Edwin Tse

David Arnold

ECON/POLI 5

University of California, San Diego

Winter 2021

13 March 2022

Final Project: How remote learning due to COVID-19 affects students' academic performance.

Abstract

This report showcased the effects of online learning during the pandemic for UC San Diego. The report finds out that the GPA has risen significantly, alongside other key factors such as satisfaction rates, when compared between the previous quarter and the pandemic quarters. Though the key variables of the data also change significantly, the variables are likely just confounding factors when comparing to external factors. Thus, this report may not be able conclude the general trend of online learning and how would online learning affect students in the future.

Introduction

Since 2020, COVID-19 has changed our lives, college students are not an exemption of this rule. One of the most profound changes is that the learning experience of most college has changed from face-to-face to become fully remote learning. Some students have been struggling with this new instruction method, and some student believed that this new learning method has been beneficial for them and created a "GPA inflation." The trend to online learning is not a change that is unexpected, however, as according to data, the trend of online learning has constantly on been the rise well-dated before the pandemic (Gallagher and Palmer). However, the pandemic undeniably accelerated the trend, as online learning has essentially become the only way possible to learn in the heights of the pandemic. This abrupted change is the focus of this report would like to investigate.

Among the United States, after Fall 2021, in-person lectures have since resumed in most colleges, albeit, with strong precaution (Hess). Therefore, it would be interesting to see whether there is a significant difference in academic results between the fall 2021 quarter and the pandemic remote instruction period (Spring 2020 – Spring 2021). Thus, to fully understand the academic of such trend to college student, this report would use the Course And Professor Evaluation (CAPE) data from University of California, San Diego to investigate such. By utilizing the average of grade point average on a quarter, this report would test the hypothesis below.

Test #1

H_0: The mean GPA score didn't change significantly between the two period

$$\mu_{covid} = \mu_{FA21}$$

H_1: The mean GPA score changed significantly between the two period

$$\mu_{covid} \neq \mu_{FA21}$$

It would be also interesting to see whether the findings point to a downward trend or an upward trend in grade point average. For this reason, would also explore the hypotheses below:

Test #2

$$H_1: There\ is\ a\ positve\ correlation\ of\ GPA\ and\ covid\ quarters$$

$$H_2: There\ is\ a\ negative\ correlation\ of\ GPA\ and\ covid\ quarters$$

Furthermore, this report would investigate whether there are other cofounding factors that leads to the changes in student academic performance. For example, studies have shown that satisfaction to learning is a key to student performance (Will). Therefore, we would like to explore whether the average satisfaction of the class and the professor changed in the COVID quarters, and thus explain the change that is shown the above parts. The CAPE database, provides a recommend score of a professor and a class. This report would use the scores and the GPA that a student receives and to check whether there is any change. However, before we made any conclusion about whether the score changes, we must check whether both scores are affected by COVID and whether is it related to student performance. Also, since we are trying to find a general trend, using non-covid quarter (Fall 2018 – Fall 2019, Fall 2021) would be a better choice since it would provide more data to ensure the integrity of comparison. Therefore, we would test the hypothesis below:

Test #3

H_0: Professor and class satisfaction and GPA are not generally correlated

H_1: Professor and class satisfaction and GPA are generally correlated

Test #4

H_1: Professor and class satisfaction and GPA are generally positively correlated

H_2: Professor and class satisfaction and GPA are generally negatively correlated

Test #5

H_0: The mean satisfaction score of both classes and professors does not change significantly between the two period

$$\mu_{rec.class\ covid} = \mu_{rec.class\ non\ covid}, \mu_{rec.prof\_covid} = \mu_{rec.prof\_non\_covid}$$

H_1: The mean satisfaction score of both classes and professors does change significantly between the two period

$$\mu_{rec.class\ covid} \neq \mu_{rec.class\ non\ covid}, \mu_{rec.prof\ covid} \neq \mu_{rec.prof\_non\_covid}$$

To further investigate are there any other confounding factors for student academic performance, we would need to fit a linear model to check their coefficient. Thus, we would fit a model as such:

Model

$$ActualGPA = Enroll\ x_1 + EvalMade\ x_2 + ClassRec\ x_3 + InstruRec\ x_4 + StudyHrs\ x_5$$

Also, research had also shown that if one is able to correctly estimate their ability, the more likely that one will be able to succeed (Bassett). This report will hypothesize that remote learning leads to a disconnect between the student and the faculty, therefore a difference in expectation. Thus, by using the student's estimation and actual grade, we could see that whether there is significance difference between student expectation and the actual outcome during the covid period. Therefore, we will test the hypothesis below:

Test #6

H_0: The difference of student average expected GPA and the average actual GPA has no significant difference during the pandemic compared to the non-pandemic period.

$$\mu_{meandiff,covid} = \mu_{meandiff,non-\ covid}$$

H_1: Student average expected GPA and the average actual GPA has significant difference during the pandemic compared to the non-pandemic period.

$$\mu_{meandiff,covid} \neq \mu_{meandiff,non-\ covid}$$

Data

This report utilizes the data taken from Course And Professor Evaluation, known as CAPE from University of California, San Diego. The data of this report is scrapped by me, on Jan 17, 2022 from cape.ucsd.edu. The dataset contains a standardized evaluation of UCSD's undergraduate courses and professors, for example, GPA, student recommendation rate of class and professor. Each of the rows of this dataset represent one section of class in each quarter. Most of the variables in the data is collected in every quarter, by student who voluntarily provide his/her opinion on the class. However, for some variable, such as GPA received are provided directly by school itself. More information of this dataset could be found on their website on cape.ucsd.edu.

