Comparison on the Student's Performances during Physical and Online Learning in Financial Mathematics Course

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ABSTRACT

On January 7, 2020, the world was surprised by the discovery of the Covid-19 virus in Wuhan, China. As of April 11, 2022, a total of 6, 214, 082 persons have died as a result of the Covid-19 pandemic. Many countries are at a worrying state since the Covid-19 has spread, including Malaysia. To counteract the impact of covid-19, the government has implemented precautionary measures at all levels, including health, economic, social, and education. A movement control order is one of the measures taken by the government since March 18, 2020, to curb the spread of Covid-19. Due to the movement control order, educators are required to switch their education delivery setting from physical to online learning. This study aims to analyse the impact of online learning on students' performances in Financial Mathematics class. Results from two learning outcomes during the hybrid and online learnings are compared to check for the effectiveness of the online learning implementation. T-test, Chi-Square test and correlation matrix analysis will be implemented. The findings of the study suggest that students performed better in online learning than in traditional learning in CLO1. The results of this study can be used as a reference for the government's future efforts to promote effective online learning.

Keywords:
Covid-19, online learning, physical learning,
Financial Mathematics, correlation

1. Introduction

Does online learning better than physical learning? With the emergence of Covid-19 since January 7, 2020, most educators and students have been asking themselves this issue. This is because, majority of them are unprepared due to little exposure to online teaching and assessments. Even if online learning has been implemented the past [1-2], it is still a choice rather than a requirement [3]. Hence, the sudden shift to online learning has surprised many individuals, and lecturers, in particular, are taking steps to improve their online techniques so that students can learn in the most conducive atmosphere possible.

Many challenges arise due to online learning. According to Student Voice Matters (SVM) [4], some of the challenges faced by the students in online learning are weak internet connection, lack of interesting engagement, family issues, and a confusing learning framework. Students with these difficulties are more likely to struggle to participate actively in online classes, putting them at risk of dropping out, especially for students who are unfortunate and marginalised [5-7]. Apart from students, universities and lecturers also face several challenges with the rise of Covid-19. Some of the

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new challenges lecturers experience during online learning is the lack of time to prepare materials for teaching [6], as well as the necessity to become familiar with the learning medium used to provide learning, such as Webex, Zoom, and Google Meeting. Furthermore, lecturers must be more innovative by trying new tools like padlet in their knowledge delivery [8]. According to Pokhrel and Chhetri [8], individuals with growing mindset would always find ways and quickly adapt to the the new learning environment. Hence, with no alternative other than visual classes, lecturers, staff and students need to support each other for the emergence of a new digital learning. Universities, in particular, have provided the lecturers with a lot of workshops to help the lecturers to incorporate the blended learning method into their visual classrooms.

To assess the success of online learning delivery, several statistical analyses need to be performed on the student's performances with the relation of course learning objectives during physical and online classes. Some of the authors that have compared the students' performances during physical and online learning are Yusniman and Khalid [9], Navarro and Shoemaker [10], Brown and Liedholm [11], Jensen [12], Fisher et al. [13], and Altahhan et al. [14]. From these four references, only Yusniman and Khalid [9] and Brown and Liedholm [11] had a similar conclusion in which online learning is better than physical mode. Navarro and Shoemaker [10], Jensen [12] and Altahhan et al. [14] found that there is no statistically significant difference in student results between online and physical mode. Whereas Fisher et al. [13] stated that their collected data showed that their students' scores are slightly lower in online learning as compared to face-face learning. Since most of the authors did not provide consistent results on which is better between online and face to face courses, this study aims to analyse the effectiveness of online learning courses on the students' scores in the course learning outcome number 1 (CLO1), CLO number 2 (CLO2), and overall scores for all CLO in Financial Mathematics in Department of Mathematical Sciences, Faculty of Science, UTM. CLO is denoted as the objective that the lecturers used as a benchmark for evaluating students' performance [15]. The CLO is considered to be achieved if the total percentage of the CLO is greater than 65% (good pass). Hence, this study also compares the performance of the student that obtained greater than 65% and lower than 65% with the different teaching mode. The Financial Mathematics courses students' scores are compared in terms of hybrid (physical in CLO1, and online in CLO2) in the year 2020 and online (online in both CLO1 and both CLO2) in the year 2021.

The remainder of this paper is organized as follows: Section 2 outlines the statistical tests that we used in the study. Section 3 discusses the results of the tests. Section 4 concludes the overall study.

1.2 Research Question

Our research aims to study the relationship between different types of classes (hybrid and online) and the students' performances before and during the COVID-19. The research question for our study is:

"What is the impact of COVID-19 on the students' performances in terms of hybrid and online learnings?"

