New Perspectives in Science Education

MEDGAR EVERS COLLEGE
THE CITY UNIVERSITY OF NEW YORK

Learning Lessons: Differences in Student Performance in Analytical Problems in Remote Learning vs In-person Learning of a Biochemistry Course

HARSHA RAJAPAKSE, PHD
MEDGAR EVERS COLLEGE, CUNY, NY, USA

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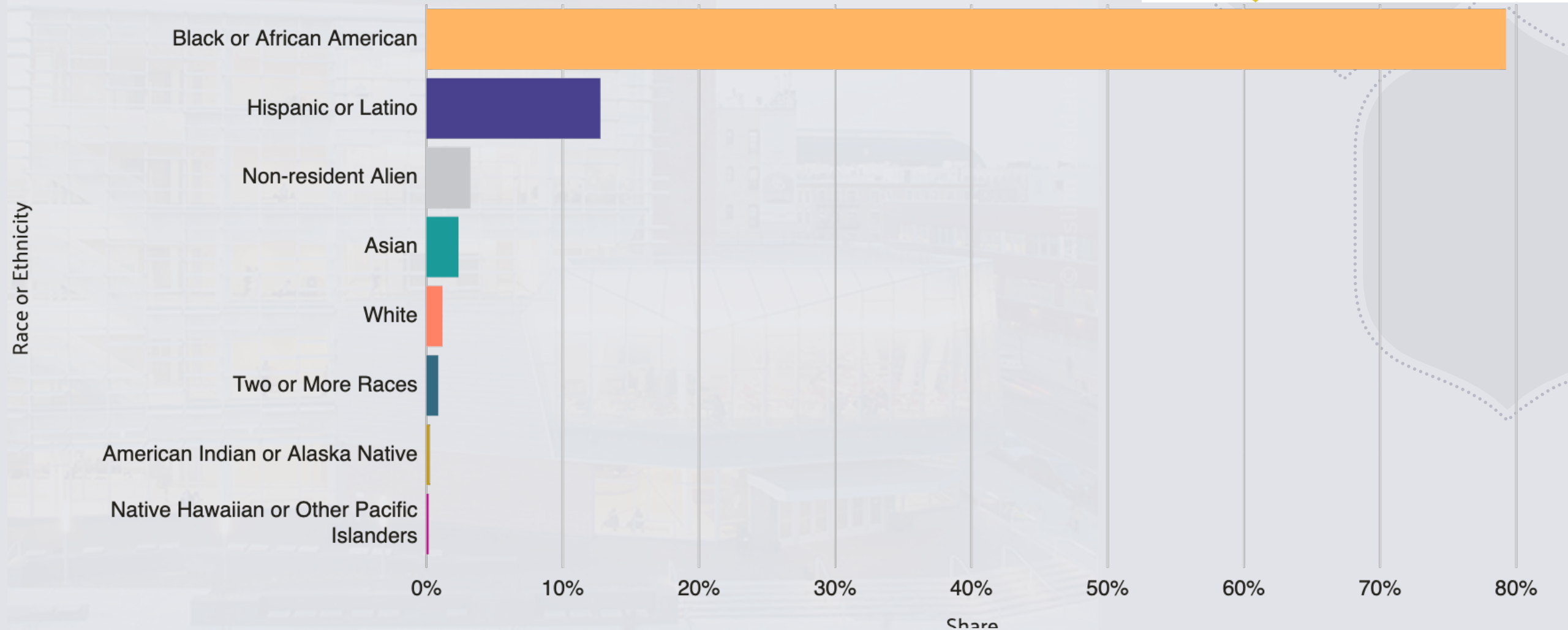

