Using OER to Enhance Transparency in Calculus I

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Innovations in MATH 1310 Calculus I

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?

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.

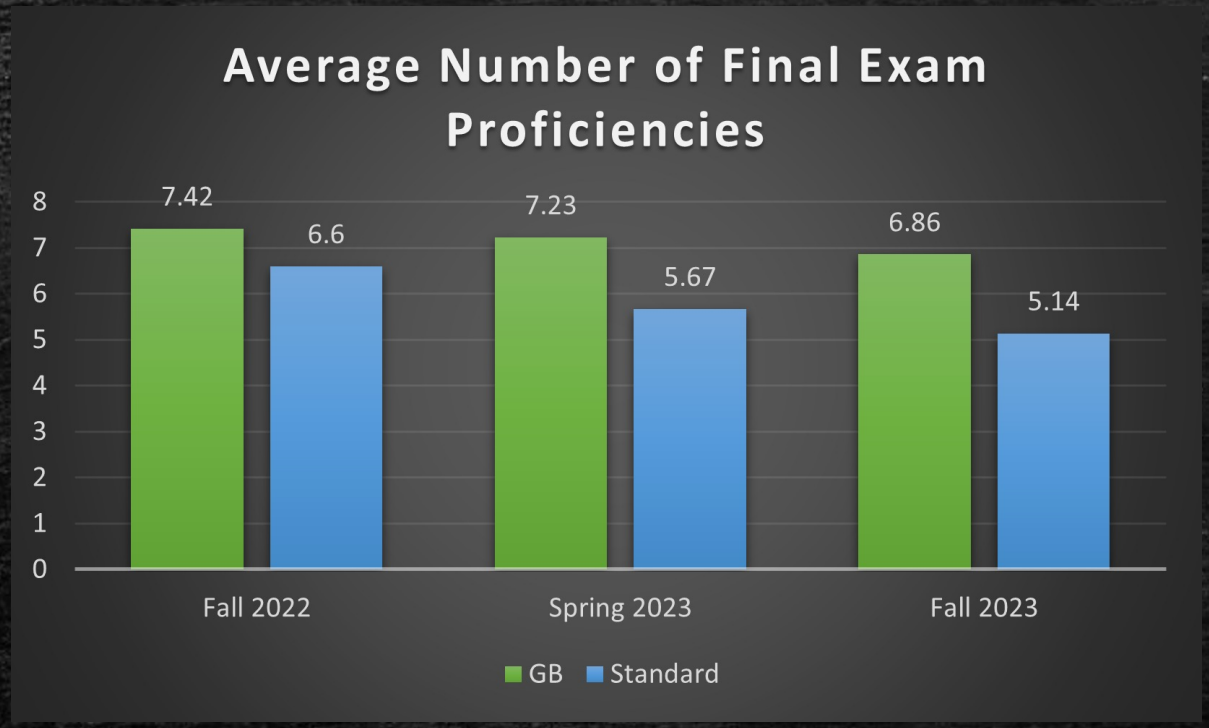
Five assessments were given during the semester, with each assessment question corresponding to a learning target, 1 question per target.

