Beyond Traditional Grading Schemes: Mastery Based Grading …

Faculty Pedagogy Colloquium
November 5th, 2019
Jeb Collins

Caveats

- Focus on math assessment types
- Assessing understanding of facts/techniques
- Unsure of its application to subjective material

- Credit to: Jessica OShaughnessy, Amanda Harsy, Mike Jenssen and Alyssa Hoofnagle

Who are we?

- Robert Campbell - College of St. Benedict & St. John's University
- David Clark - Grand Valley State University
- Mike Janssen - Dordt College
- Jessica Kelly - Christopher Newport University
- Austin Mohr - Nebraska Wesleyan University
- Jessica OShaughnessy - Shenandoah University

Throughout the course, please write questions on your note cards. We will pick them up later to help us tailor the rest of the sessions.

Mastery Grading

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Definitions and Motivations

What do we want for our students?

- Persistent problem solvers
- Desire for understanding, not points
- Confidence (in the right doses!)
- Engages with material
- Growth Mindset

Traditional Points-Based Grading

- Students try for points, not understanding
- Failure means done, don’t keep trying to understand
- Failure means lack of confidence in their ability
- Hard to assign a grade that accurately reflects students understanding

Mastery Based Testing: What is it?

- Courses split into topics/standards
- All or nothing grading
- Multiple Opportunities
- Given entire class to demonstrate mastery
- Complete forgiveness in retakes

Mastery Based Testing: Why do it?

- Failure should be a learning tool!
- Allows students to focus on specific concepts.
- Students learn at their own pace.
- Develop the growth mindset
- Grade is meaningful to instructor and student

- Test anxiety?
- Grade shock?

Student Opinions

- Students love it
- Some students want to master everything
- Students look for testing opportunities

“I like the way that [mastery-based exams] ensure you keep working at a topic until you know how to do it, rather than just deciding not to care because you won’t see it again after the test.”

“I feel that mastery-based testing alleviated a lot of the pressure brought upon me as a college student from exams normally,

and also re-enforced learning concepts I had difficulty mastering helping to solidify knowledge of concepts that I did not understand as well.”

What's next?

Today:

1. Case studies: What do *we* do?
2. Initial planning: What do *you* want to do?
3. Summary & Homework!

Saturday (1 - 3 pm)

1. What does *mastery* really mean?
2. Practice writing learning targets
3. Nuts & bolts
4. Planning time with organizers (tailored from your requests).

How it works

- Case study in Calculus 1
- Roughly 25 - 30 students
- Mostly freshman or sophmores

How it works

- 16 topics or objectives
- Covers all class material
- Mastery used only on exams
- Homework/Projects done as usual, integrated into final grade as usual

Test Objectives

	Objective Topic	Sections in Rogawski	Sections in "Active Calculus"	UH Video
1	Numerical and Graphical Limits	2.2	1.7	#1
2	Limit Laws and Continuity	2.3, 2.4	1.7	#2, 4
3	Algebraic and Trigonometric Limits	2.5, 2.6	1.7	#3
4	Limits at Infinity	2.7	—	#16
5	Definition of the Derivative	3.1, 3.2	1.1-1.8	#5
6	Derivative Rules	3.3, 3.6, 2.7	2.1-2.6, 3.9	#6, 7, 8, Extras #1, 2
7	Rates of Change and Higher Derivatives	2.1, 3.4, 3.5, 4.1	1.5, 1.6, 1.8	#9, 11, 12
8	Implicit Differentiation and Equation of the Tangent Line	3.8, 1.8, 4.1	2.7	#10
9	Related Rates	3.10	3.5	#9
10	Extreme Values	4.2	3.1	#18
11	Sketching Functions	4.4, 4.6	3.2	#14, 15, 16, 17
12	Optimization	4.7	3.4	#19
13	Approximating and Computing Area	5.1	4.1, 4.2	#21
14	The Definite vs. Indefinite Integral, Net Change	5.2, 5.3, 5.6	4.3	#22, 24
15	The Fundamental Theorem of Calculus	5.4, 5.5	4.4, 5.1, 5.2	#23
16	Integration Techniques	5.2, 5.3, 5.7, 5.8	5.3	#24, 25, 31, 32, 33

How it works - 1st Test

- 4 Topics
  - Each topic may have multiple parts
  - Graded as a whole
- Graded as M/J/A or M/P/D or M/P/N
  - Only Master gets credit
  - Other two used for informational purposes to the student

How it works - 2nd Test

- New 4 different topics
- Old 4 topics from test 1
  - Different versions
  - Only attempt if not mastered on first test
  - No penalty for reattempt
- Still graded on mastery basis

How it works - 3rd/4th Tests and Final

- Another 4 topics on each test
- All older topics also on each test
- Chance for retesting if mastery is not already achieved
- 3rd Test = 12 topics
- 4th Test = 16 topics
- Final = Different version of 4th test

Reassessment Opportunities

- Opportunities between exams to demonstrate mastery
- In-class quiz
  - One question at end of class
- Office hours
- Reassessment Week
- Allows students to focus on one problem
- Decrease stress about next exam
- Increase confidence going forward in the class