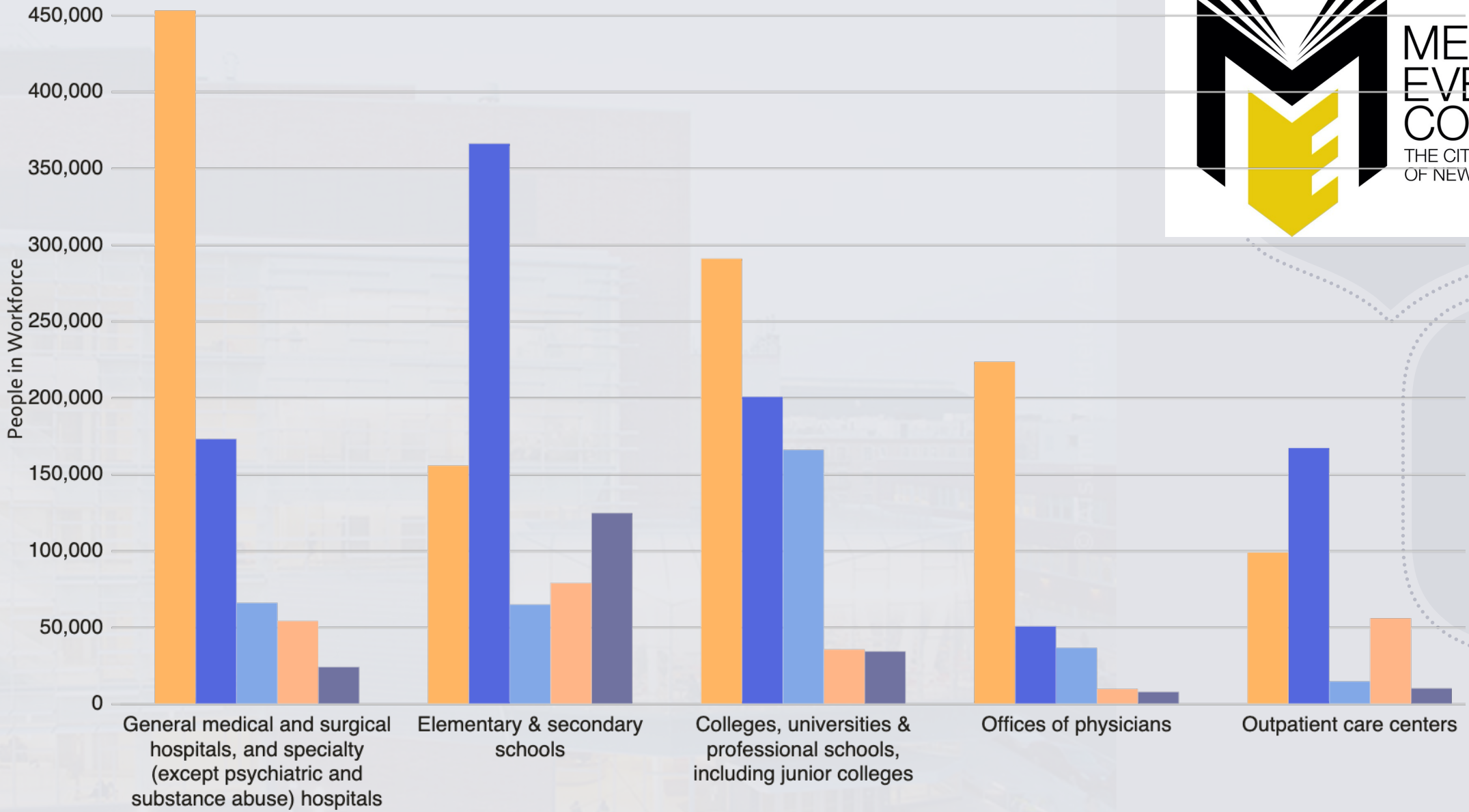

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2014 2015 2016 2017 2018 2019

Biochemistry CHM341/ CHML341

- 4-Credit course
- Offered every semester, 35-40 students per semester
- This course concerning the chemical characteristics of living matter.
- Covered topics: General concepts of the cell, biomolecules, carbohydrates, amino acids, peptides, protein structure and function, lipids, enzymes, nucleic acids, cellular mechanisms.
- Laboratory studies include modern experimental and research techniques in Biochemistry

Research Question ?

- **Does student performance in answering analytical questions get affected by instructional modality?**

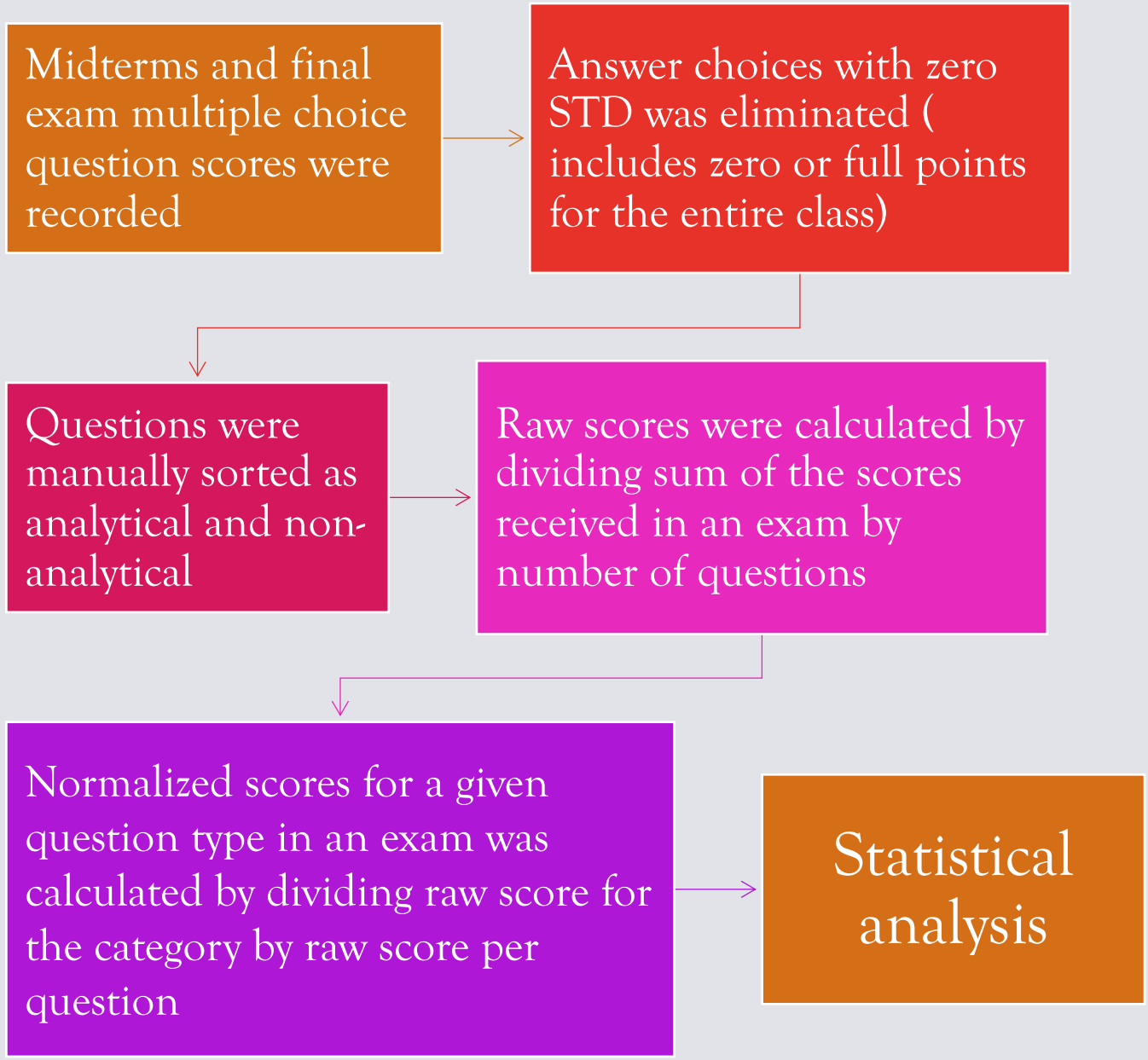
- Compare in-person vs online

Study sample:

- Total of 205 participants; 97 in-person students (Fall 2018, Spring 2019 and Fall 2019) and 108 online students (Fall 2020, Spring 2021, and Fall 2021), who completed the Biochemistry (CHM341)
- Three mid-semester exams, and the final exam
- 22372 in-person responses and 13223 online responses were analyzed.
- The normalized score of the analytical problems and the non-analytical problems of the participants from in-person instruction and online instruction served as the primary comparative factor in assessing performance differences between online and in-person students.

Data collection and processing

Student performance was quantified and compared in in-person and online modalities based on students' normalized average score per analytical question and normalized average score per analytical question.



