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The Effect of Delivery Modality on Student Performance in a Quantitative MBA Course

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Abstract

Supply Chain Management, MGSC 625, is a quantitative graduate course offered at a public university in Houston, Texas. Since 2015, this course has been taught as a face-to-face lecture-based course, as a hybrid course combining face-to-face lectures and live online lectures and as an online asynchronous course with archived recorded lectures. This article explores the effect of differences in the delivery modalities, face-to-face live, hybrid and online recorded lectures, on student performance.

Keywords: delivery modalities, face-to-face, hybrid, asynchronous

Introduction

The benefits and limitations of online instruction, when compared to classroom-based face-to-face (F2F) instruction, has been research and debated for a number of years. There appears to be a blurred dichotomy between two schools of thought. There are educators who posit that the personal touch of a live instructor and F2F classroom interactions among students is essential to the college learning experience, particularly so for students whose secondary education learning experiences have not fully prepared them for college (Ramsden and Entwistle, 1981). Brown (1996) and Hara and Kling (2000) suggest that students in the online environment may experience isolation, confusion and frustration that adversely affect the efficacy of their learning.

Another school of thought advocates for online instruction suggesting that online participation may be less intimidating to students who tend to be more reserved in a classroom. McLaren (2008) advises that student learning is enhanced by the quality and quantity of interactions, both student to student and student to instructor interactions, which exist in the online environment.

Differences in student performance, in the F2F, hybrid and online environments, has also been well researched without a clear conclusion of which modality is best suited for student learning. Carmel and Gold (2007) advise that there is not a statistically significant difference in student performance between F2F and hybrid modes of instruction. Helms (2014) suggest that online students have significantly lower grade point averages (GPAs0 that F2f students. Other authors advise that statistically significant differences existed in student performance between online and traditional courses (Atchley, Wingenbach, and Akers, 2010; Faux and Black-Hughes, 2000; Paden, 2006; Shoenfeld-Tacher, McConnel, and Graham, 2001).

This paper explores the existence of a difference in student performance among students taught F2F, in hybrid mode and fully online in a quantitative MBA course, Supply Chain Management. Student performance data from sections of the course offered F2F in Fall 2016, online in Fall 2018 and as a hybrid of F2F and online in Fall 2020 are used in the analysis. This study assumes that student performance is variable while student knowledge is fixed from semester to semester. Results of this case study may not be extendable to other larger delivery modality studies since the student performance observations in each of the three groups of data are nonrandom.

Data and Graphics

Table 1: Data Sets

Fall2018 Online	Fall 2016 F2F	Fall 2020 Hybrid
97.35	100	89.3
87.025	98.4	100
92.5	84	100
97.175	100	100
95.35	92	100
51.95	102	91.97
91.85	102	95.83
100	100	42
53.275	100	67.4
95	100	98.8
92.575	100	89.83
98	102	97.6
87.375	98.8	98.8
97.525	100	32.9
98	90	
100	99	
95.925	82	
100	100	
94.175	100	
97	100	
85.525	98.4	
	100	
	100	
	100	
	100	
	100	
	100	
	100	

Table 1 displays student performance scores for sections of the course offered F2F in Fall 2016, online in Fall 2018 and as a hybrid of F2F and online in Fall 2020.

