

A picture is worth 1000 words, what is Geogebra worth?

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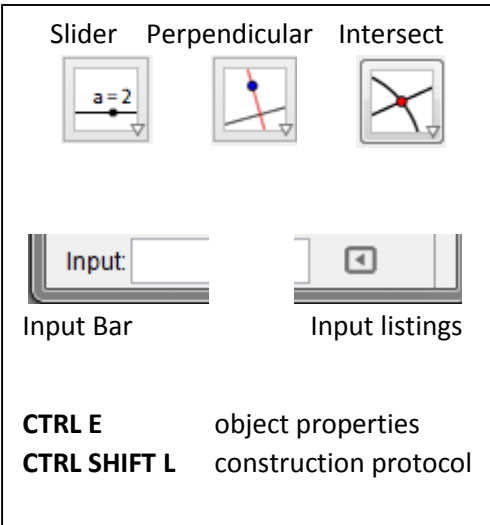
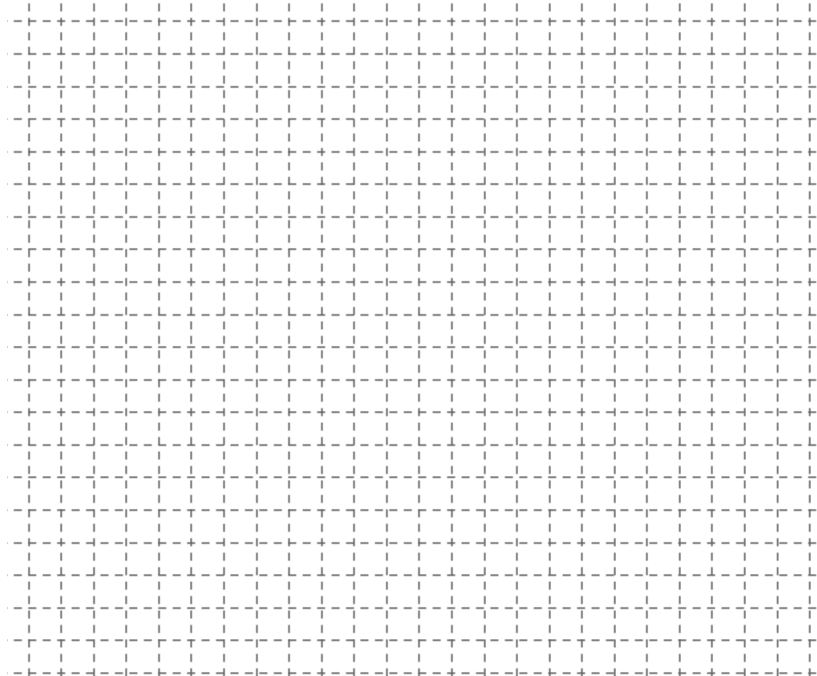
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Note1: All materials and files, along with the slide show itself, are available at the above web address)

Note2: Many of the things we talk about with Geogebra can be done with Geometer's Sketchpad or other software as well. I feel that Geogebra's main advantages are the price (\$0), portability (no download required to view creations).

