Flipping a math class:
How I learned to stop worrying and abandon in-class lecturing

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If you only remember one thing from this talk, remember:

Curriculum ≠ Pedagogy
How did I get here?

A Private Universe (~2.5 min.)
Why am I giving this talk?

- Tell you what to do
- Share experiences
- Prompt reflection, discussion, and debate
- Help you dream?

The world is so complicated - the more I learn, the less clear anything gets. There are too many ideas and arguments to pick and choose from. How can I trust myself to know the truth about anything?

And if everything I know is so shaky, what on earth am I doing teaching?

I guess you just do your best. No one can impart perfect universal truths to their students.

... except math teachers.

*ahem*

Thank you.
Here’s what I will do.

- Motivate pedagogy vis-a-vis learning science
- Describe a pedagogical model I’ve been trying
- Introduce you to GoogleModerator, LiveScribe, and PRS
- Leave time for discussion (go ahead and interrupt!)
Curricular context: 
“Applied Calculus” - Math 135 @ Macalester

- Designed in conjunction with biologists (and others)
- Required for biology major (and others)
- Assumes solid knowledge of high school algebra
- Unexpected gateway to applied math/stat major
- Envisioned as part of a sequence with Statistical Modeling
- Approx. 120 students in 5 sections per year
- Approx. 30% of graduating seniors leave having taken
Curricular context: “Applied Calculus” - Math 135 @ Macalester

- Functions as models
- Fermi Estimation
- Dimensional Analysis
- Lin. alg. and model fitting
- Modeling and computation
- Multivar. diff. calculus
- Optimization
- Integration
- Differential Equations

- Population growth
- Population interactions
- Metabolism
- Pharmacokinetics
- Spread of disease
- Agriculture/food supply
- Health care systems
- Environment/pollution
Curricular context:
Differential Equations - Math 312 @ Macalester

- Taken by mathematicians, applied mathematicians, physicists
- Requires multivariable calculus, linear algebra
- Approx. 45 students in 2 sections per year
- Biased towards dynamical systems
  - Separation of variables, integrating factors, undetermined coefficients, series solutions
  - Linear equations in n dimensions
  - Geometric arguments, stability, bifurcations, normal forms
  - Computation
I base my pedagogy on this framework (but there are plenty of other good ones out there).
My view:
This is what math classes have historically looked like.
Not the same.

Curriculum ≠ Pedagogy
Educational technology is like a hammer.
Here’s what I do.

Lectures occur in a pre-class format.

Students pose and answer each others’ questions online.

Face-to-face time is freed up not only for assessment, but much more.
Lectures occur in a pre-class format.

[Knowledge-centeredness, learner-centeredness]
Pros and cons of LiveScribe

**PROS**

- Cloud-based, non-college tool
- Pause button (for students)
- Cheap (~$100), no fee for students
- Easy to use
- Low “activation energy” for recording
- “Free” publishing mechanism (cloud-based)
- One good recorded lecture can last a long time
Pro and cons of LiveScribe

**CONS**

- Cloud-based, non-college tool
- Editing is impossible
- The medium is limited
- First term recording is labor-intensive (payoff comes later)
- One or two students complain that I am not teaching them
Students pose and answer each others’ questions online.

[Knowledge-, learner-, and community-centeredness]
Pros and cons of GoogleModerator

**PROS**

• Free
• Automatic prioritization of questions
• Intuitive Google interface for posing/responding
• Robust back end

**CONS**

• Not part of institutional CMS
• Students sometimes resistant
• Students are identifiable
Face-to-face time is used for clicker questions (and more).

[Assessment-centeredness]

Morphine is administered to a patient intravenously at a rate of 2.5 mg/hr. About 34.7% of the morphine is metabolized and leaves the body each hour. Which differential equation best describes the amount of morphine in the body (M, in mg) as a function of time (t, in hr)?

1. \( \frac{dM}{dt} = 2.5 - 0.347 \)
2. \( \frac{dM}{dt} = 2.5 - 0.653 \)
3. \( \frac{dM}{dt} = 2.5 - 0.347M \)
4. \( \frac{dM}{dt} = 2.5 - 0.653M \)
Pros and cons of PRS Clickers

**PROS**

- Grading is automatic
- Gets students into their seats (on time)
- Flexible, easy to use
- Instant feedback
- Students find them to be fun

**CONS**

- Somebody has to buy them
- They are physical objects that need to be maintained
Here’s what I do.

Lectures occur in a pre-class format.

Students pose and answer each others’ questions online.

Face-to-face time is freed up not only for assessment, but much more.
What is the “much more”?

- Q & A
- Discussion
- Practice / homework problems
- Group exercises
- Computer labs
- Project work
My big messages

• Curriculum ≠ pedagogy
• Learning science informs what we **should** do in the classroom
• Technology has changed what we **can** do in the classroom
• Know why you do what you do