

Mastery Based Testing

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

Dr. Chris Lee

Roanoke College

MAA Sectional Meeting

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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>

The screenshot shows a web browser window with the address bar displaying 'mbtmath.wordpress.com/about'. The page title is 'Mastery-Based Testing in Undergraduate Mathematics'. The main heading is 'About'. The text describes the blog as a project of a group of MAA Project NExT Gold '14 Dots interested in exploring and publicizing the use of mastery-based testing in undergraduate mathematics courses. It lists the members and contributors: Alyssa Armstrong, Jeb Collins, Amanda Harsy Ramsay, Jarod Hart, Katie Haymaker, Mike Janssen, Austin Mohr, Jessica OShaughnessy, Jessica Stewart Kelly, and Derek Thompson. On the right side, there are navigation links for 'About', 'Presentations', and 'Resources'. Below these is a search bar and sections for 'Recent Posts' and 'Recent Comments'. The 'Recent Posts' section lists three articles: 'Streamlining the logistics of MBT', 'Sal Khan from Khan Academy Speaks at TED about Mastery-Based Learning', and 'Mastery-Based Testing with Core Concepts'. The 'Recent Comments' section shows a comment from 'amandaharsy' on the article 'Streamlining the logistics of MBT'.

About – Mastery-Based × +

mbtmath.wordpress.com/about

Mastery-Based Testing in Undergraduate Mathematics

[About](#) [Presentations](#) [Resources](#)

About


This blog is a project of a group of [MAA Project NExT Gold '14 Dots](#) interested in exploring and publicizing the use of mastery-based testing in undergraduate mathematics courses. Members of our group (and contributors to the blog) include:

- [Alyssa Armstrong](#), Wittenberg University
- [Jeb Collins](#), West Texas A&M University
- [Amanda Harsy Ramsay](#), Lewis University
- [Jarod Hart](#), University of Kansas
- [Katie Haymaker](#), Villanova University
- [Mike Janssen](#), Dordt College
- [Austin Mohr](#), Nebraska Wesleyan University
- [Jessica OShaughnessy](#), Shenandoah University
- [Jessica Stewart Kelly](#), Christopher Newport University
- [Derek Thompson](#), Taylor University

Recent Posts

Streamlining the logistics of MBT
Sal Khan from Khan Academy Speaks at TED about Mastery-Based Learning
Mastery-Based Testing with Core Concepts
Cranking MBT up to 11 with Specifications Grading (Part III)
Cranking MBT up to 11 with Specifications Grading (Part II)

Recent Comments

 amandaharsy on Streamlining the logistics of MBT

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

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.