We would be using all the numeric variables of this dataset and some categorical variable, which are:

Terms – which shows what term is this class at

gpa – which shows the average GPA that students received in that class

gpa_expected – which shows the average GPA that students that they expect received in that

class – which shows the rate of the average class recommendation rate that the cape surveyed from student

instr – which shows the rate of the average instructor recommendation rate that the cape surveyed from student

Enroll – the student count that enroll to a particular class section

Evals.Made – the number of student that submitted a CAPE survey in a particular class section

Study.Hrs.wk – the number of hours that a student studied in a class

Here are some summary statistics of the table, the summary below would only focus on the variables that this report would use:

Observation: 56031 rows

Variables: 11

Mean of GPA student received: 3.258

Mean of GPA expected: 3.523

Mean of class recommendation rate: 89.16

Mean of instructor recommendation rate: 89.54

Range of Terms: FA07 – FA21 (Fall 2007 to Fall 2021)

The main potential bias the data collected by surveying may not reflect the entire student body, as the filling of the report is not mandatory. Therefore, some of the data collected may only reflect the opinion of the selected few, as these only the people who have the strongest opinion would want to complete the survey. The other less important potential bias of this report is that some classes do not have their capes reported, which is because of their class sizes.

The main bias of the report is that we could not keep the student population at a constant, that means that the student in each class may not be the exact same class. Therefore, there is a chance that the academic performance changes and the result found in the report is due to the changes of the student population.

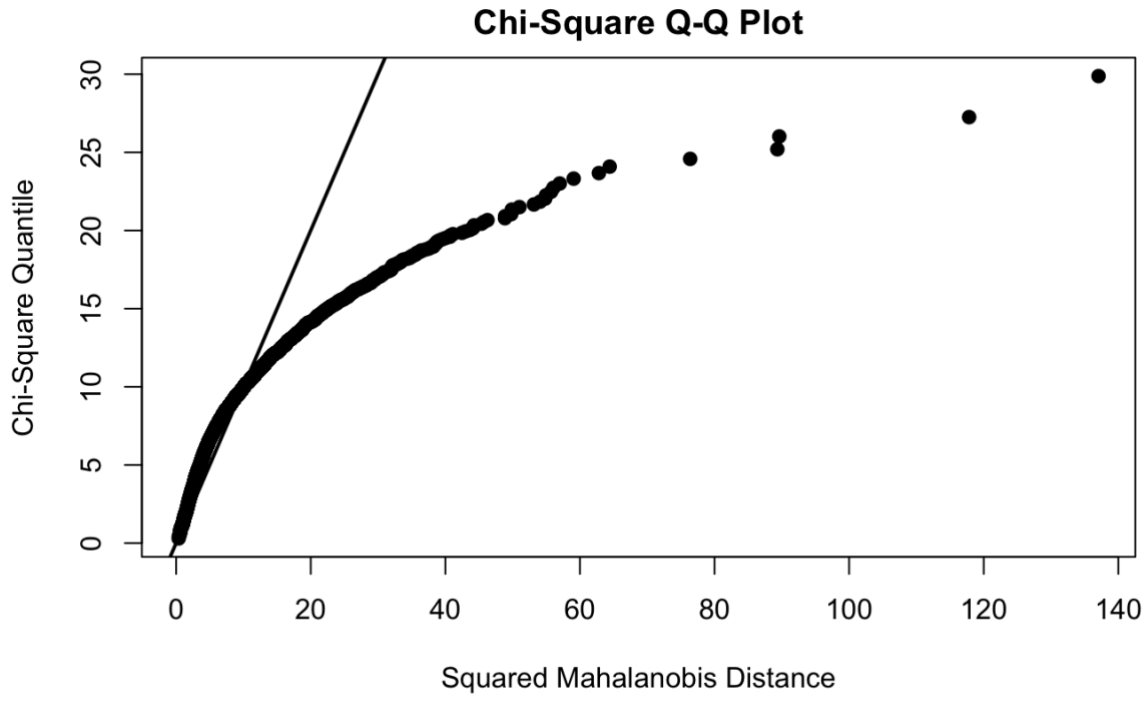
Methods

We would perform 6 hypothesis tests, using R's packages and functions. For all of the 6 tests, we will use 0.05 as our significance value. Below are each test's detail methods:

Test#1

Test would be done a t-test() function. This function will directly output the p-value. The null hypothesis is rejected if the p-value is smaller than the significance value. In order to use the t-test, we would need to check with 2 assumption, one being the assumption of 2 independent dataset and the assumption of normally distributed data.

Assumption of the independent dataset is met because the entries of the two datasets would not affect the outcome of the other. Then, to test the assumption whether the dataset is normally distributed, the MVN function in R was used. By using the MVN function, we have the results below:



Since the data did not follow the straight line well, the data did not follow the assumption of normally distributed data. Thus, we would need to use Mann-Whitney-Wilcoxon Test to test the results.

