Preparing Our Students
with Standards Based Grading

A Mastery-Based Assessment and Teaching Approach

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My Program Learning Outcomes

- **Graph precalculus functions and solve related equations**, and shift easily from geometric to algebraic approaches and vice versa.
- **Compute or estimate limits** of elementary and transcendental functions geometrically, algebraically, and numerically.
- **Differentiate** precalculus functions using basic differentiation rules, up to and including the chain rule.
- **Interpret ordinary and partial derivatives** geometrically and in applications as an instantaneous rate of change.
- **Antidifferentiate** functions using basic antidifferentiation rules, u-substitution, integration by parts, and partial fraction decomposition.
- **Interpret antiderivatives and integrals geometrically and in applications** as the net change in a function.
- Classify and solve linear differential equations using an appropriate method.
- Apply the Laplace transformation method to solve initial value problems.

Analytic Geometry and Calculus I

- Compute limits geometrically, algebraically, and numerically.
- Learn basic differentiation rules, up to and including the chain rule
- Begin interpreting derivatives geometrically and in applications
- Learn antidifferentiation rules, up to and including u-substitution
- Interpret integrals as a net change
- Introduce Riemann sums and the concept of integration

Analytic Geometry and Calculus II

- Master antidifferentiation rules, up to and including u-substitution, integration by parts, and partial fraction decomposition.
- Study applications of integration, and master the concept of an integral as an infinite sum of infinitesimals.
- Introduce sequences and series.
  - Develop fluency with if, then statements.
  - Emphasize representation of functions by power series and Taylor series.

Analytic Geometry and Calculus III

- Extend the ideas studied in Calculus I and II to 3+ dimensions.
- Emphasize interpretation of derivatives and gradient, both geometrically and in applications.
- Emphasize the connection between algebraic or computational approaches and geometric approaches to the same problems.

Elementary Differential Equations

- Reinforce skills in differentiation and antidifferentiation, and algebraic manipulation.
- Classify and solve ODEs by an appropriate method.
  - Separable
  - First order linear
  - Homogeneous polar
  - Bernoulli
  - Reduction of order
  - Homogeneous ODEs with Constant Coefficients
  - Cauchy-Euler DEs
- Method of undetermined coefficients
- Variation of parameters
- Series solutions about an ordinary point
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Outline

- What is Standards Based Grading? (SBG)
- What does a C in Precalculus Really Mean Anyway?
- Making Grades Meaningful
- The Pitch (for Engineering Students)
- Benefits of Using SBG
- Logistics and Other Challenges

What is SBG?

- Grades are determined by how well the student displays a mastery of **standards**
- ≈ 30 standards per course
- 0 to 4 GPA scale
- 8 to 10 quizzes & a comprehensive final
- **Students can improve grade through reassessment**
- 70-80% of final grade in the course
- 5-10% homework, 15-20% final exam

What is SBG?

- Standards clearly **document**
- Limitations on Rea
  - # of reassessmer
  - # of reassessmer
  - Time-limited (2-

ANALYTIC GEOMETRY & CALCULUS II

Course Standards & Grading Rubric

WHAT DO I NEED TO KNOW BEFORE I BEGIN?

- **G.1. Arithmetic, algebra, and trigonometry**– Use precalculus skills including techniques of algebraic manipulation from high school algebra; logarithmic and exponential properties; factoring; techniques for solving algebraic equations; techniques for graphing functions from college algebra and their transformations; knowledge of x- and y-intercepts; right triangle trigonometry and the unit circle; graphs of sine, cosine, and tangent functions, and their inverses; and some trigonometric identities (Right triangle identities, reciprocal identities, Pythagorean identities, double angle formulas for sine and cosine functions, and power reducing formulas).
- **G.2. Analytic Geometry and Calculus 1** – Use skills learned in calculus 1, including techniques for evaluating a limit algebraically, conceptual understanding of limits, differentiation rules including the chain rule, antidifferentiation rules up to u-substitution, the Fundamental Theorem of Calculus, and interpretation of the derivative and integral, geometrically and in applications.

ADVANCED ANTIDIFFERENTIATION AND INTEGRATION TECHNIQUES

- **I3: Basic rules, algebraic manipulation, and u-substitution for antidifferentiation** – Apply the nine methods we studied for algebraic manipulation, as well as u-substitution, to write an integrand in an integrable form using basic rules. These nine methods include: (1) Expanding expressions of the form

Why SBG?