Course Grade

Labs 20%

Tests 80%

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

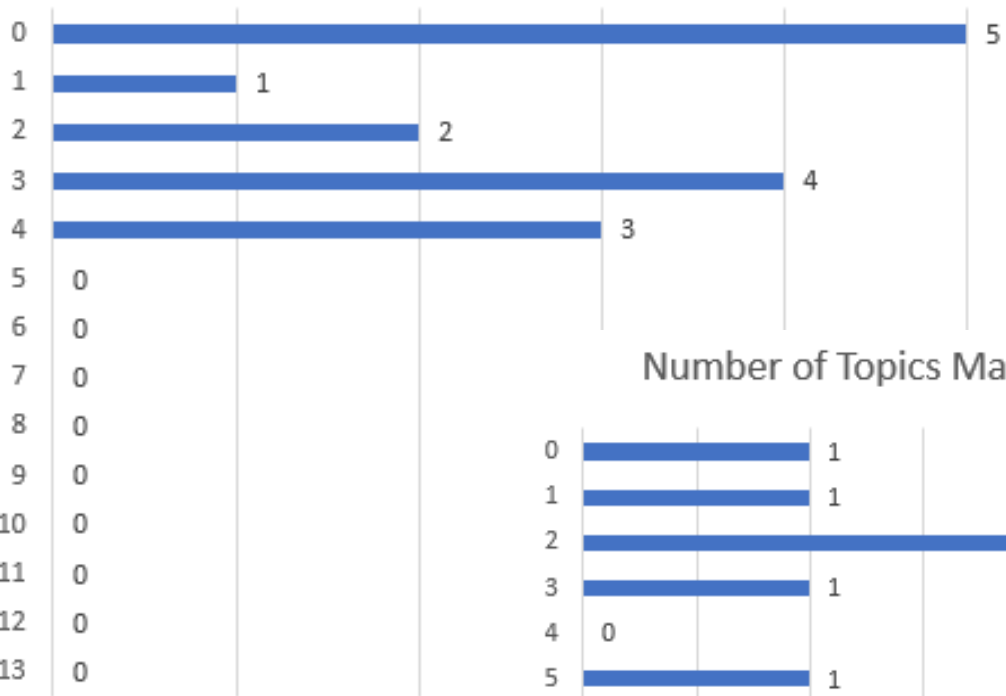
Qualitative data

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

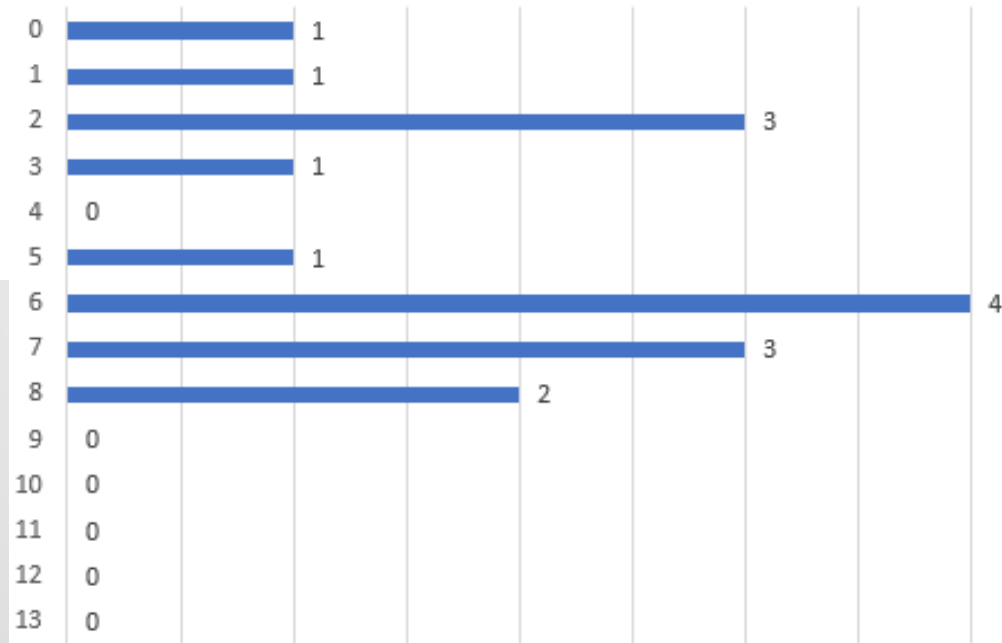
Calculus II, Fall 2017

After Test 1

Number of Topics Mastered by Individual Students



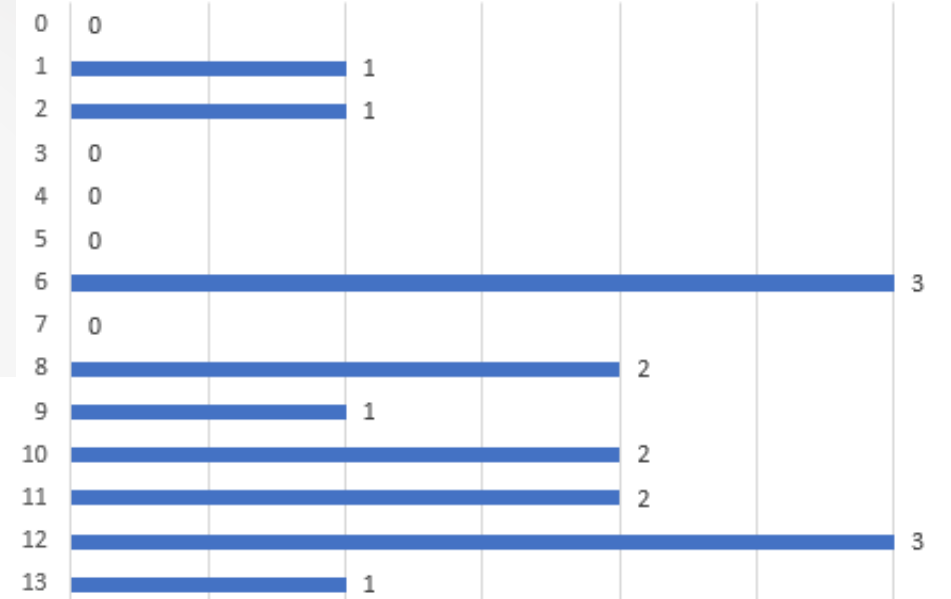
Number of Topics Mastered by Individual Students