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



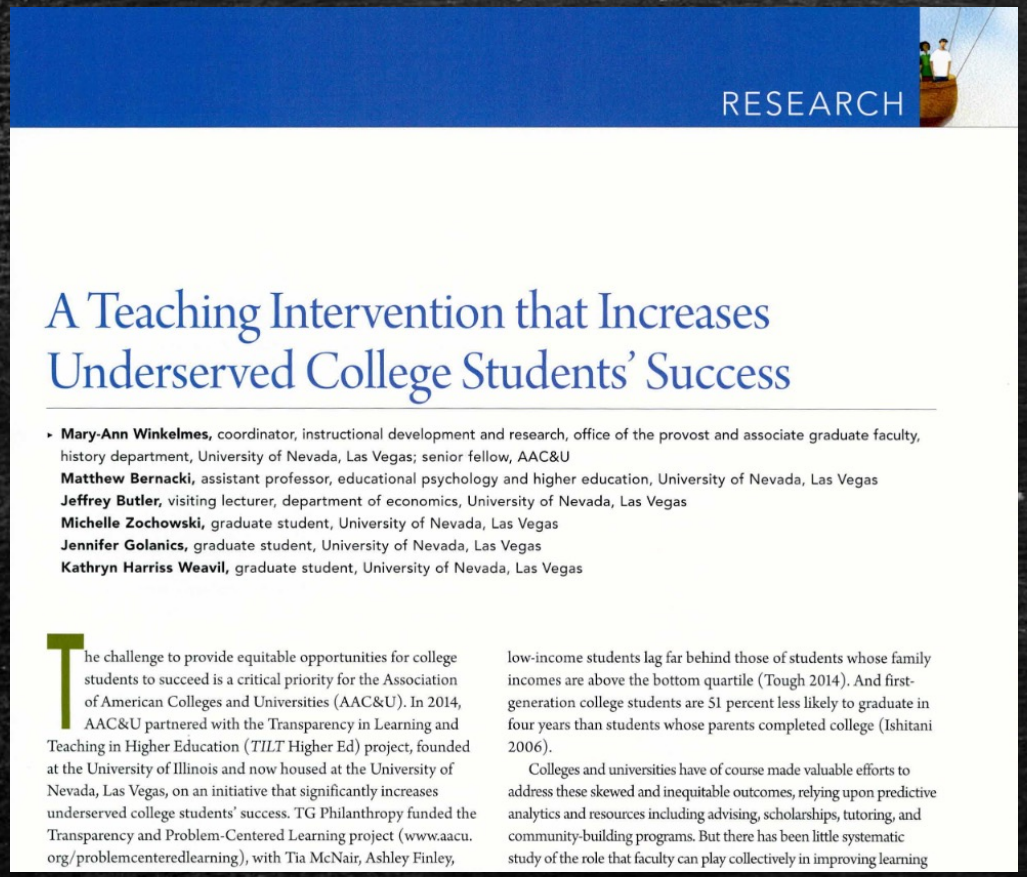
We are seeing statistically-significant learning differences between the growth-based assessment structure and the standard assessment structure.

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 Winkelmes, 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
Jeffrey Butler, visiting lecturer, department of economics, University of Nevada, Las Vegas
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Jennifer Golanics, graduate student, University of Nevada, Las Vegas
Kathryn Harriss Weavil, graduate student, University of Nevada, Las Vegas

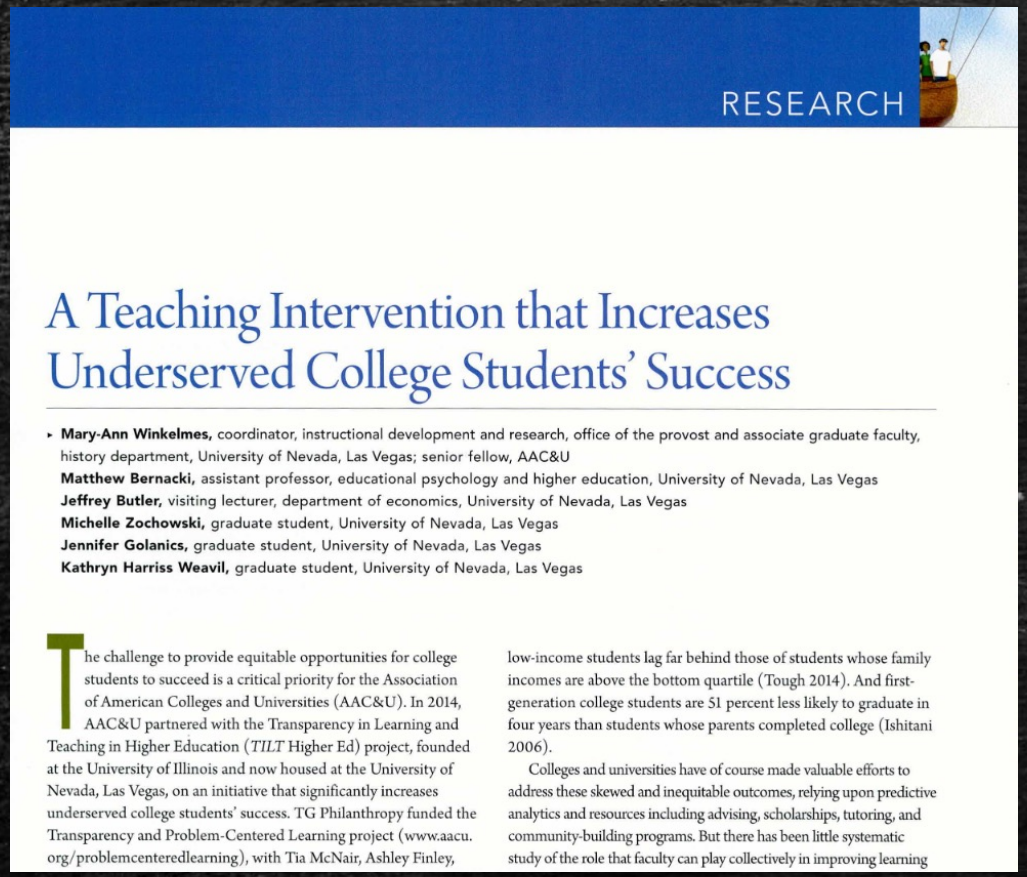
The challenge to provide equitable opportunities for college students to succeed is a critical priority for the Association of American Colleges and Universities (AAC&U). In 2014, AAC&U partnered with the Transparency in Learning and Teaching in Higher Education (*TILT* Higher Ed) project, founded at 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), 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

