Mastery Based Testing

An Introduction and Observations from Implementation in a Variety of Levels of Mathematics Courses

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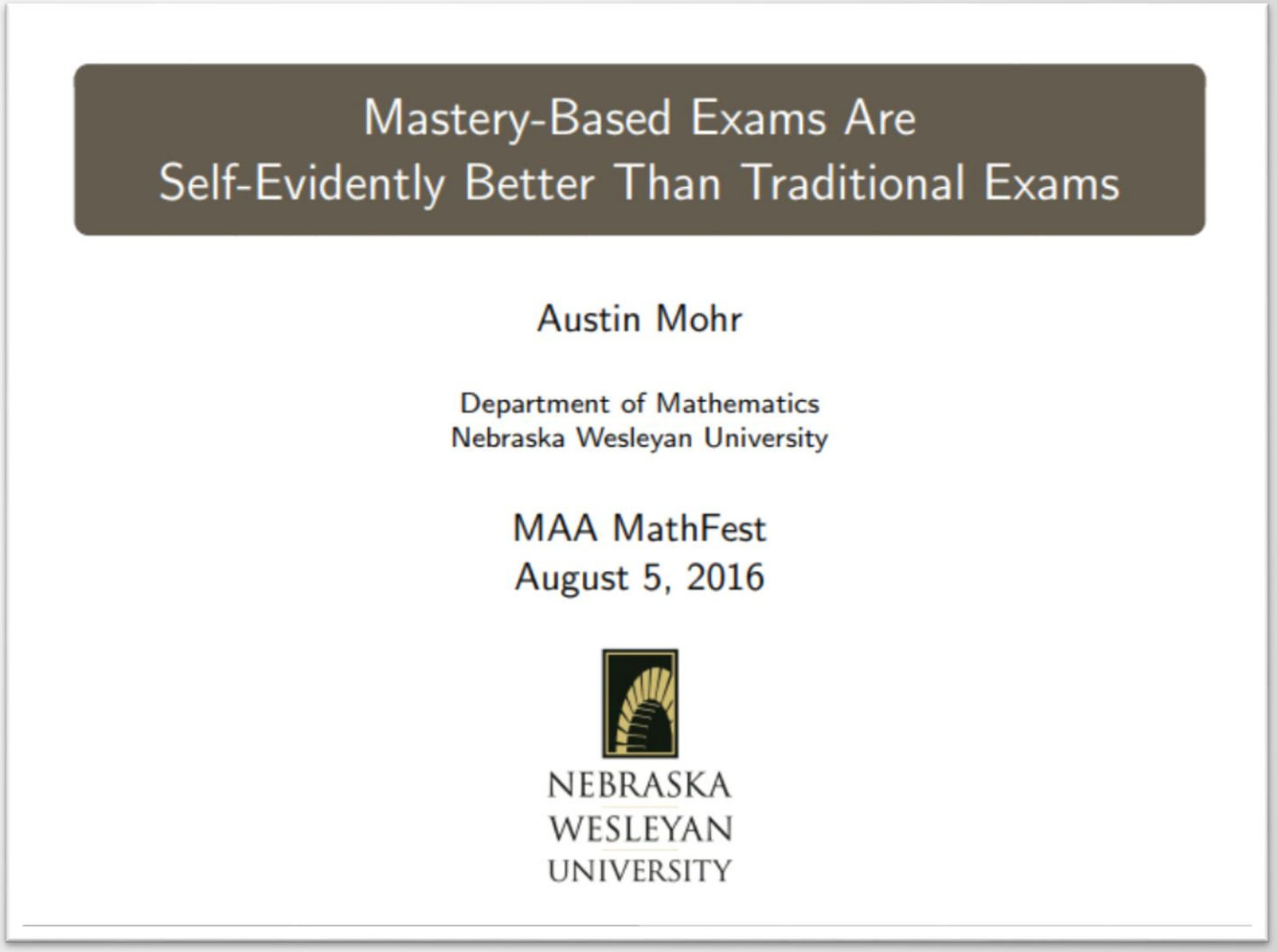
Roanoke College

