

# Using OER to Enhance Transparency in Calculus I

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# Innovations in MATH 1310 Calculus I

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**GOAL:** to improve access to success in MATH 1310 for all students and to close outcome gaps that exist between various student groups

**2016-2019:** flipped classroom pilot initiated to improve student outcomes

**2019-2020:** full transition to flipped classrooms after positive results (i.e. increased learning, lower DFW rates) from the pilot

**2022-current:** growth-based assessment structure pilot to improve student outcomes further

# What does growth-based assessment look like in MATH 1310 Calculus 1?

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Twenty-five distinct learning targets capturing the most important mathematical ideas of the course were created and shared on course LMS sites.

Course materials were redesigned to align with the new learning targets.

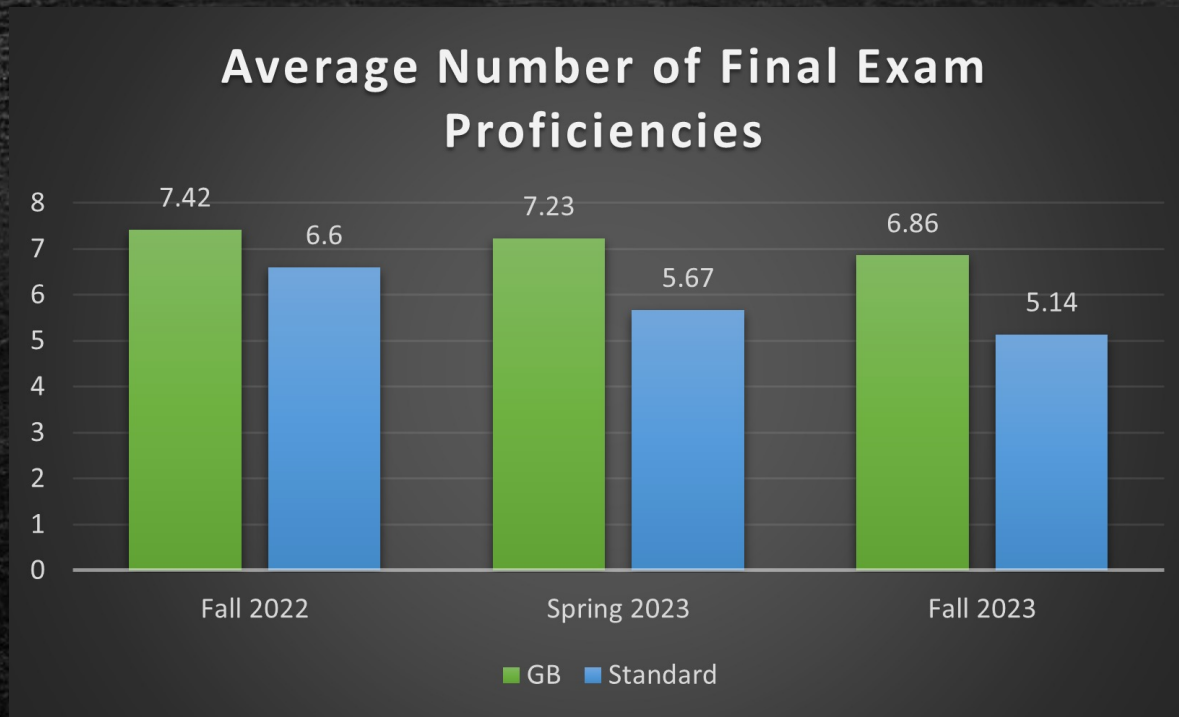
Five assessments were given during the semester, with each assessment question corresponding to a learning target, 1 question per target.

Responses to each question were awarded a proficiency score to measure student progress toward each learning target.

Students had multiple attempts – typically 3 or 4 – to demonstrate proficiency on each target, with only their maximum score counted.

A student's letter grade was based on the number of demonstrated proficiencies.

# Growth-Based Assessment: Some Results



We are seeing statistically-significant learning differences between the growth-based assessment structure and the standard assessment structure.

These differences persist when we control for prior math knowledge & experience.

Notably, students who identified as members of an underrepresented minority group or as a first-generation college student benefitted **more** from the growth-based assessment structure – shrinking the gap.

Why, though? What is the mechanism?

