E-320: Teaching Math with a Historical Perspective

Oliver Knill,   Harvard Extension, Fall 2017

Key information:
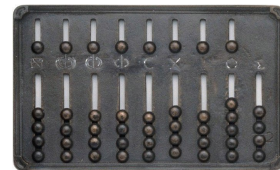
- **Website:**
  www.math.harvard.edu/knill/teaching/mathe320

- **Class:** Online Live Web conference

- **First Class:** Monday, Aug 28, 2017, 5:50-7:50 PM

- **Instructor:** Oliver Knill, 432 Science Center, knill@math.harvard.edu

Abstract:

In this course, now taught for the 9th time at the Harvard exension school, we take a panoramic tour over all mathematics. In each topic, we process historically look at topics which can be pedagogically relevant. The process of learning mathematics correlates with the history of mathematics. The struggle of research mathematicians finding new mathematics is similar to the challenges which students experience when they learn established mathematical theories. This process continues even today, as new mathematics is developed and refined and taught. In this course, we take a wide panoramic stroll through the landscape of all mathematics

and study it primarily from a historical perspective. History of course includes the current time. The connections to other fields, to other cultures and to other epochs including current developments in mathematics will help us to widen the horizon as a teacher and to inspire the classroom.

Prerequisites:

Previous mathematics background can be of advantage, but an open mind is more important. Interesting and new mathematics can be enjoyed also without vast background knowledge. Of course, you benefit more from this course if you know already different areas of mathematics.

Methodology:

We will visit different fields of mathematics. The range of mathematical topics is broad. The main goal is to stimulate interest, get a global view and see connections between different fields and different areas and different approaches. After a general overview of Mathematics in the first lecture, we will work each week with a specific branch of mathematics and see its historical context. We mainly follow the **case method** rather than a systematic **encyclopedic approach**. This allows us to pick concrete examples. As a balance, we encourage read some math on the side. A specific story is more engaging and each "case" can serve as a crystallization point for an entire subject. In a time, when knowledge explodes fast and a plethora of possibilities are offered electronically, teaching requires both to be broad as well as some care for details. The dilemma of combining these two extremes can be achieved with a "short story approach" combined by mixing different teaching elements like presentation, experimentation, discussion and problem solving. The case method is well established at business schools, where "discussions focused on real-world situations" is considered a good way to prepare students. In our case, the "real word situations" are "historical highlights".

Participants can adapt such models for their own teaching. Besides the material, pedagogical questions will come up. One main theme will be a general general principle: difficulties for the pioneers developing a topic reverberate today in the classroom.

No textbook is required. I will suggest some reading material. We have used various books in the past. The pioneering book "Math through the Ages", by William Berlinghoff and Fernando Gouvea (2004, ISBN 978-0-99385-736-6) is great. An other more recent book is John Stillwell's book "Elements of Mathematics" which just appeared. It has a similar approach we follow. It has many nice ideas.
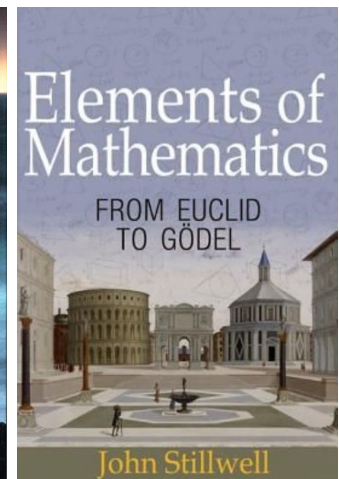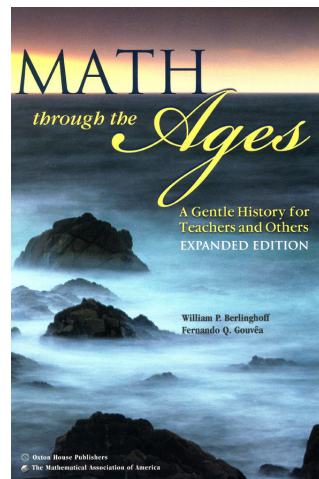
Project:

The project topic this fall is:

"Four millenia, four milestones, four lives "

The project is to write four short stories, each should deal with a major mathematical idea and each be connected to a major mathematician. One from -1000-0 AC, one from 0-1000 BC and one from 1000 to 2000 BC and one from 2000-

Course policies:

We follow the standard Harvard Extension School's policies on academic integrity. It is placed online at
www.extension.harvard.edu/resources−policies/student−conduct/academic integrity
This document also describes how to use sources responsibly. In particular, the project in this course should be written and completed by each student individually.

Grades:

The course grade is based on three parts:

- Quizzes: 30 percent

- Class participation: 30 percent
- The final project: 40 percent

Day to Day Syllabus:

The lecture sequence has worked well in the last 8 times the course was taught. We use part of the lecture to get an overview over the topic in a lecture using multimedia. As we have a webconference, we might have to slow down a bit the pace. We discuss then some particular problems and also will conclude with a small quiz. We will use part of the discussion to review the lecture and prepare each other for the quiz.

Lecture	Topic	Presentation
August 28, 2017	Mathematics	What is mathematics?
September 4, 2017	Labor day	No class
September 11, 2017	Arithmetic	Representing Numbers
September 18,2017	Geometry	Shapes and Symmetries
September 25, 2017	Number theory	Primes and Equations
October 2, 2017	Algebra	Symmetries and Games
October 9, 2017	Columbus day	No class
October 16, 201	Calculus	Summation and Differences
October 23, 2017	Set theory	Sets and Infinities
October 30, 2017	Probability	Chance and Processes
November 6, 2017	Topology	Polyhedra and Invariants
November 13, 2017	Analysis	Fractals and Dimension
November 20, 2017	Cryptology	Codes and Cyphers
November 27, 2017	Dynamics	Chaos and Predictability
December 4, 2017	Computer science	Artificial Intelligence
December 11, 2017	Outlook	Projectdiscussion