

Closing Equity Gaps in Calculus for Life Sciences Courses by Emphasizing Contextualization, Active Learning, and Supporting Student Motivation



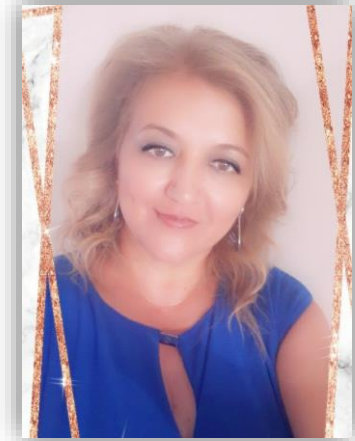
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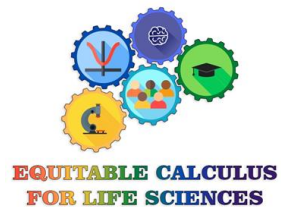
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A collaborative project between a four-year university and two community colleges



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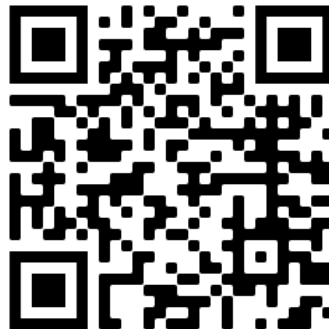
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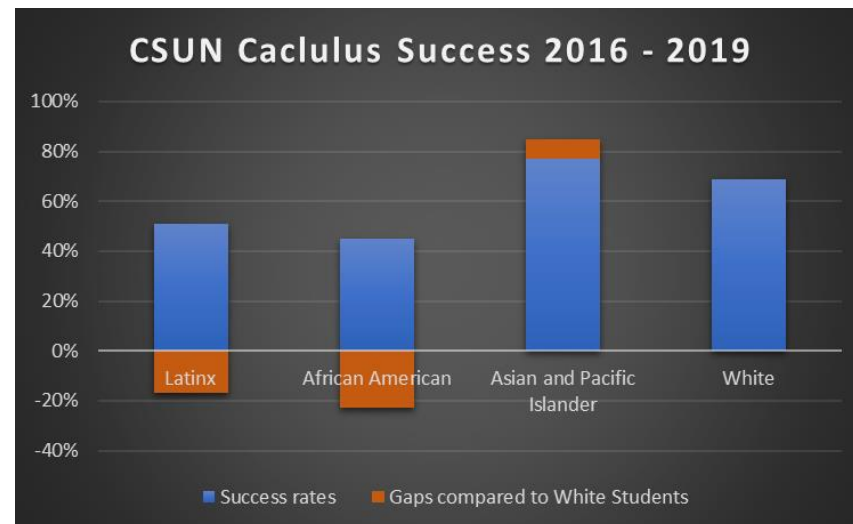
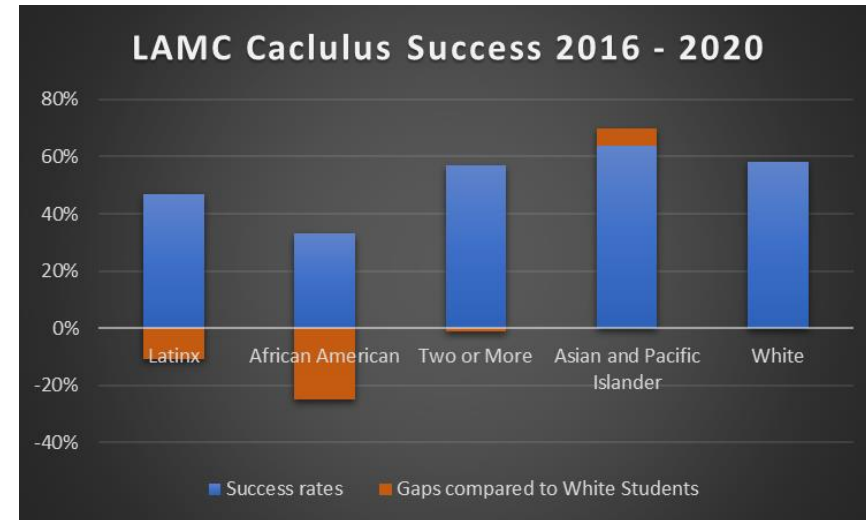
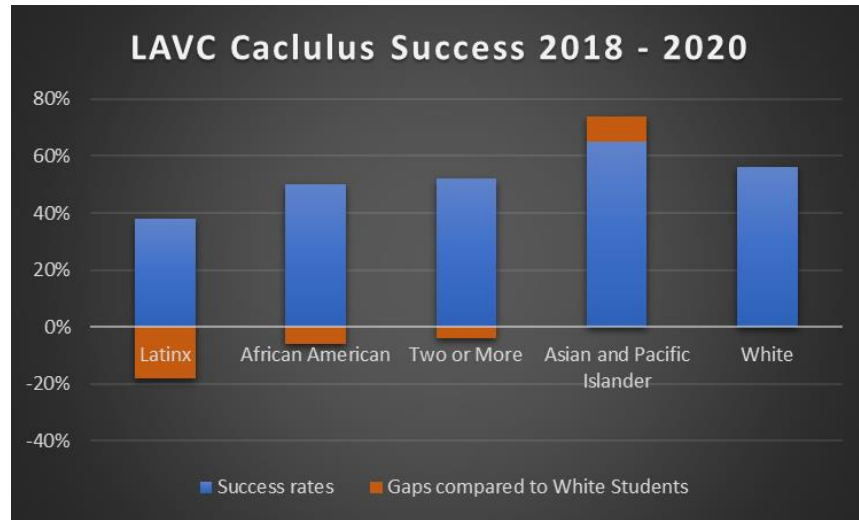