Topic Questions

- Main learning objectives for the class
  - Test all material through topics
- Difficult enough so that mastery means mastery
- Be able to create multiple versions
  - Different enough for reassessment
  - Still tests same material at same level of difficulty
  - Need anywhere from 2-10 different versions per semester

How to Grade

- Binary scale (mastery or not) to determine if student earns credit for learning objective
- Some will divide non-mastery into groups: Journeyman, and Novice
  - Master: Student understands the concept and has a (mostly) correct solution (with maybe a small technical error not relevant to the specific learning target)
  - Journeyman: Student understands some of the concept, but the solution is missing key components or details. The student needs to review the concept in order to reach mastery.
  - Novice: Student does not understand much, if any, of the concept. The solution is incomplete or missing, and the student needs to review the concept in order to reach mastery.
- Will student benefit from attempting this problem again?

Logistics - Writing Problems

- Generate library of problems
  - One file for each topic
- “Writing” exam involves copy-paste
- Large upfront time cost, little time cost during semester.

Logistics - Recording Grades

Record grades ***carefully*** and ***thoroughly***. You will need to record more data than a traditional gradebook:

- Which mark did they earn?
- On which learning objective and assignment?
- When?
- Revisions?

Options for recording:

- Excel Workbook
- Learning Objective list for each student
- Your Learning Management System

Core Concepts

- Some concepts worth more than others
- Relevant for some sequential courses (Calc I, II, III)
- Must master to receive a C in the course
  - % based - each of the 7 core concepts are worth 10% towards exam grade

Questions?

Case Studies:

Mastery Testing

Structure of Course (Calculus I)

- Mastery grading was limited to **only** tests
  - Traditional grading was used for homework, quizzes, exam, etc.
- Not all topics were covered through test objectives

Test Objectives

	Objective Topic	Sections in Rogawski	Sections in "Active Calculus"	UH Video
1	Numerical and Graphical Limits	2.2	1.7	#1
2	Limit Laws and Continuity	2.3, 2.4	1.7	#2, 4
3	Algebraic and Trigonometric Limits	2.5, 2.6	1.7	#3
4	Limits at Infinity	2.7	—	#16
5	Definition of the Derivative	3.1, 3.2	1.1-1.8	#5
6	Derivative Rules	3.3, 3.6, 2.7	2.1-2.6, 3.9	#6, 7, 8, Extras #1, 2
7	Rates of Change and Higher Derivatives	2.1, 3.4, 3.5, 4.1	1.5, 1.6, 1.8	#9, 11, 12
8	Implicit Differentiation and Equation of the Tangent Line	3.8, 1.8, 4.1	2.7	#10
9	Related Rates	3.10	3.5	#9
10	Extreme Values	4.2	3.1	#18
11	Sketching Functions	4.4, 4.6	3.2	#14, 15, 16, 17
12	Optimization	4.7	3.4	#19
13	Approximating and Computing Area	5.1	4.1, 4.2	#21
14	The Definite vs. Indefinite Integral, Net Change	5.2, 5.3, 5.6	4.3	#22, 24
15	The Fundamental Theorem of Calculus	5.4, 5.5	4.4, 5.1, 5.2	#23
16	Integration Techniques	5.2, 5.3, 5.7, 5.8	5.3	#24, 25, 31, 32, 33

Logistics

Tests

- Timing: spaced throughout the semester
- Format: questions are organized into objectives
- Grading: each objective receives its own grade
  - “Mastered” or “Not Yet”

MATH 140, Calculus and Analytic Geometry, Fall 2016
Test #1
September 19, 2016 Name:

	Test #1			
Objective Number	1	2	3	4
Mastered				
Not Yet				

Objective #1: Numerical and Graphical Limits

1. Draw a single function which satisfies the following:

$$\lim_{x\to -2^-} f(x) = 3\,, \quad \lim_{x\to -2^+} f(x) = -\infty\,, \quad \text{and} \quad \lim_{x\to 0} f(x) = 2 \neq f(0)$$

2. Suppose $s(t)$ describes the motion of a particle after t-seconds have elapsed. After conducting some experiments, you obtain the data below:

t	.998	.999	.9995	.99999	1.00001	1.0005	1.001	1.002
$s(t)$	-4.01289	-4.00869	-4.00013	-4.00005	-2	1	-2	1

Based on the data, find the following limits. (If a limit doesn't exist or you do not have enough information, explain why.)

(a) $\lim_{t\to 1^-} s(t) =$

(b) $\lim_{t\to 1^+} s(t) =$

(c) Does $\lim_{t\to 1} s(t)$ exist? Is the $s(t)$ continuous at $t = 1$?

