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A Comparison of Student Performance in Online and Face-To-Face Learning for Statistics Subject

Siti Balqis Mahlan, Maisurah Shamsuddin, Rozita Kadar, Jamal Othman and Naemah Abdul Wahab

Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA Cawangan Pulau Pinang, Pulau Pinang, Malaysia

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Abstract

Due to the Second Movement Control Order (MCO 2.0), online teaching and learning (TnL) continued. Covid-19 seems to have an impact on students in many ways. The purpose of this study was to determine whether or not there are differences in academic achievement between online and face-to-face learning. Hence, the assessment marks for 150 students from the last five semesters of a statistics course were taken. During the Covid-19 pandemic, these five semesters include two sessions of face-to-face learning and three sessions of online learning. The data collected were analyzed using descriptive statistics, ANOVA and Post-Hoc test. Based on descriptive data, it was revealed that the achievement of marks for face-to-face learning sessions in the September - January 2020 session was higher than earlier semesters of study, while female students outperformed male students. However, female students' performance was seen slightly decline for the online semester. The findings from the Analysis of Variance (ANOVA) indicated significant differences in achievement based on the semester of study, gender as well as interaction between gender and semester of study on mark achievement. Based on the Post-Hoc test results, it was discovered that face-to-face learning performed better than online learning throughout the last two semesters. However, performance during the first semester of online learning (March - July 2020 session) was similar to that of face-to-face learning. It is intended that the findings of this study would help educators improve the effectiveness of their teaching methods.

Keywords: Teaching and Learning (TNL), Analysis of Variance ANOVA, Post-Hoc, Face-To-Face Learning, Online Learning.

Introduction

The risk of the Covid-19 pandemic leading to MCO in March 2020 last year made history on MCO 2.0, forcing online teaching and learning sessions to continue in institutions of higher learning for the new semester of 2021. It turns out that the Covid-19, which has been in effect since last year, was the reason for the change in the usage of online teaching and learning. As a result of this circumstance, students must fully utilise their electronic devices as a medium to continue online learning sessions at home or at their campuses.

Online teaching and learning have their own issues such as an unconducive student environment, student commitment to online learning, insufficient internet facilities and devices, problems with effectiveness in teaching and learning delivery, problems with lecturers' digital device skills as well as a lack of cooperation between students and parents. These difficulties might have an indirect impact on students' academic performance. This research attempts to observe whether or not there are students' achievement issues with online teaching and learning. If so, they must be addressed and solved as soon as possible.

Munirah et al (2021) found that online learning is less effective and uninspired among students than face-to-face learning. Munirah et al (2021) noted that students' readiness for online learning is good, but must be accompanied by adequate internet connection and technological equipment.

According to Kok (2021), the implementation of face-to-face teaching and learning, as opposed to online, is the focus of student choice during the Covid-19 epidemic. According to Kok (2021), students' readiness for online learning is moderate. However, the research was limited to the subject of Professional Introductory Studies. Agustin et al. (2020) found out that students prefer face-to-face learning over online learning, especially when there are some limits encountered by students during the learning process while using the WhatsApp application.

Based on the study of Fatih and Hafize (2008), the level of achievement of students who take online classes is better when compared to the face-to-face method. The findings of the study were obtained using the Man-Whitney U Test in which achievement scores for both learning methods were considered. A study by Suzanne and Heather (2014) also discovered that online learning was more satisfying than face-to-face learning. Students are more satisfied with online learning methods.

Chalerm et al (2020) conducted a similar study, which evaluated the test scores of students who have taken online and offline tests. The findings indicated a significant difference in scores between the two approaches, with the online examination scoring significantly higher. They also proposed that more studies need to be done to discover new effects and assessments to maintain the level of knowledge in the long term.

Muntajeeb (2011) concluded that academic achievement among students who follow face-to-face learning was found to be relatively low since the learning is limited to the classroom only. Meanwhile, online academic achievement was at a relatively high rate due to the availability of information shared online, which is more creative than traditional methods. Muntajeeb's (2011) study used the 'Wiziq.com' website as a tool to test the effectiveness of online learning on student achievement.
Cindy, Cristy and Jeanine (2010) stated that there were no significant differences in the achievement of students conducting face-to-face or online learning. Both students' achievement was similar for both methods. Cindy et al (2010) also stated that what is more important in learning is the teaching method as opposed to the knowledge delivery platform used. Similar results were also obtained from the study of Hope, Davids, Bollington, and Maxwell (2021) who stated that changes to online learning did not affect student performance despite changes in test format. They, therefore, expected that educators should

have confidence in the implementation of higher-level online tests as compared to face-to-face classes.

