

An Implementation of Standards-Based Grading in a Large Linear Algebra Class

Dr. Rose Morris-Wright

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About Me



Hello! I am an assistant adjunct professor at UCLA. I grew up in Santa Fe, New Mexico, and went to graduate school at Brandeis University, in Boston.

I specialize in geometric group theory. This area uses ideas from topology and hyperbolic geometry to study infinite groups.

At UCLA, I mostly taught 2 different levels of linear algebra, approximately 1000 students per year.

Now I work at Middlebury College and teach on average 100 students per year.

Outline

Today, I would like to speak about an alternative grading method I used in teaching at UCLA. This will include:

- Motivation for this innovation
- How the innovation was implemented
- Feedback and results
- How this project will inform my future teaching
- Variations and how you may incorporate parts of this into your teaching

Motivation: Flexibility and Accessibility

There is no good way to give exams online.

Student success should not be dependent on their performance on only one day. This is an accessibility issue.

Motivation: Student Anxiety

Student anxiety and mental health issues are significant barriers to success, especially in STEM classes.

Motivation: Holding students to rigorous standards

A high grade should reflect a significant accomplishment.

A student who gets a B should have completely mastered 80% of the material. Understanding all of the material with an 80% confidence level, should not get a B.

Student grades should be given in reference to fixed standards that do not depend on other students in the class.

How we grade affects how students approach learning

Traditional Exams

Students focus on maximizing points and getting partial credit.

Standards based Grading

Students focus on learning skills.

Context

I made this change in my class “Math 33A: Linear Algebra with Applications” at UCLA in Fall 2021 and again in Spring 2022

- 425-500 students per quarter
- 6-7 graduate TAs
- 3 additional graduate assistants hired to help me develop materials
- 10 week course
- Mostly 1st and 2nd year undergraduate students
- ~30% engineers, ~20% Math majors,

Learning Outcomes

24 in total

Examples:

- Find a basis for the solution set of a homogeneous system of equations.
- Use eigenvalues and eigenvectors to analyze discrete dynamical systems.
- Determine if a given statement about linear algebra is true or false and justify with a theorem or counterexample.

How to Demonstrate Mastery of an Outcome

For each outcome I created a short quiz on Canvas.

Each quiz randomly pulls a question from a question bank. Quizzes are timed, open book, asynchronous. Some quizzes are graded automatically, others are graded by TAs.

If a student gets the question completely correct, including explanation, they have demonstrated mastery.

Otherwise they can try again, with a new randomly pulled question. They get a total of three tries.

Sample Quiz questions:

Find a basis for the kernel and image of a linear transformation.

Variations:

1. $T : \mathbb{R}^4 \rightarrow \mathbb{R}^3$,
 $T(x, y, z, w) = (x + Ay, y + Bz, x + Cw)$
where A,B,C randomly generated.
1. $T : \mathbb{R}^2 \rightarrow \mathbb{R}^2$, T projects orthogonally onto the line $y = x$ and the rotates counterclockwise by 45° .

Computing final grades

Students final grade is determined by a combination of how many standards they complete and some participation points given for homework and in class participation.