MAA Sectional Meeting

November 18,2017

Where it all began…. (for us)

Trip to MathFest 2016 with colleagues and students



Mastery-Based Exams Are
Self-Evidently Better Than Traditional Exams

Austin Mohr

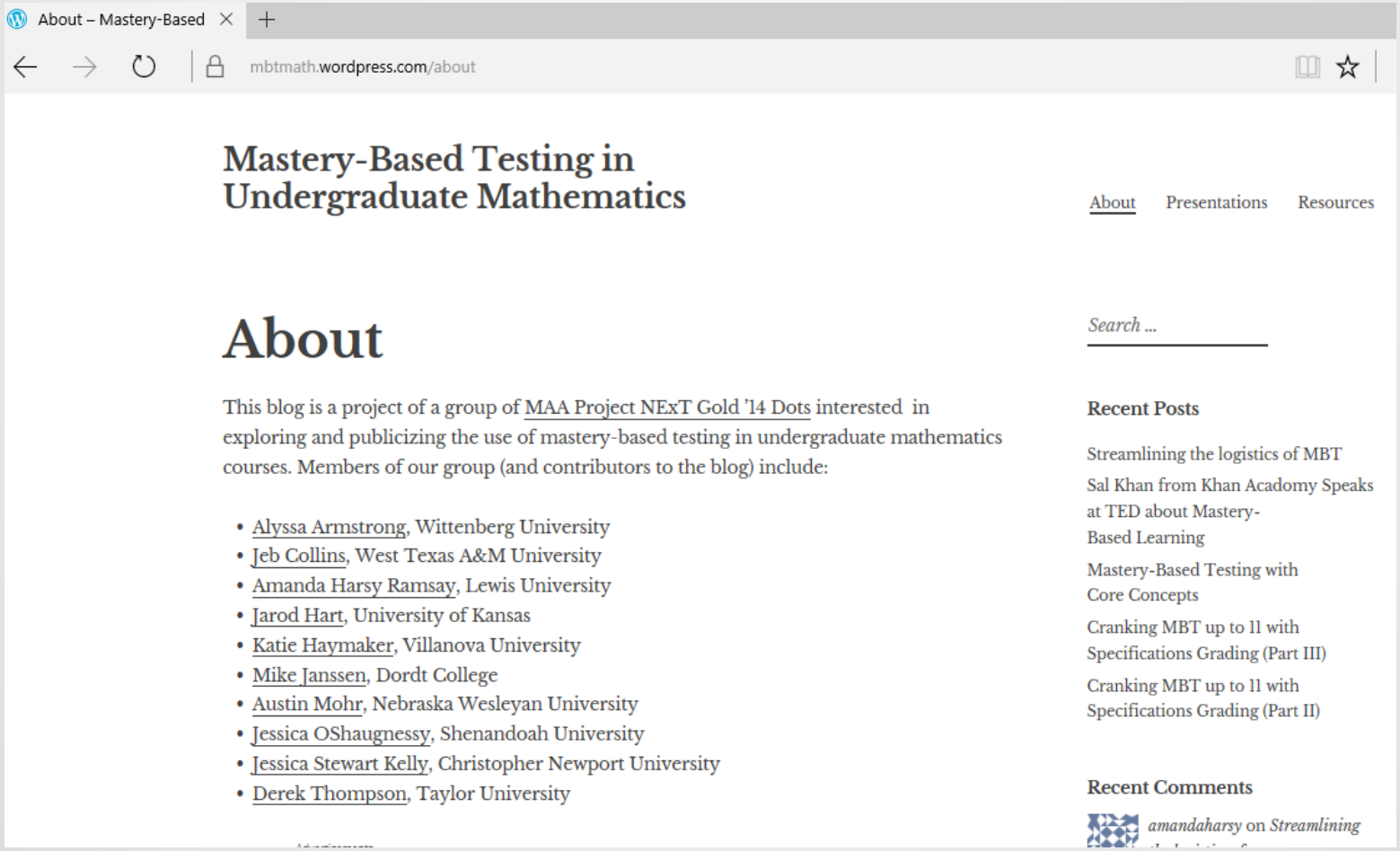
Department of Mathematics
Nebraska Wesleyan University

