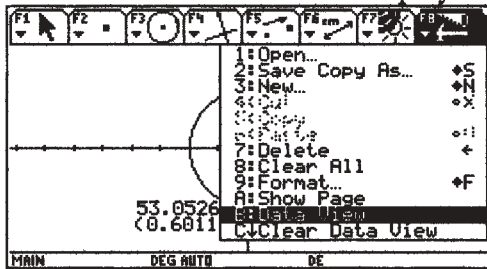


Figure 5

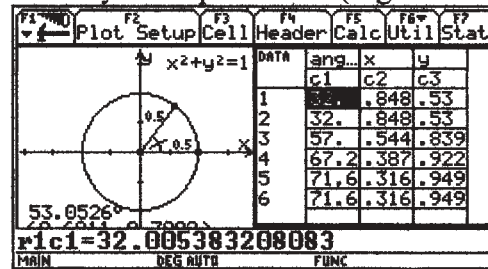


Figure 6

A scatter plot of the data is created. Students can then fit the correct trigonometric function to the scatter plot (Figures 7 and 8).

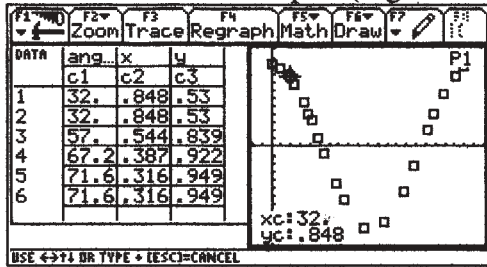


Figure 7

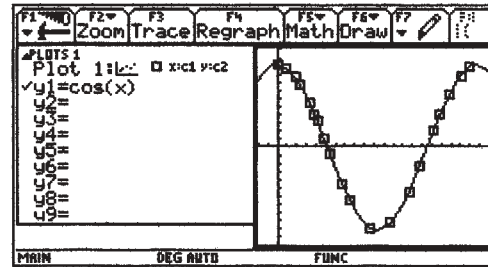


Figure 8

Detailed instructions for this activity appear in the Texas Instruments Exploration Series *Discovering Math on the TI 92* and *Discovering Math on the Voyage200*.

The next activity presents an example of a geometry exploration to find the minimal path using the TI- 89/92 Plus or Voyage 200. *Cabri Geometry* is used in the illustrations below. Sketchpad could also be used. The posed problem in *Geometry: A Guided Inquiry* is the following:

A camper at position A must quickly put out a campfire at position B. The river is represented by the horizontal line segment CD passing through point P. Where should point P be positioned on the river so that the camper will travel the shortest (minimal) path from point A to the river at point P and then to the fire at point B?

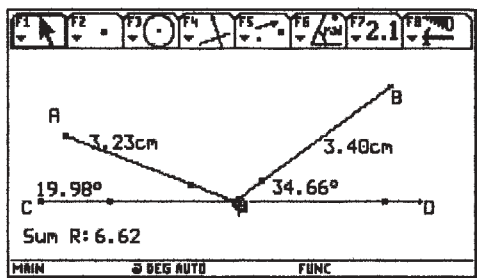


Figure 9

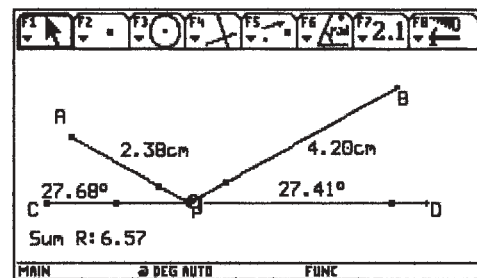


Figure 10

Figures 9 and 10 illustrate a student's sketch of the problem using the pull down menus in the Geometry editor of the TI-89/92 Plus or Voyage 200. Points and segments are drawn

and labeled. Measures AP and PB are displayed on the screen. Notice that the sum  $AP + PB$  is given in the bottom left of the screen. The figures depict the grab and move feature. Once Point P is selected, with the words "This Point," pressing the key with a hand displayed on it and moving the cursor pad actually moves the point and drags the segments! The measures and sum also change automatically. This can be animated to go back and forth showing that as we move to either side of the correct point the distance increases.

The students are then guided to the conjecture that the path is minimal when the measure of angle CPA (angle of incidence or angle coming in) is equal to the measure of angle DPB (angle of reflection or angle going out). The angles can be selected and measured using appropriate selections from the pull down menus. These measures also change automatically when P is dragged along segment CD. Finally, in a geometry course the students are motivated to prove the conjecture. The proof involves the properties of reflection, congruent triangles and the shortest distance between two points is a straight line.

The distances can easily be stored in the Data Matrix Editor or List Editor. The data can then be analyzed with scatter plots and curve fitting. In a calculus class the students can apply optimization techniques to the curve of best fit.

The same model is used to solve an optics problem to find the path followed by a light ray traveling from an object located at a point A, bouncing off a flat mirror located along segment CD, and traveling to an eye or other object located at point B. The work is based on Fermat's principle that a light ray traveling from one point to another will follow the fastest available path. After beginning with this simple example, students in a calculus class extended the problem to reflections of light rays in a curved mirror using differential calculus.

### References

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- Connors, Mary Ann. "Connecting Geometry and Pre-Calculus with the TI-89/Voyage 200", Teachers Teaching With Technology International Conference, New Orleans, LA, March 10-14, 2004, *Proceedings of the Teachers Teaching With Technology International Conference* (CD).
- Chakerian, G. D., Calvin D. Crabill, and Sherman K. Stein. *Geometry: A Guided Inquiry*. Pleasantville, NY: Sunburst Communications, Inc., 1987.
- Brueningsen, C., et al. *Discovering Math on the TI 92*. Texas Instruments, 1996.
- Brueningsen, C., et al. *Discovering Math on the Voyage200*. Texas Instruments, 2003.