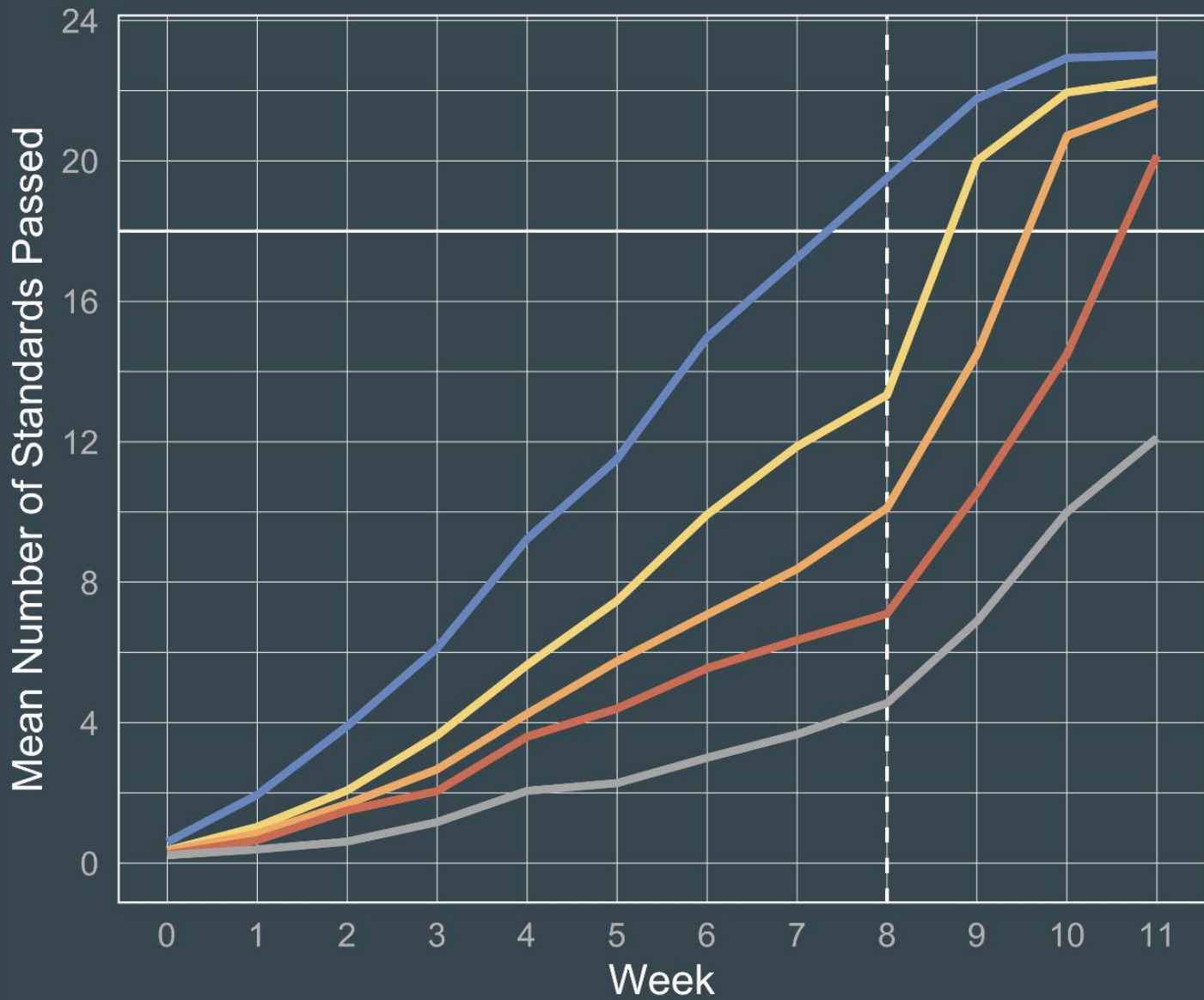
A student who completed almost all of the homework and

Completed at least ____ Standards (Out of 24)	Got a Grade of _____
22	A
18	B
16	C
12	D

Student Feedback

- “The format of the class was such a weight off my shoulders, and allowed me to tackle concepts at my own pace.”
- “It helped me to break down my studying and ensure I master each individual topic rather than being overwhelmed at the end of the quarter “
- “I feel I was thus much more focused on learning than just getting the grade I wanted.”

Mean Trajectories of Student Groups in Math 33A



Student passed 18 standards by:

- Week 8 or earlier (138 students)
- Week 9 (159 students)
- Week 10 (88 students)
- Finals Week (20 students)
- Not by end of course (18 students)

Other data

- We also looked at students grades in Math 33A and in subsequent courses.
- No significant correlation was found between whether or not a student took Math 33A with standards based grading and difference between their grades.
- The identity of the instructor was the best predictor of the students grades and their grades in subsequent courses. As so far we only have data from 1 instructor we're not picking up any possible effect by the grading system.

Key elements that made this work

- Good communication and buy-in from all teaching staff and students.
- Support from the math department.
- Fast grading turnaround time.
- High expectations and good communication about what those expectations are and the reason behind credit/no credit policy
- Lots of paths to success, but material still builds on itself.

Improvements for next time

- More encouragement for students to attempt quizzes on schedule.
- More encouragement for TAs to grade outcomes quickly.
- Clearer communication about standards based system, but not on the first day of class.
- Smaller percentage of grade coming from homework. Higher number of standards completed necessary get a particular grade.
- I also tried making some of the outcome quiz questions harder. This had mixed results.

Limitations of this model with a large class

- Students talk to each other about the questions on the outcome quizzes. You have to be OK with this.
 - This is can be somewhat mitigated by making a high number of variations of each problem, but this is a lot of work.
- Students know that a portion or their grade is autograded, and this affects student attitudes and effort.

Variations

Partial mastery grading:

- You can have 5-10 core learning outcomes and the rest of the material on a final exam.

Mastery grading for formative evaluations

- You can have homework or other written assignments graded on a credit/no credit and allow multiple tries.

Principles and Philosophy that I will continue

- Listening to students and using survey data to inform teaching decisions.
- High flexibility for students is great for both students and teachers, and possible to achieve while keeping high expectations.
- Matching assessments and evaluations to desired student attitudes towards learning.

Additional References

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