Humberto Raya Mendoza - Math
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www.equitablecalculus.org

Recent Calculus Success Rates



Preparation

Motivation

Stereo Type Threat

Why don't more students succeed in Calculus?

Sense of Belonging

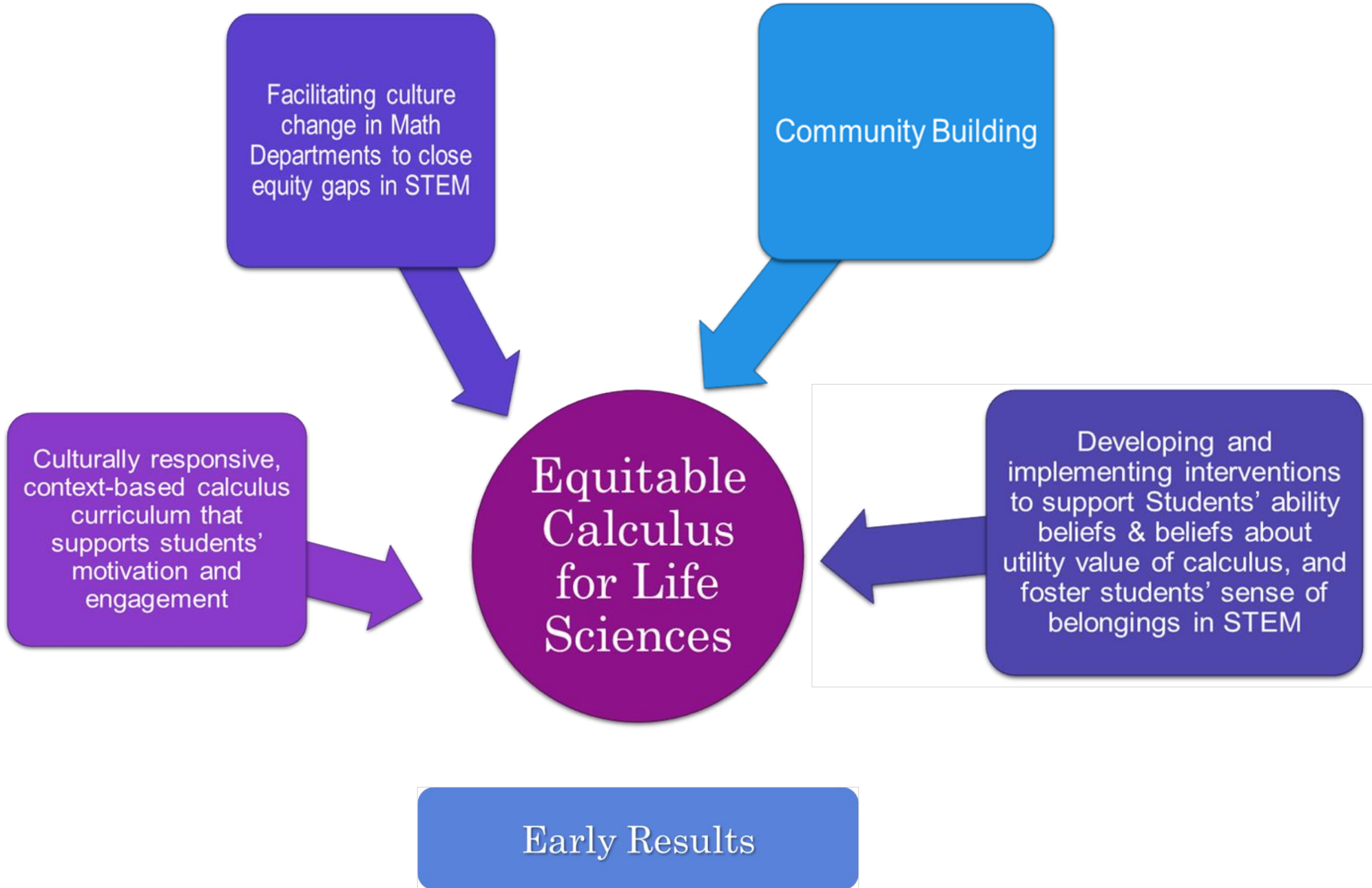
Relevance

Faculty Perception

Culturally Responsive Pedagogy

Tenants

- Activate students' prior knowledge.
- Make learning contextual.
- Consider your classroom setup.
- Form relationships.
- Discuss social and political issues.
- Tap into students' cultural capital.
- Incorporate popular culture.





Increasing Student Motivation and Engagement through Incorporating Elements of Culturally Responsive Pedagogy

Consider a very simplified model for how fast a virus can spread in an ER waiting room. In this model we are interested in the number of viruses in a room at any given time. If all people entering a room are infected at the same time, the number of viruses are based on two factors which are both themselves functions of time: $p(t)$ The number of people in the room, and $r(t)$ the number of viruses in each person's body. The total number of viruses present at any moment in the room, $n(t)$ would be the number of people multiplied by the number of viruses in each person's body. So we have $n(t)=p(t)\times r(t)$. Now suppose that we are interested in the rate at which the number of viruses in the room is changing, the derivative $n'(t)$. How would we find that rate based on the rate at which people are entering the room and how fast the number of viruses in each person's body is changing?

It turns out that the rate of change the product of two functions can't just be calculated by multiplying the two rates by each other. In other words: $n'(t)\neq p'(t)\times r'(t)$.

The take the derivative of a product we need to use the Product Rule for derivatives, The following video explains the process and provides a derivation of the formula:

Flipped Classroom – Active Learning

Contextualized Content and Projects

Gamification

Math Apps

Community building

Utility Value Interventions

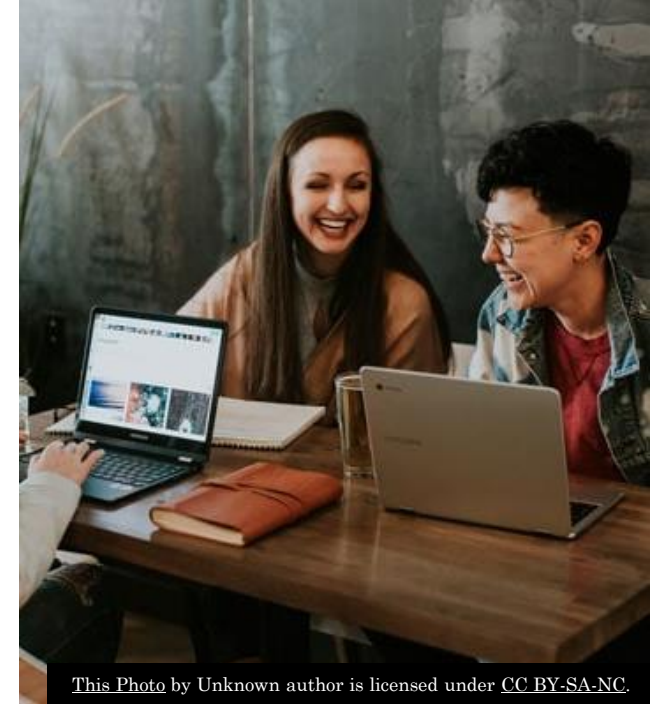


Facilitate culture change in Math Departments to close equity gaps in STEM

- Dr. Jose Vargas (jose.h.vargas@csun.edu, CSUN, Health Equity Research and Education Center) has developed and conducted 2 series of faculty professional development workshops to teach faculty about how to incorporate culturally responsive pedagogy in their course, as well as support student motivation and success
 - Ecological systems theory of social identity biases
 - Motivation and Moral position
 - Counter-discourse actions to system-justifying mechanisms
 - Critically conscious course syllabi
- Dissemination

Student Support and community building

- Student Mentors
- Pre-Semester Bridge (Summer and Winter)
 - Academic Reviews
 - Learning Skills
 - Campus Visits
 - Science Lab Visits
- Tutoring Workshop





Utility Value Intervention

- Designed by Dr. Stacy Priniski (stacy.priniski@temple.edu, Temple U, Hope Center for College, Community, and Justice).
- Evidence-based strategies to help students see relevance and usefulness of course topics
- Utility Value
 - usefulness
 - relevance
 - purpose
 - meaning
 - Is it worth doing?
 - Is it interesting?
 - Is it useful?
 - Is it me?
 - What will it cost me?
- We can help student figure it out themselves.
- If it is worth it, it is more interesting, it gives sense of purpose; if you can apply it, you can understand it.
- Correlational studies and laboratory experiments showed benefits of UV.
- Can be implemented in a multi-section lower division math course.

Implementation of Interventions

Students are given three activities (<30 mins) as course assignments.

- Students are presented 5 quotes ostensibly from former students, about the usefulness of calculus.
- Students are asked to rate how interesting the quotes were, how similar they were to their own experiences, and the degree to which the quotes helped them connect calculus to their own lives.
- Responses graded on thoughtful completion.
- Currently implemented in Qualtrics. Transition to Canvas or other LMS is straightforward.

Assignment

Students are given 5 quotes.

Quote 5

I thought calculus was pretty tough. I had to work harder in that class than most of my other classes. But the tutors helped. I also did extra practice problems online. That helped too. Over time it got easier. Now looking back I'm glad I put in all that work because calculus shows up more than I expected. There are equations for modeling enzyme reactions, for bacteria growth under the influence of different environmental features. I've seen those in my classes. And it seems like calculus can be applied to most kinds of research, including the kind of research I want to do on the gut microbiome and diet.

- *Carmen, age 21, major: Microbiology*

- Which quote did you like the most? Why?
- What would you tell future students about how what you're learning in calculus relates to your life?