# Impacts of Transparency on Student Outcomes

RESEARCH

## A Teaching Intervention that Increases Underserved College Students' Success

► **Mary-Ann Winkelmess**, coordinator, instructional development and research, office of the provost and associate graduate faculty, history department, University of Nevada, Las Vegas; senior fellow, AAC&U  
**Matthew Bernacki**, assistant professor, educational psychology and higher education, University of Nevada, Las Vegas  
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**T**he challenge to provide equitable opportunities for college students to succeed is a critical priority for the Association of American Colleges and Universities (AAC&U). In 2014, AAC&U partnered with the Transparency in Learning and Teaching in Higher Education (TILT Higher Ed) project, founded at the University of Illinois and now housed at the University of Nevada, Las Vegas, on an initiative that significantly increases underserved college students' success. TG Philanthropy funded the Transparency and Problem-Centered Learning project ([www.aacu.org/problemcenteredlearning](http://www.aacu.org/problemcenteredlearning)), with Tia McNair, Ashley Finley,


low-income students lag far behind those of students whose family incomes are above the bottom quartile (Tough 2014). And first-generation college students are 51 percent less likely to graduate in four years than students whose parents completed college (Ishitani 2006).

Colleges and universities have of course made valuable efforts to address these skewed and inequitable outcomes, relying upon predictive analytics and resources including advising, scholarships, tutoring, and community-building programs. But there has been little systematic study of the role that faculty can play collectively in improving learning

Winkelmess et al (2016) asked:

*"What is the effect when teachers provide two transparently designed, problem-based take-home assignments on spring-term first-year college students' learning experiences?"*

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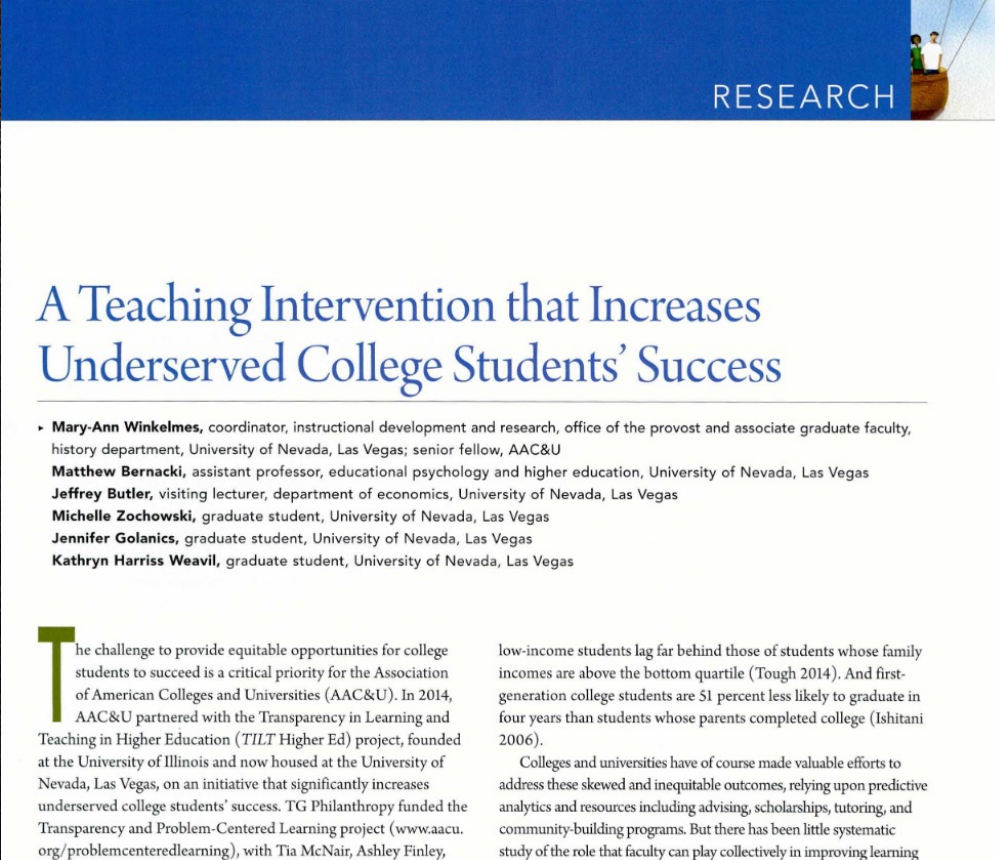
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Winkelmess et al (2016) found:

*"Students who received more transparency reported gains in three areas [...]: academic confidence, sense of belonging, and mastery of the skills that employers value. [...] For first-generation, low-income, and underrepresented students, those benefits were larger."*

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This article studies to the impacts of a transparently-designed *assignment*. But what if we scale that idea up to the course design level?