Winkelmes 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?"

Impacts of Transparency on Student Outcomes



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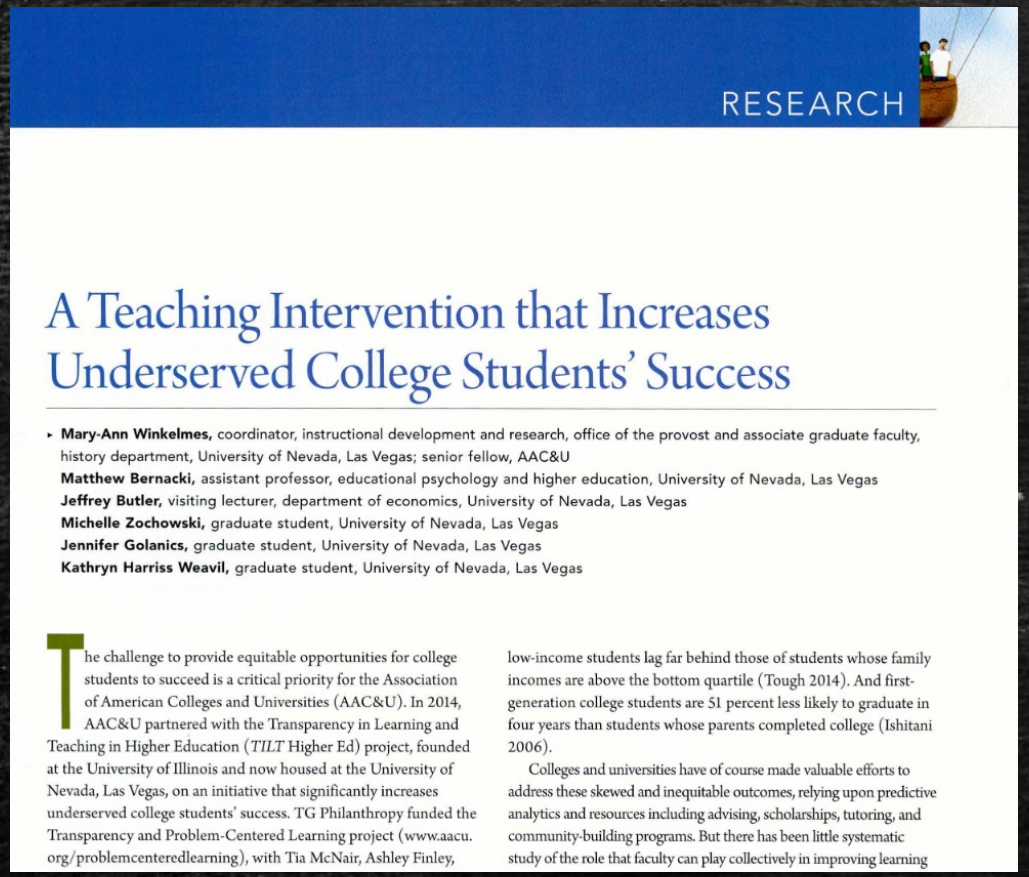
Winkelmes et al (2016) found:

"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."

Impacts of Transparency on Student Outcomes



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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.