Conditions and assumptions:

Every student was given the same opportunity to learn ,

- All sections of the course were taught by a full-time biochemistry professor at Medgar Evers College.
- The same number of contact hours and office hours

  Textbook learning, open educational resources (OER), PowerPoint notes, lectures, class discussions, and assessment tasks to engage students in the learning process in both modalities.
- No special preferences or weights were given to students based upon gender or rank.
- Each student's separate answer choices were considered a single, discrete entity or statistic.
- This study did not differentiate between male and female students, part-time and full-time students or non-transfer and transfer students.

Cont.....Conditions and assumptions:

Normalizing the scores to their own general performance eliminate any conditional differences ,

- Possible differences due to other variables were minimized using normalizing.

Such as, increased stress due to financial problems, limited access to technology, lack of technical knowledge, dealing with family responsibilities

- The two modalities used different criteria for test taking

Online students had access to more resources than in-person students. In-person students were actively proctored

- Some students received extra attempts to make up exams due to unexpected technical difficulties (ex: internet re-set)

The picture can't be displayed.

Analytical questions.....?

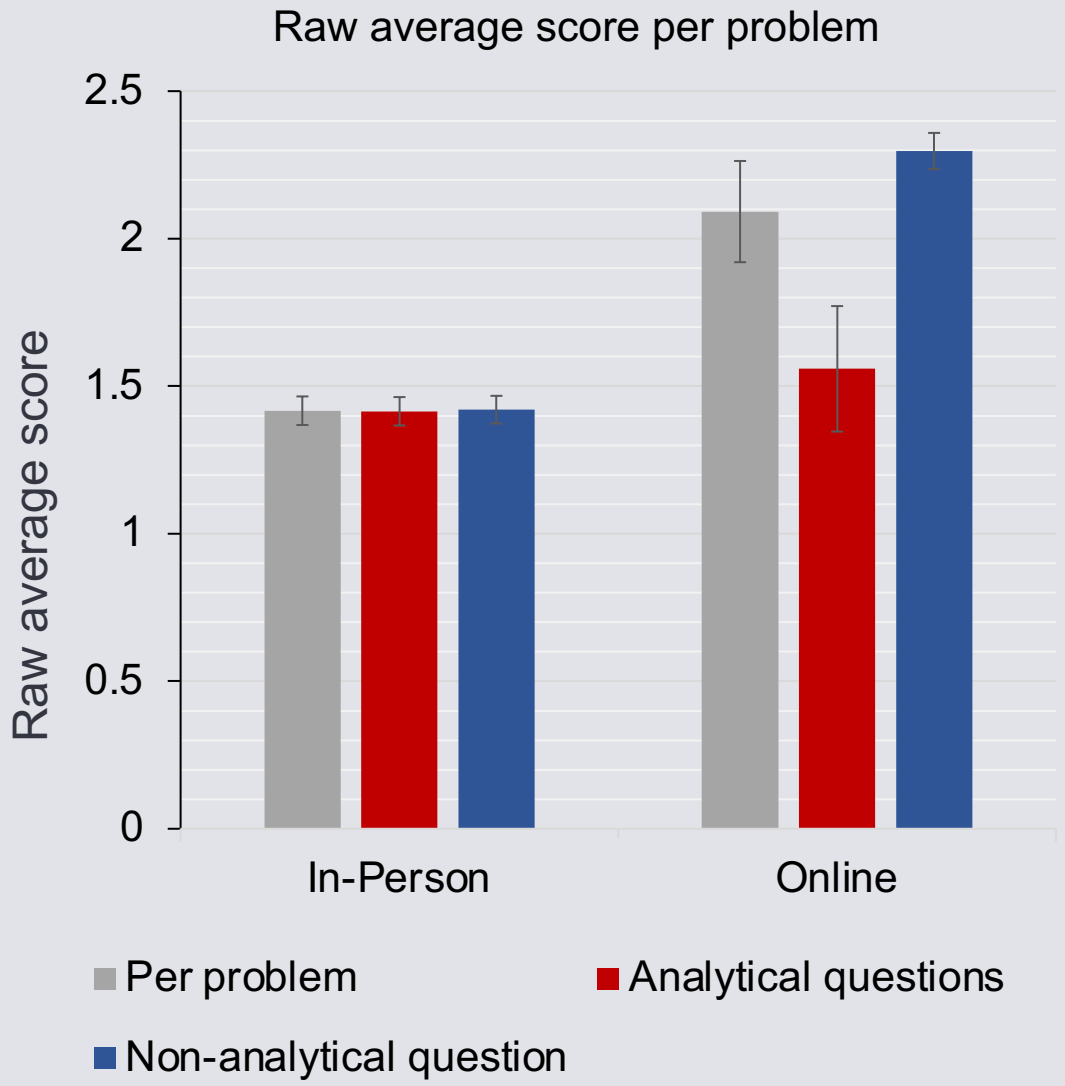
Can you answer that question directly by what is written or mentioned in the lecture, or can be answered by a web search? → non-analytical question

All the other questions → analytical questions.

Analytical questions	Non-analytical questions
Which one of the following sequences result three fragments upon treatment with Chymotrypsin? *I. Tyr- Phe- Met-Lys-Val* *II. Phe-Met-Lys-Val-Tyr* *III. Met-Lys-Val-Tyr-Phe* a. I only b. II only c. I and II only d. II and III only	Buffering capacity refers to, a. the effectiveness of commercial antacids b. the extent to which a buffer solution can counteract the effect of added acid or base c. the pH of a buffer solution d. the molecular weight of the substance used as a buffer
Which two amino acids could participate in H-bonding via R groups within a tertiary structure of a protein? a. Val and Lys b. Tyr and Thr c. Leu and Asp d. Met and Arg	Most of the protein synthesis occurs in the, a. Nucleolus b. mitochondria c. cytoplasm d. smooth endoplasmic reticulum
Carbonic anhydrase has two substrates, carbon dioxide and bicarbonate, which are both converted to carbonic acid. Kinetic data for each is given below. While determining the kinetics of HCO_3^- as a substrate, how would the addition of CO_2 effect the reaction if the rate were measured by the disappearance of bicarbonate? *Substrate* | *Km (mM)* | *Kcat (sec-1)* | *Kcat/Km (m M-1sec-1)* CO_2 | 12 | 1×10^6 | 8.3×10^4 HCO_3^- | 26 | 4×10^5 | 1.5×10^4 a. CO_2 would increase the activity of the enzyme b. CO_2 would cause an apparent decrease in the Km for HCO_3^- c. CO_2 would act as a noncompetitive inhibitor d. CO_2 would act as a competitive inhibitor	A transaldolase is an enzyme that catalyzes: a. transfers of three-carbon units from a ketose to an aldose b. isomerization of ketoses into aldoses such as the conversion of ribulose-5-phosphate to ribose-5-phosphate c. epimerization of ketoses such as the conversion of xylulose-5-phosphate into ribulose-5-phosphate d. TPP-dependent transfer of 2-carbon units to the recipient aldose