Logistics

Revisions

- Timing: on testing days and last week of semester
- Format:
  - similar, but not identical questions to previous tests
  - students chose which objectives to revise
- Attempts: three attempts per objective

Grading

Math 140–Calculus and Analytic Geometry

Name:_____

	Test #1						Test #2				Test #3				Test #4					
Objective	#1	#2	#3	#4	#5	#8	#6	#7	#9	#10	#11	#12	#13	#14	#15	#16	#17	#18	#19	#20
Test Attempt #1	O	O	O	O	O	M	M	O	O	O										
Test Attempt #2	M	M	O					O												
Test Attempt #3																				

only 6, 7a

Current Test Average: _____

Current Homework Average: _____

Current In Class Assignments (Mathematica Labs) Average: _____

Current Daily Assignments Average: _____

Current Class Average: C

Good and Bad

- Partial adoption of MBT
  - Easier to grade and make assignments
  - Student buy-in
- Growth Mindset
- Grading
  - My perspective versus student perspective
- Test Anxiety

Core Concepts

- A course is part of a sequence
- Some concepts necessary to continue
- Helps students focus on key topics

- Communication is key
- Careful tracking of concepts

Core Concepts - Calculus

- **Limit Techniques (R)**
- Delta-epsilon proof
- Continuity
- **Infinite limits (R)**
- **Definition of Derivative (R)**
- **Derivative Techniques (R)**
- Implicit Differentiation
- Related Rates
- Mean Value Theorem
- **Graphing (R)**
- Optimization
- Newton's method
- **Basic Integration (R)**
- Fundamental Theorem of Calculus
- Numerical Integration
- **Integration by Substitution (R)**

Core Concepts

	MB Q1 (13795)	MB Q2 (13796)	MB Q3 (13797)	MB Q4 (13798)	MBT Q5	MBT Q6	MBT Q7	MBT Q8	MBT Q9	MBT Q10	MBT Q11
	limits	proofs	continuity	inf limits	derivatives	derivative tech	implicit	related rates	mvt	graphing	optimzation
	M	I	I	I	I	M	I	R	R	I	R
	M	M	I	M	M	M	M	M	M	C	R
	M	M	I	M	M	M	I	I	I	M	R
	M	M	M	M	M	M	M	I	M	M	M
	M	I	R	M	M	M	M	M	R	M	R
	M	M	M	M	M	M	M	M	M	M	M
	M	M	I	M	M	M	I	I	R	M	R
	M	M	M	M	M	M	M	M	M	M	M
	M	M	M	M	M	M	M	M	M	M	M
	M	I	I	M	M	M	I	I	R	C	R
	M	I	M	M	M	M	R	R	R	M	R
	M	I	I	M	M	M	M	R	R	M	R
	M	M	I	M	M	M	M	M	R	M	R
	M	M	M	M	M	M	M	M	M	M	M
	M	M	I	M	M	M	M	M	M	M	M
	M	I	I	M	M	I	I	R	M	M	R
	M	I	M	c	M	M	M	R	I	c	I
	M	M	I	M	M	I	M	R	R	M	R
	18	11	7	16	17	16	12	8	8	14	6
	1			1	3	3		2		2	2

Linear Algebra

- Choose 16 topics
- Course combines proof work and computational work
- Each course objective reflects combination

Follow-up Questions on Mastery Testing

1. Is this a method of assessment that you are interested in?
2. What course could you see implementing mastery testing in?
3. Do you have any additional questions?

Case Studies:

Fully Standards-Based Grading (SBG)

Full SBG: Standards

- No points!
- *All* assessments involve standards.

I *reason* clearly and can *critique* others' reasoning. ***(Master 2/2)***

RC.1: I can write a convincing explanation of my work that clearly explains why it is correct and would convince a skeptic. [6]

RC.2: I can accurately critique the reasoning of others, identify common misconceptions, and modify their work to produce a correct response. [2]

I understand the *meaning of the derivative.* *(Master 6/7)*

DM.1: I know the limit definition of the derivative and can explain the purpose of each symbol in the definition. [2]

DM.2: I can calculate derivatives and estimates of derivatives using difference quotients (including average and instantaneous velocity) [4]

DM.3: I can explain the connection between average and instantaneous rates of change, and can interpret them using secant and tangent lines and limits. [2]

DM.4: I can find the tangent line to a function at a given point. [4]

DM.5: I can recognize points at which a function is (and is not) differentiable, and can use the definition or interpretation of the derivative to support my thinking. [2]

DM.6: I can use tangent lines to approximate function values and roots. [2]

DM.7: I use derivative notation correctly (such as $f'(x)$ and $\frac{dy}{dx}$) [4]

Full SBG: Grades

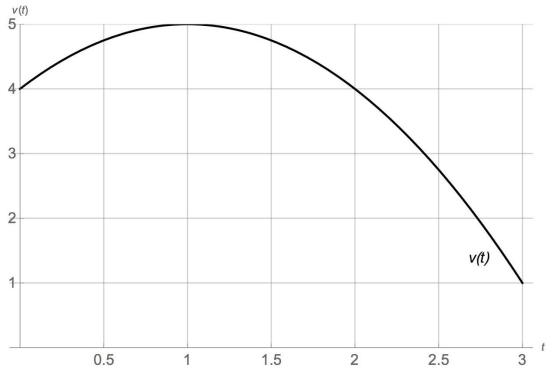
- Grades are directly based on which (or how many) standards are mastered.
- Can include other relevant categories too.