Test#2

Test will be done by fitting a logistic regression model, predicting a classifier that would return 1 if the quarter is during the pandemic and the GPA scores that the student received. After that, check on the result of the summary function to check whether the coefficient is positive.

Test#3

Test will be done by fitting a linear regression model on the entire CAPE dataset. The null hypothesis is rejected if the p-value of the t-statistic is smaller than the significance value.

Test #4

Test will use the linear regression model fit on Test#3 and check whether the coefficient is positive or negative to determine whether is it positively correlated and negatively correlated. The report will also discuss the p-value output by the summary function and determine whether the result is statistically significant using the significance level of 0.05.

Test#5

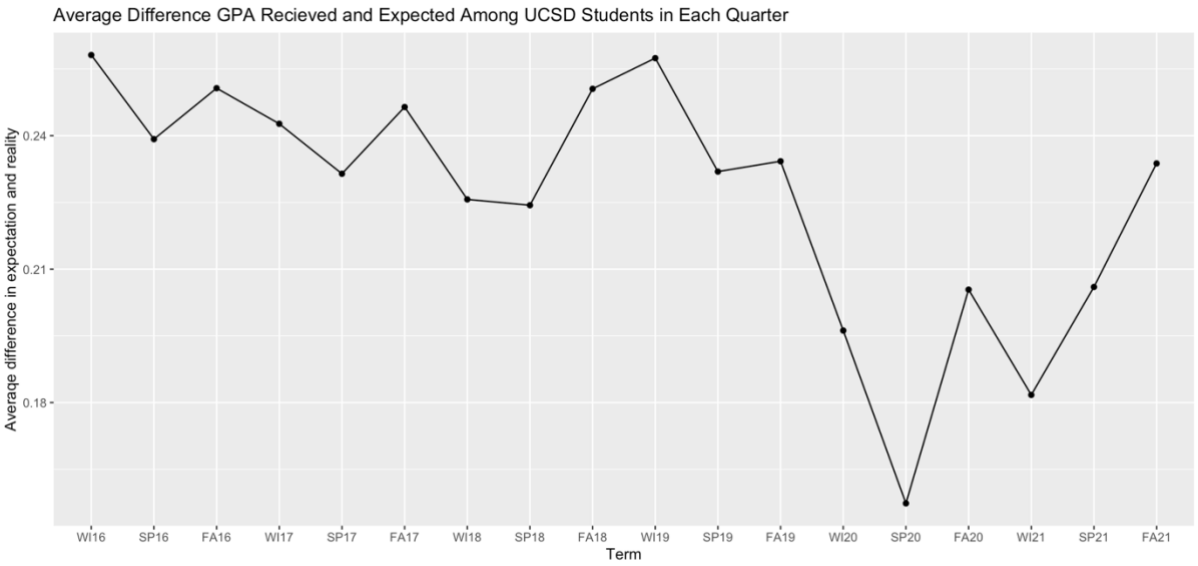
This test will run the t-test, using R's Mann-Whitney-Wilcoxon Test function twice to test the two sets of variables. The assumption of such test is listed on Test#1.

Test#6

This test would need to setup an engineered feature called mean_diff, using the formula:

$$\left|\mu_{expectedGPA} - \mu_{actualGPA}\right|$$

The distribution of such variable is shown in the line plot below



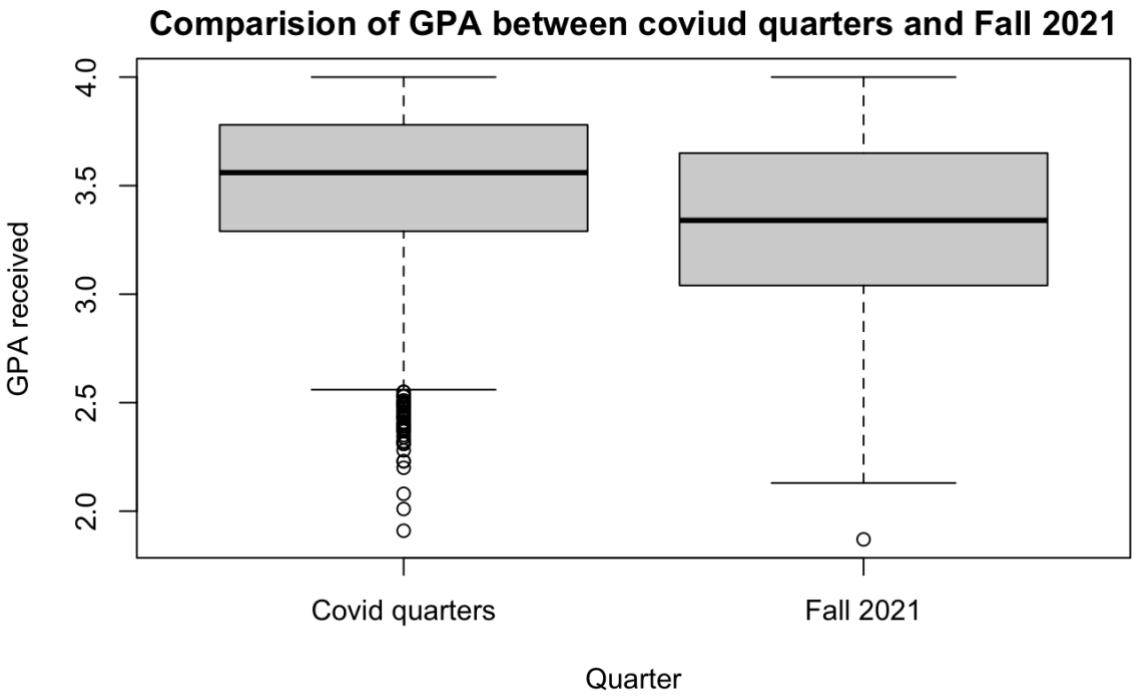
Then, it will use R's Mann-Whitney-Wilcoxon Test function twice to test the two sets of variables, used in both Test#1 and 5.