The study of Jean, William and Scot (2011) showed good academic achievement in mathematics subjects during online learning. Jean et al (2011) also demonstrated unsatisfactory academic achievement for face-to-face learning. Overall, their study found significant differences in the performance of mathematics courses where learning methods could influence students 'academic achievement.

In addition, there is also a study on the performance of male and female students conducted by Ahlam et al (2020) who presented that the academic performance of female students during online learning was better than that of male students. Male students showed lower efficacy in their ability for self-directed learning. These findings are consistent with previous research by Chyung (2007) on online learning for male and female students in terms of performance, motivation, perception, and learning habits. The study observed that female students have higher abilities than male students in improving performance and self-efficacy.

Edwin (2017) stated that the academic achievement of students who took statistical subjects while online was lower when compared to the performance during face-to-face teaching. The study also compared the performance between male and female students, which found an excellent performance of female students during online learning. However, during face-to-face learning, it was found that the performance of male students was better compared to the performance of female students.

There are a few additional instruments in Richard's Study (2004), namely age and gender factors that were used by researchers to compare the achievement between face-to-face and online learning. The study found that performance during online learning was better. However, there was no evidence to show the existence of an association between age and gender with learning performance except for students aged 33 years and below. These students have better performance in online learning.

Namsook et al (2007) found no significant difference between face to face and online learning methods. However, when the primary studies were classified according to whether or not the experimental study included a pre-test, the student achievement comparison revealed an intriguing result. Although no difference was found in prior knowledge between online and face to face learning in the pre-tested group of studies, student achievement in online learning was significantly higher than face to face learning. Student achievement in the no-pre-test group of studies, on the other hand, have shown no significant difference between the two methods of learning.

In a study conducted by Jessica et al (2005), it was revealed that the results of independent samples using t-tests have no significant difference in grade between the online and traditional classroom contexts. On several dimensions, however, students enrolled in the online course were significantly less satisfied with the course than traditional classroom students. The result from the study was equivalent to the findings of Sugama et al (2020) study, where there no significant changes were revealed between the data groups using the

mixed learning technique or the full online method. The complete online learning experience has the same influence on student creativity as face-to-face learning.

A study conducted by Hanan et al (2015) identified if there were any significant differences between the two groups of teaching methods using multiple regressions and ANCOVA. Age and gender were identified as determinants of student achievement in face-to-face collegiate algebra classes, according to multiple regression analyses. Age and gender had no effect on students' grades in comparable college algebra online courses. According to ANCOVA, the average grade of in-person students was greater than that of online students.

The study in this article examines the comparison of performance for academic achievement, especially for students who have taken statistics course during face-to-face and online learning. The interaction relationship between male and female students on learning performance in the relevant semester was also considered.

Methodology

The study involved a total of 150 respondents who took a statistics course. The data used were the evaluation results for five semesters of study from March - July 2019 and September 2019 - January 2020 during face-to-face learning. The online learning was conducted throughout March - July 2020, September 2020 - January 2021 and March - August 2021. The marks for 15 male students and 15 female students were randomly selected for each semester involved.

In addition to descriptive statistical data, this study also used two-way ANOVA tests to test several hypotheses. The Levene test was also performed before ANOVA to check whether or not the assumptions of homogeneity or similarity of variance are met. The hypothesis test used in the Levene Test was H_o: Variance is equal and H_1: Variance is not equal. The results obtained should not reject H_o ($p > 0.05$) so that the assumption of similarity of variance is met and thus the ANOVA test can be continued.

In this analysis, students were divided into five groups based on the semester of study. The following Table 1 shows the division of the group:

Table 1
Group Division by Semester

Group	Semester
1	Semester March - July 2019 (face-to-face learning)
2	Semester September 2019 - January 2020 (face-to-face learning)
3	Semester March - July 2020 (online learning)
4	Semester October 2020 - February 2021 (online learning)
5	Semester March – August 2021 (online learning)

Hypothesis testing for two-way ANOVA was performed; H_o will be rejected if the p-value is less than 0.05. Next, a Post-Hoc comparison test was conducted to identify different groups (semesters of study). This test is performed if the results from the ANOVA show a significant difference for the group tested. Variables for gender were not tested because the Post-Hoc

Test was only applied to three groups and above only. If the ANOVA research found no significant difference, e.g. ($p > 0.05$), Ho will not be rejected, and the researcher did not have to conduct Post-Hoc. The Post-Hoc Test (Tukey) was chosen for this study since the number of samples was the same for each group tested.