Base Grade	**Big Ideas mastered**	**Guided Practices completed with an E or M**	**WebWorks completed with 95% or higher**
A	10 (of 10)	≥ 27 (of about 29)	≥ 10 (of about 11)
B	9	24-26	9
C	7 - 8	21-23	7 - 8
D	5 - 6	18-20	5 - 6
F	Have not **fully** completed **any** row.		

Full SBG: Assessments

- Standards are fine-grained.
- Problems may include multiple independent standards.

While running on snowshoes, David's *velocity* $v(t)$ (in miles per hour) at time t (in hours) is given by the graph below:



[FTC.1, F.1, IE.3] Make a good estimate for how far David traveled during these 3 hours. How do you know? You may estimate v values from the graph.

To determine whether a fleet of cars is meeting a goal of 26 miles per gallon (mpg), a random sample of 50 car trips was tested. The sample mean value of the trips was 26.02 mpg. The sample standard deviation was 4.83 mpg. Does this data provide good evidence that the fleet is failing to meet the goal for fuel efficiency? To answer this question, we will be doing a hypothesis test using the hypotheses $H_0 : \mu = 26, H_A : \mu \neq 26$.

a. (BC: Explain Type I and II Errors) Explain what a type I and type II error would be in this hypothesis test.

b. (BC: Explain Power) Explain what the power of this test would be.

c. (B: Compute p-values of Means) Find the appropriate p-value.

Full SBG: Mastery

- Students must demonstrate mastery of each standard multiple times (more times required for more important standards).

Learning Goals	Anywhere Points	Quiz Only		
Identify Proper Experimentation Techniques				
Explain Power				
Explain Type I and II errors				
Apply Properties of Random Variables				
Compute Means, Medians, and Standard Deviations				
Compute Combinatorial Probabilities				

Full SBG: Differences

David's specifics

- Students can revise standards (one per week).
- ~ 40 standards grouped into "Big Ideas*".
- Final grade tied to *number* of Big Ideas mastered.

+ Grade never drops, only builds. Reduces stress.

+ Focuses students on learning, dramatically improves office hours.

- Grade looks like F for most of the semester. Can increase stress.

*Idea ~~blatantly~~ lovingly stolen from Kate Owens, College of Charleston

Robert's specifics

- Numerous opportunities to show mastery of each standard.
- Each standard tied to a particular grade.
- Final grade based on completion of all standards for that grade.

+Students recognize exactly what they need to study

Follow-up Questions on SBG

1. Is this a method of assessment that you are interested in?
2. What course could you see implementing SBG in?
3. Do you have any additional questions?

Case Studies:

Mastery Grading in Proof-Based Courses

Discrete Structures - Dordt University 2019

- IBL intro to proof course
- Mastery-based written homework: three problems every two weeks
- Problems are “typical”
- Graded EMRN:
  - **E**xceeds expectations: this could be the official class solution
  - **M**eets expectations: generally correct and reasonably well-written, but some room for improvement
  - **R**evision needed: Major gaps in logic, misuse of notation, or unclear communication.
  - **N**ot assessable: Difficult to read, heavy abuse of notation, or significant mathematical flaws.

Discrete Structures - Dordt University 2019

- Revision structure:
  - Day 0: First draft due - required for second revision
  - Day 5: TA feedback returned
  - Day 9: Revised submission due
  - Day 9 + n ($n \leq 7$): Professor feedback returned
  - Day 16 + n ($n \leq 7$): Second (final) revision due. All grades are final.

Discrete Structures - Dordt University 2019

Final Grades

In general, your final grade will be the highest completed row. Exceptions may be made in extreme circumstances.

Grade	Daily work†	Written work* (M or higher)	Written work (E)	Midterms	Portfolio
A	30	20/22	15	90%	93%
A–	28	19/22	13	87%	90%
B+	27.5	17/22	10	84%	87%
B	26	16/22	8	80%	84%
B–	24.5	15/22	6	77%	80%
C+	23	13/22	4	74%	77%
C	21.5	12/22	2	70%	73%
C–	19	11/22	1	67%	70%
D	16.5	9/22	0	55%	60%

†Updated April 1, 2019

Syllabus grade table

Intro to Proofs (David's Full SBG)

- Still 100% points-free!
- Proof method standards required for higher grades (direct, contradiction, etc.).
- Writing/Communication:
  - Class "style guide".
  - Each proof is assessed all-or-nothing for following the style guide.
  - Counts as a separate grade category.
- Assessments:
  - Proof Portfolio (with drafts/revisions)
  - Weekly quizzes focused on math content
  - Group projects (with drafts and peer review)

	D	C	B	A
Learning Targets mastered (Most recent & 2 best are all E's/M's)	16	19 including 5+ Proof Methods	22, including 6+ Proof Methods	25, including 7+ Proof Methods
Preview Activities completed (with thoughtful effort)	16	18	20	22
Professionally communicated proofs (See Style Guide for details)		8	10	12
Lead Authorships (Portfolios & Projects)		5	6	7

"You can literally see yourself learning the subject."

"I am not a fan of this grading system, but it really does make you learn and understand the material."