MAA MathFest
August 5, 2016

NEBRASKA
WESLEYAN
UNIVERSITY

Online resource

http://mbtmath.wordpress.com



Mastery based testing – the easy part

- Course content remains the same
- Content from entire course is broken in to “topics”
- We’ve used anywhere from 14 to 30 topics for a course

Mastery topics – Calculus II

1. Differential Equations
2. Applications of Integration
3. Sequences & Series
4. The Ratio Test
5. Power Series
6. Taylor Series
7. Applications of Series
8. Vectors
9. Dot & Cross Products
10. Applications of Dot & Cross Products
11. Vector-Valued Functions
12. Motion in Space
13. Surfaces in Space
14. Functions of Several Variables
15. Partial Derivatives
16. Double Integrals
17. Applications of Double Integrals
18. Double Integrals in Polar Coordinates

Points based testing

The process…

- Cover material for 2,3, or 4 weeks
- Give a test
- For each problem, assign points based on correctness
  - What does a 7/10 really mean compared to an 8/10??
- Mark up the test with corrections
- For a student with a 70% average, how do you best help them improve?

The outcome…

- Students carefully look at your comments – to see if they agree with your grading
- Content and assessment moves on to new material, previous material (possibly) revisited on the final
- A portion of the students grade is locked down
- Students begin asking if you will drop their lowest test score, or ignore earlier test scores if they show improvement

Mastery based testing – the mechanics

- Work on a topic is graded as either "**mastered**" or "**not mastered**"
  (no points are used, there is no partial credit)
- Once you master a topic, you need not ever attempt it again on future tests, including the final exam.
- If a topic is not mastered on a given attempt, it may be worked again at the next opportunity, no limit on attempts.
- There is no penalty whatsoever for multiple attempts being needed to master a topic.
- Test grade is calculated using proportion of topics mastered.

Testing / Grade Scale

Course Grade

Labs	20%
Tests	80%

Test 1: Topics 1-4

Test 2: Topics 1-9.

Test 3: Topics 1-13.

Test 4: Topics 1-18.

Final Exam: Topics 1-18.

On every Friday between tests you may work up to two topics.

Overall test grade is determined by the number of topics mastered.

# Mastered	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Test Grade	100	96	92	88	84	80	76	72	68	64	60	56	50	40	30	20	10	0

Name_____

Find the equation of a line that lies in the plane $x - 2y + 3z = 10$.

Name_____

A projectile is launched horizontally at 1100 feet per second from a height of 5 feet above the ground. What will be the speed of the projectile when it strikes the ground?

What does mastery of a topic mean?

- It **does not** mean perfect.

- It **does** mean that you have demonstrated a full understanding of the topic, and that future work on the topic is not necessary.

The good…

- Clear content objectives
- Reduced test anxiety
- Intelligent studying, test preparation, and use of feedback
  - use of office hours changes dramatically
- Tenacity / perseverance
- Removal of artificial deadlines for understanding content
- A clear path to improvement of grade
- For the instructor – a clear measure of which material in the course students do or do not understand.

The (possibly) bad…

- Writing multiple version of problems is more work initially
  -balanced by grading being substantially easier
- Incredible opportunity for student procrastination
- Not everything studied will be tested
- Brutal on truly weak students
- A student used to getting a “C” on everything may fail.

First experience

- Last fall
- Vector calculus
- 17 motivated students

I think that over the semester my enjoyment of mastery based testing continued to grow. The first day I was a bit nervous about testing be 100% or nothing but in the end it shows if you really understood the material and I think that's extremely beneficial, especially in mathematics.

I could always tell why I didn't get mastery- didn't integrate correctly, didn't check all critical points, had no idea what I was doing- it was always crystal clear.

I am proud to have taken part in the test run of mastery based testing. My grade may not have been stellar, but that's an issue with how I study, not the testing method.

Research Question

Does the benefit of, and acceptance of, mastery based testing vary among different student cohorts?

