My Experiences with Using Inquiry-Based Learning in Upper-Division Math Classes

Jeremy L. Martin
University of Kansas

Teaching Matters Seminar
April 19, 2021

Inquiry-Based Learning (IBL)

> *"IBL is a form of active learning in which students are given a carefully scaffolded sequence of mathematical tasks and are asked to solve and make sense of them, working individually or in groups."*
>
> (Academy of Inquiry-Based Learning)

- Closely related is the Moore method.
- I don't use IBL or Moore method as systematically as I might — I just try to maximize the amount of class time spent having students talking rather than myself talking

MATH 724 (Combinatorics) — Overview

Prerequisite: MATH 290 and one course numbered 450+

F'13: 8 students (4 grad/4 undergrad)
F'17: 15 students (6 grad/9 undergrad)

Textbook: K. Bogart, Combinatorics through Guided Discovery
(free at OpenMathBooks)
— Contains lots of problems and some discussion, but not
solutions or proofs

Topics: combinations and permutations, inclusion/exclusion,
partitions, a little graph theory, generating functions, etc.

Proof-based; often supplemented by machine computation

Coursework: Biweekly written homework (collaboration allowed);
take-home midterm and final (collaboration not allowed)

MATH 724 (Combinatorics) — Teaching Method

- Each day, I assign a sequence of problems from Bogart and students work through them in small groups
- I visit each group at least once per class period (usually more)
- Mix up the groups each week
- Students sometimes present to class
- I spend $\sim 10\%$ of time presenting material in "plenary session"
- Some homework problems are done first in class

MATH 724 (Combinatorics) — Reflections

- Based on surveys, most students like the format
- I like the format (less lecture prep, more thinking on my feet and interacting)
- 2013: students liked to work as "committee of the whole"
- **Biggest challenge**: students have different backgrounds and work at different speeds
  - Quicker/more advanced students can be given extra challenges
  - Students are pretty good about helping peers who are falling behind (up to a point); important to set an example of showing respect

MATH 696 (Topics in Topology) — Overview

Prerequisite: MATH 500

S'21: 9 students (2 grad/7 undergrad); Zoom; synchronous; students strongly requested to turn o their cameras

Textbook: M. Starbird and F. Su, Topology Through Inquiry (AMS/MAA, $\sim$\$50) — Like Bogart, contains lots of problems and some discussion, but not solutions or proofs

Topics: Beginning point-set topology (topological spaces, bases, continuity, compactness, connectedness, metric spaces). I hope there is time for a little algebraic topology.

Proof-based (but proof-writing experience is variable)

Coursework: Biweekly written homework (collaboration allowed); take-home midterm and final (collaboration not allowed)

- The master spreadsheet has a list of problems that students need to be ready to present
- I **choose students to present in class** (using Zoom screen share), then ask for feedback from other students and give my own feedback
- I **keep a record of who has presented** when, and try to call on students who have not presented as often
- I also try to make sure that **everyone speaks at least once** each class (e.g., by asking quieter students to comment). In practice this doesn't always happen but it is a good goal
- Occasional **small-group discussions**, usually on harder problems (using Zoom breakout rooms)

- **Biggest challenges:** varying backgrounds, but also varying personalities — some students are very willing to jump in and comment; some need me to invite them explicitly

- **Quality** of feedback from students is good (constructive, respectful); I would like more **quantity** (sometimes they just nod and smile and I don't know how much they have digested)

- Do students like this format for this topic?

- Do students learn topology better this way?

- How much better would this work in person?

Also, I still talk too much.

Thank you!

jlmartin@ku.edu