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

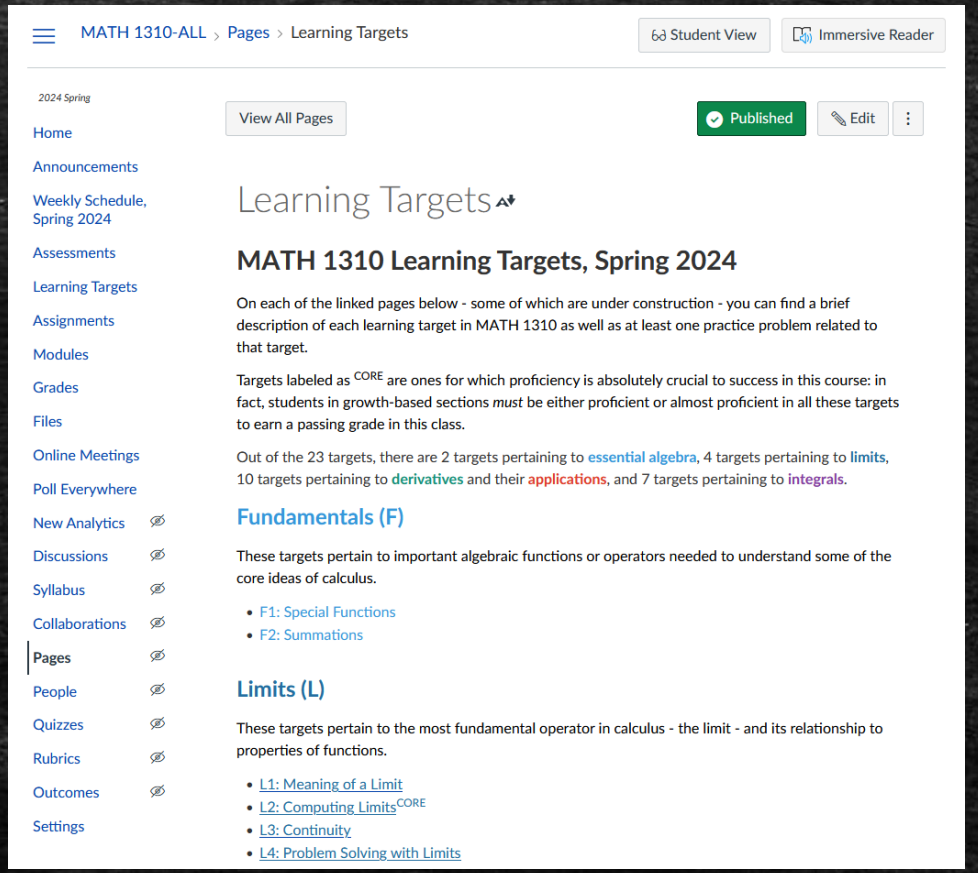
OER's Current Role in Promoting Transparency in MATH 1310

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.



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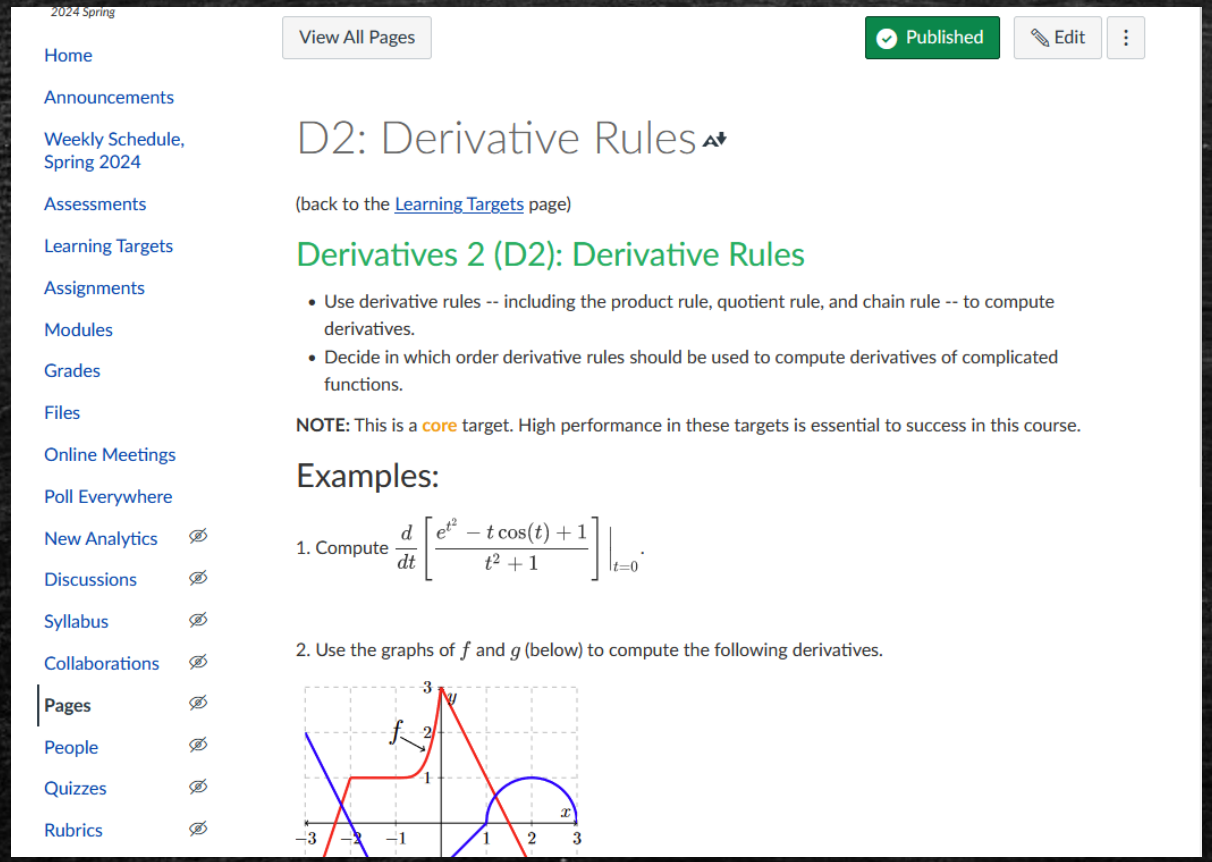