Fall 2017 – I am incorporating mastery based testing in 4 courses

- INQ 240 – Introductory Statistics (general education course)
- Math 122 – Calculus II
- Math 311 – Operations Research
- Math 332 – Applied Differential Equations

What could vary?

Quantitative data

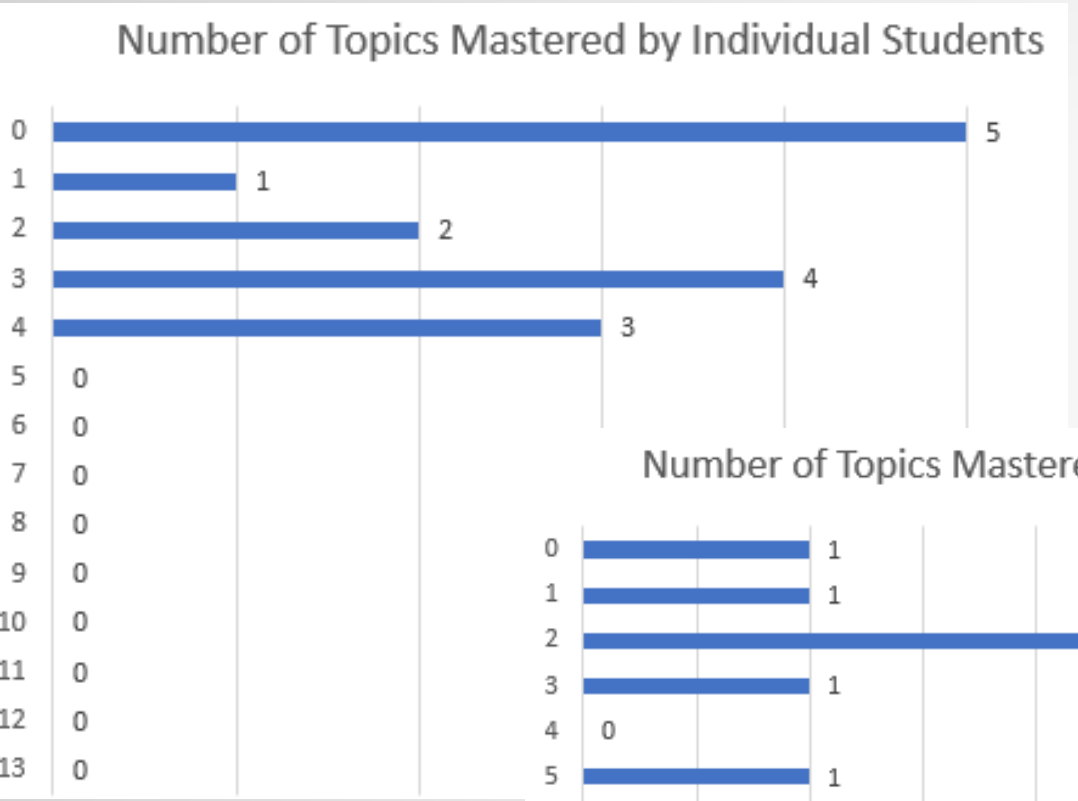
- Grade distributions
- Mastery rates
  - by student
  - by topic
  - by version
  - vs. number attempted