Online students earned higher overall scores

- Unnormalized scores demonstrate a significantly higher score per problem in online education compared to in-person [$t(22) = 2.07$, $p < 0.05$]
- No significant difference in raw average scores of analytical questions and non-analytical questions in in-person modality
- There is a significant difference in raw average scores of analytical questions and non-analytical questions in in-person modality



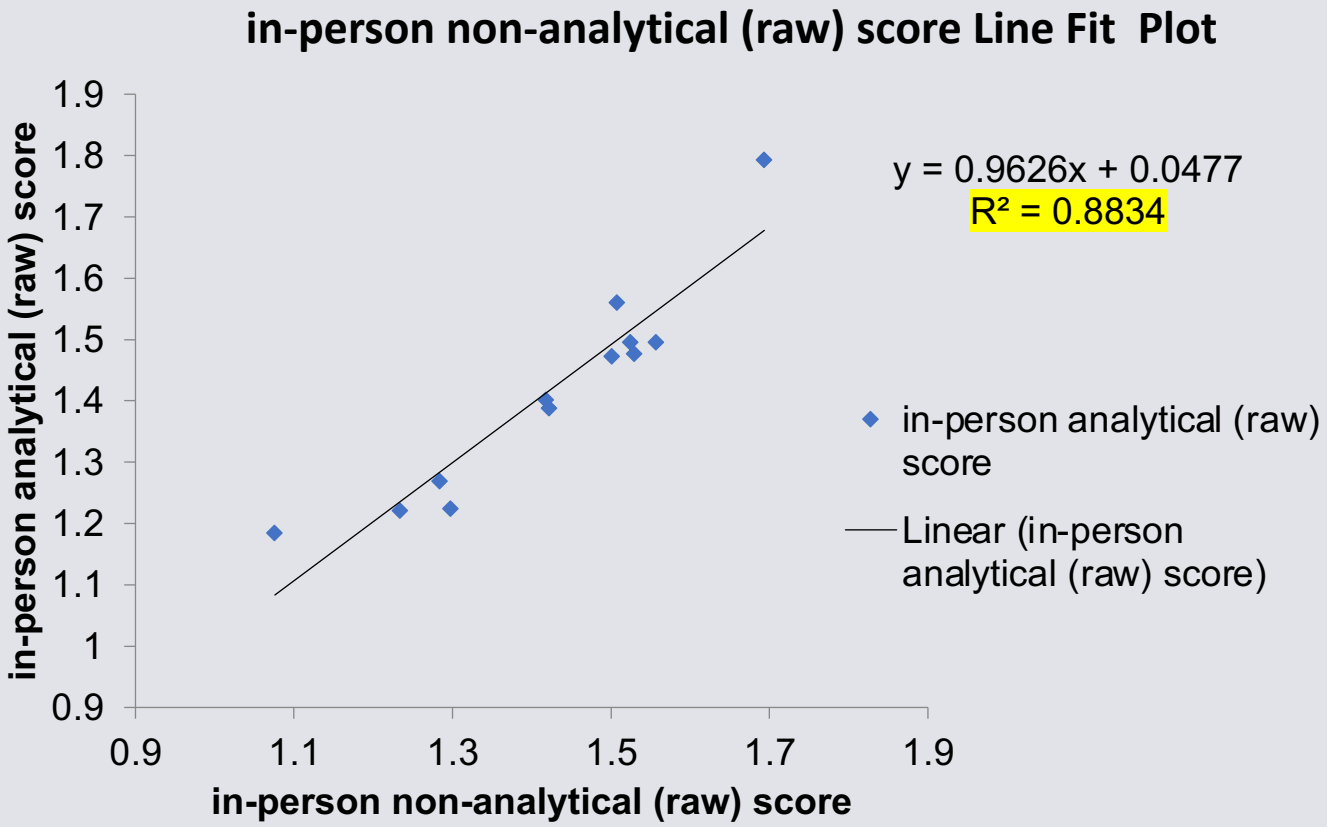
There is a significant difference between normalized average scores of analytical questions and non-analytical questions in online students

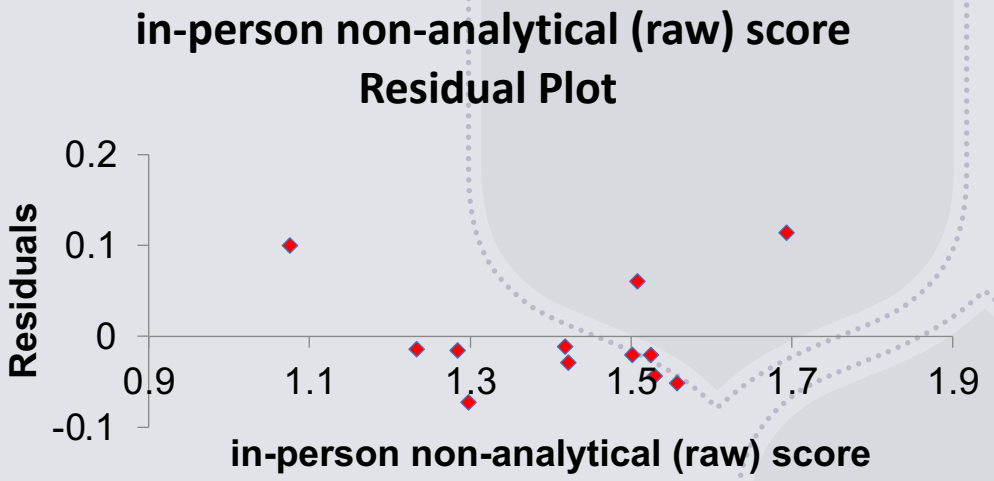
The independent sample t-test showed no significant difference in average student scores between analytical questions and non-analytical questions in in-person modality [$t(22) = 2.07$, $p = 0.7$].