Figure 1 displays a scatterplot of the student performance data. Although a majority of scores are within the range 85 to 100, there are outliers in the range 30-60 indicating that differences exist in the variation of the data among the three groups. Figure 2 displays a box and whispers plot on the data. The edges of the box represent the lower and upper quartiles. Note that the interquartile range (IQR) is quite small for the F2F course, but larger for the online and hybrid courses further reinforces the non-homogeneity of the variation among the groups.
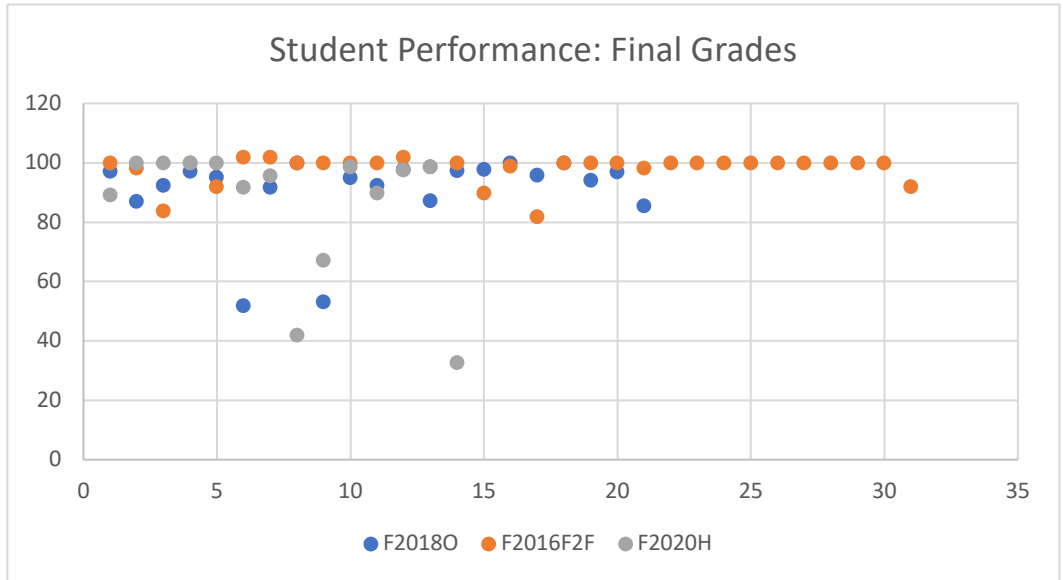
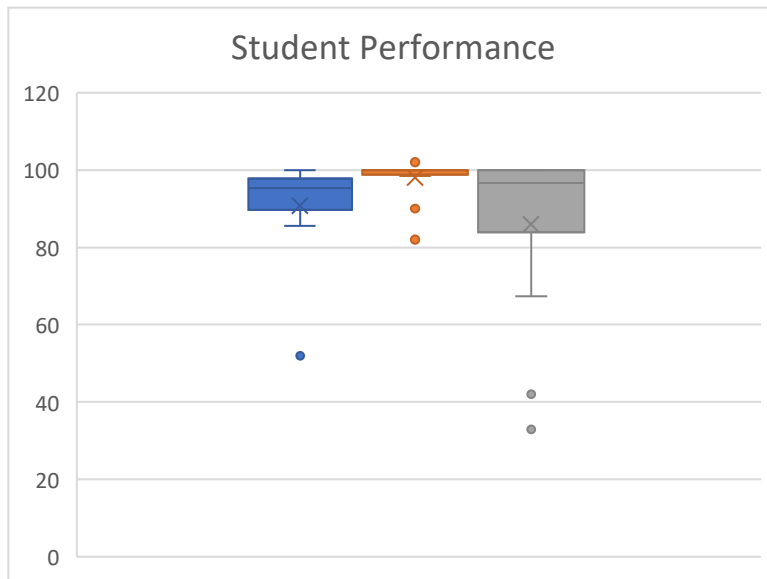Figure 1: Scatterplot of Student Performance Scores

Figure 2: Box and Whiskers Plot of Student Performance Scores

Data Analytics

The key research question of this study is:

Is there a difference in the student performance scores of students taught online, F2F and in hybrid modes?

Expressed statistically:

$H_O: \mu_O = \mu_{F2F} = \mu_H$ (mean student performance is the same across different delivery modalities)

H_A: at least one μ is different

Table 2: One-Way ANOVA (Completely Randomized Design)

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
F2018O	21	1907.575	90.8369	178.9589
F2016F2F	31	3040.6	98.08387	23.7914
F2020H	14	1204.43	86.03071	500.4327

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1576.238	2	788.119	4.59798	0.01368	3.142809
Within Groups	10798.54	63	171.4055			
Total	12374.78	65				

Assuming significance level $\alpha = .05$.