What would a transparently-designed course look like?

What impact would such a course have on student learning and retention?

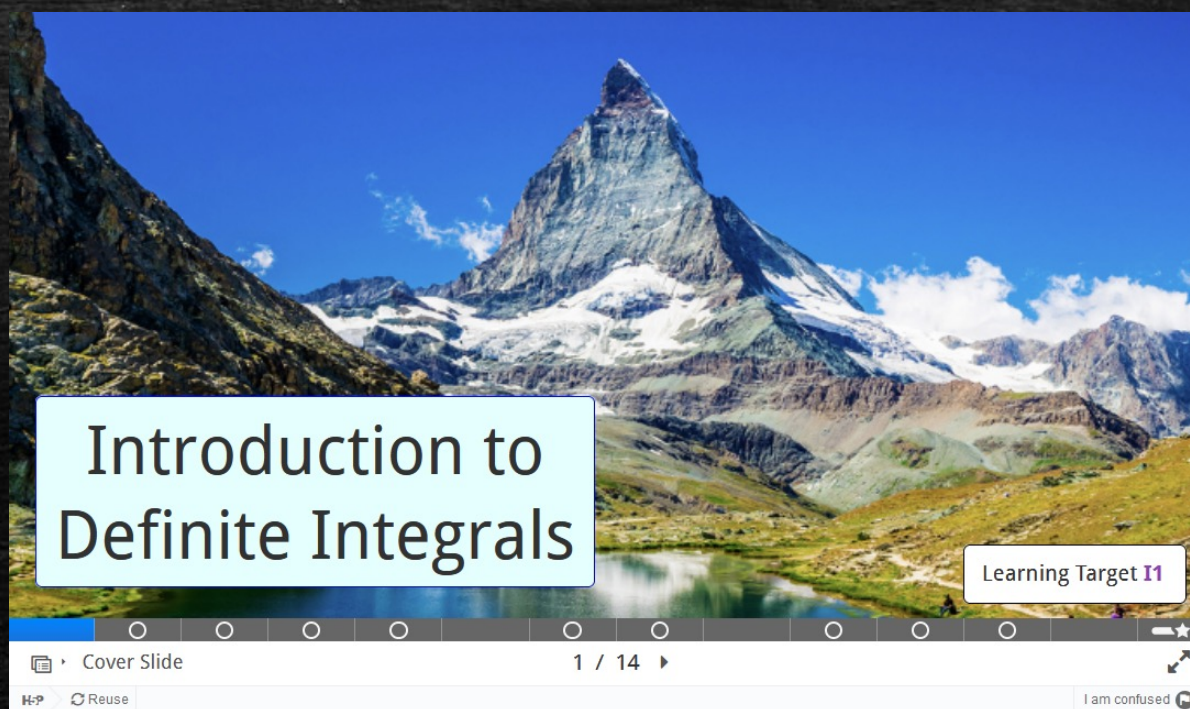
Before a course can be  
transparent, it must  
first be accessible.  
Cost is a barrier.

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My OER project seeks to expand transparency in  
learning calculus to all students, regardless of  
privilege.