Analysis and Discussion

The results of the descriptive study conducted on statistical data showed that the average student scores were almost the same for the three groups of semesters. Figure 1 illustrates a declining trend from semester to semester. However, it was shown that this fall started from the last two semesters of face-to-face learning and continued to decline to the last three semesters of online learning. For semester March-July 2019 (face-to-face), the average mark was 76.5%, September 2019 - January 2020 (face-to-face) was 77.6% and March-July 2020 (online) was 77.4%. On the other hand, the scores for the last two semesters of online learning were a bit low; semester October-February 2021 (online) and March-August 2021 (online). Figure 1 below shows a graph of mean marks based on semester of study.

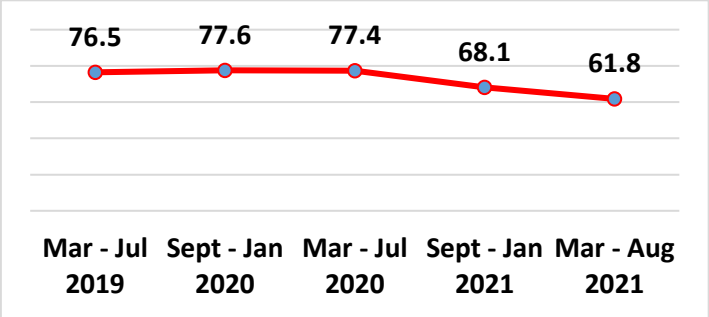

Figure 1. Line Chart for Student Marks by Group (Semester of Study)

Furthermore, Figure 2 below presents that the average score for female students was higher than male students, which is 74.7% and 69.9%, respectively.

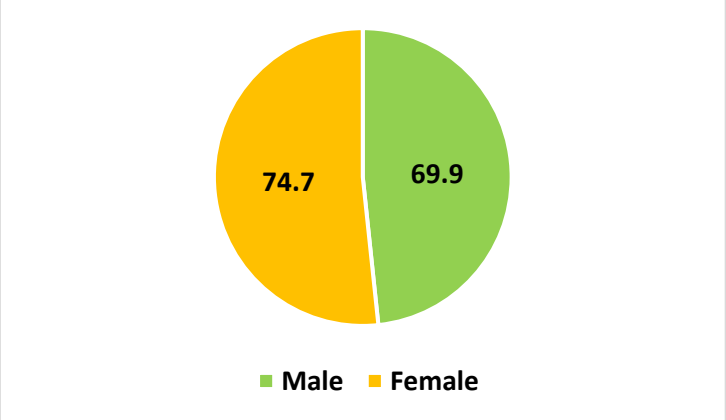

Figure 2. Pie Chart for Student Marks by Gender

It can be seen based on Figure 3 found that the mean mark for female students in the semester Sept - Jan 2020 was the highest at 84.9% compared to other semesters. However, the performance of female students was found to slightly decrease during online learning over face-to-face learning.

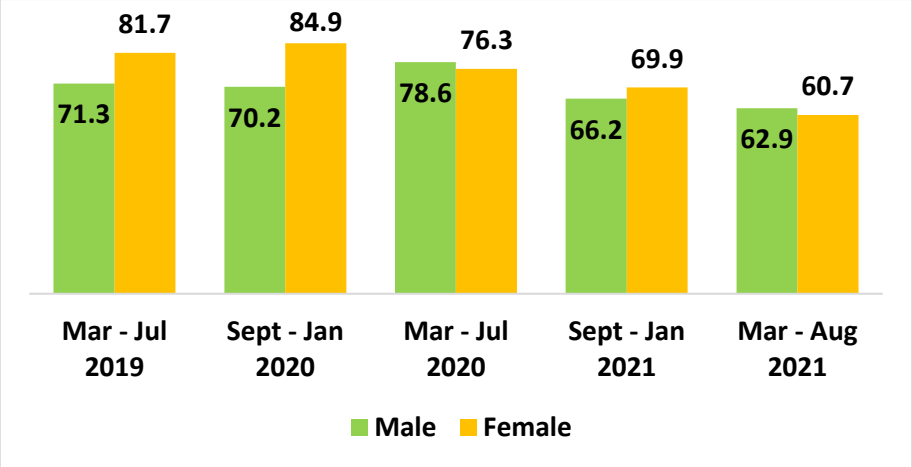

Figure 3. Mean Student Marks by Semester and Gender

The mean score of male students of 78.6% was the highest in the semester March-July 2020. This shows that female students were more excellent during the semester face to face compared to male students who were better in the semester of online study except in the semester September-January 2021, which slightly decreased.

Next, the Levene test was conducted and the results of the study findings showed a value obtained; $p = 0.146$ was significant ($p > 0.05$). Thus, it can be concluded that the population of variance for each group was the same (the assumption of homogeneity of variance has been met). This indicates that ANOVA tests can be performed.

The following Table 2 displays the results for a two-way ANOVA test that involved independent variables, which included group (semester of study), gender, and the interaction between the group (semester of study) and gender.