Specifications Grading in Abstract Algebra (Mike)

- On a spectrum with standards-based grading
- Specifications: rubric which clearly describes what must be done to earn a passing designation
  - E.g.: "If you wish to use a result we have not proved in class or you have not proved on an earlier homework problem, it should be stated as a lemma and proved independently."
  - Encourage self-regulation/reflection/metacognition before submitting work
- Assess an *assignment* (or collection of assignments) Pass/No Pass according to *specifications*.
- Limited revision opportunities via tokens (or free revision for GFE)
- Final grades come from tallying the number of satisfactorily completed items in various categories, e.g., homework, exams, reflections, portfolios, etc.; more/higher hurdles

Follow-up Questions on Proof-based Mastery Grading

1. In what proof-based courses could you implement a form of mastery grading?
2. What form of mastery grading are you most interested in implementing?
3. Do you have any additional questions?

Case Studies: Group Q&A

What questions do you have about our Case Studies?

Please focus on clarifying questions, rather than implementation details.

Initial Planning

Discussion (10 min.)

First think about each of the following prompts on your own.
Discuss your answers with the people at the table.

- Why do you want to use mastery grading?
- Which course do you want to use mastery grading in?
- Which system of mastery grading are you most interested in?
- What do you want to accomplish most by the end of the minicourse? i.e.: outline of a system to use, learning targets started, a prototype assessment, etc.
- What is the biggest hurdle that you foresee?

Wrap-up and Homework

Wrap-up

- How do we start planning a mastery-grading course?
- Homework
- On your notecard,

Write 3 sentences that describe

what Mastery Grading means in **your** understanding.

Turn your notecard in on the way out.

- Minicourse evaluation: https://www.surveymonkey.com/r/NRN5DWZ

Mastery Grading: Session 2

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Please sit at a table that best matches your interests, course, or institution.

What is mastery grading?

- Clear content objectives
- No partial credit--credit only for mastery
- Multiple attempts to achieve mastery with complete forgiveness

Questions:

- Which is easier to convert--a brand new course or a prior prep?
- What if a student masters some but not all core concepts? Do they still fail if they've master other non-core concepts?
- Does this work in remedial math courses? In particular, general ed or non-cumulative courses.
- How could you ask questions without giving away which objective is being tested?
- Do you return tests? Are you worried about students sharing test questions?
- How do you deal with a coordinated courses, multiple instructors, and large classes?
- Is specs grading only intended for proof-based courses?
- How does this apply to group work?

What is a learning target?

- In short: some ability or skill a student should exhibit
- Bloom's taxonomy overview:
  - Remembering - remember previous learned info
  - Comprehending - demonstrate understanding of facts
  - Application - apply knowledge to actual situations
  - Analysis - break down objects/ideas into simpler parts and find evidence to support generalizations
  - Synthesis - compile component ideas into a new whole or propose alternative solutions
  - Evaluation - make and defend judgments based on internal evidence or external criteria
- Ideally, your course will have a mix of all six
- Action verbs!

Writing a good learning target

- Walk the line
  - Too specific: only one way to assess
  - Too broad: can you be sure students have actually met the learning target?
- Iterate!
- Examples
  - “I can distinguish between abelian and nonabelian groups and their properties.”
  - “I can use proof by induction.”
  - “I can construct an example of a group with prescribed properties.”

“Easy Hard” Questions

Justin Wright (Plymouth State)

Problems that illuminate student understandings and misunderstandings.

Example (Calculus II).

Write an integral that would require 37 applications of integration by parts.

Email Justin for other examples??

What is mastery?

Sample #1: Calculus 1

Does this student demonstrate mastery? Why?

Objective #5: Definition of the Derivative

1. Let $f(x) = -x^2 + 4x - 3$. Find the derivative using the definition.

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

$$f'(x) = \lim_{h \to 0} \frac{-(x+h)^2 + 4(x+h) - 3 - (-x^2 + 4x - 3)}{h}$$

$$f'(x) = \lim_{h \to 0} \frac{-(x^2 + 2xh + h^2) + 4x + 4h - 3 + x^2 - 4x + 3}{h}$$

$$f'(x) = \lim_{h \to 0} \frac{\cancel{-x^2} - 2xh - h^2 + \cancel{4x} + 4h \cancel{-3} \cancel{+x^2} \cancel{-4x} \cancel{+3}}{h}$$

$$f'(x) = \lim_{h \to 0} \frac{-2xh - h^2 + 4h}{h}$$

$$f'(x) = \lim_{h \to 0} \frac{h(-2x - h + 4)}{h}$$

$$f'(x) = \lim_{h \to 0} -2x - h + 4$$

$$f'(x) = -2x - 0 + 4$$

$$\boxed{f'(x) = -2x + 4}$$

Sample #2: Calculus 1

Does this student demonstrate mastery? Why?

Objective #8: Implicit Differentiation and the Equation of the Tangent Line

1. Find the equation of the line tangent to the graph of

$$x^2 + 2xy - y^2 + x = 2$$

at $(1, 2)$. Your answer should be in slope-intercept form.