Model

The model would just fit a normal linear model using the R's lm function. If the coefficient is non-zero, and with a p-value that is a bigger than our significance value of 0.05, we would be able to claim that value is correlated to the report measure of student's academic performance – GPA.

Results

Test #1



From the box plot above, we could see there is a difference between the median, 1st and 3rd quantiles between the 2 groups. The test returns the result:

data: covid$gpa and fa_21$gpa
W = 2812966, p-value < 2.2e-16
alternative hypothesis: true location shift is not equal to 0

We could see that the p-value is less than our significant value of 0.05, thus we are able to reject our null hypothesis and safely assume that there is significant difference between covid quarters and Fall 2021. This result matches the distribution output on the boxplot above.

Test #2

Using the logistic regression fitted in the code, we could find that the gpa coefficient is 1.29679, with a p-value of less than 0.05. This means that we could see a statically significant increase of GPA received by students during the covid quarters. On average, the

increase is 1.29679.

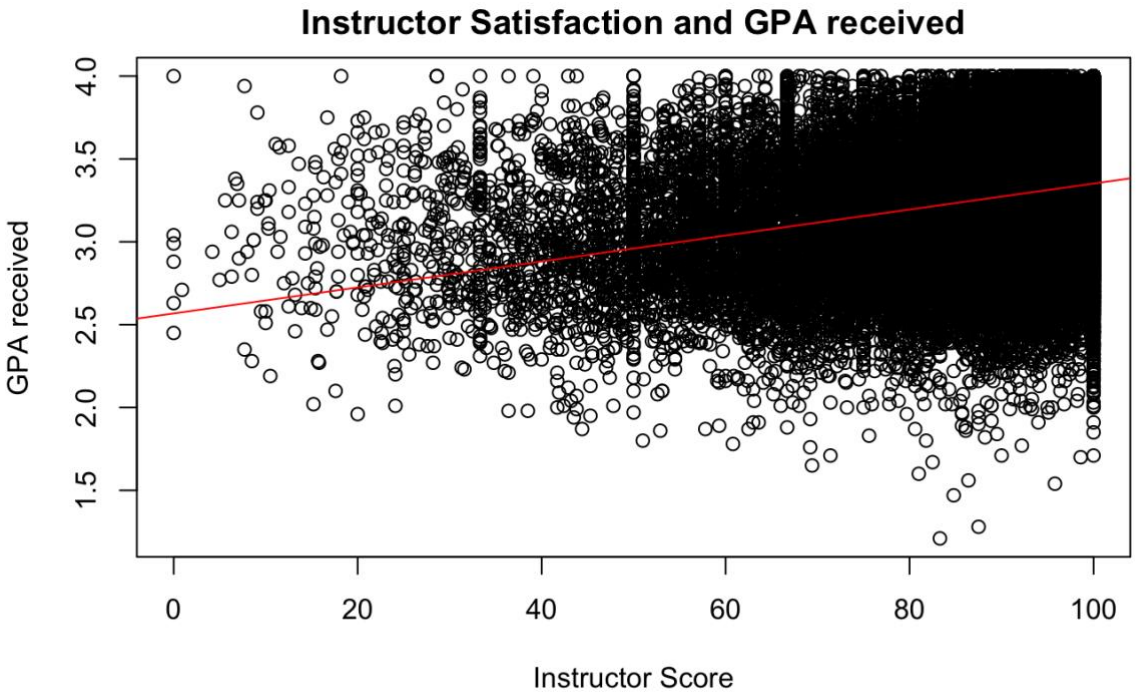
Test #3 & Test #4

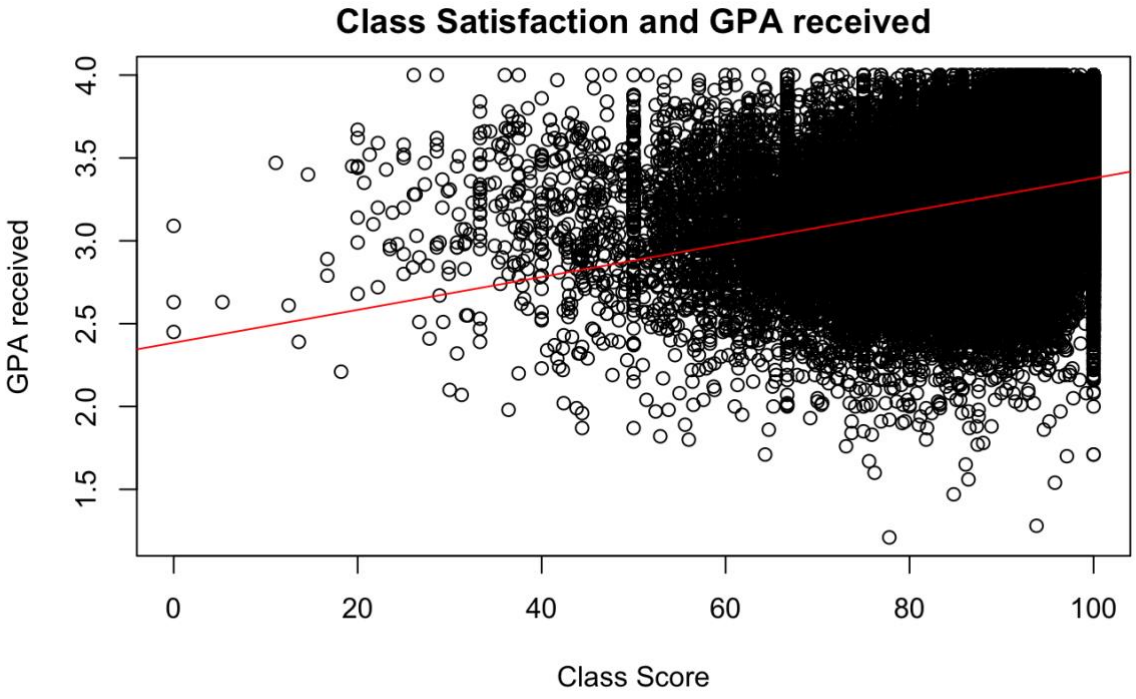
From the summary of the linear regression fitted:

instr	0.0041627	0.0001751	23.77	<2e-16 ***
class	0.0066010	0.0002099	31.45	<2e-16 ***

The instructor and class coefficient are positive and the p-value is less than 0.05, which is our significance value. Therefore, we can reject the null hypothesis that professor and class satisfaction and GPA are not generally correlated because they have a p-value of less than 0.05, and we can accept the hypothesis that they are positive correlated since the coefficient is positive.

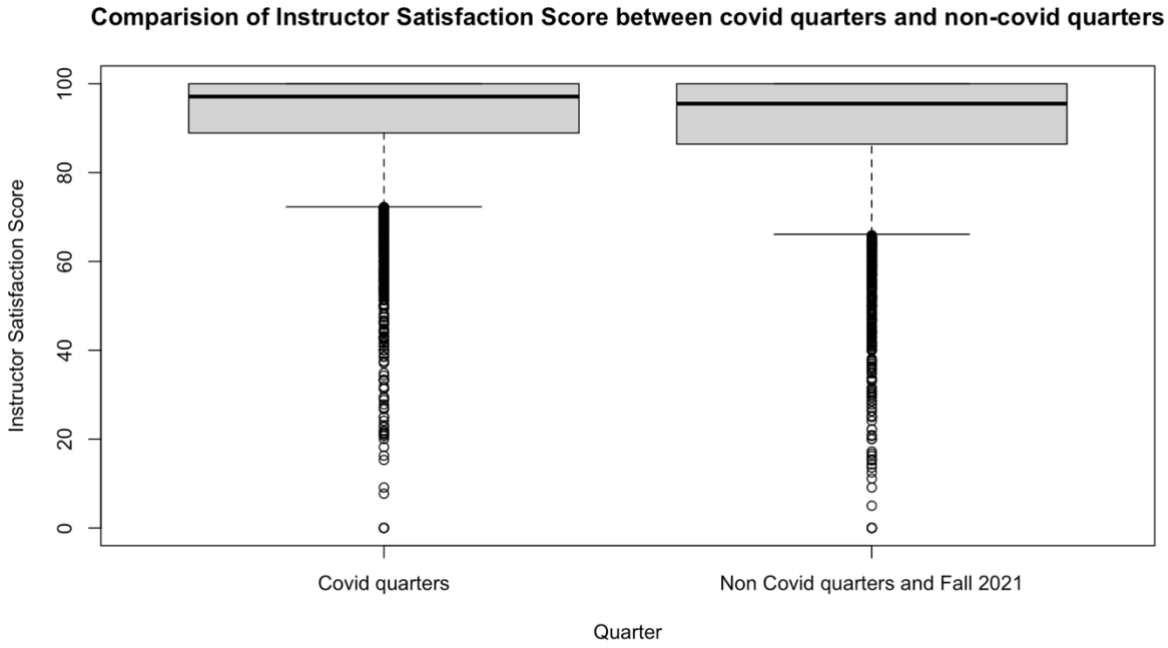
By plotting a scatter between instructor and class score against the GPA that students received, we could also observe the trend shown in the regression result.