- I. Introductory Pen and Paper problem.
From **Malcolm Swan**, University of Nottingham.
 - a. Draw a shape on grid paper. Find its perimeter and area.
 - b. Plot a Cartesian point to represent your shape: (perimeter, area)
 - c. Which points represent squares? rectangles? equilateral triangles? etc. Draw a shape that may be represented by (12,4). Draw a shape that may be represented by (4,12). Find all of the "impossible" points.
- II. **Perim v. Area** (Farrar) – When I came across this problem for the first time, I used Geogebra to approach it myself. And as soon as I started dragging shapes around, it completely changed how I thought about the problem.
 - a. How does Geogebra change the student entry points to Swan's task? How does it change the focus of the task itself?
 - b. How could the two approaches (pen/paper and Geogebra) be merged in a lesson plan to complement each other?
 - c. What are other concepts that can benefit from a dose of dynamic geometry software?
- III. About me: I have taught math in Oakland public high schools for seven years. During that time, Geogebra has become a more and more valuable tool in my lesson preparation, and as a student-used tool. I think of using Geogebra in three modes: 1. Construction, 2. Demonstration, and 3. Manipulative.
- IV. **Mode1: Construction.** I ask myself as often as possible: "how would I do this in Geogebra?" Whether my goal is merely to create a precise diagram, solve a problem, or to create demonstrations, manipulatives for my classes.
 - a. **(Live Construct#1)** Start simple: sliders can be used to control other objects. Let's look at something from Algebra 1, create sliders named m and b then input $y = m x + b$. One direction this can be taken is to demonstrate slopes of a perpendicular line. How might your students' concept of perpendicular linear equations when seeing or interacting with this kind of applet?
 - b. **(Live Construct#2)** The power of Geogebra is in the objects that are dependent upon other objects. Let's consider trigonometry. We'll construct a right triangle at the origin in a manner that will represent the set of all right triangles. (this construction builds up to the first two demonstrations)



These demonstrations and manipulatives can be downloaded from my website. To explore how they were made, open the construction protocol. (ctrl shift L)

- V. **Mode2: Demonstration** – One of the strengths of technology in general is to perform repetitive calculations, allowing us to see a multitude of examples.
- [Trig Segments](#) (Farrar) Shows the position and relative magnitude of the trigonometric segments. I like to use this in class as a reference *any* time that I want to find an approximate trig value.
 - [Wheel Sinewave](#) (Farrar) How many students consider a graphs, trig ratios, and trig functions to be three separate topics? I use a “mechanical” construction and the **trace** option to plot the sine and cosine waves point by point based upon the segments in a circle.
 - [Euclid’s Pythagorean Proof](#) (Farrar) Euclid’s proof can be a dense diagram. I show a continuum of equi-area triangles using shears and rotations to illustrate the famous proof. This is part of a theme in my demonstrations: if we prove that a sheared triangle as an area unchanged, then we can see *all* of the sheared triangles. Geogebra reinforces the power of proof: I constructed this Pythagorean demonstration once, but the construction holds for all right triangles... and we can see those right triangles by moving the original points.
 - [Epsilon Delta Limits](#) (Farrar) A huge roadblock for calculus students is the epsilon delta limit definition. If students can visualize the mapping of neighborhoods, however, then the question can be posed as concisely as “can we make it fit?”
- VI. **Mode3: Manipulative** – my favorite use of Geogebra. I create a set of applets for students, upload them to the web (or the integrated sharing service GeogebraTube) and have pairs of students do investigations.
- [Triangle Inequality](#) (Farrar) – I use a set of applets each year in a Geometry class to have students come up with the triangle inequality. Students work in pairs from instructions that instruct them to “find all possible lengths for \overline{AB} ”
 - [Painting with Linear Factors](#) (Riley Lark) – Great for an Algebra 2 or Math Analysis course. This lets students see linear factors of a polynomial as *lines*. And it lets them dig into the conditions and consequences of multiplicities, holes, asymptotes without being bogged down by the calculations. I usually structure this task with the goal of student-conjectures.
 - [Square Not Square](#) (John Golden) – This applet is a little different than the rest. The task: identify the imposter squares by dragging the available points. Then, classify each shape as specifically as possible.
 - [Distances to Vertices](#) (Farrar) – Harold Jacobs’ Geometry text begins with the story of the Surfer and the Spotter. Paraphrased, shipwrecked sailors land on a triangular island and want to build shelters that are convenient to their interests. The surfer wants short access to the beaches (sides), and the spotter wants short access to the lookout points (vertices).
My applet is based around the spotter, as it measures distances to the vertices. There are various measures that get revealed as point D is dragged around the triangle.

Thank you to Markus Hohenwarter and the [Geogebra](#) developers, along with [John Golden](#), Phil Grebe, Harold Jacobs, [Riley Lark](#), [Dan Meyer](#), Tom Rike, [Michael Serra](#), [Malcolm Swan](#), the staff at Oakland High and Skyline High, and my students!