$2x \to x$
$y \to \frac{dy}{dx}$

$$\frac{d}{dx}\left(x^2 + 2xy - y^2 + x\right) = 2\,\frac{d}{dx}$$

$$2x + \left(xy + 2x\frac{dy}{dx}\right) - 2y\frac{dy}{dx} + 1 = 0$$

$$2x + xy + 1 = 2x\frac{dy}{dx} - 2y\frac{dy}{dx}$$

$$2x + xy + 1 = \frac{dy}{dx}(2x - 2y)$$

$$\frac{dy}{dx} = \frac{2x + xy + 1}{2x - 2y} = \frac{2(1) + 2 + 1}{2 - 4} = \frac{5}{-2}$$

$$\boxed{y = -\frac{5}{2}x + \frac{9}{2}}$$

$y = mx + b$

$2 = -\frac{5}{2}(1) + b$

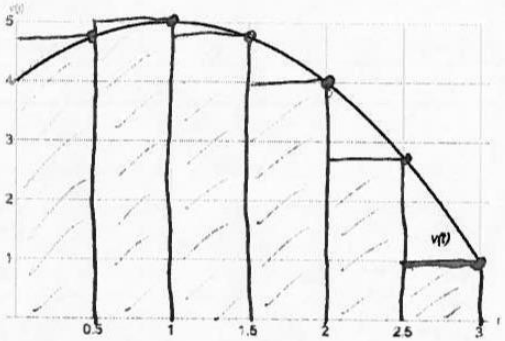
$2 + \frac{5}{2} = b$

$b = \frac{9}{2}$

Sample #3: Calculus 1

For *which* of the 3 learning targets has this student demonstrated mastery? Why?

1. While jogging, David's *velocity* $v(t)$ (in miles per hour) at time t (in hours) is given by this graph:



On the graph, *carefully* draw boxes which could be used to calculate the right sum R_2 on $[0, 3]$. Then write a calculation that uses your boxes from R_2 to estimate the distance that David traveled on $[0, 3]$. You may estimate v values from the graph. *Show the calculation.*

FTC.1: I can calculate the area between curves, net change, and displacement using Riemann sums and the FTC.
F.1: I can read and use graphs and tables to gain relevant information within a problem.
IE.3: I attend to details and precision in my work.

Distance $= 0.5(4.75 + 5 + 4.75 + 4 + 2.75 + 1)$

$= 0.5(22.25)$

$= 11.125$ miles

David doesn't actually jog and cannot vouch for the graph's feasibility.

Hands-on: Constructing Learning Targets

Prompts for table work (20 min.)

1. Briefly describe your target course. What is special? What limitations do you have?
2. Write one specific learning target for your course.
    - If time, create a sample question that assesses that learning target (or match it to an existing assessment that you have).
3. Share your target (and question) with your table.
4. Discuss with your table: What are you excited / scared / enthusiastic / worried about with this target, question, or mastery grading system?
5. Whole group discussion.

Nuts and Bolts of Mastery Grading

Student Buy-in

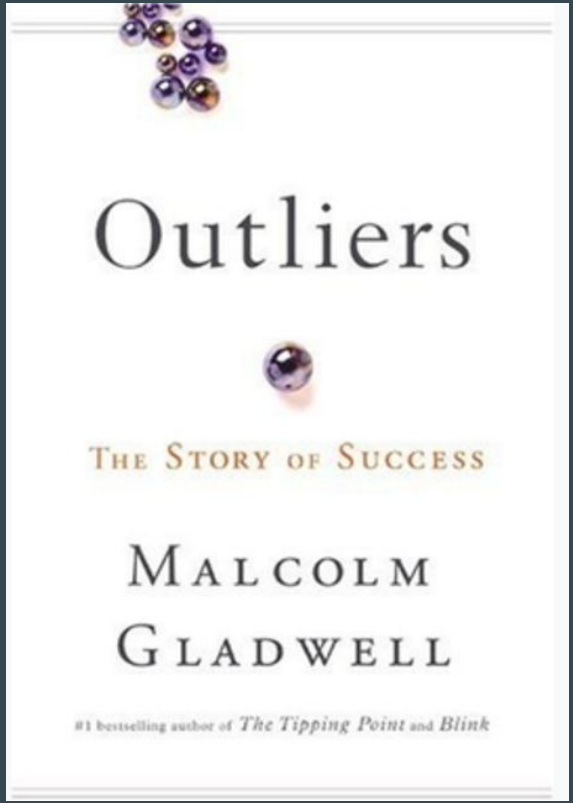
"We like to think of our champions and idols as superheroes who were born different from us. We don't like to think of them as ordinary people who made themselves extraordinary."

Carol Dweck, Mindset: The New Psychology of Success

Student Buy-in

Growth Mindset

- YouTube Videos
- Malcolm Gladwell--10,000 hours of "deliberate practice"



Student Buy-in

Logistics

- Well-crafted syllabus statement
- David's videos
- Review day before first test
- Class discussion when returning first test
- Preparing for the first retake

Requires revisitation throughout the entire semester

- Beginning: Big idea
- Middle: Encouragement
- End: Realistic expectations

Administration or Parental Buy-in

- Grades are meaningful
- Test anxiety
- Best practices for assessment (Linda Nilson, Carol Dweck)
- Results (Amanda Harsy Ramsay, Lewis University)

How do we integrate into an existing course model?

