E-320: Teaching Math with a Historical Perspective

Oliver Knill,   Harvard Extension, Fall 2015

Key information:

- **URL:** http://www.math.harvard.edu/knill/teaching/mathe320_2015_fall

- **Class:** Story Street Room, 307, 5:30-7:30PM

- **First Class:** Mon, Aug 31, 2015

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

- **Office hours:** Before and after the lecture as well as by appointment.

- **Optional text:** "Math through the Ages", by William Berlinghoff and Fernando Gouvea (2004, ISBN 978-0-99385-736-6).

Abstract:

The process of learning mathematics correlates with the history of mathematics. The struggle of research mathematicians finding new mathematics is similar to the challenges of students learning 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 to widen the horizon of the teacher and to inspire the classroom.

Prerequisites:

The presentation part should be accessible to a general audience. A good calculus background is 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:

Using a "case method" methodology we 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. The **case method** can be complemented with a **encyclopedic approach**. The later is valuable too but the advantage of the case method is that one can pick concrete examples. As a balance, we encourage read the text book. 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. We have used various books in the past. This year, we use the pioneering book "Math through the Ages", by William Berlinghoff and Fernando Gouvea (2004, ISBN 978-0-99385-736-6). This book is affordable, inspiring and also "doable".
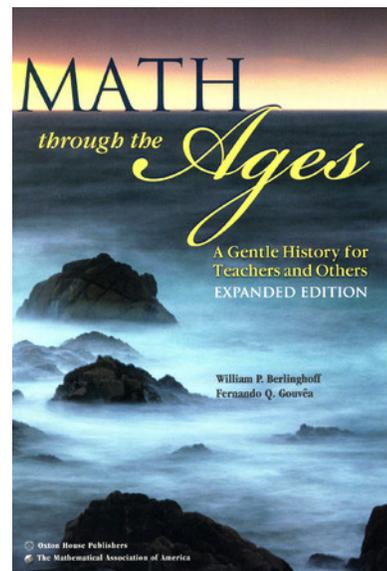
Project:

The project topic this fall is:

"Ten core concepts or ideas in mathematics".

Depending on personal preferences, each student writes a 10 section paper describing and illustrating 10 major ideas. It is up to you to chose the topics. In the past, some have used topics from a single subject or focused on some cultural area or researched beyond the mathematics in

which one is comfortable with. One approach is to take the stand of a teacher explaining to a student the "top 10" ideas. 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 awarding and challenging. The project should be something which brings you forward and allows you to research with a wide array of resources.

Course policies:

As a student you are responsible for understanding 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 individually.

Grades:

The course grade is based on three parts:

- Quizzes after each lecture: 40 percent

- A final project: 40 percent

- Class participation 20 percent

Blog:

Every year we have kept a blog fed by input of students and developments just happening in the mathematical world. Since the course is kept with a distance option, students taking the course remotely can interact with me email. If you can make it to class, that is even better as this allows to discuss things in person also and meet other students.

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. Notes from the lecture can be used. It is helpful to take notes therefore during the presentation part, notes which can be used for the quiz.

Lecture	Topic	Presentation
August 31, 2015	Mathematics	What is mathematics?
September 7, 2015	Labor day	No class
September 14, 2015	Arithmetic	Representing Numbers
September 21,2015	Geometry	Shapes and Symmetries
September 28, 2015	Number theory	Primes and Equations
October 5, 2015	Algebra	Symmetries and Games
October 12, 2015	Columbus day	No class
October 19, 201	Calculus	Summation and Differences
October 26, 2015	Set theory	Sets and Infinities
November 2, 2015	Probability	Chance and Processes
November 9, 2015	Topology	Polyhedra and Invariants
November 16, 2015	Analysis	Fractals and Dimension
November 23, 2015	Cryptology	Codes and Cyphers
November 30, 2015	Dynamics	Chaos and Predictability
December 7, 2015	Computer science	Artificial Intelligence
December 14, 2015	Outlook	Also project discussion