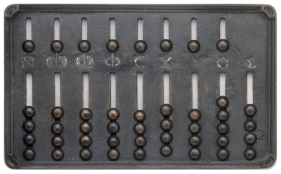
E-320: Teaching Math with a Historical Perspective

Oliver Knill, Harvard Extension, Fall 2016

Key information:

- **Website:** www.math.harvard.edu/~knill/teaching/mathe320_2016_fall
- **Class:** Science Center, 104, 5:30-7:30PM
- **First Class:** Monday, Aug 29, 2016
- **Instructor:** Oliver Knill, 432 Science Center, knill@math.harvard.edu
- **Office hours:** Before and after the lecture as well as by appointment.



Abstract:

In this course, 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:

A calculus 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.

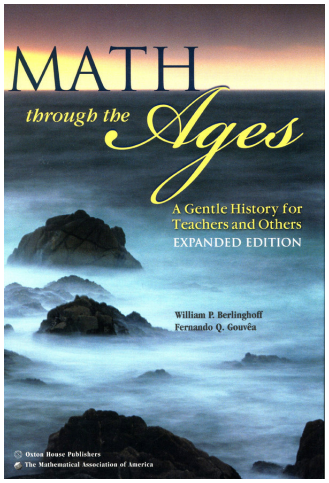
Methodology:

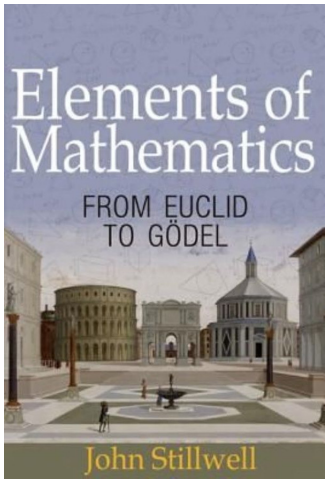
We will visit different fields of mathematics. The range of mathematical topics is broad. The main goal is to stimulate interest, get a global view and see connections between different fields and different areas and different approaches. After a general overview of Mathematics in the first lecture, 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.

Text:

The lectures are independent from the text and no textbook is required. 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 I can recommend 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:

"10 breakthrough ideas which can influence the teaching of mathematics ".

It is up to you to chose the 10 topics and how to approach them. One possibility is to imagine the reader is a student or friend of yours. An

other approach is waring the hat of a journalist describing some ideas to a more general audience. It turned out that the freedom of choice is both rewarding but it can also be challenging. The project should be something which brings you forward.

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/acad 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 after lecture: 40 percent
- The final project: 40 percent
- Class participation: 20 percent

Day to Day Syllabus:

The lecture sequence has worked well in the last 6 times the course was taught. We use part of the lecture to get an overview over the topic in a lecture using slides and multimedia. We work on in class on some particular problems. We always end the lecture with a short quiz. This quiz is closely tied to the lecture and notes can be used.

Lecture	Topic	Presentation
August 29, 2016	Mathematics	What is mathematics?
September 5, 2016	Labor day	No class
September 12, 2016	Arithmetic	Representing Numbers
September 19,2016	Geometry	Shapes and Symmetries
September 26, 2016	Number theory	Primes and Equations
October 3, 2016	Algebra	Symmetries and Games
October 10, 2016	Columbus day	No class
October 17, 201	Calculus	Summation and Differences
October 24, 2016	Set theory	Sets and Infinities
October 31, 2016	Probability	Chance and Processes
November 7, 2016	Topology	Polyhedra and Invariants
November 14, 2016	Analysis	Fractals and Dimension
November 21, 2016	Cryptology	Codes and Cyphyers
November 28, 2016	Dynamics	Chaos and Predictability
December 5, 2016	Computer science	Artificial Intelligence
December 12, 2016	Outlook	Project discussion