What Does a C in Precalculus *Actually Mean* Anyway?

SBG ties grades to evidence of learning!

Student #1	Student #2:
Average: 74 **Final Grade: C**	Average: 75.25 **Final Grade: C**

We have little to no knowledge of what that student knows, needs to study for the final, or might need to study before calculus 1.

Before & After: Conversations with Students

Why did I get a 2 over “Mean Value Theorem”? I thought that was at least a 3.

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I’m really struggling with the graphs of transformations. Can you show me what I’m doing wron

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How do you know when to use u-substitution versus integration by parts?

I only need thre
points to get a B.

I have a C, and I really want a B. What do I need to do to get a B in the class?

I got a 1 on eigenvalue methods. Can you show me what I’m doing wrong?

Making Grades Meaningful

F7. Solve application problems.	3.00
F8. Transformations of Functions	3.00
F9: Combinations of Functions	3.00
F10: One-to-One Functions and Their Inverses	2.00
F11: Quadratic Functions	3.00
F12: Polynomial Functions and Their Graphs	2.00
F13. Dividing Polynomials	3.00
F14. Theorems about Polynomials	2.00
F16: Rational Functions	3.00
F17: Exponential Functions and Their Graphs	1.00
F19: Logarithmic Functions and Their Graphs	1.00
F20: Laws of Logarithms and Solving Logarithmic Equations	1.00
F21: Solving Exponential Equations	1.00
T22: Angle Measure	3.00
T23: Right Triangle Trigonometry	3.00
T24: Applications Involving Right Triangles	4.00

Real Grades from a TU Precalculus Student

HW Average: 4.0
Standards Average: 2.67
Grade: C+/B-

2.75 to 3.4 earns a B

If she earns 3's on two of these, her new standards average will be 2.8.

Making Grades Meaningful

	F13. Dividing P	F14. Theorems	F16: Rational F	F17: Exponentia	F19: Logarithmi
Student 1	1.00	0.00	3.00	0.00	0.00
Student 2	2.00	3.00	2.00	1.00	1.00
Student 3	4.00	3.00	2.00	2.00	0.00
Student 4	4.00	1.00	1.00	1.00	2.00
Student 5	3.00	2.00	3.00	1.00	1.00
Student 6	3.50	2.00	2.00	1.00	1.00
Student 7	4.00	2.00	2.00	4.00	1.00
Student 8	4.00	3.50	2.00	1.00	1.00
Student 9	1.00	2.00	1.00	2.00	0.00
Student 10	4.00	3.50	2.00	2.00	3.00

Benefits of SBG

1) **Establishes clear expectations.**
2) **Students can improve their grades.**
   - Quizzes cover fewer topics, more thoroughly.
   - Focus on a few concepts at a time.
   - Conversations about math during office hours
   - Review quiz keys, feedback, related homework, and class notes
   - Assess understanding…and reassess if necessary
3) **Helps the students hold themselves accountable**
   - Their grade is entirely in their hands.
4) **Stresses mastery: working out problems in a completely correct way**
5) **Makes grades meaningful**
   - 4 to 3.5 = mastery
   - 3 = good understanding
   - 2 = enough understanding to go on to the next class
   - A student who earns a C is prepared for the next class in sequence.

High Standards

Clear Expectations

Opportunities to Learn from Feedback and Mistakes

Growth Mindset

GRIT

The Pitch For Engineering Students

- Goal: Be prepared OSU's 3000 level engineering analysis
- "It's a lot of hard work, but if you do the work – I'll work hard and you'll work hard – you'll learn."
- "If you study the materials I provide for you, and listen to my feedback, you will learn…and your grades will reflect that."
- "It's okay to make a mistake, but I need you to know the material by the end of the semester, and the sooner the better because this material builds on itself."
- "Everyone is going to want to study with you!"
- "When you go to OSU or another university, you're going to want to know what you're doing."