Assignment Responses

- I don't think anyone from the beginning willingly takes calculus with the intent of enjoying it, save for the very few exceptional students who love math. Calculus has a sort of stigma in high school as the peak of the challenge math has to offer: pages and pages of formulas for just one question. After actually experiencing calculus, safe to say my perspective has changed dramatically: in every chapter we're given real-world examples, whether it be populations to red blood cell counts to finding the areas of complex shapes. Furthermore, the work is hardly the massive spike I feared and is more a transition (but still a challenge) from the math we've already learned in prior semesters. Calculus may be a difficulty spike, but along with it comes multiple opportunities to realize why math actually matters in this world.
- So I never considered myself a math person but as you go through and put the work in not only does it get easier, it also gets interesting seeing how can use a simple formula to solve a big problem. The majority of our lives we will continue to use math daily to solve a simple problem such as finding the average price of a certain candy bar or you may pick a career that requires lots of math. I find myself having an easier time in chemistry because of the math that I've learned in calculus so that's a plus.

Impact of UV Interventions on Student Grades

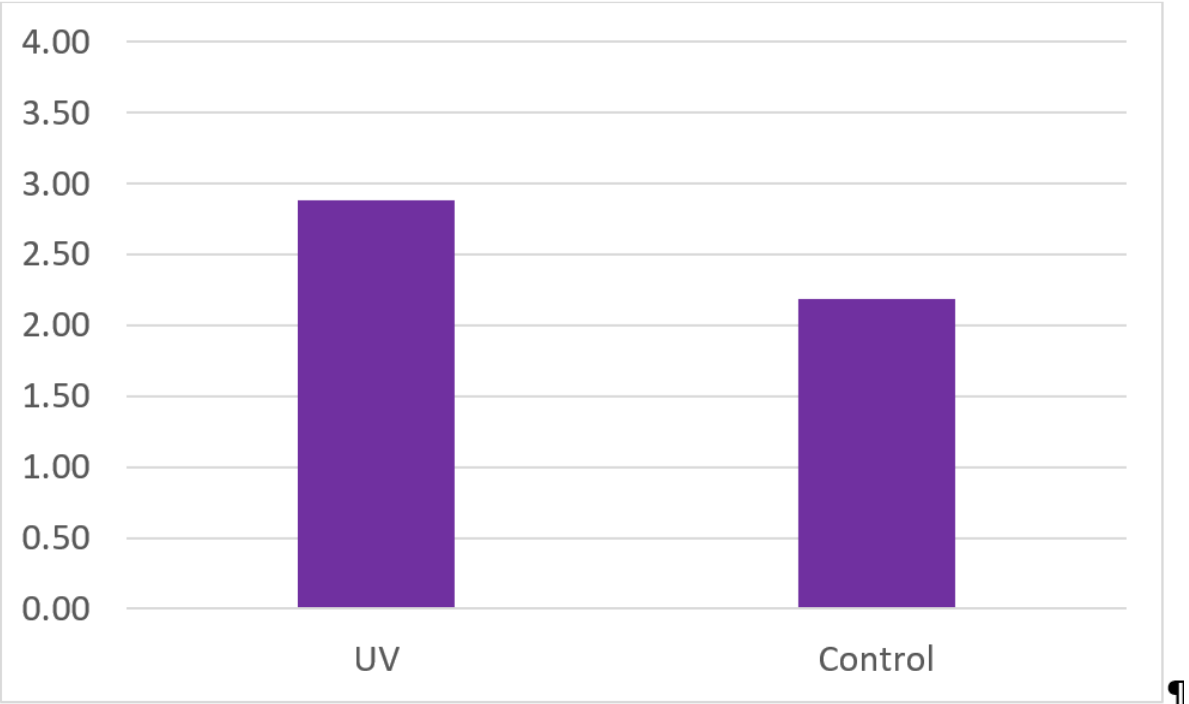


Figure 2. Grade average for students receiving utility value intervention vs. control group.

CSUN Math 255A completed three utility value assignments in Spring 2022. The plot shows average course grade among students receiving utility value and control interventions.