After Test 2

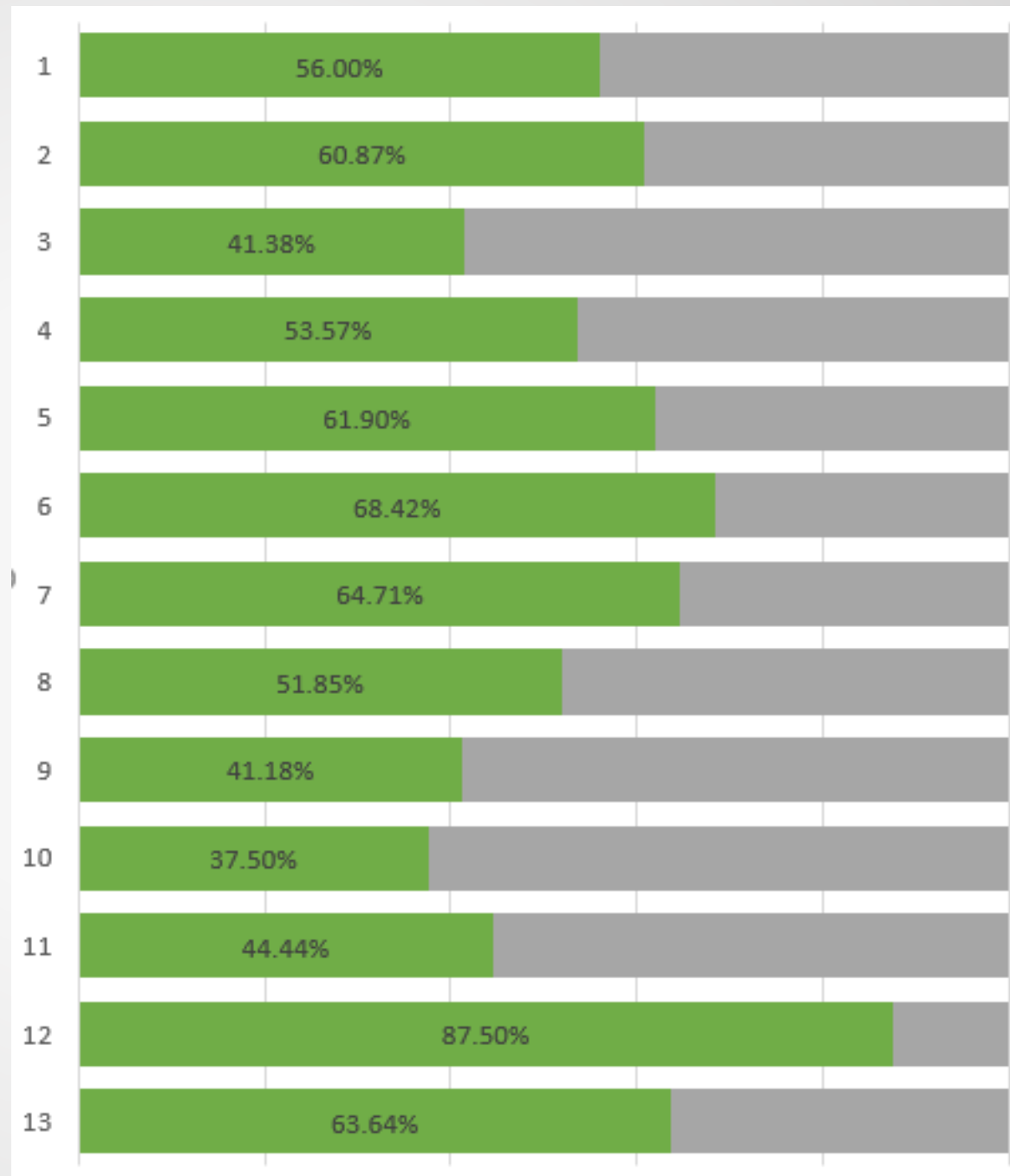
After Test 3

Number of Topics Mastered by Individual Students

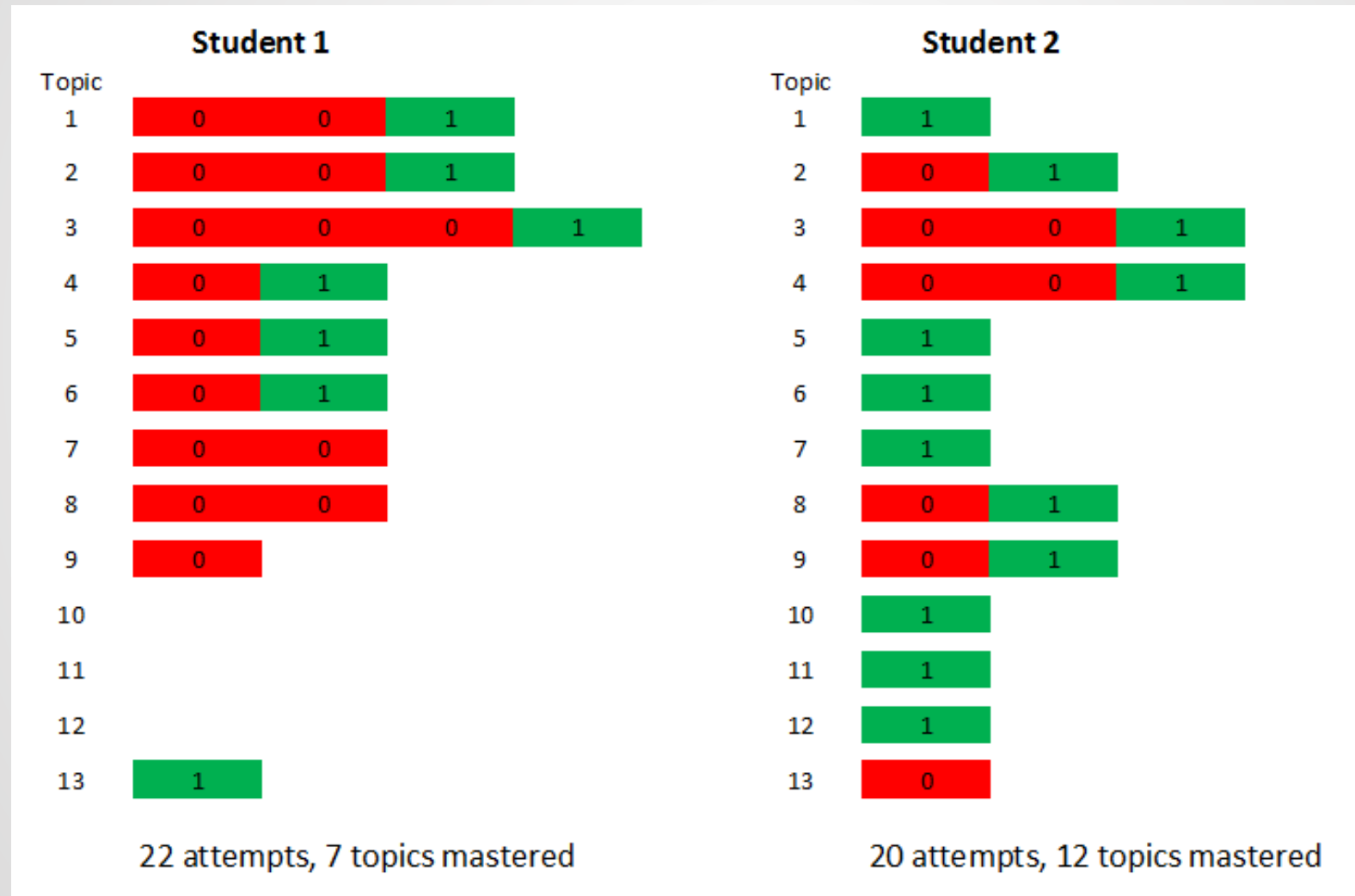


Calculus II, Fall 2017

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”



The image shows a YouTube Red player interface. At the top left is the YouTube Red logo. To its right is a search bar with the word "Search" and a magnifying glass icon. The main video area shows Sal Khan speaking, wearing a purple sweater over a light-colored shirt, with his hands raised. The video player includes a progress bar at the bottom of the video frame showing 0:13 / 10:49, and standard playback controls like play, volume, and full screen. Below the video, the title "Let's teach for mastery -- not test scores | Sal Khan" is displayed, followed by "692,503 views". To the right of the views are icons for likes (20K), comments (147), share, and a menu. At the bottom left is the TED Talks channel logo and name, with the text "Published on Sep 26, 2016". At the bottom right is a red "SUBSCRIBE 8.3M" button.

Thank you. Questions?

Chris Lee

clee@roanoke.edu