F= 4.598, p = 0.014

Decision: Since $p < .05$, reject Ho.

Conclusion: Student performance for at least one modality, is different.

Table 2 reveals a One-Way ANOVA Test of the equality of the student score means. Note that the substantial difference in variation among the groups in the first part of the table, from a low of 23.7914 to a high of 500.4327.

In evaluating the equality of means, the F test statistic is 4.60 with a corresponding p-value of 0.01368. At a 5% significance level, a statistically significant difference exists among the mean students' scores of students taught online, F2f and in hybrid modalities.

Although One-Way ANOVA may indicate that a significant difference exists among means, it does reveal which mean is different. To determine which mean score is different, a multiple comparisons test, such as the Fisher's Least Significant Difference (LSD) Test may be used.

Fisher's LSD tests for significant pairwise differences among means. The test provides a confidence interval (CI) on the difference in means. If the CI includes zero, the mean scores between two groups are not significantly different. If the CI does not include zero, the two means are significantly different.

Table 3: Fisher's Least Significant Difference Test

F2018O		F2016F2F		F2020H				
Mean	90.8369	Mean	98.08387	Mean	86.03071			
MSE		171.405						
t63		1.669						
	μ1 - μ2		ME		LCL	UCL		
F2F-O	7.246966		6.175601		1.071365	13.42257	CI does not include 0. Mean performance of F2F and Online are different	
O-H	4.80619		7.539255		-2.73306	12.34545	CI includes 0. Mean performance of Online and Hybrid are not different	
F2F-H	12.05316		7.036059		5.017098	19.08922	CI does not include 0. Mean performance of F2F and Hybrid are different	

Table 3 reveals the result of the pairwise confidence intervals among the means. Note that the CIs for F2F and online, and F2F and hybrid, illustrate that those means are significantly different. It appears that mean student performance in the course with F2F lectures is significantly higher than the scores in the hybrid or online course.

Limitation of the study: homogeneity of variances

One assumption of the One-Way ANOVA test is the equality of variances across groups. Yet ANOVA is known to be robust from violations of the assumptions that underpin the test. Would a violation of the assumption of equal variance among the three groups be enough to affect the result from the ANOVA test?

To evaluate the equality of variances across the three course modalities, a Bartlett's test is applied to the data sets:

Ho: Are variances the same across lecture modalities

Ha: variance of at least one modality differs

Using a Bartlett's test online calculator (Statolohttps://www.statology.org/bartletts-test-calculator/gy):

Test Statistic B=115.88268
p-value = 0.00000

At a 5% significance level, a significant difference exists in the variance among course delivery modalities. Is the inequality of variances enough to affect the validity of the ANOVA results? While there may not be an exact method to test the validity of the ANOVA in the absence of the inequality of variances, if another ANOVA-type yields the same results, then the results of the test are probably valid.

The Kruskal-Wallace (KW) test is a non-parametric alternative to One Way ANOVA. The test is a distribution-free test, evaluating the equality of medians across groups. In the case of the three course modalities:

H_O: $M_{dO} = M_{dF2F} = M_{dH}$ (median student performance is the same across different delivery modalities)

H_A: at least one M_d is different

Using an online KW test calculator (https://www.statology.org/kruskal-wallis-test/):

H Statistic = 6.59806
p-value = 0.03692

At a 5% significance level, there is a significant difference in the median student performance scores of students taught online, F2f and in hybrid modalities. This agrees with the results from the parametric One-Way ANOVA.

Conclusions

This article has explored the effect of differences in the delivery modalities, face-to-face live, hybrid and online recorded lectures, on student performance in a quantitative MBA course. The results from this case study reveals a significant difference in student performance across delivery modalities. Student performance in the section of the course offered in a face-to-face modality, is significantly higher the sections taught in hybrid or online modalities.

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