# OER's Current Role in Promoting Transparency in MATH 1310

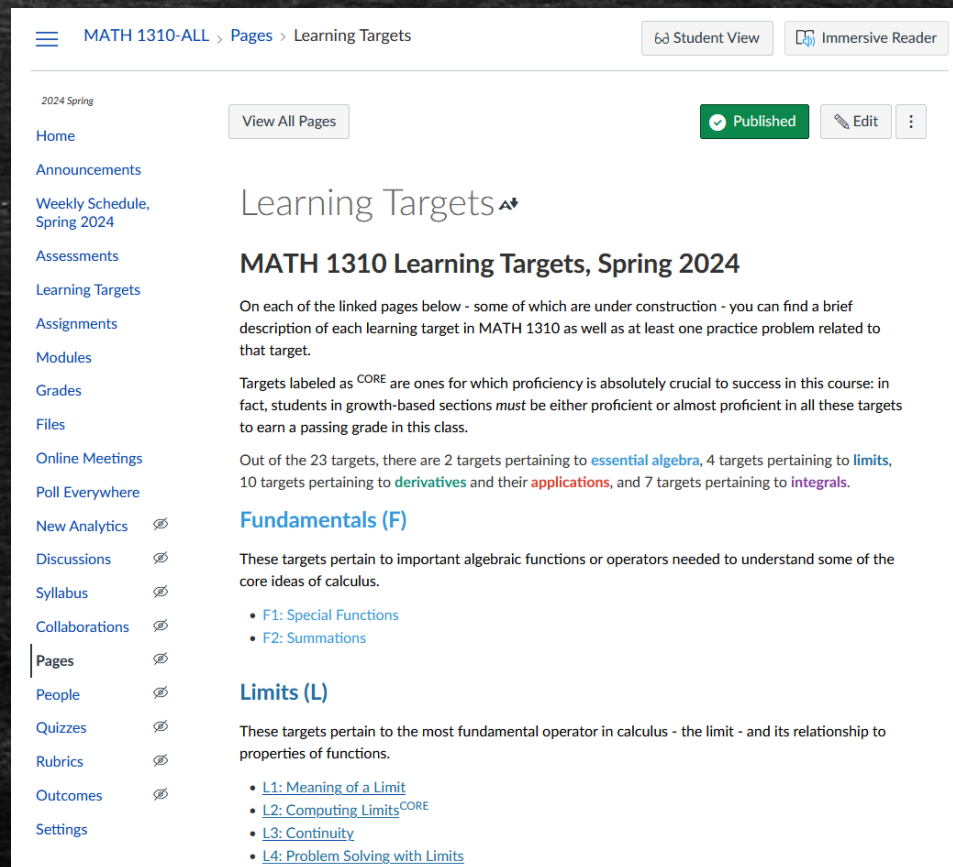
Learning-target-aligned H5P activities are used as pre-class assignments.



[\(link to activity\)](#)

# OER's Current Role in Promoting Transparency in MATH 1310

Course learning targets are currently available to students in MATH 1310.



The screenshot shows a web page titled "MATH 1310-ALL > Pages > Learning Targets". The page is for the "2024 Spring" semester. On the left is a navigation menu with links: Home, Announcements, Weekly Schedule, Spring 2024, Assessments, Learning Targets (highlighted), Assignments, Modules, Grades, Files, Online Meetings, Poll Everywhere, New Analytics, Discussions, Syllabus, Collaborations, Pages, People, Quizzes, Rubrics, Outcomes, and Settings. The main content area is titled "Learning Targets" and "MATH 1310 Learning Targets, Spring 2024". It includes a "View All Pages" button and a "Published" status indicator. The text explains that each linked page provides a brief description of a learning target and a related practice problem. It notes that targets labeled as "CORE" are crucial for success. A breakdown of 23 targets is provided: 2 for essential algebra, 4 for limits, 10 for derivatives, and 7 for integrals. Two sections are highlighted: "Fundamentals (F)" with targets F1: Special Functions and F2: Summations, and "Limits (L)" with targets L1: Meaning of a Limit, L2: Computing Limits (CORE), L3: Continuity, and L4: Problem Solving with Limits.

MATH 1310-ALL > Pages > Learning Targets

63 Student View Immersive Reader

2024 Spring

View All Pages

Published Edit

## Learning Targets

### MATH 1310 Learning Targets, Spring 2024

On each of the linked pages below - some of which are under construction - you can find a brief description of each learning target in MATH 1310 as well as at least one practice problem related to that target.

Targets labeled as **CORE** are ones for which proficiency is absolutely crucial to success in this course: in fact, students in growth-based sections must be either proficient or almost proficient in all these targets to earn a passing grade in this class.

Out of the 23 targets, there are 2 targets pertaining to **essential algebra**, 4 targets pertaining to **limits**, 10 targets pertaining to **derivatives** and their **applications**, and 7 targets pertaining to **integrals**.

#### Fundamentals (F)

These targets pertain to important algebraic functions or operators needed to understand some of the core ideas of calculus.

- F1: Special Functions
- F2: Summations

#### Limits (L)

These targets pertain to the most fundamental operator in calculus - the limit - and its relationship to properties of functions.

- L1: Meaning of a Limit
- L2: Computing Limits<sup>CORE</sup>
- L3: Continuity
- L4: Problem Solving with Limits

# OER's Current Role in Promoting Transparency in MATH 1310

2024 Spring

View All Pages

Published Edit

Home

Announcements

Weekly Schedule, Spring 2024

Assessments

Learning Targets

Assignments

Modules

Grades

Files

Online Meetings

Poll Everywhere

New Analytics

Discussions

Syllabus

Collaborations

Pages

People

Quizzes

Rubrics

## D2: Derivative Rules <sup>▲</sup>

(back to the [Learning Targets](#) page)

### Derivatives 2 (D2): Derivative Rules

- Use derivative rules -- including the product rule, quotient rule, and chain rule -- to compute derivatives.
- Decide in which order derivative rules should be used to compute derivatives of complicated functions.