1.3 Research Objectives

The objectives of the study are as follow:
1. To analyse the relationship between CLO1 of hybrid and online classes.
2. To analyse the relationship between CLO2 of hybrid and online classes.
3. To analyse the relationship between overall marks of hybrid and online classes.
4. To analyse the relationship between overall marks of hybrid and online classes.

5. To analyse the relationship between type of classes and students' performances.
6. To analyse the relationship between type of gender and students' performances.

2. Methodology
2.1. T-test

The formula of the *t*-test is:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

where $\bar{x}_1$ is the mean from group 1, $\bar{x}_2$ is the mean from group 2, n_1 is the number of size from group 1, n_2 is the number of size from group 2, s_1^2 is the variance from group 1 and s_2^2 is the variance from group 2.

T-test is used to test for the significant difference between groups. In this study, there are three hypothesis assumptions that will be used to do the t-test.

H_0: There is no significant difference between CLO1 of hybrid and online classes.
H_1: There is significant difference between CLO1 of hybrid and online classes.

H_0: There is no significant difference between CLO2 of hybrid and online classes.
H_1: There is significant difference between CLO2 of hybrid and online classes.

H_0: There is no significant difference between the total marks of hybrid and online classes.
H_1: There is significant difference between the total marks of hybrid and online classes.

The null hypothesis will be rejected if the *p*-value is less than 0.05 significance level.

2.2 Chi-Square Test

The formula of the Chi-Square test is:

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{\left(O_{ij} - E_{ij}\right)^2}{E_{ij}}$$

where χ^2 is denoted as the Chi-Square test, *r* is the number of row, *c* is the number of column, O_{ij} is the observed frequency of row *i*, and column *j* and E_{ij} is the expected frequency of row *i* and column *j*.

$\bar{x}_1$ is the mean from group 1, $\bar{x}_2$ is the mean from group 2, n_1 is the number of size from group 1, n_2 is the number of size from group 2, s_1^2 is the variance from group 1 and s_2^2 is the variance from group 2.

Chi-Square test is used to test for the significant relationship between groups. In this study, there are two hypothesis assumptions that will be used to do the test.

H_0: The type of classes and students' performances are independent
H_1: The type of classes and students' performances are dependent

H_0: Gender and students' performances are independent
H_1: Gender and students' performances are dependent

The null hypothesis will be rejected if the *p*-value is less than 0.05 significance level.

3. Results and Discussion
3.1 Descriptive Analysis

Figures 1(a) and 1(b) show the number of counts for students' results in hybrid and online classes based on CLO 1 and CLO 2. A65 denotes the number of counts for students who scored 65 percent or higher, whereas B65 denotes the number of counts for students who scored less than 65 percent. According to Figure 1(a), when the mode of learning switched from hybrid to online classrooms, the number of students who scored above 65 percent climbed to 142.86 percent, while the number of students who scored below 65 percent reduced to 66.67 percent. This suggests that switching the teaching mode from hybrid to online will help students perform better on the CLO1 assessment. Figure 1(b) reveals, however, that the pupils do not perform well in CLO2, as the number of students who scored above 65 percent drops to 48 percent, while the number of students who scored below 65 percent rises to 175 percent. As a result, to confirm the descriptions acquired from the bar charts in Figures 1(a) and 1(b), some statistical testing will be used to the collected data in the following section in order to analyse the students' performance pattern before and after online learning.
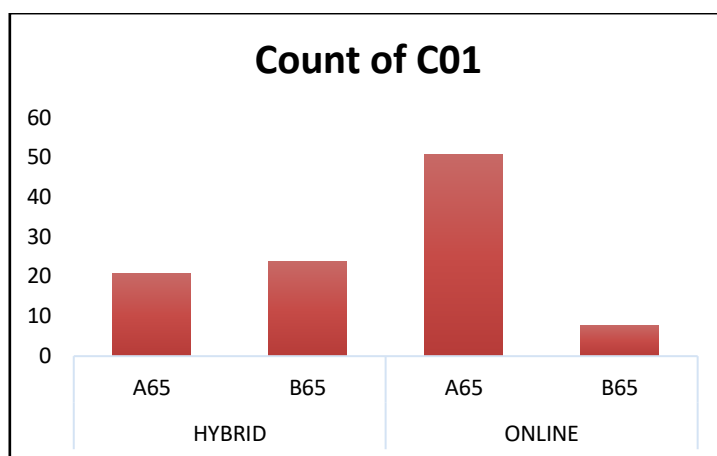