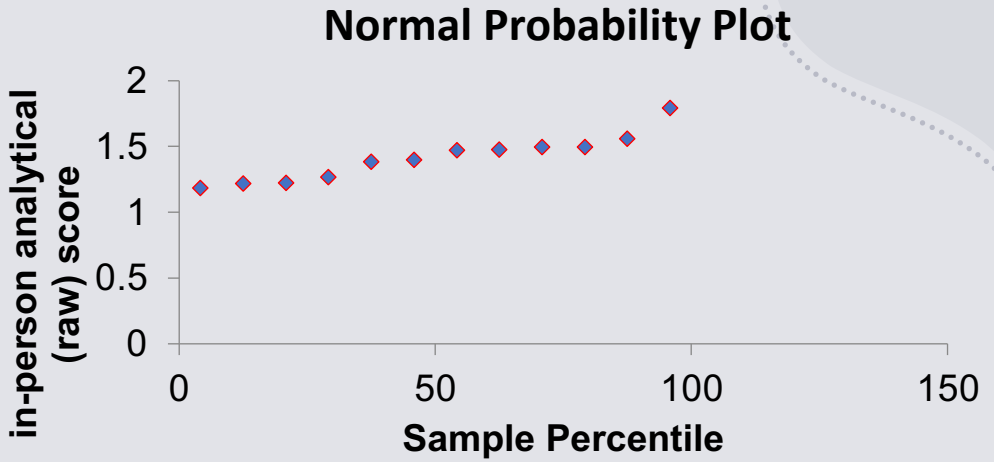
The independent sample t-test showed a significant difference in average student scores between analytical questions and non-analytical questions in online modality [$t(20) = 2.09$, $p < 0.001$].

	in-person analytical	in-person non-analytical	online analytical	online non-analytical
Mean	0.999	1.002	0.705	1.109
Variance	0.001	2.180E-04	0.043	0.004
Observations	12	12	11	11
df	22		20	
P(T<=t) two-tail	0.732	Non-significant	*5.008E-06	* Significant
t Critical two-tail	2.074		2.086	

In-person students showed an excellent performance correlation between their scores of analytical and non-analytical questions







In-person students showed an excellent performance correlation between their scores of analytical and non-analytical questions

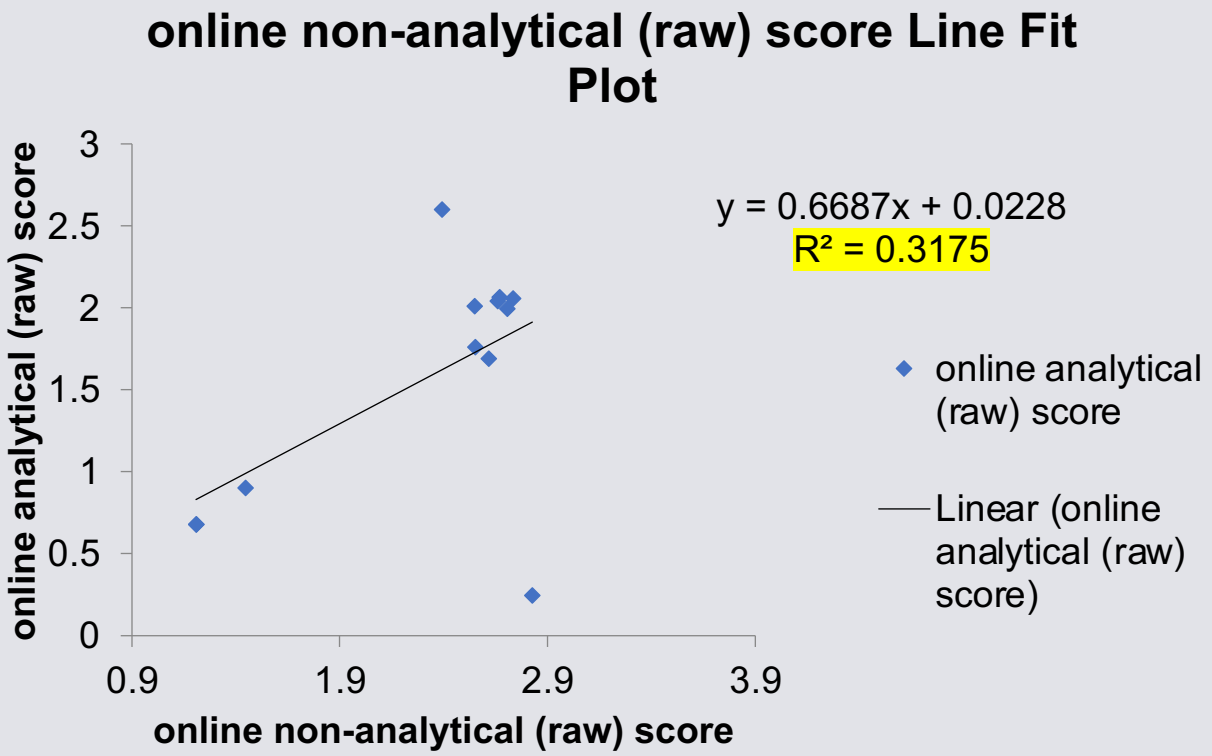
Regression Statistics	
Multiple R	0.94
R Square	0.88
Adjusted R Square	0.87
Standard Error	0.06
Observations	12.00

