## Geometry #2

**Before Tuesday, August 28**

Go to the Forum "Demonstrative Mathematics" and make at least one substantive contribution by 11 pm, Tuesday, August 28, and at least one substantive response to others' postings before class on Thursday, August 30. Write about the following:

How/when do we move to "demonstrative mathematics" in the K-12 curriculum? In geometry? In algebra? To what extent does this parallel the historical development of mathematics or not? Provide concrete examples.

**Before Thursday, August 30**

1. Go the website http://www.geogebra.org/cms for the free dynamic geometry program Geogebra. Download it, start it up, and then experiment with it. In particular, go to the Help menu and spend some time working through the instructions to see what it can do. Then use Geogebra to make a construction illustrating some particular geometric theorem. Go to the forum "Sharing Geogebra Sketches" and submit one of your constructions as an attachment—see some suggestions for constructions in the questions for discussion. Notice that you can export diagrams to active web applets.

2. If you did not do so already, make a sketch with Google SketchUp and submit it through the forum "Sharing SketchUp Sketches."

3. Read Dunham Chapter 1. As you read, think about the following questions for discussion.

   (a) To what extent is the historical development of mathematics reflected in the order and manner in which topics are introduced and developed in the K-16 curriculum?

   (b) How does Euclid prove that the sum of the measures of the angles in any triangle is 180 degrees?

   (See the website aleph0.clarku.edu/~djoyce/java/elements/elements.html).

   (c) Optional—try to carry out the quadrature of a rectangle (page 13 of Dunham) with Geogebra or some other dynamic geometry software such as Wingeom or Geometer's Sketchpad.

   (d) What does it mean for two quantities to be commensurable or incommensurable? Can two irrational numbers be commensurable?

(e) Look up some other pretty geometric dissections. See, for example, www.ics.uci.edu/~eppstein/junkyard/dissect.html. Optional—can you reproduce one of these using Geogebra or other dynamic geometry software, such as Wingeom or Geometer's Sketchpad?

(f) Look up how to construct a regular pentagon with straightedge and compass. Optional—can you do this with Geogebra or other dynamic geometry software, such as Wingeom or Geometer's Sketchpad?

(g) What are the constructible numbers? How can we use compass and straightedge constructions to add, multiply, invert, and take the square roots of constructible numbers?

(h) What does it mean for a geometric shape to be quadrable? Why doesn't Hippocrates theorem imply that a circle is quadrable?

**Thursday, August 30, 7–9 pm**

Attend the Adobe Connect session to discuss the readings, discussion questions, forum, and comments and questions on the assigned homework due on Sunday.

**Before Sunday, September 2, 11 pm**

Homework problems due Sunday, September 2, 11 pm, uploaded to the Moodle site as a single file less than 2 MB, or else emailed to the address mathhist@ms.uky.edu.

1. Derive the formula for the volume of a frustum given on page 4 of Dunham. (Do this without consulting outside resources.)

2. Provide a description of two proofs that $\sqrt{2}$ is irrational (see page 10 of Dunham). You are free to search outside resources to find these proofs.

3. In the discussion beginning on page 3 of Dunham we learn that every polygon can be subdivided into a finite number of pieces and reassembled into a square of the same area. Hence, given any two polygons $P$ and $Q$ of the same area, $P$ can be subdivided and reassembled into $Q$ (we say that $P$ and $Q$ are *equidissectible*.

   (a) Give examples in K-12 curriculum in which this concept is used to derive formulas for areas of certain shapes.

   (b) Find an explicit way of dissecting a $1 \times 2$ rectangle into a finite number of pieces that can be reassembled into a square. (Do this without consulting outside resources.)

(c) Find an explicit way of dissecting a $1 \times 3$ rectangle into a finite (hopefully small) number of pieces that can be reassembled into a square. (Do this without consulting outside resources.)

(d) Find a description of *Dehn's theorem* and give an example of two three-dimensional polyhedra having the same volumes that are not equidissectible (you do not have to present the proof).

4. Begin thinking about a potential presentation topic.