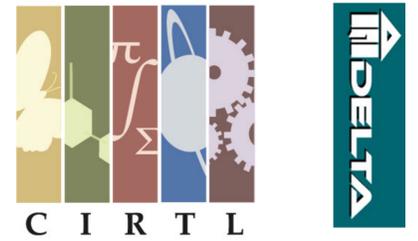




# Impacts of *case-based learning* course style on biology undergraduates' performance within minority and non-minority demographics

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## Background and Introduction

- Traditional lecture formats have been shown to be less effective than active learning formats, particularly among underrepresented minorities (URMs), possibly contributing to the so called "Achievement Gap", or underperformance of URM students as compared to non-URMs (1).
- Case-based learning (CBL) is a form of active learning in which students collaboratively address problems raised by a "case", which is typically a short topical story describing a conflict, mystery, or controversy. CBL has been considered a promising teaching approach to help overcome barriers rooted in cultural and preparatory differences (2).

(1) Chamany, K., Allen, D., and Tanner, K. (2008). Making biology learning relevant to students: Integrating people, history, and context into (college) biology teaching. *CBE Life Sci. Educ.* 7, 267-278.  
(2) Knight et al 2008. Investigative Cases and Student Outcomes in an Upper-Division Cell and Molecular Biology Laboratory Course at a Minority-serving Institution. *CBE Life Science Education.* (7) 382-393

## Greater enrollment proportion of URM students in case-based learning alternative than traditional lecture

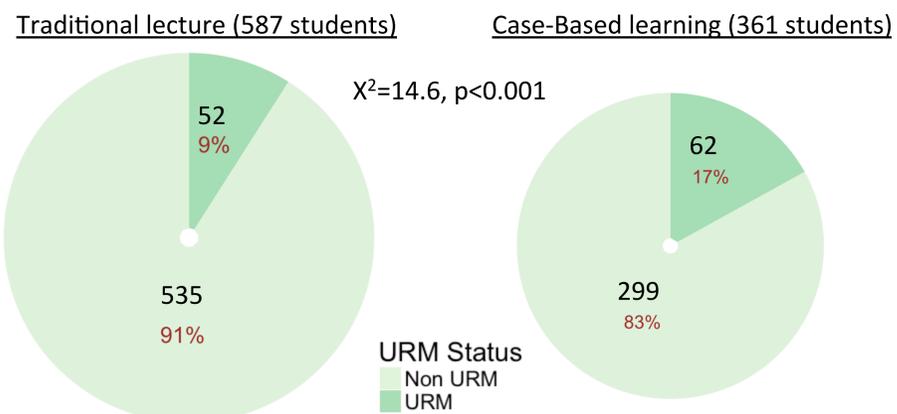


Figure 1. Enrollment in traditional lecture (N=639) and case-based learning alternative (N=423). Data pooled across Spring 2015 and 2016 semesters.

## Methods

- We collected data (course performance as well as demographic information reported to the university) for students in BIO 152, the second semester Introductory Biology sequence course.
- Data are pooled across two semesters for which the case-based learning alternative was offered (Spring 2015 and Spring 2016).
- We assessed performance outcomes (final course grade and grades for aspects of the Independent Project) between traditional lecture students and students in the case-based learning alternative and focused on impacts both within and across URM and non-URM students.

## Results and Conclusions

- Enrollment of URM students was proportional higher for the case-based learning alternative as compared to traditional lecture (Figure 1). Interestingly, this was observed for both semesters despite students being 'blind' to course type during registration in 2015.
- An achievement gap was observed for course formats, but was diminished for the case-based learning alternative (Figure 2). Consistent with national findings, URMs students underperformed compared to non-URM students, and this effect remained statistically significant (p values<0.001) even when statistically controlling for parent income level, despite a drop in sample size (709 of 948 students reported income).
- Improvement of oral presentation (but not paper or project) grades for case-based learning students (Figure 3). Possible explanation: Students gave biweekly oral presentations in the case based learning whereas traditional lecture students had limited opportunities. However, effect was not observed when examined within URM students only (N=114, p=0.38).
- ACT scores differentially predict student success across course type and student demographic. Among non-URM students in traditional lecture, course grade is positively predicted by ACT scores across the board, whereas only ACT English arises as a predictor for URM students in case-based learning, particularly for the Independent Paper and Project.

## Lower discrepancy in final course grades between URM and Non-URM students in the case-based section than in traditional lecture

