IMPROVING PROOF-WRITING WITH READING GUIDES

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MathFest 2016, Columbus OH

August 5, 2016

INTRODUCTION

Discrete Structures: an introduction to logic and proof, set theory/axioms, functions, relations, graphs, and Boolean algebras/lattices.

Textbook: *Mathematics: A Discrete Introduction* by Scheinerman

Traditional lecture.

Needed to make some changes.

book, content, delivery

Discrete Structures: an introduction to logic and proof, set theory/axioms, functions, relations, graphs, and Boolean algebras/lattices.

Textbook: *Discrete Mathematics* by Jongsma

A mix of math and CS majors (with a token engineer).

Goal: Improve quality of proof writing and depth of knowledge.

2007 conference proceedings from RUME conference (Soto-Johnson, Dalton, Yestness) studied student descriptions of how proof-writing improved.

Three main themes:

1. Practicing writing proofs
2. Observing proofs being done by others *increase*
3. Receiving feedback on proofs *1,3 already in place*

Flipped classroom model? *not a lot of time*

LOW-COST FLIPPED CLASSROOM

Lew Ludwig: "Before students can become effective writers of mathematics, they first need to become proficient readers of mathematics."

MAA Notes Series, 2015

Create opportunities for reading and observing proofs.

Enter the reading guide.

THE IDEA

Rather than prepare traditional lecture notes, I wrote one reading guide per section of the text. In general, the reading guides:

- Encouraged students to provide their own working definitions/examples/non-examples;
- Asked students to solve warm-up problems to reinforce key concepts;
- Helped students read, analyze, and fill in gaps in proofs in the text.

The reading guides usually took only a bit longer to prepare than traditional lecture notes.

- (In the proof of FTA): List all points in the proof where it is clear that we are using strong induction.
- Give a working definition of a countable set.
- Compute $\bigcap_{r>0,\ r\in\mathbb{R}} (0, r)$.
- Regarding the proof of the uncountability of $[0, 1]$:
    - What does the list represent? What assumption are we making that we will later contradict (you probably need to finish reading the proof to answer this)?
    - How is the real number d constructed? How do we *know* d is not on the list?

- Course was specifications graded; learning community credit granted for good faith effort on each reading guide as well as presenting solutions to problems/proofs from reading guide/daily work.
- Students began each class (5–10 minutes) in assigned groups of 2–3 and discussed lingering questions from the reading guide (as well as daily work from previous section).
- Then 10-15 minutes presenting daily work problems.
- Finally, we used the reading guide as a basis for discussion (20–25 minutes).

REACTION

STUDENT RESPONSES

"Which course assignments, activities, and/or teaching methods were most helpful for your learning?"

- "I could have re-read the parts I didn't understand"
- "Should have spent more time reading the chapters"
- "[The] reading notes made sure I read everything and understood them"

Students seem to have accepted that the burden of learning shifted.

Did I achieve my goal of improving proof-writing?
We'll see in modern algebra this fall.

It was a really enjoyable semester for me, and not an outrageous amount of work. I'll do it again in this course.

Still:

- More intentional planned discussion points beyond the reading guide
- Ensure we have enough time to discuss things in depth (maybe don't be so ambitious): "would have benefitted from more time discussing the reading"

Thanks!