Qualitative data

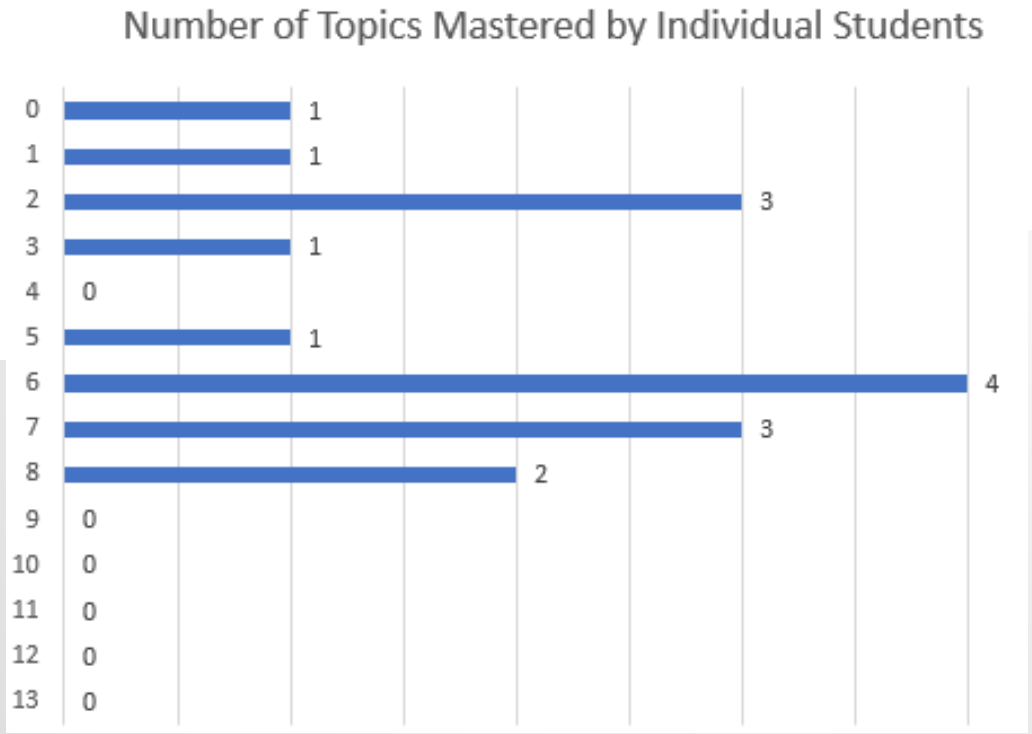
- Student effort
- Perseverance
- Test anxiety
- Fairness of grading
- Grade reflective of knowledge?