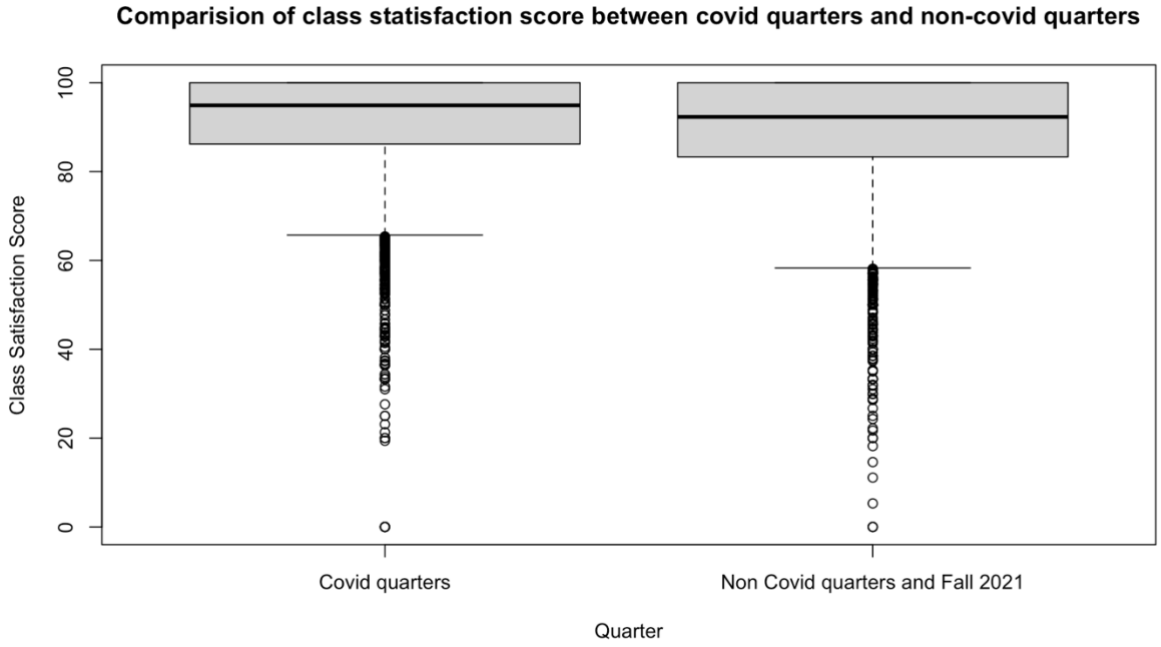




The red line shown is the fit line of the regression model, and we could see that both lines trended upwards which shows the students satisfaction of class and instructor correlated to the GPA received.

Test #5





From the box plots above, we could see there is a difference between the median, 1st and 3rd quantiles between the 2 groups.

For the instructor score, the test returns the result:

data: covid$instr and non_covid_fa$instr
W = 18464360, p-value = 3.757e-12
alternative hypothesis: true location shift is not equal to 0

For the class score, the test returns the result:

```
data:  covid$class and non_covid_fa$class
W = 19054072, p-value < 2.2e-16
alternative hypothesis: true location shift is not equal to 0
```

Each test matches the difference shown in the boxplot as both test favors the alternative hypothesis, which means that the mean satisfaction score of both classes and professors does change significantly between the two period.