Students…

- Learn *what* to study and *how* to study.
- Learn that they *can learn* challenging material.
- Learn that they can't just memorize quiz keys or solutions to problems, but that **they actually have to understand the concept to earn an A.**
- **They can get the grade they want if they learn.**

High Standards

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Logistics and Other Challenges

- Pitch the idea to your students and colleagues
- Sign-up process for reassessments
- Writing quizzes…and more quizzes
- Grading quizzes (making this feasible)
- Post quiz keys for this semester and provide quiz keys from the previous semester
- Issues with academic integrity (cheating) and test security

Creating a Culture That Supports Learning

Students…

- Set goals for their grades and their learning
- Revisit tough concepts.
- Ask about concepts, not about grades & points.
- Conversations about grades are redirected to content.
- Study in groups, and discuss content.
- Support the culture and **become self-directed learners.**

High Standards

Clear Expectations

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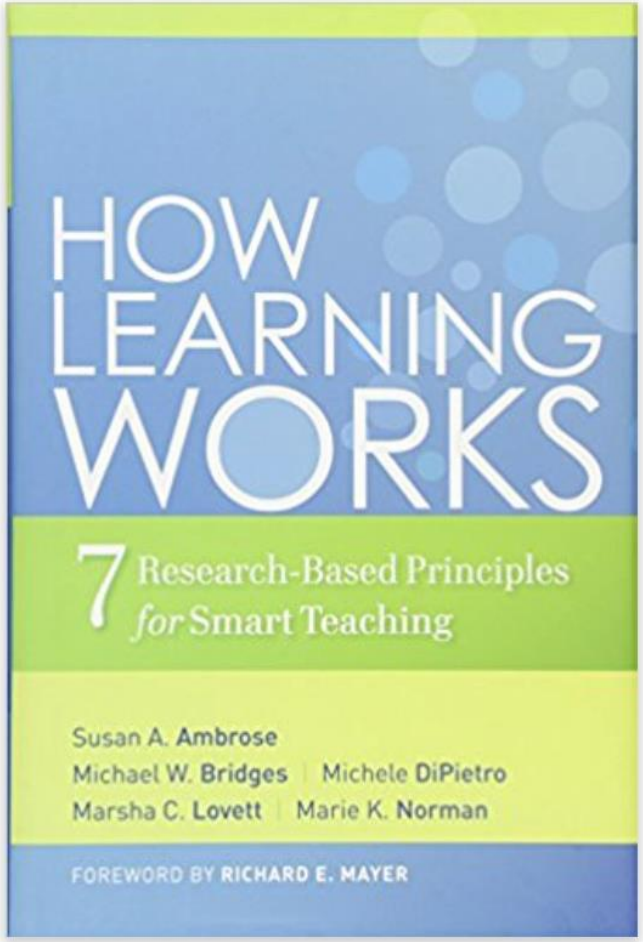
How Learning Works: 7 Research-Based Principles for Smart Teaching

1) How does prior knowledge affects student learning?
2) How does the way students organize knowledge affect their learning?
3) What factors motivate students to learn?
4) How do students develop mastery?
5) What kinds of practice and feedback enhance learning?
6) Why do student development and course climate matter in student learning?
7) How do students become self-directed learners?



Standards-based grading (SBG) **motivates students to develop mastery**, by creating a culture that sets clear expectations, and encourages practice and learning from feedback, so that the students become **self-directed learners**.

Structure Encourages Behaviors that Foster Learning

Traditional Grading

- Time-limited: We expect mastery in time for the exam, and if they don't master the material, we hope they'll study it for the final.
- Little (immediate) incentive to learn from feedback
- More material assessed at one time
- No incentive to learn tough concepts (I'll skip that one!)

SBG

- Not time-limited, but instructors set the pace
- Less content, more thoroughly assessed
- Can't skip a tough concept without it bringing down the student's average
- Immediate incentive to learn from feedback (students can reassess)

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Questions?

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About Reassessment Quizzes

- Study using quiz keys, class notes, feedback, and related HW
- More definitions and concept questions on reassessments
- More variations on a theme
  EX: all three types of exponential equations
- Different applications of the same concept

Part of a Spring 2018 Quiz Key

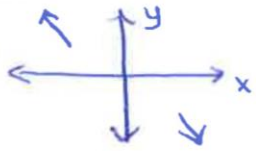
Problem about Graphing Polynomials:

(a) Use the leading term test to determine and describe the end behavior of the polynomial function, and as always, explain your reasoning.

Leading term of $P(x)$: $-3x^5$

Explanation: $a_5 = -3 < 0$ $\Rightarrow$

$n = 5$ (odd)



Since n is odd & $a_n < 0$, the end behavior is the same as that of $y = -x^3$.

End behavior:

$y \to$ $-\infty$ as $x \to \infty$

$y \to$ ∞ as $x \to -\infty$