**NOTE:** This is a **core** target. High performance in these targets is essential to success in this course.

**Examples:**

1. Compute  $\frac{d}{dt} \left[ \frac{e^{t^2} - t \cos(t) + 1}{t^2 + 1} \right] \Big|_{t=0}$ .
2. Use the graphs of  $f$  and  $g$  (below) to compute the following derivatives.

Each learning target page provides learning goals appearing in lessons and example problems from previous assessments.

# Current Work

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With funds from the Jefferson Trust by way of the Affordability & Equity program, two faculty colleagues, an undergraduate student, and I are working to add: solutions to the provided problems; rubrics used to score those problems; and scored examples of student work on those problems.

The course H5P activities have been made public and are already being used in calculus instruction in a local high school.

I am also hoping to create and implement transparently-designed OER more extensively in upcoming calculus course redesigns.

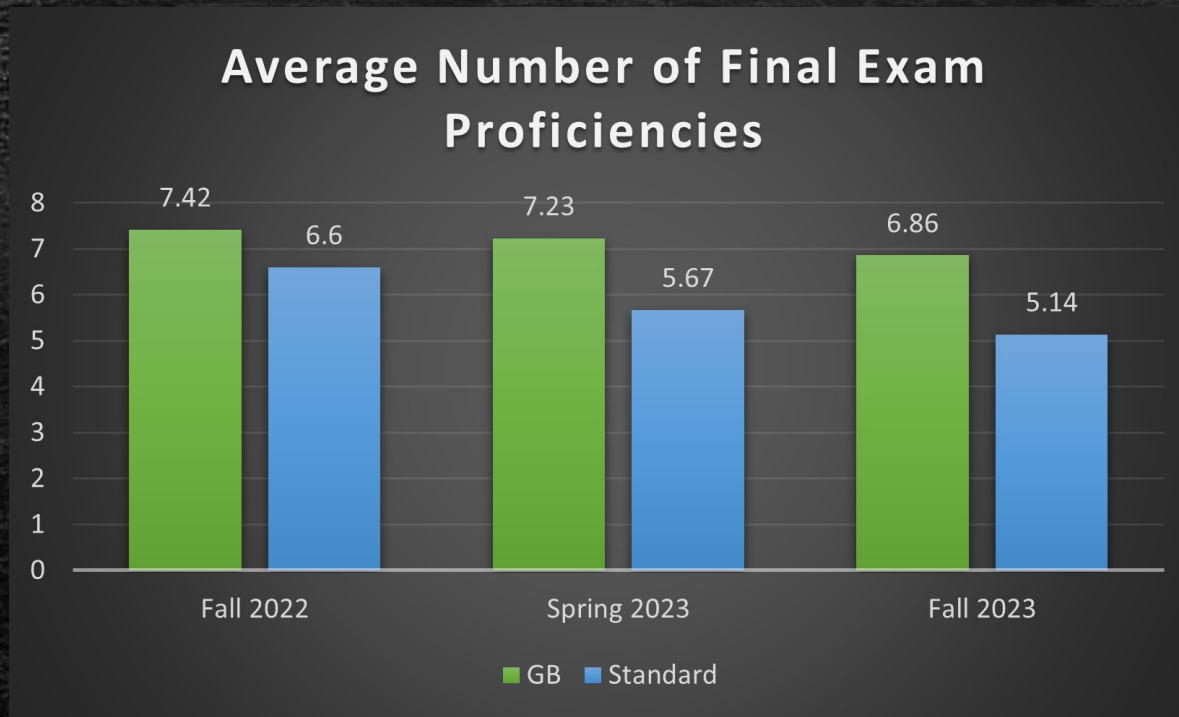
# Questions? :)

## References

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Winkelmess, M., Bernacki, M., Butler, J., Zochowski, M., Golanics, J., & Weavil, K. (2016). A Teaching Intervention that Increases Underserved College Students' Success. *Peer Review*. 18.

# APPENDIX: P-values & Effect Sizes in the Growth-Based Assessment Pilot



Raw Differences:

- Fall 2022: 0.82
- Spring 2023: 1.56
- Fall 2023: 1.72

Standardized differences & p-values:

- Fall 2022: **0.32** ( $p=0.018$ )
- Spring 2023: **0.58** ( $p=0.001$ )
- Fall 2023: **0.62** ( $p=6.18 \times 10^{-6}$ )