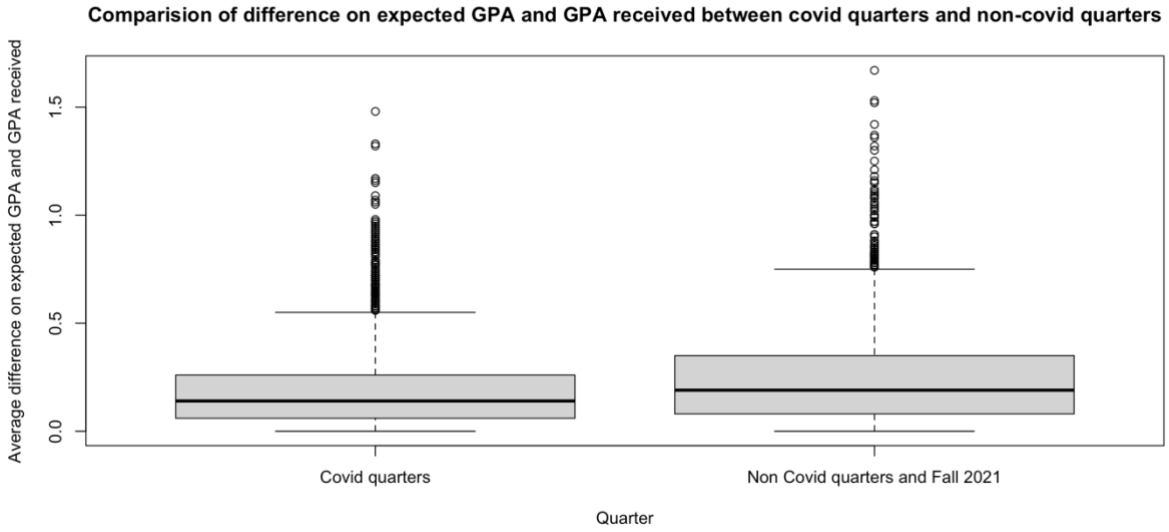
Model

The model outputs a coefficient grid shown below:

```
$coefficients
                Estimate   Std. Error    t value     Pr(>|t|)
(Intercept)   0.1472317790 2.049828e-02   7.182640  6.957903e-13
Enroll       -0.0009755300 3.338168e-05 -29.223512 9.173638e-186
Evals.Made    0.0008496494 5.852868e-05  14.516804  1.256815e-47
Study.Hrs.wk -0.0056752782 6.342480e-04  -8.948043  3.771222e-19
gpa_expected  0.9562639953 5.787882e-03 165.218281  0.000000e+00
class        -0.0028737924 1.600616e-04 -17.954287  8.558524e-72
instr         0.0014809840 1.281097e-04  11.560283  7.340294e-31
```

Since all the coefficient included have a p-value that is lower than 0.05, we could see there is some correlation between the GPA that a student received and the coefficient above. Among the all the coefficient, we could see that the gpa_expected has the highest coefficient, meaning that this value is the most strongly correlated with the actual GPA that a student received.

Test #6



From the box plots above, we could see there is a difference between the median, 1st and 3rd quantiles between the 2 groups.

The test produced a result shown below:

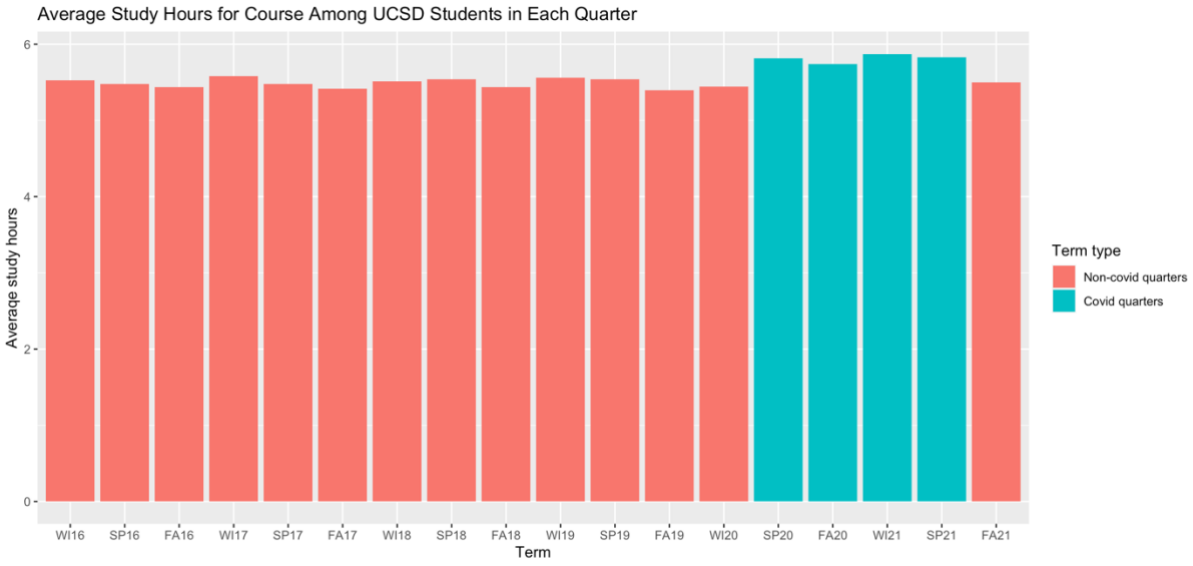
```
data:  covid$mean_diff and non_covid_fa$mean_diff
W = 8652056, p-value < 2.2e-16
alternative hypothesis: true location shift is not equal to 0
```

We could see that the p-value is less than our significant value of 0.05, thus we are able to reject our null hypothesis and safely assume that there is significant difference of average expected GPA and the average actual GPA during the pandemic and the non-pandemic period. This result matches the distribution output on the boxplot above.