(a)
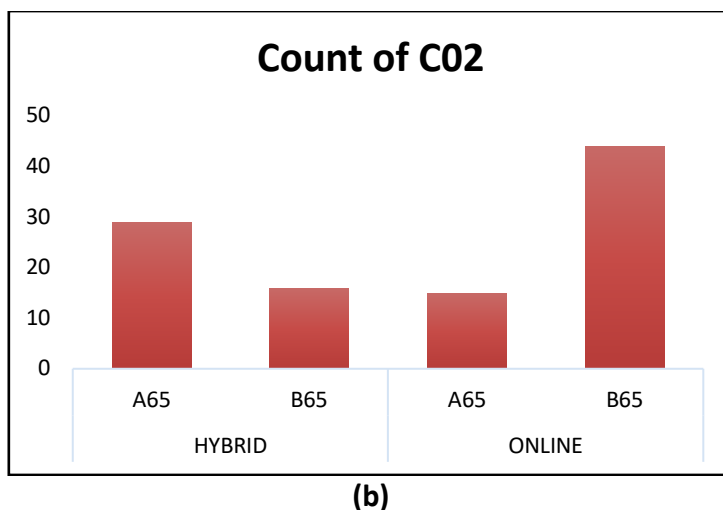
Fig. 1. Bar chart of the number of counts of CLO1 (a) and CLO2 (b) during hybrid and online classes

3.2 Statistical Testing
3.2.1 T-Test

In Figure 1, we compare CLO1 and CLO2 students' performance based on the percentages of students who scored above and below 65 percent. Figure 2 depicts a comparison of average CLO1, CLO2, and Overall Scores between hybrid and online classrooms. According to Figure 2, students' average CLO1 scores decreased when the medium of instruction was changed from hybrid to online, but their CLO2 and total scores improved significantly when compared to hybrid and online. However, based on Figures 1 and 2, we are unable to determine whether hybrid and online programs would result in significant changes in student performance. As a result, a t-test is used to determine whether there is a significant difference between average CLO1, CLO2, and Total Marks of students in hybrid and online classrooms.
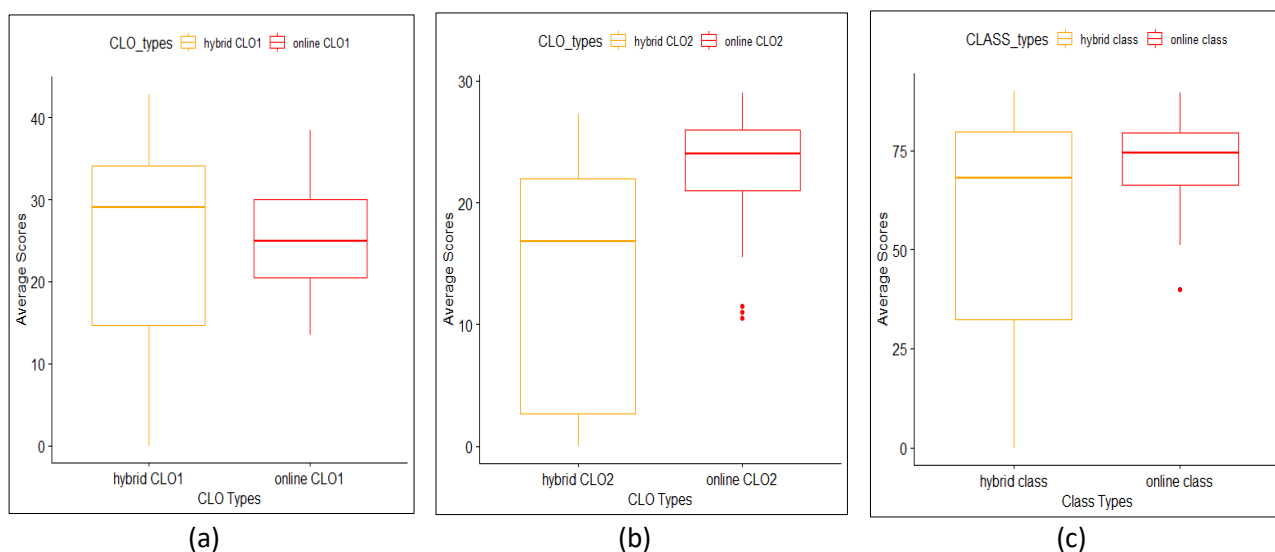
Fig. 2. The average scores for CLO1 (a), CLO2 (b), and total scores for all CLO (c) during hybrid and online classes

Table 1
T-test results for CLO1, CLO2, and Total Marks during hybrid and online classes

Variable	*p*-value
CLO1	0.2214
CLO2	0.0000
Marks	0.0214

Table 1 shows that the p-value of the CLO2 variable is less than 5% of the t-significance test's level, implying that there is a significant difference between the CLO2 online in 2020 and CLO2 online in 2021. In addition, the *p*-value of the total mark variables is less than 5% of the *t*-significance test's level, implying that there is a significant difference between the Total Marks in hybrid and online classrooms.