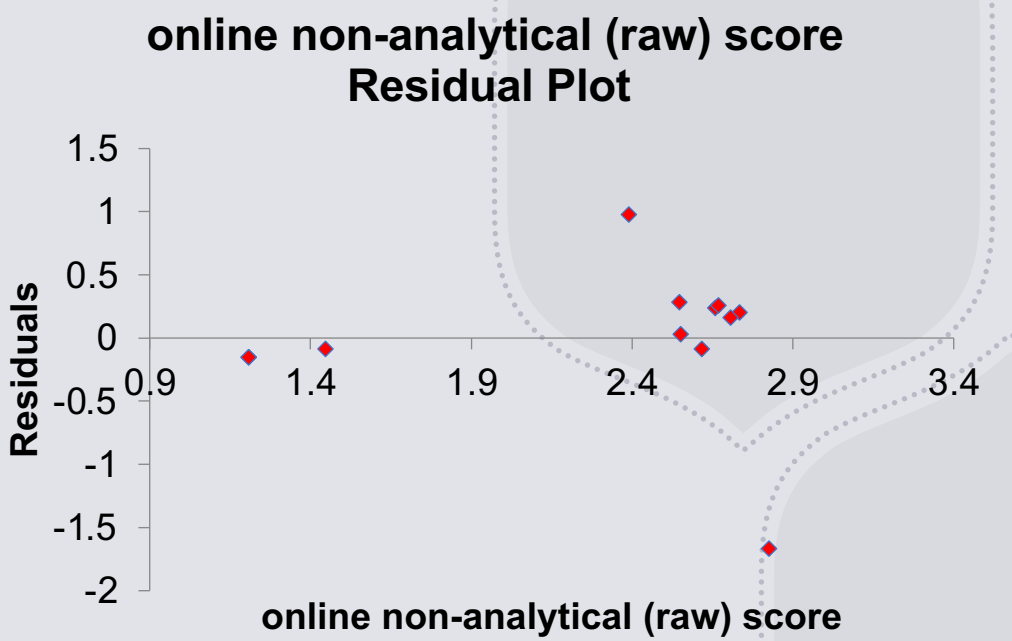
Pearson Correlation factor = 0.94

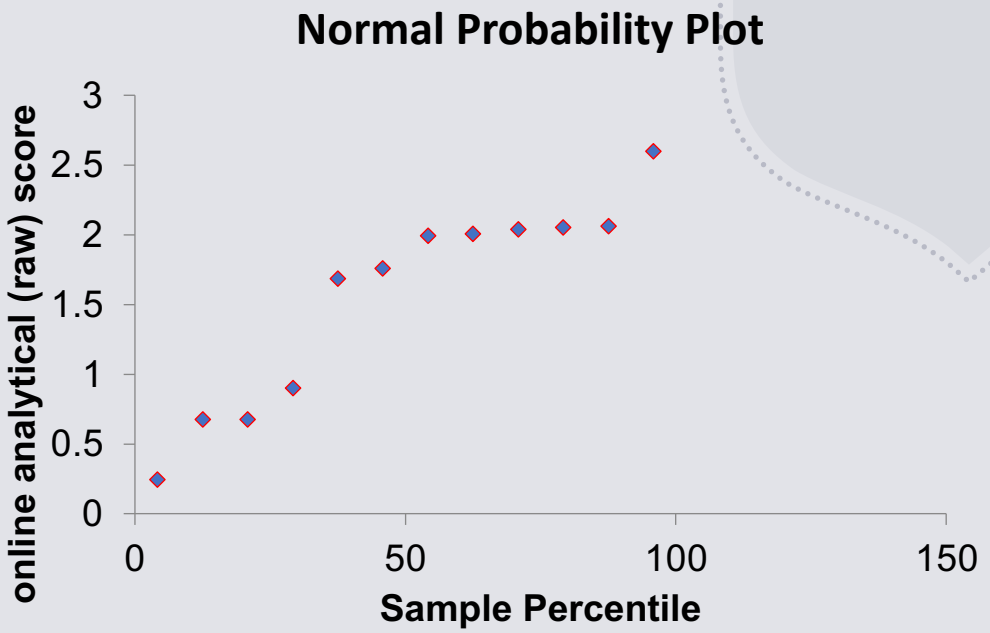
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.00	0.29	0.29	75.74	5.5896E-06
Residual	10.00	0.04	0.00		
Total	11.00	0.33			

Online students showed a poor performance correlation between their scores of analytical and non-analytical questions







Online students showed a poor performance correlation between their scores of analytical and non-analytical questions

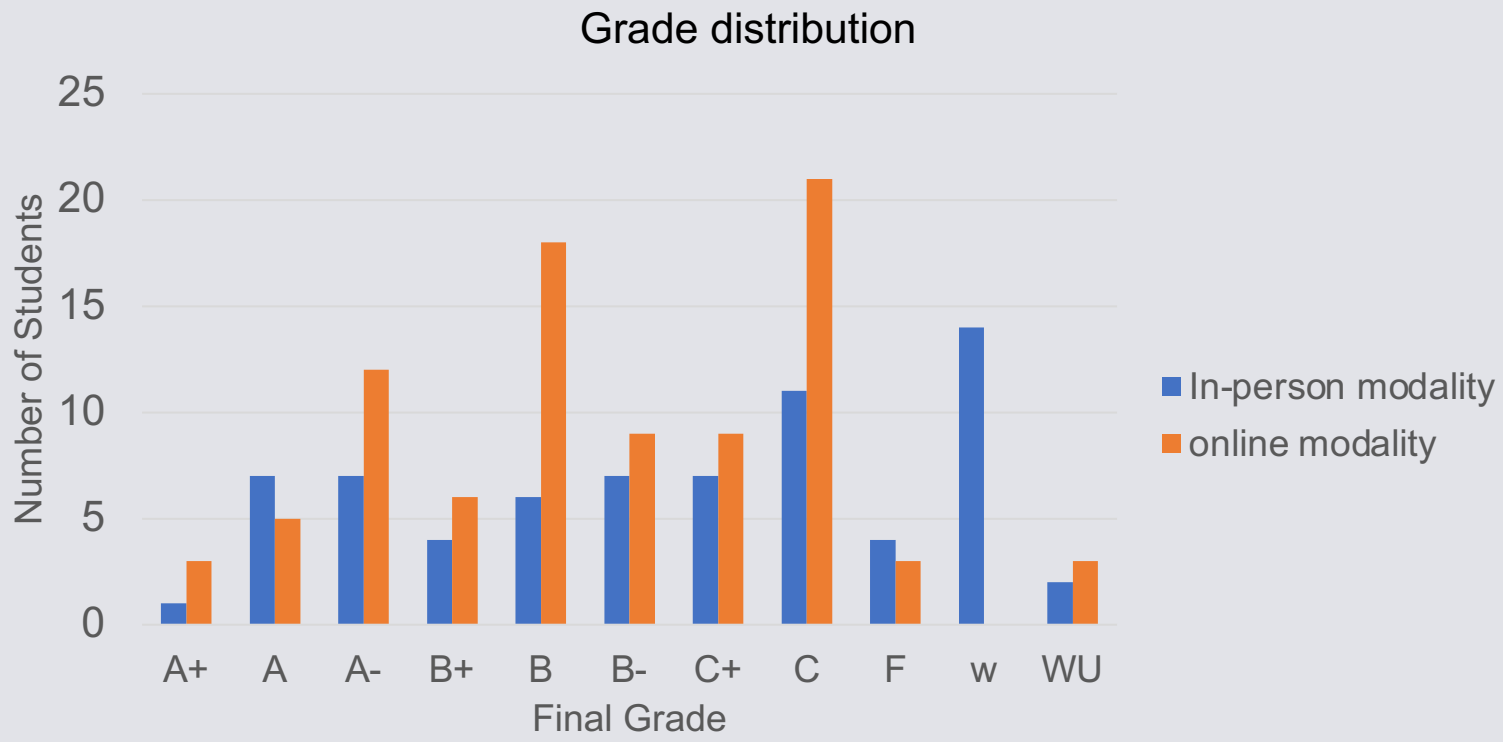
Regression Statistics	
Multiple R	0.56
R Square	0.32
Adjusted R Square	0.25
Standard Error	0.64
Observations	12.00

