PROJECTS FOR CLASS PRESENTATION

PR HEWITT

(1) Look up the way Archimedes approximated π in Dunham's *Journey through Genius*. Be prepared to discuss the following:
   - How did Archimedes prove that $A/C^2 = \pi/4$?
   - How did Archimedes get both upper and lower bounds for π?
   - How did Archimedes use one approximation to get a better one? Give details!
   - Where and when did Archimedes live? What were the circumstances of his life?

(2) Read about how Robert Moses teaches the arithmetic and algebra of negative numbers in his book *Radical Equations* (written with Charles Cobb). Be prepared to discuss the following:
   - What is Moses' background, both mathematically and otherwise?
   - What is the history of the achievement gap in the US? What is the history of racial segregation in education? Do you believe the two are linked?
   - Is his teaching method effective in getting kids to understand why $(-2) \times (-3) = 6$? In your experience, would this work? Does it work with your nonmathematical friends?

(3) Project 3, p 72 of *Math through the Ages*. Be sure to provide a space-time plot which summarizes the histories of both the ancient Greek, Hellenistic, and Roman eras in the Mediterranean. Include on your plot famous mathematicians and scientists from this era.

(4) Project 2, p 120 of *Math through the Ages*. Be sure to provide a space-time plot which summarizes the major events of European history in the 15th–17th centuries.

(5) Project 1, p 206 of *Math through the Ages*. Visit the Toledo Museum of Art and compare paintings from the 13th–16th centuries. Note which artists use the theory of perspective and which do not. Include brief biographies of all the artists you cite.

(6) Read about medieval Indian mathematics in chapter 9 of Joseph's *Crest of the Peacock*. Be sure to provide a space-time plot which summarizes the major political developments and dynasties of this period. Be prepared to discuss the following:
   - Who were the major Indian mathematicians of this period? What topics were they interested in?
   - What is *chakravala* and how does it relate to "Pell's equation"?
   - What were the main accomplishments of the Kerala mathematicians?

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(7) Read about the development of spherical trigonometry in the Islamic Empire in section 7.5 of Katz' *A History of Mathematics*. Be sure to provide a space-time plot which summarizes the major political developments of the Islamic Empire. Be prepared to discuss the following:
   - What is *qibla* and when did it become important in Islam? (You may want to read about this topic online — try Wikipedia.)
   - Describe the trigonometric method for computing qibla. Apply this method to find qibla for the UT campus. (You will need the latitude and longitude for the campus, which you can find with Google Earth or Google Maps.)

(8) Read "Certain mathematical achievements of James Gregory", by M Dehn and E Hellenger, *American Mathematical Monthly*, 1943 (reprinted in *Sherlock Holmes in Babylon*, edited by Anderson, Katz, and Wilson) and also his biography at MacTutor (http://www-history.mcs.st-and.ac.uk/). Be sure to provide a space-time plot which summarizes the major political developments of Europe in the 16th–17th centuries. Be prepared to discuss the following:
   - What were the contributions of James Gregory to the early development of calculus?
   - Who were Gregory's main influences?
   - What was the relationship between his work and Newton's?
   - Whom did Gregory most influence?

(9) Investigate the history of various musical "temperaments", and especially the role played by both mathematicians and musicians in the debate, including (but not limited to!) Zhu Zaiyu, al-Kindi, Vincenzo Galilei, Marin Mersenne, Simon Stevin, Christiaan Huygens, JS Bach, Wolfgang Mozart, and others. Be sure to provide a space-time plot. Be prepared to discuss the following:
   - Comparison of scales: chromatic, diatonic, enharmonic.
   - Comparison of tuning: meantone tempered, equal tempered, and well tempered.
   - Description and examples of a "wolf interval". (Bring a sound sample!)

(10) Construct models of the figures tetrahedron-in-a-cube, octahedron-in-a-cube, and dodecahedron. These are all illustrated in chapter 6 of *Yearning for the Impossible*. (For bonus points, build a dodecahedron-in-an-icosahedron.) Use these to demonstrate the three kinds of 3-dimensional symmetry.

(11) Read chapters III–V of Osserman's *Poetry of the Universe*.
- Discuss the ways in which the development of noneuclidean geometry has affected our view of the universe.
- Describe the Poincaré and Klein-Beltrami models of noneuclidean geometry. (Stillwell refers to these as the conformal and projective models.) In particular, show how angle and distance are measured in these models.
- Include a space-time plot with both lifespans of the major mathematicians and scientists mentioned in these chapters as well as the major world events that occurred during this period.

(12) David Hilbert presented a list of twenty-three problems in mathematics at the Paris conference of the International Congress of Mathematicians in 1900. In this project we are interested in the 1st problem, on the *continuum hypothesis*.
- State the 1st problem in Hilbert's words (translated to English, of course), and then restate it in your own words.
- Several people made contributions to our understanding of infinite cardinals, including Georg Cantor, Thoralf Skolem, Kurt Gödel, Wacław Sierpiński, and Paul Cohen. Give brief biographical sketches of each of them, including a brief description of their contributions to the solution of Hilbert's problem.
- Include a space-time plot with both lifespans of the mathematicians mentioned above as well as the major world events that occurred during this period.

Univ of Toledo