3.2.2 Chi-Square Test

Table 2 provides the Chi-Square test for classes, and gender with the students' performances that are above and below 65%. Because the *p*-value is less than the significance level of 0.05, the results show that hybrid and online classes are influenced by the students' performance, but gender has no relationship on student achievement.

Table 2
Chi-Square test results for classes and gender with
the students' performances that are above and below 65%.

Variable	*p*-value
Classes	0.0000
Gender	0.4533

The results in Table 2 are supported by Figure 3. The correlation plot between CLO1 and CLO2 with class type, and gender is shown in Figure 3. Positive correlation is indicated by blue, while negative correlation is indicated by red. The stronger the colour intensity, the stronger the correlation between the corresponding row and column variables. Based on Figure 3, the is a strong correlation between between hybrid and online classes with the students' scores since they have high intensity of blue and red colours as compared to male and female. There is a strong positive association between hybrid and CLO2 with average scores greater than 65% (CO2A65) and CLO1 with average scores lower than 65% (CO1B65). In the same columns of CO2A65 and CO1B65, there is a strong negative relation between the columns and online class. This concludes that students performed well in hybrid classes as compared to online classes in CLO2, and performed well in CLO1 during online classes. This conclusion agrees with the bar charts obtained in Figure 1(a) and Figure 1(b). However, because the colour is not as intense as the one observed in the row of hybrid and online classes, there is no strong relationship between the students' results and gender.
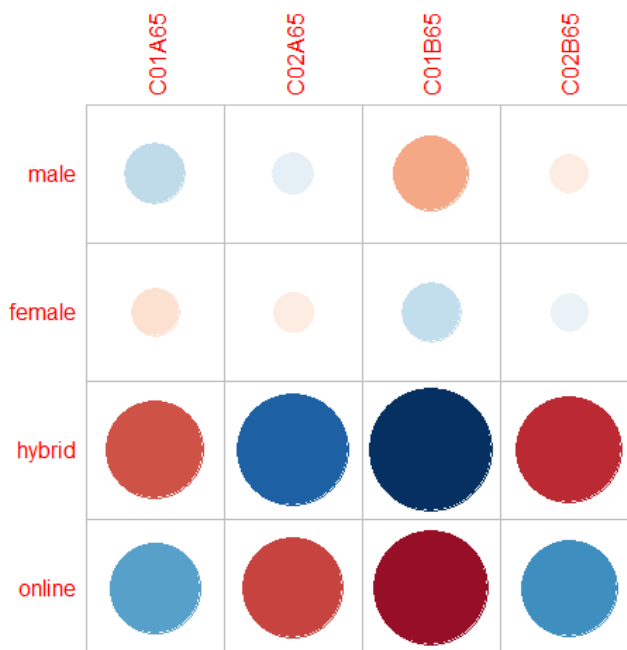
Fig. 3. Correlation plot between CLO and type of classes, and gender.

4. Conclusion

This study analysed the effectiveness of online learning courses on the students' scores in the course learning outcome number 1 (CLO1), CLO number 2 (CLO2), and overall scores for all CLO in Financial Mathematics in Department of Mathematical Sciences, Faculty of Science, UTM. There are two modes of learning methods that are being compared which are hybrid (physical in CLO1, and online in CLO2) in the year 2020 and online (online in both CLO1 and both CLO2) in the year 2021. The data for both years are tested by using *t*-test and Chi-Square test to check for their significant difference and independency. From the results, it can be seen that the students performed well in CLO1 for online class. Whereas the CLO2 for both years 2020 and 2021 were performed online, hence we could say that students performed well in CLO2 2020 as compared to CLO2 2021. CLO2 is more difficult as compared to CLO1 since there are many theoretical definitions that need to be understood by the students to score well in CLO2, hence engagement between students and lecturers are crucial. Since the students had met the lecturer during CLO1 2020, thus, during CLO2 2020, they were actively engaged with the lecturers during the question-and-answer session. Meanwhile, in 2021, students did not get the chance to meet the lecturer physically, thus in CLO2 2021, there were less interaction between lecturer and students during the question-and-answer session. As a result, in comparison to CLO2 2021, students did better in CLO2 2020.

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