Pearson Correlation factor = 0.56

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1.00	1.90	1.90	4.65	0.06
Residual	10.00	4.08	0.41		NOT significant
Total	11.00	5.97			

Final grade distribution was significantly different in two modalities

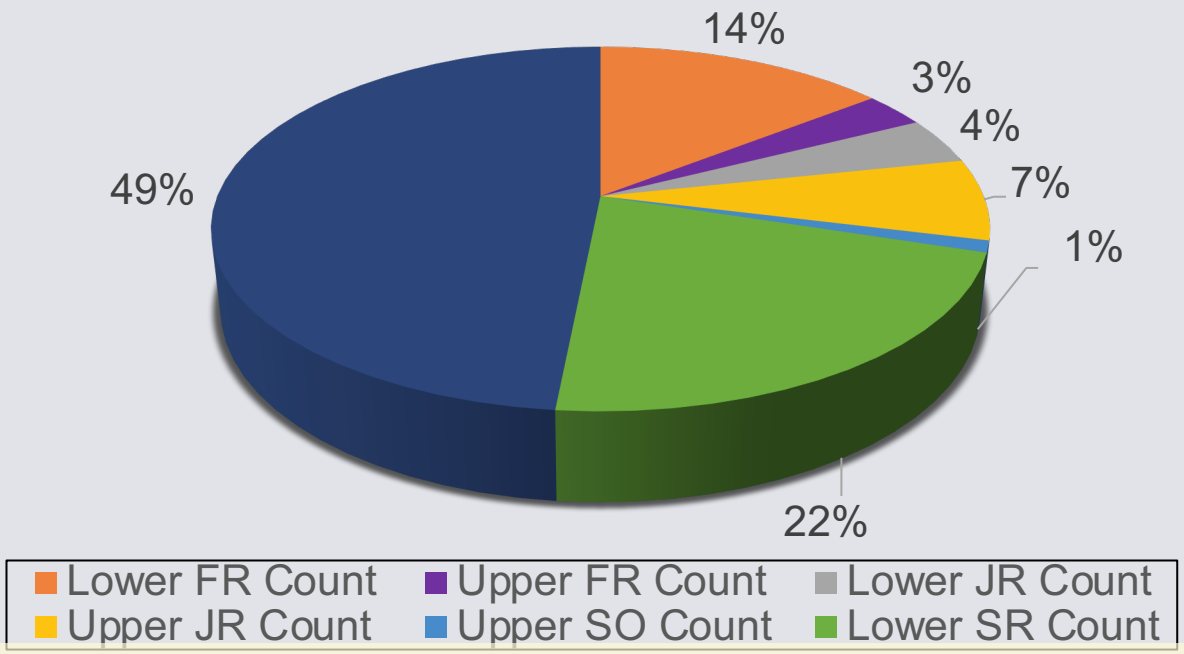


	% students with the grade	
	in-person	*online*
A+	1.43	3.37
A	10.00	5.62
A-	10.00	13.48
B+	5.71	6.74
B	8.57	20.22
B-	10.00	10.11
C+	10.00	10.11
C	15.71	23.60
F	5.71	3.37
W	20.00	0.00
WU	2.86	3.37

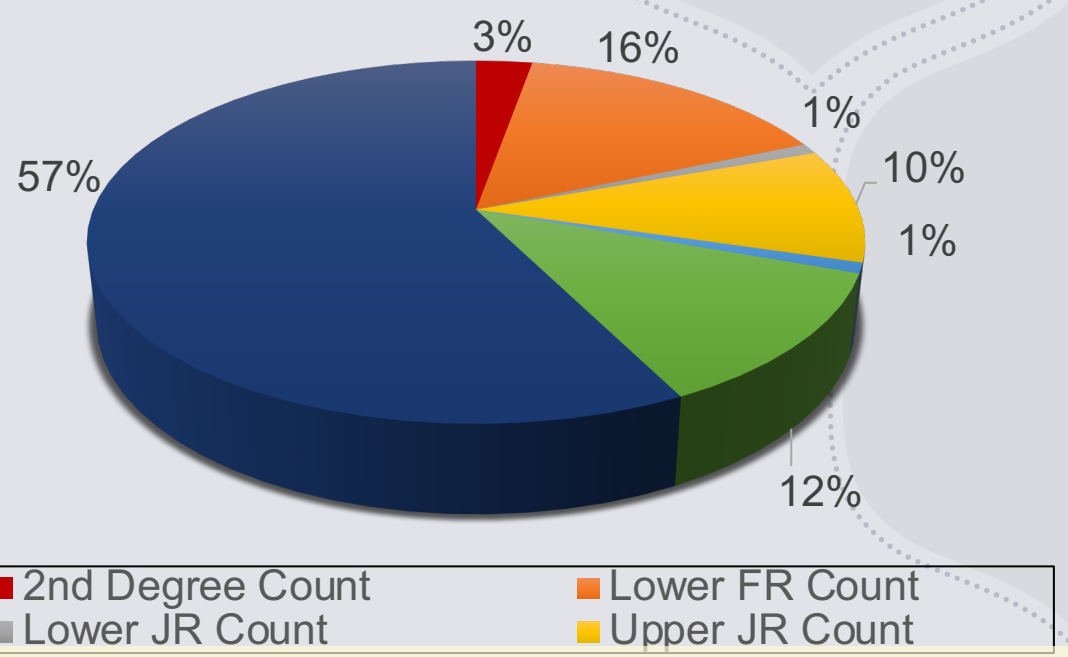
*Two grade distributions are significantly different , $\chi 2 = 29.56$, $df = 10$, $p=0.001$