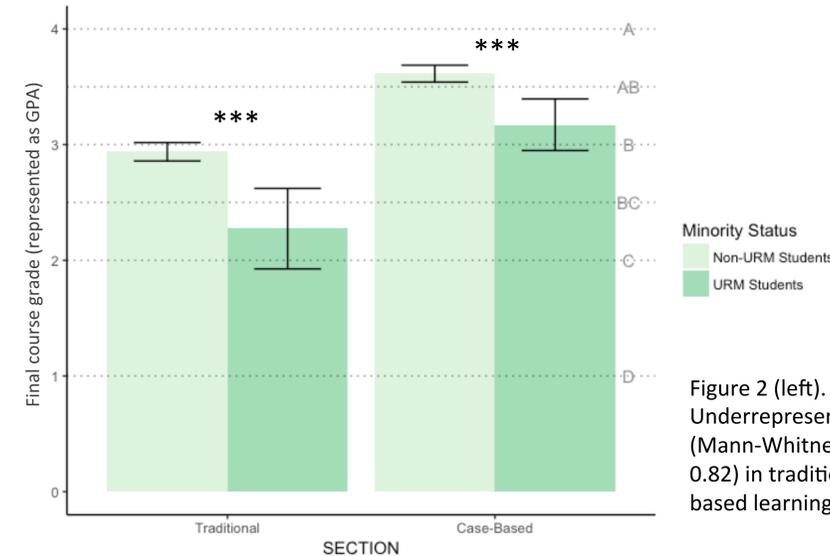


Figure 2 (left). Final course grades (mean +/- st. error) in traditional lecture and case-based-learning alternative. Underrepresented minority students show lower final grades than non-URM students across both formats (Mann-Whitney U tests, p values < 0.001). However, mean grade ranges from B to C (Cohen's D effect size= 0.82) in traditional lecture whereas mean grade ranges from AB to B (Cohen's D effect size= 0.72) in case-based learning alternative.

## Traditional lecture

	ACT		
	English	Math	Science
Presentation	0.122	-0.051	0.017
Final Paper	0.078	0.019	-0.030
Project total	0.100	0.028	-0.014
Course Grade	<b>0.270</b>	<b>0.241</b>	<b>0.243</b>

## Case-Based learning

	ACT		
	English	Math	Science
Presentation	0.006	0.051	-0.049
Final Paper	0.052	0.075	-0.033
Project total	0.076	0.085	-0.036
Course Grade	<b>0.267</b>	0.150	0.060

## Traditional lecture

	ACT		
	English	Math	Science
Presentation	0.163	0.231	0.292
Final Paper	0.171	0.142	0.210
Project total	0.192	0.146	0.157
Course Grade	0.311	<b>0.515</b>	0.342

## Case-Based learning

	ACT		
	English	Math	Science
Presentation	0.019	-0.112	-0.130
Final Paper	<b>0.456</b>	0.082	0.119
Project total	<b>0.390</b>	0.002	0.080
Course Grade	0.331	0.123	0.010

Table 1. Correlation coefficients (Spearman r) for ACT test scores and aspects of Bio 152 grades. Bolded if significant after Bonferroni correction (alpha=0.004). Course grade predicted by ACT scores for non-URM students in traditional lecture, whereas ACT English predicts URM student Independent Project/Paper in the case-based learning alternative.

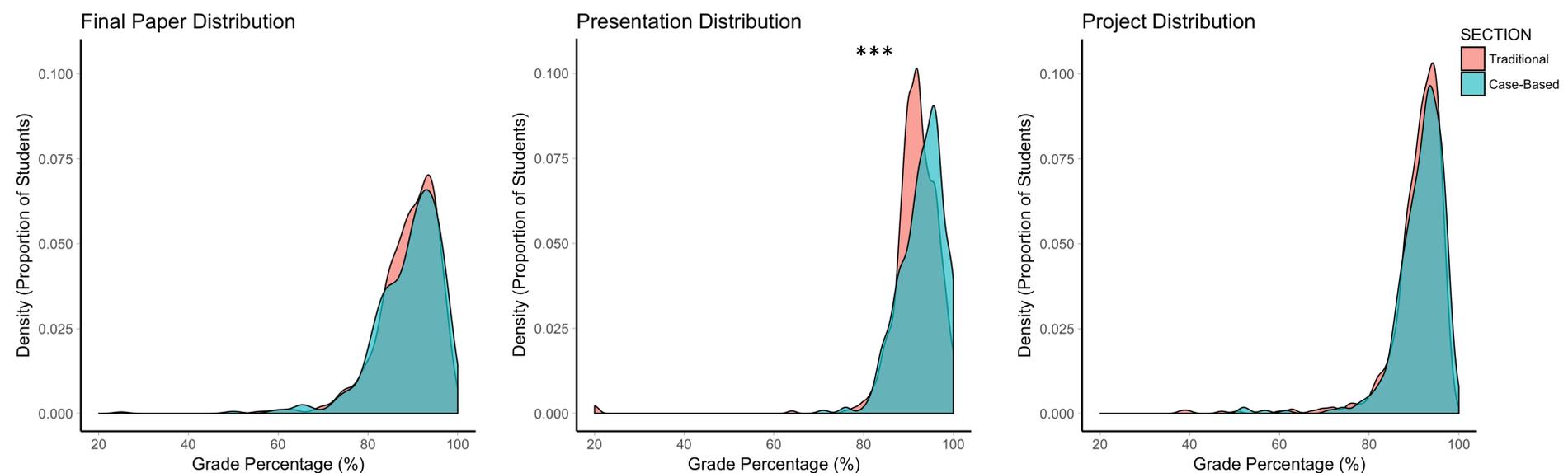


Figure 3. Higher Independent Project Presentation grades (middle) by students in the Case-Based Learning alternative (N<sub>CB</sub>=361) than students in traditional lecture (N<sub>T</sub>=587). Mann Whitney Z=4.40, p<0.001. IP Paper grades (left) and IP Project grades (right) did not differ across Case-Based Learning and Traditional lecture sections (p>0.05).