Calculus II, Fall 2017

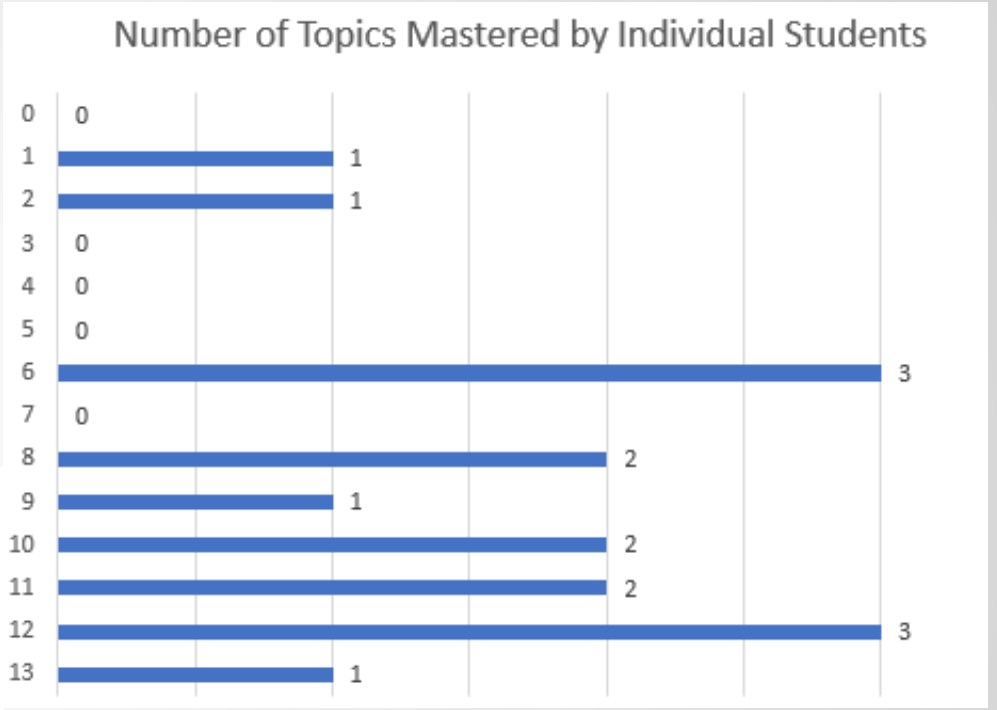
After Test 1



After Test 2

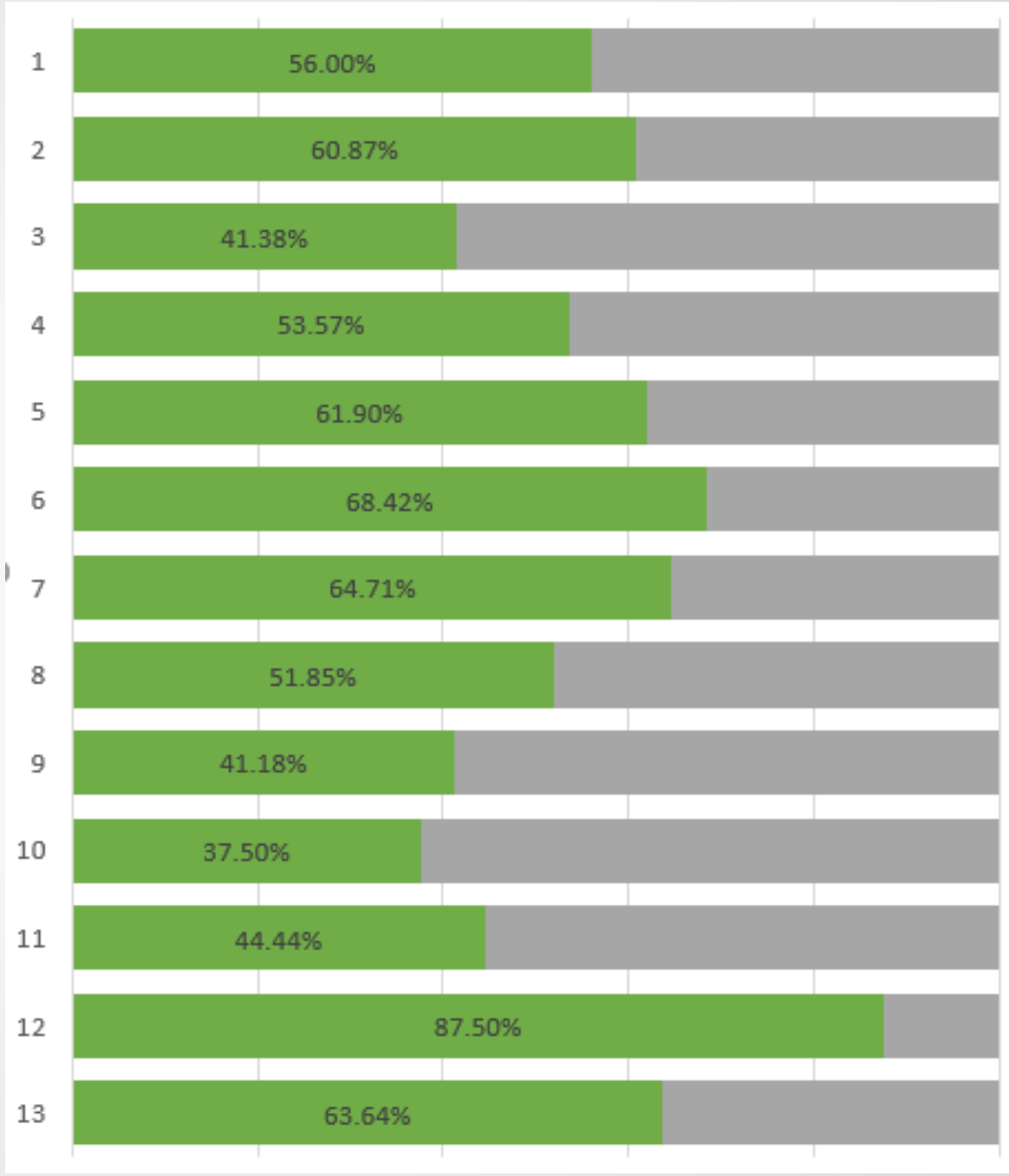


After Test 3

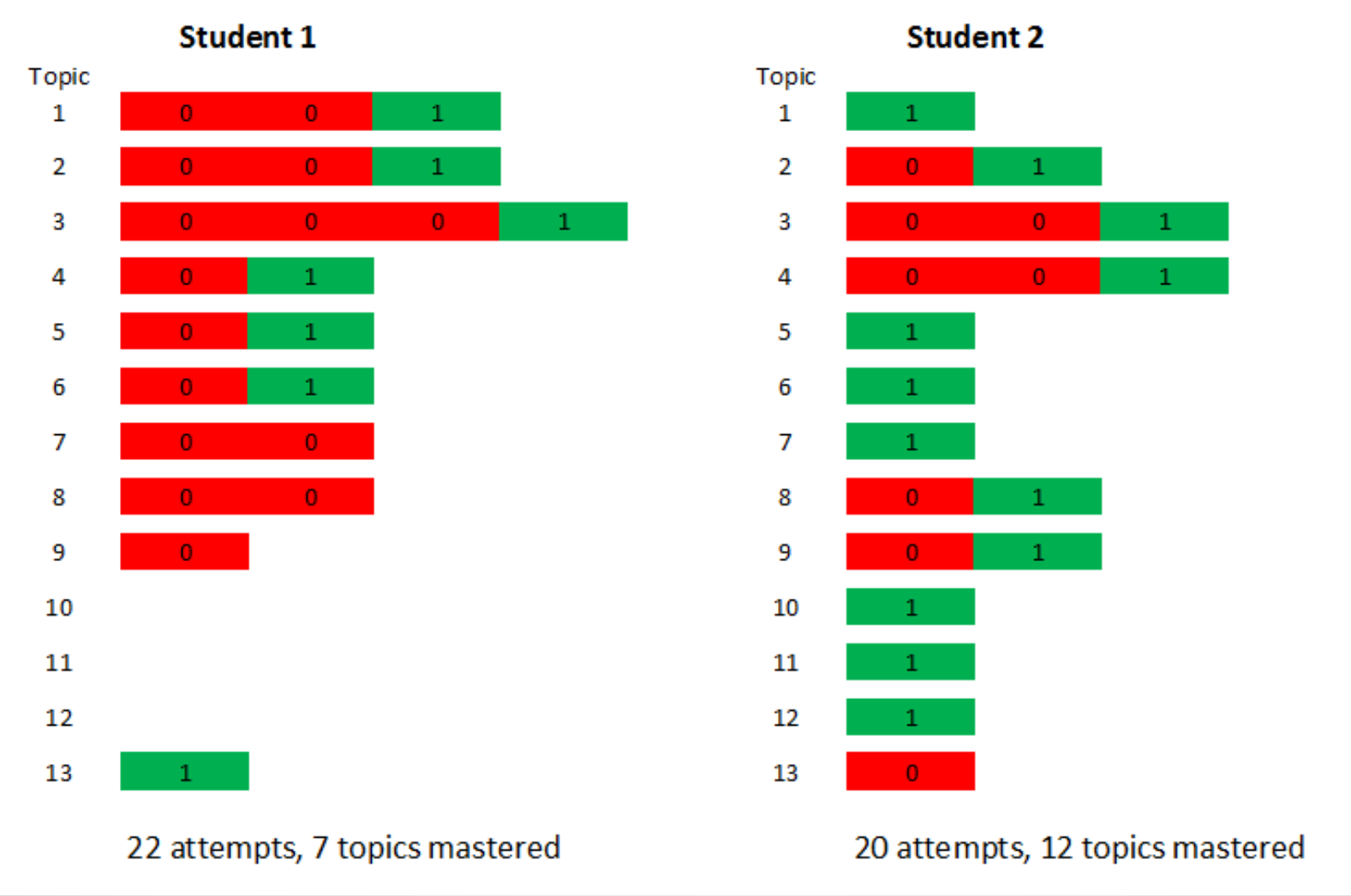


Calculus II, Fall 2017

Current mastery rate by topic



Two different students in Calculus II – current progress on 13 topics covered



Preliminary Qualitative Observations

(ramble on here)

Suggested viewing

Sal Kahn – TED Talk: “Let’s teach for mastery – not test scores”

Thank you. Questions?

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