Logistical tips

- Don't overwhelm students with details early on
- Ensure your grading is done in a timely fashion; schedule it!
- Consider electronic submission of work (LaTeX for proof-based courses)
- Restrict number/timing of reassessment opportunities
- End the course early to allow for additional assessment opportunities
- Supply the students with tools to track their progress
- **Warning:** mastery grading systems are not friendly to students who fall behind!

Math 304 Grade Checklist

Name:_____

Grade	Initial	E's	Secondary	Reflections
A		☐ ☐ ☐	☐ ☐	☐
A-		☐ ☐	☐ ☐	
B+	☐ ☐	☐ ☐	☐ ☐	☐
B		☐ ☐ ☐	☐ ☐	
B-		☐ ☐	☐	
C+	☐ ☐	☐ ☐ ☐	☐	☐
C	☐ ☐		☐	
C-	☐ ☐		☐	
D+	☐ ☐		☐	☐ ☐ ☐
D	☐ ☐		☐	
D-	☐ ☐		☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	

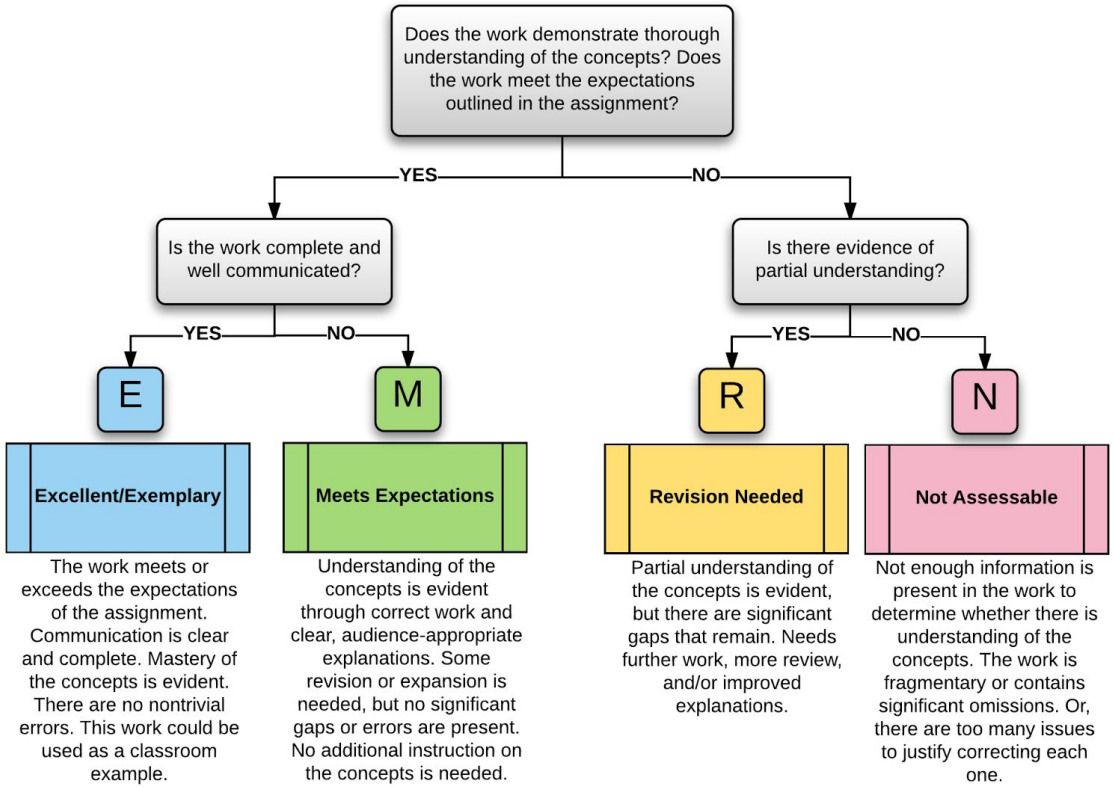
Tokens used: ☐ ☐ ☐ ☐ ☐ **Grade Goal:** _____

Grading Scale

Avoid points!

EMRN rubric:

- Incorporates communication
- Fast & easy to evaluate
- Share with students!
- Variations:
  - R → P (“Progressing”)
  - N → F (“Failed”)



EMRN rubric based on the EMRF rubric, due to Rodney Stutzman and Kimberly Race: http://eric.ed.gov/?id=EJ717675

Image created by Robert Talbert

Recording Grades

Record grades ***carefully*** and ***thoroughly***. You will likely need to record more data than a traditional gradebook:

- Which mark did they earn?
- On which learning target and assignment?
- When?
- Revisions?

Options for recording:

- Magic Excel Workbook
- Learning Target list for each student
- Your LMS (next!)

