Techniques Grading in an IBL-style Intro to Proofs Course

Rationale - Implementation - Conclusions

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March 3, 2022

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The “Why?” and the “What?”

Primary Objectives of an Intro to Proof class

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What it is:

- Learn how to think like a mathematician i.e. 'how to start'.
- Learn how to communicate Mathematics using the correct vocabulary.
- Realize that 'solving a problem' is not the same as 'understanding the solution of a problem'.
- Learn how to persevere with a difficult question, even when no goal might be immediately within your sights.

What is Techniques Grading?

- A Hybrid of Standard- and Specification-Based (and some other alternate) Grading methods
- Term coined by Dr. Andrew A. Cooper from UPenn in PRIMUS, 2020.
- Learning objectives are not an exhaustive list of content - instead, a list of broad techniques and themes.

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- Learning objectives are not an exhaustive list of content - instead, a list of broad techniques and themes.
- Proper choice of techniques $\rightarrow$
  - gives big picture view of the subject
  - allows a student to demonstrate mastery without attaching particular problems to a standard

The “How?”

Components of the Course I

	Assignment Category	Types of Problem Covered	Goal	Scoring System
Content Based	Exams (2 Midterms + 1 Final)	MCQ, Short answer Proof Evals, Proof Identification	Notation Proficiency in Set Theory, Logic, Modular Arithmetic, Reading comprehension	Numerical, 70% for A
	Homework (weekly)	Computation, Enumeration Proof Review	Practice new vocabulary, Group work, Community building	Numerical, 80% for A

Components of the Course II

Participation Based	Checkpoint Quizzes (daily)	Concept Check	Self-assessment	Completion, Infinite attempts
	Reflection Exercise (4 or 5)	Creative writing and reflection essays on articles, videos, book chapters	Formative assessment, Fostering a growth mindset, Promoting awareness of DEI issues, Promoting and applying logical thinking to real life	Completion

Components of the Course III

Technique Based	In-class Participa-tion and Presenta-tion	Different Proof Techniques (Direct, Indirect, By Cases, Existence, Induction etc.) - Not a com-prehensive list	Stress the major underlying themes and highlight the thinking process	“Frequent” in-class participation required for A - recommend using a spreadsheet to keep track

Components of the Course iv

	Practically Perfect Proofs (15-20 problems, 2 weeks deadline for first draft, then another two for revision)	A collection of harder Proofs Students are allowed to use any proof technique	Proof writing proficiency, LaTeX proficiency, Identification of the correct technique, Creating a concrete list of achievements over the semester	EMPX rubric, Latest score is counted, Three quarters E and rest M needed for A

Components of the Course v

Preparation for Senior IS Thesis	Expository Paper (video presenta-tion and written article)	A 5-7 page write-up in the style of a Math paper, on a topic of their choice, of the appropriate level of difficulty	Multistep process - Learn how to find sources (bibliography) - Submit a brief outline (identify main results and proof techniques) - Peer review first drafts - Ask and answer questions during audiovisual presentation - Submit a final paper Main focus on communication skills, Demonstration of understanding through visual or tabular examples.	Graded based on how many tasks were completed from a rubric, Mathemati-cal accuracy is given less focus than logical consistency

Integration with IBL

- 20 Students, Meeting MWF for 50 minutes.

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Typical second half of class:

- Students shuffled into groups of four at the start of each new concept (typically every week).
- Group work using handout with minimal prior lecture - necessary to prepare IBL style notes beforehand.
- Instructor moving around helping with conceptual mistakes, giving hints to get started, asking leading questions - but no explicit solution.

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In-between classes:

- Students write down outlines for complete proofs.

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Typical first half of class day:

- Students present their proofs (not preassigned) - I typically go in alphabetical order
- Sometimes I will write it down on board as the students dictate to make it a bit faster.
- Motivate new concept (5-10 minutes) - but not necessarily precise statements of definition or theorem

How to get students invested?

- Clarify the goal of each type of assignment - explain why homework score cannot work as a substitute of exam or presentation scores
- Encourage discomfort and frustration while learning!
- Invite students to take chance and make mistakes - and make reassessments part of the norm.
- Set a higher standard for acceptable final work.

“Did it work?”

Anonymous Student Feedback

Students liked (aka 'Things to Keep'):

- the sheer number of examples/exercises covered.
- satisfaction of solving the P^3 exercises.
- Allowing collaboration for homework
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Numerical Scores (average out of 5):

Stimulated interest 4.67
Clarity of explanations 4.67
Helpful feedback 4.67
Organization 4.6
Attended class 4.7

Thank you!

Questions? Email me at schowdhury@wooster.edu.

Find Course Document and Lecture Notes at

`github.com/subhadipchowdhury/Notes_Intro_To_Proof`