Table 2
Two-Way ANOVA Test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8609.660[a]	9	956.629	7.275	.000
Intercept	783515.207	1	783515.207	5958.895	.000
Gender	878.460	1	878.460	6.681	.011
Semester	5996.893	4	1499.223	11.402	.000
Gender * Semester	1734.307	4	433.577	3.297	.013
Error	18408.133	140	131.487		
Total	810533.000	150			
Corrected Total	27017.793	149			

Initially, a study was conducted to observe the effects of interactions between groups (semesters of study) and gender. It was found that the value of $p = 0.025 < 0.05$. With this, H_o was rejected indicating a significant interaction between group (semester of study) and gender on student scores. The following hypotheses were used:

H_o : There is no effect of interaction between the semester of study and the gender of students on the level of achievement of marks.
H_1 : There is an interaction effect between the semester of study and the gender of students on the level of achievement of marks.

This study continued to find out if there was a significant difference in scores for each group (semester of study) and gender. It was seen that students' scores differed significantly by gender when p-value = 0.02 < 0.05; whereas a difference was observed in marks between male and female students. The hypothesis tests used are:

H_o : There is no difference in the level of score achievement based on gender.
H_1 : There are differences in the level of score achievement based on gender.

From the output of SPSS, the value of p for the group (semester of study) was p = 0.03 < 0.05. It shows that there was a significant difference in marks between five different semesters of study. The following hypothesis was tested to examine the achievement of marks for the semester.

H_o : There is no difference in the level of achievement of marks based on five different semesters of study.
H_1 : There are differences in the level of achievement of marks based on five different semesters of study.

Next, a Post-Hoc (Tukey) comparison test was used to find out the semester of study that shows better achievement. The test results are as shown in Table 3 as below:

Table 3
Post-Hoc (Tukey) Test

Semester	N	Subset	
		1	2
Mar - Aug 2021	30	61.80	
Sept - Jan 2021	30	68.07	
Mar - Jul 2019	30		76.50
Mar - Jul 2020	30		77.43
Sept - Jan 2020	30		77.57

Based on the above results, the achievement of marks for three semesters of study, namely September-January 2020 (face to face), March-July 2020 (online), and March-July 2019 (face to face) was the same as they are in the same group, while the student achievement for the March-August 2021 semester and October-February 2021 (online) was different from the other three semesters where the achievement was relatively low. Although the March-July 2020 semester also conducted online learning, the achievement was in the same group as face-to-face learning where the score performance was quite satisfactory. This means that there is no strong evidence to conclude that face-to-face or online learning methods can influence student achievement levels. It may be due to other factors that need to be identified in more depth and require further study. This study has obtained findings that are very similar

to the study of Cindy et al (2010); Hope et al (2021), which stated that student achievement is similar for both methods.

Although there was a slight decrease in marks in the semester of March-August 2021 and the semester of October-February 2021, it may be due to changes in the format of the latest questions on the assessment conducted, which requires high-level questions. The performance of marks during online teaching in the semester of March-July 2020 statistically had the same achievement as face-to-face learning. This may be because the format of assessment in the semester of March-July 2019 and September-January 2020 (face to face) did not have much difference when compared to that in the earliest semester of online learning (March-July, 2020). However, this study was limited to students who took the statistics course only.

Based on this study, it can be concluded that the level of student achievement is not significantly affected by the learning method, be it face-to-face or online. However, a student's level of performance is influenced by gender factors. As found in this study, female students overall have better achievement than male students during face-to-face learning. Meanwhile, the performance of male students was better during online learning. It can be concluded here that there is an interaction effect between the semester of study and the gender of the students on the marks.

The results of this study in particular have similarities with some research findings from other researchers who studied whether or not student achievement has any relationship with virtual learning methods, which is most likely influenced by other factors that need to be examined for further study. This study also found that gender factors can affect student performance, which is similar to most researchers showing that the performance of female students is more excellent when compared to male students. Nevertheless, the findings of this study found that the achievement of male students was better during online learning, while the achievement of female students was better during face-to-face learning.

Conclusion

Online learning continued again during MCO 2.0. Academic achievement for students should be emphasised as various factors can affect the performance of a student according to the background of each student. The achievement of marks is an important focus to achieve the targeted objectives set by the respective faculties and departments with both learning methods; face-to-face or online learning.

However, a student's academic performance is logically closely related to a student's self-learning method. Subsequent studies are suggested so that researchers can take into account other more relevant factors. This study was limited to a group of students who only took statistics course. With this, it can be recommended that other researchers take more samples; for instance, by taking a sample of students consisting of various courses so that they can make comparisons in more detail.

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