Pref. name	GRACE used	Advanced homework																							
		Advanced Homework #1 (1.1 #3)											Advanced Homework #2 (1.4 #3 or 1.5 #4)										AH2 1.6 #3		
Target		IE.2	IE.3	R.1	C.1	C.2	C.3	RC.1	L.2	DM.2	DM.3	DA.1	Grace	IE.2	IE.3	C.1	C.2	C.3	C.4	RC.1	DM.2	DA.1	DA.3	DA.4	DM.5	F.1
B	1	M	M	M	P	P	M	M	M	M	M	M	R	M	M	M	M	M	-	M	M	M	M			
Z	4	M	P	X	P	X	M	X	X	P	M	M		M	P	P	X		X	P			M	M	M	M
D	1	M	P	M	P	P	M	P	X	P	M	M														
N	1	M	M	M	M	P	M	M	M	M	P	M	G	M	P	M	M		M	M			M	M	M	M
Li	3	M	P	M	P	P	M	E	M	M	M	P		M	M	M	P	M	-	M	M	M	E			
K	4		M	X	M	P	M	P	X	P	P	M	R	M	P	M	P	P	M	M	M	M	M			
R	2	M	P	M	M	M	M	M	M	M	M	M	R	M	M	M	M		M	M			M	M	M	M
C	3	M	M	X	M	P	M	P	X	P	P	M	R		P	M	P	P	M	M	M	M	M			
G	1	M	M	X	P	P	M	P	X	P	P	M	Rx		M	M	P	M	-	P	M	M	X			

	DA: Derivative applications						FTC: Integration					Big Ideas											GP	WW	Base Grade
	A.1	DA.2	DA.3	DA.4	DA.5	DA.6	FTC.1	FTC.2	FTC.3	FTC.4		IE	R	C	RC	F	L	DM	DS	DA	FTC	Total			
	8	4	6	4	2	2	2	2	2	2		3	3	3	2	3	3	6	4	5	3				
es	15	8	9	7	4	4	4	4	4	4															
B	10	4	6	4	3	1	3	2	1	2		3	4	3	2	3	3	7	4	5	3	10	29	11	A
Z	8	4	4	2	2	2	2	2	0	2		2	3	2	2	3	3	5	4	4	3	6	29	9	D
D	9	0	3	2	1	0	0	0	0	0		1	0	2	0	0	2	3	0	1	0	0	18	7	F
N	9	5	6	5	2	2	2	2	1	2		3	4	3	2	3	3	6	4	6	3	10	29	10	A
Li	6	3	4	3	1	0	2	2	1	2		2	3	3	2	1	3	6	4	0	3	7	22	7	C
K	9	5	6	3	2	3	3	2	2	2		3	3	3	2	3	3	6	4	5	4	10	28	9	B
R	12	5	6	5	2	1	2	3	1	2		3	4	3	2	3	4	6	4	5	3	10	28	10	A
C	11	4	6	4	2	2	3	3	1	2		3	3	3	2	3	2	6	4	6	3	9	28	10	B
G	11	4	5	4	2	3	2	1	2	3		3	3	3	2	3	3	6	4	5	3	10	30	10	A

Midterm Grading: Canvas

MBT Q5 Out of 10	MBT Q6 Out of 10	MBT Q7 Out of 10	MBT Q8 Out of 10	MB Q9 Out of 10	MBT Q13 Out of 10	MBT Q14 Out of 10
-	✓	-	-	-	-	-
✓	✓	✓	✓	✓	-	-
✓	✓	-	-	-	✓	-
✓	✓	-	-	✓	✓	✓
✓	✓	✓	✓	-	✓	✓
✓	✓	✓	✓	✓	✓	✓
✓	✓	-	-	-	✓	-
✓	✓	✓	✓	✓	✓	-
✓	✓	✓	✓	✓	✓	-

Midterm Grading: Canvas

Assignments 20.00% of grade	Mastery Based Questions 0.00% of grade	Mastery Based Test Grade 70.00% of grade	Assignment Presentations 10.00% of grade	Total
88.52%	-	96%	92.5%	94.15%
84.44%	-	80%	95%	82.39%
84%	-	64%	85%	70.1%
77%	-	68%	72.5%	70.25%
91.67%	-	30%	90%	48.33%
78.89%	-	64%	90%	69.58%
87.04%	-	92%	95%	91.31%
92.22%	-	76%	90%	80.64%

Midterm Grading: Blackboard

MBT Q1	MBT Q2	MBT Q3
M	M	M
I	M	M
R	M	I
M	M	R

Midterm Grading

- Grades assigned based on how many mastered questions
  - 16 topics
- Midterm - students have attempted 8 topics one time
- All students enter midterm “failing”
- Formula: 2Q+3
  - Works best without Core Concepts

Work time

Find prompts for preparing your course in your packet.

Organizers will circulate to answer questions and help you think about your mastery grading plan.

Summary, Wrap-up, and Evaluations

Things to know

- The Shared Google Drive folder is full of Mastery Grading Goodness, including:
  - Resource list
  - Everything we've used in this minicourse, and more
  - Space to share your own syllabi, problems, etc.
- Keep in touch! Opt-in mailing list for questions, successes, failures, etc.
- Don't forget final evaluations:

https://www.surveymonkey.com/r/NRN5DWZ