Online and in-person student composition by academic level was comparable

In-person Student Composition by Academic Level



Online Student Composition by Academic Level



% In-person lower and upper junior, senior and second degree combined = 81.44%
% online lower and upper junior, senior and second degree combined = 83.33%

The two percentages were not significantly different. (Probability attached to the difference in percentages, z= 0.355, 2-sided P= 0.76)

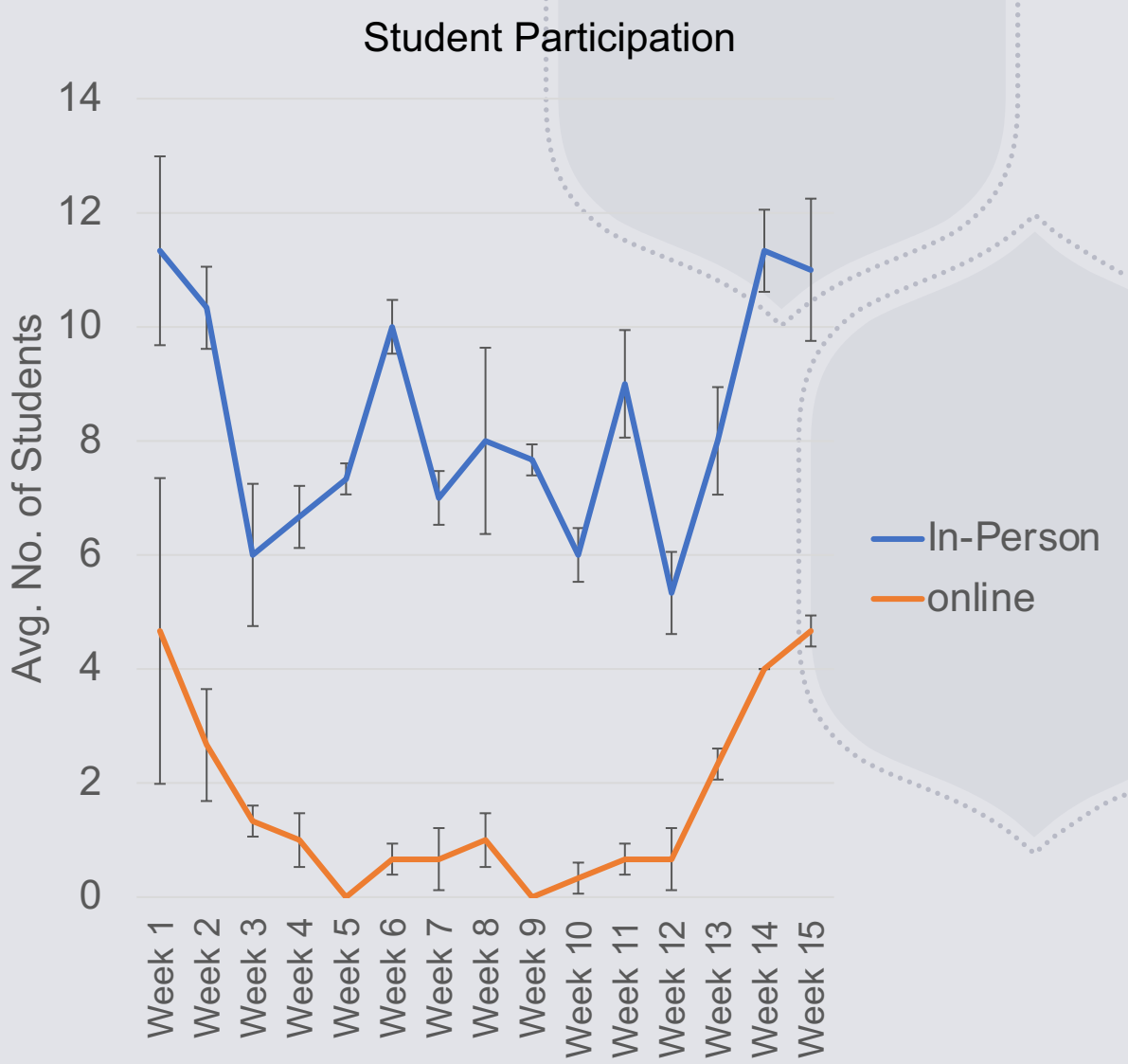
Student participation followed the same pattern in both online and in-person, but the number of students participated were significantly different

- The pattern of student participation by week was not significantly different

  ($\chi 2 = 11.07$, $df = 14$, $p = 0.68$)

- The number of students participated is significantly different

  ($t\ (449)$, $p = 1.17 * 10^{-10}$)



Conclusions:

- **Does student performance in answering analytical questions get affected by instructional modality?**

There is a significant difference between normalized average scores of analytical questions and non-analytical questions in online students

The independent sample t-test showed a significant difference in average student scores between analytical questions and non-analytical questions [$t(20) = 2.09$, $p < 0.001$] while there was no significant difference in average student scores between analytical questions and non-analytical questions [$t(22) = 2.07$, $p = 0.7$].

In-person students showed an excellent performance correlation between their scores of analytical and non-analytical questions

Online students showed a poor performance correlation between their scores of analytical and non-analytical questions

Final grade distribution was significantly different in two modalities

Limitations:

The assumptions are not 100% true

This study investigated the differences in students average scores for analytical questions and non-analytical questions. What about cheating while no proctoring the exams?

The study was done using Biochemistry CHM341 data only and this could preclude the generalization of our results.

Subsequent studies should include students enrolled in multiple courses and universities to achieve an accurate representation.

Thank you!

New Perspectives in Science Education

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All the participants in the study who are my former students