Discussion

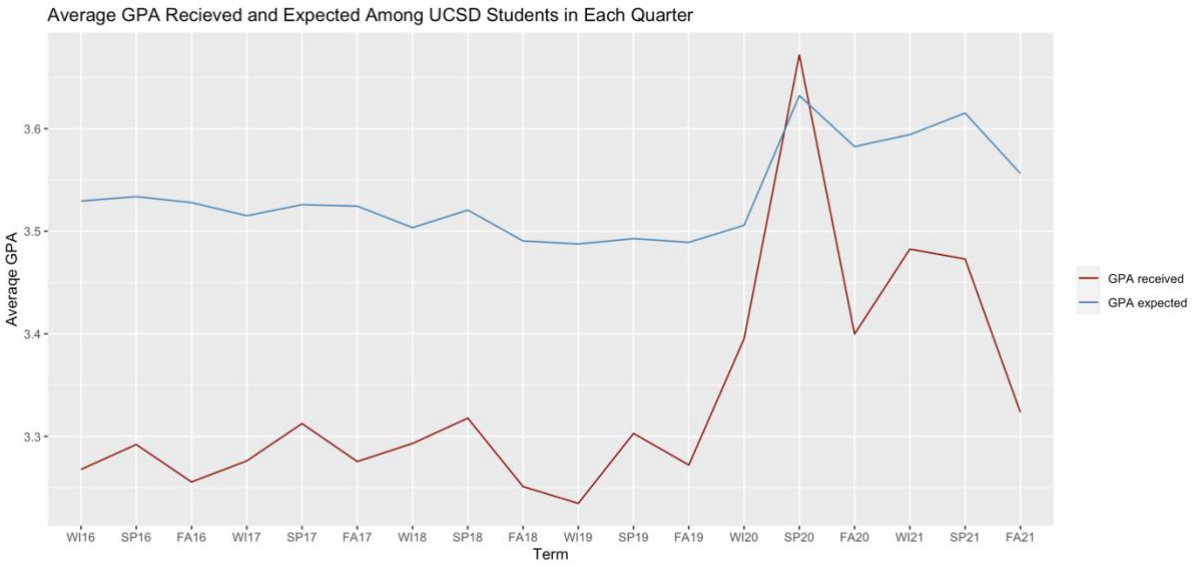
The tests shown above generally confirm the report's hypothesis that the pandemic does have a profound effect of student's academic performance. Since all test performed shown there is significant statistical difference between the pandemic and non-pandemic eras. However, instead of a disconnection between the instructors and student, which in theory would decrease the rate of satisfaction. As a surprise, the report discover that online learning does have a benefit of increasing the instructor and student satisfaction and also the student's average GPA scores. This could confirm statistically that there is a "GPA inflation" during the pandemic quarter since the average GPA risen significantly. I believe a couple factors would have affected it, which includes the increase of study hours, student adapted well in the remote learning system, instructor tends to be more lenient on grading on online learning alongside with UCSD's policy of P/NP grading during the pandemic.

First on the increase of study hours, since the switch to online learning most student would not require to commute to the campus, which is a significant amount of time savings. According to online sources, a typical San Diego commute is roughly around 25 minutes (BestPlaces), and according to UC San Diego's own Institutional Research, 81% of undergrads commute to campus. Thus, if all student uses the commute time to study for a course, the average study hour would have risen by 2.36 hours. However according to the CAPE data collected:



We could see that while there is a slight uptick in the hours spend, it is negligible as it has only variate by less than 30 minutes. Thus, it is not likely a factor to consider.

Secondly would be that student have adapted extraordinary well in the online learning method.



However, as according to the chart, the GPA that students expect has remain relatively steady, while the GPA that a student received increased by 8% only on Spring 2020. This shows that though student received a better grade on general, it is not likely because of student's adaptation because the expectation remains relatively flat.

Lastly, on instructor tends to be more lenient on grading on online learning alongside with UCSD's policy of P/NP grading during the pandemic. During the pandemic, UCSD on most quarters allow students for applying their coursework to P/NP, thus students could theoretically P/NP all of their coursework that would affect their GPA to P/NP and allows for a general higher average GPA. This would be able to directly explain the generally higher GPA, but doesn't explain for the sudden spike during Spring 2020. I would speculate that since Spring 2020 is the first quarter of remote learning, instructors are struggling to convert their teaching method and learning materials and thus more lenient on student. Furthermore, this theory could explain that why the satisfaction score risen. As CAPE asked student to fill in their survey prior the final exam, the satisfaction is not likely reflected that how student saw the class after the final grade releases. Thus, student may sense that the instructor has been more lenient and gave the class a higher satisfaction score.

Conclusion

Though we are able to complete a thorough analysis on the data scraped on the CAPE website, due the factors that the CAPE data could not accurately record statistically, including school policy and the leniency of the instructors, this report could not conclude a solid trend for online learning in the future. Thus, the long-term effect of online learning remains to be seen.

Choosing the right learning method is never easy, as it is a choice that one needs to be made without knowing the effect of it beforehand. The findings of this report will hopefully provide more insights to school administrators, students and parents to online learning in the future, as online learning has become more and more dominant.

References

Bassett, Blake. “Expectation Management: A Manager’s Guide.” *Medium*, 11 Mar. 2020, https://medium.com/@blakebassett/expectation-management-a-managers-guide-7910a1673d1f.

BestPlaces. “Commuting in San Diego, California.” *Https://Www.Bestplaces.Net*, https://www.bestplaces.net/transportation/city/california/san_diego. Accessed 18 Mar. 2022.

Gallagher, Sean, and Jason Palmer. “The Pandemic Pushed Universities Online. The Change Was Long Overdue.” *Harvard Business Review*, Sept. 2020. *hbr.org*, https://hbr.org/2020/09/the-pandemic-pushed-universities-online-the-change-was-long-overdue.

Hess, Abigail Johnson. “65% of Colleges Are Preparing for In-Person Classes This Fall.” *CNBC*, 23 June 2020, https://www.cnbc.com/2020/06/23/65percent-of-colleges-are-preparing-for-in-person-classes-this-fall.html.

Will, Madeline. “Study: Teacher Satisfaction, Collaboration Are Keys to Student Achievement.” *Education Week*, 16 Feb. 2017. *www.edweek.org*, https://www.edweek.org/teaching-learning/study-teacher-satisfaction-collaboration-are-keys-to-student-achievement/2017/02.