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D2: Derivative Rules

(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

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.

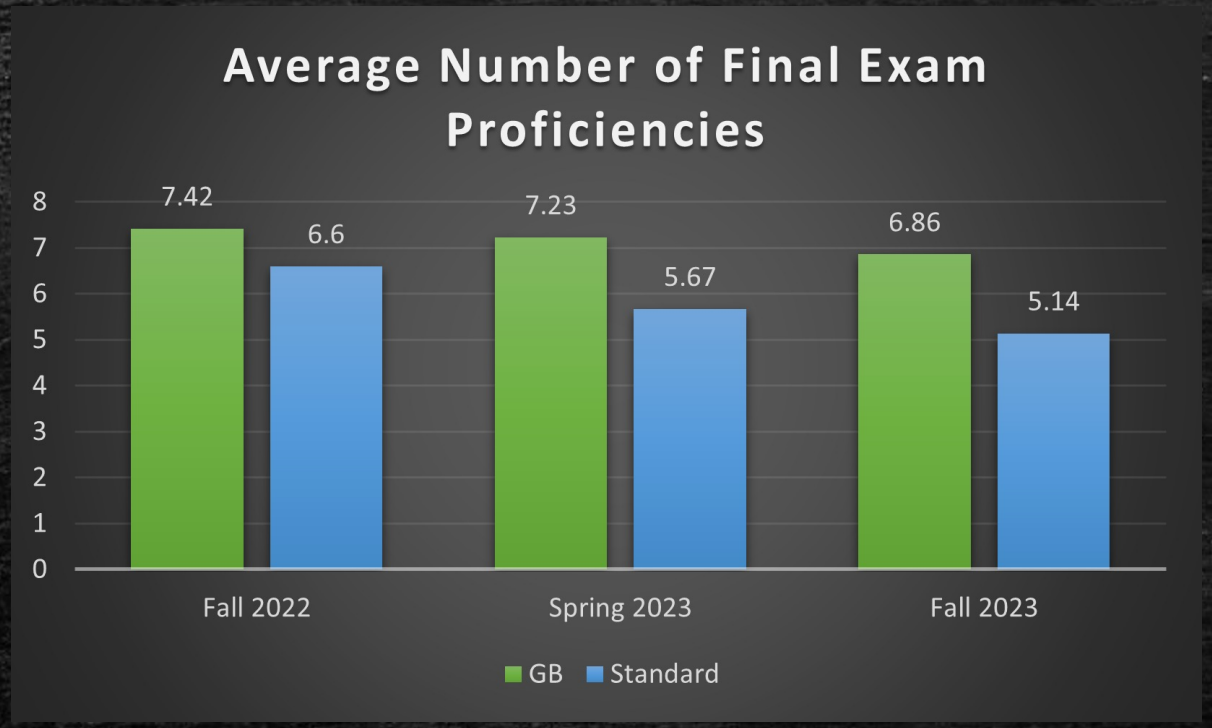
I am also hoping to create and implement transparently-designed OER more extensively in upcoming calculus course redesigns.

Questions? :)

References

Winkelmes, 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** ($p=6.18\times10^{-6}$)