Equity Gap In Calculus for Life Sciences at CSUN

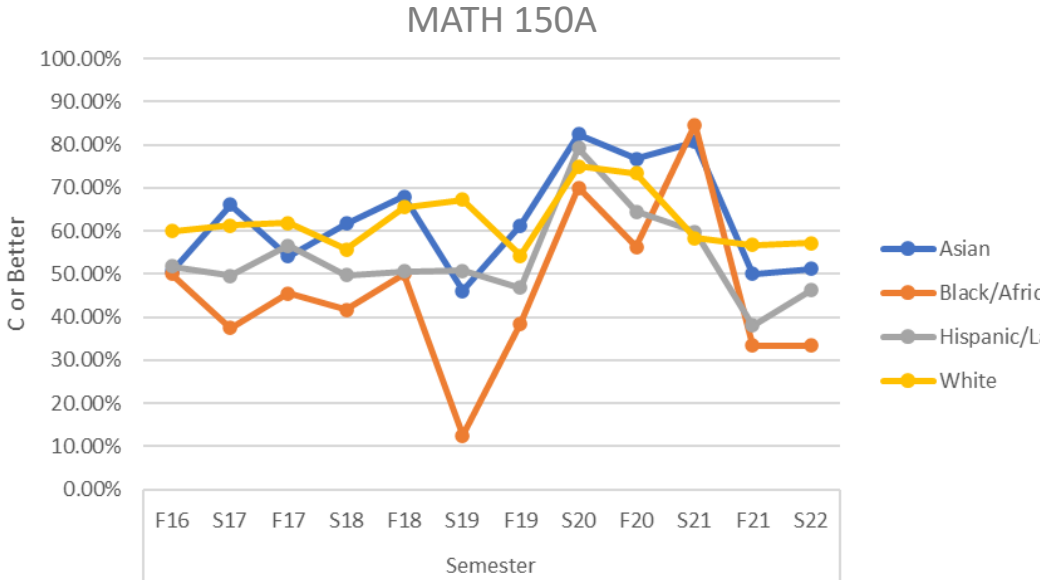


Figure 5. Historical passing rates in Math 150A Calculus

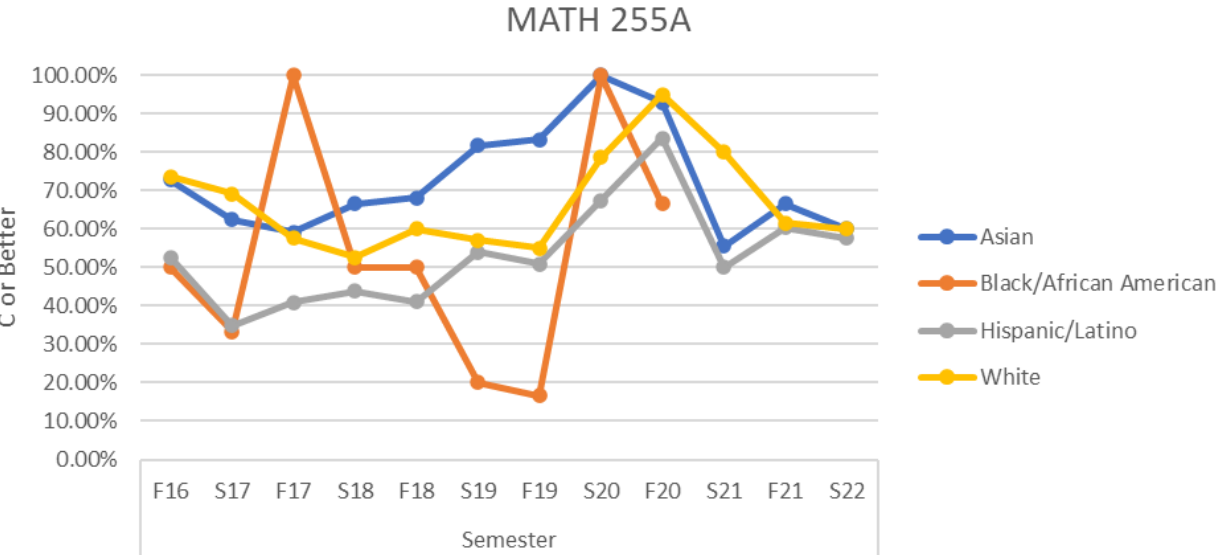


Figure 6. Historical passing rates in Math 255A Calculus for Life Sciences.

Challenges

Articulation

Recruitment

Student buy-in

Special populations

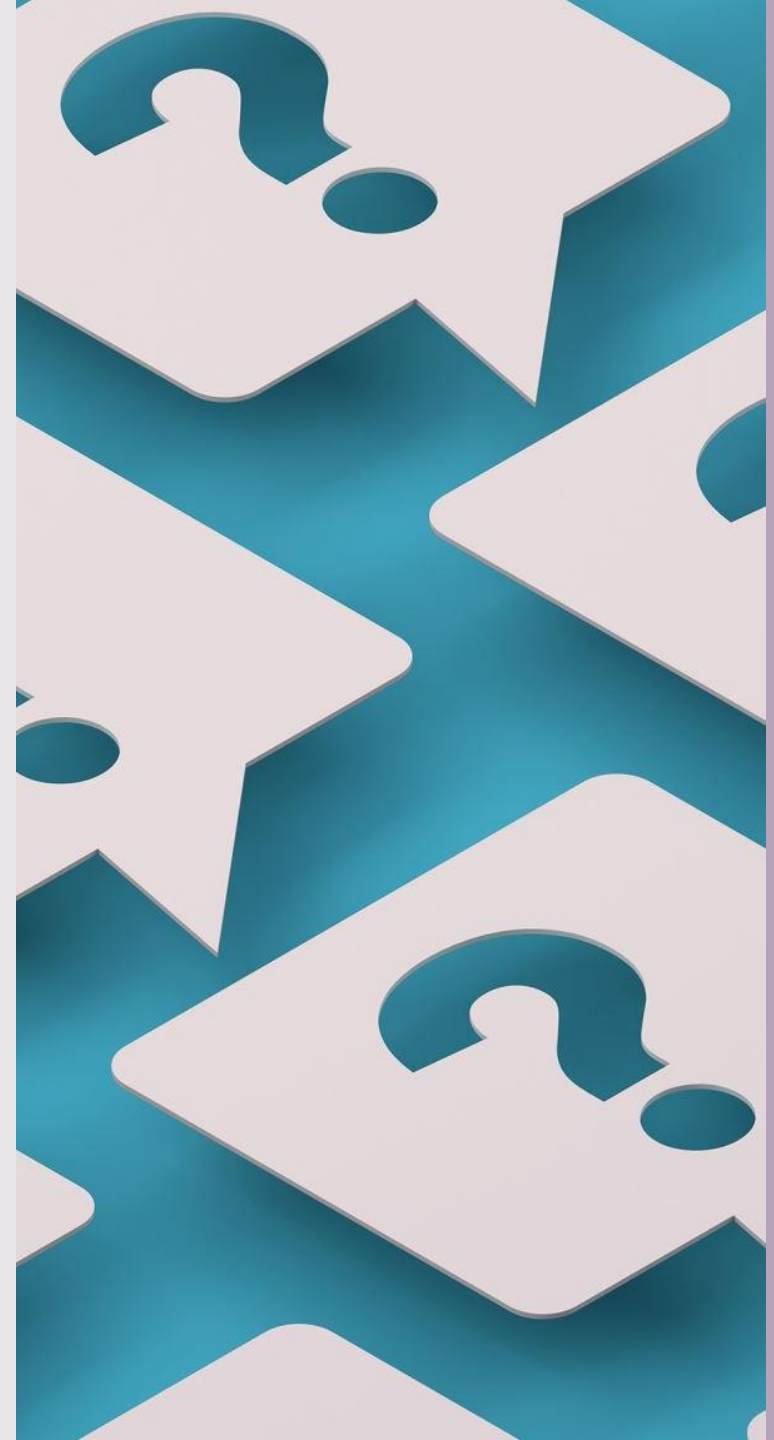


Questions or Comments?

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Thank you