Title: Academic Performance in Online versus Blended Classes in Principles of Economics and Statistics Courses

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This study compares the academic performance of students in online principles of microeconomics and business statistics classes with their peers taking the same courses in a blended classroom setting. The data used in this study comes from courses taught by the same instructors utilizing the same course content and student performance assessments. Both the online and blended courses utilized the same learning management system (LMS) and the same publisher provided coursework management system (CMS). After controlling for demographic and pre-college ability factors, the results indicate students in online courses perform better when compared to their blended class counterparts in the business statistics courses.

INTRODUCTION

There has been much discussion on college campuses, and in the literature, over the past 20 years about the growing use of technology in course content delivery. Technology is being used to either supplement classroom delivery of course content or to replace it altogether. Online courses are defined as courses with no face-to-face instruction and are offered totally on the Web with the utilization of a learning management system (LMS). Instructors still play an important role in content delivery, but not through direct face-to-face instruction. According to Pew Research Center surveys conducted in spring 2011, 89% of four-year public colleges and universities offered online classes, and 46% recent college graduates report that they had taken an online course (Parker, Lenhart & Moore, 2011).

Technology enhanced courses can be either technology enhanced or blended (hybrid) courses. Generally, if more than 20% of learning activities is Web based, the courses are considered blended courses. Otherwise, they are classified as technology enhanced courses. Blended courses are thought to combine the best features of face-to-face instruction and online learning (UWMilwaukee, 2016).

Blended and online course delivery has definite cost advantages over traditional face-to-face classroom instruction. These cost advantages come both from the demand side (lower opportunity cost

for students) and the supply side (lower instructional costs and enhanced flexibility of course delivery) (Buttermore, Baker, and Culp; 2014).

A second driver is the growing utilization of technology by both students and faculty. It is only natural that this technology would spill over into the classroom. Many colleges and universities contract with one of the many LMSs available. Instructors are provided readymade LMS course sites provided for each courses taught. Except for online courses, the degree of utilization of the LMS for a course is at the instructor's discretion and some still use the technology to enhance the classroom. A growing number of University faculty are converting their courses to a blended format. Textbook publishers are developing user friendly CMSs to supplement the institution provided LMS. Publisher based coursework management systems provide students an e-text, a variety of instructional activities, and tutorials designed to enhance student learning. Incentives for the instructors include self-graded online quizzing and homework features. These features reduce seat time taken up with these activities and provide instant feedback for students.

For Slippery Rock University (SRU), a member university of the Pennsylvania State System of Higher Education (PASSHE), blended and online instruction has gone from an evolving medium to a mandate. PASSHE states its commitment to online and blended classroom instruction in its recently published *Strategic Plan 2020* (2015). *Strategic Plan 2020* is based on the premise that today's students need "…the ability to problem solve and learn new fields and work effectively in both face-to-face and virtual environments." The need to adapt to an ever changing student population is the challenge issued to all PASSHE schools. PASSHE universities must realize that "expectations for how, where, and when they (students) learn, coupled with a demand for education built around technology, create complex challenges for all universities." To meet this challenge, *Strategic Plan 2020* directs the 14 PASSHE universities to increase the number of courses and programs available to students through distance education. Specifically, the goal is to increase the number of students in online and blended courses to 53,000 by 2020. Currently, PASSHE serves 110,000 students. The target goal of 53,000 students in online and blended courses by 2020 is slightly less than half of the total students currently served by PASSHE.

This study uses Slippery Rock University (SRU) as a case example. SRU enrolls a diverse student body primarily from Western Pennsylvania and neighboring states. There is also a small and growing international student contingent. With a total enrollment of approximately 8,500 students, SRU offers a full range of traditional academic programs, both at the undergraduate and graduate level. In many ways, SRU reflects the institutional characteristics of a representative major public university. At SRU the method of course delivery of courses such as principles level economics and business statistics has seen a significant evolution over the past decade from being offered through traditional face-to-face classroom instruction, with little or no technology enhancement, to all sections of these basic courses being offered in either online or blended course format. More and more sections of these courses are being moved from a blended course format to an online format. This move is primarily in response to the desire to provide as much flexibility as possible in student scheduling of classes. This allows the University to reach more students, thereby fulfilling the mandate of a state university, while at the same time enhancing revenues.

While most faculty and administrators readily agree that technology enhanced courses contribute to student success, they are less enthusiastic about the effectiveness of online course delivery as compared to that of blended course design. This issue is actually a two-part question. The first part involves relative academic performance by students in the two alternative modes of delivery. The second part involves the relative achievement of student learning outcomes. Both parts of this question are equally important in measuring the effectiveness of online instruction as compared to blended classes. Both, however, use different types of data for comparative studies. In this case study, the authors examine only the comparative academic performance of students in totally online versus blended classroom formats of the same courses. The data used in this study is academic performance data from undergraduate principles of microeconomic and business statistics courses taught by the same instructors, using the same ancillary materials, covering the same course content, and utilizing the same means of assessment.

LITERATURE SEARCH

Relative student academic performance has been an important topic of discussion since the advent of technology enhanced instruction. A limitation of many studies exploring comparative performance is the stated investigation of the achievement of student learning outcomes through the utilization of midterm/final exam scores and/or final course grade as measures of these learning outcomes. Student academic performance is no longer commonly considered a measure of the level of mastery of student learning outcomes for program assessment purposes by either ACBSP or AACSB, the two major business program accreditation agencies. This does not, however, reduce the importance of investigating relative student academic performance in determining the effectiveness of different modes of classroom delivery. Students, instructors, and administrators are very concerned about the level of student academic performance in both blended and online classes. Our literature review has been restricted to looking at studies that compare the academic performance of students in technology enhanced or totally online courses to a control group that utilize face-to-face instruction as the mode of content delivery without technology enhancement. The authors have also restricted the literature survey to studies that looked at academic performance comparisons in undergraduate economics or business statistic courses. An early study by Agarwal and Day (1998) attempted to measure the value added by online course components in what the authors called "partial" online principles of economics and graduate courses. The courses used supplemental e-mail contact with students, online exercises, and online class discussion lists to supplement classroom content delivery. Reported results indicated that students in the partial online classes performed significantly better on concept questions on the final exam when compared to a traditional classroom control group. Results were best for students with higher GPAs.

Navarro and Shoemaker (2000) used multimedia CD-ROMs containing video, audio, and text lectures as primary content delivery methods in a macroeconomic principles class. They compared the performance (grade) of the "online" class with that of "traditional student learners" on 15 short answer essay questions on the final exam. The online learners performed better (received higher grades) on this exam than the students taught in the face-to-face traditional classroom.

Data on students in introductory economics classes that used technology enhancements was compiled across several institutions by Sosin et al. (2004). These enhancements included Web pages, posted PowerPoint notes, and e-mail dialogue. No wholly online classes were included in the data. The authors found that the use of technology significantly improved student performance as measured by test scores. The authors also reported that females performed worse than their male counterparts and that self-reported GPAs had a significant impact on higher reported test scores.

A comparison of the relative academic performance by students in an introductory business statistics course was performed by Sue (2005). A comparison was made of grade performance on four exams during the semester. The population studied was 46 students in an online section and 41 students in a face-to-face classroom setting. Both courses were taught by the same professor. Online students were asked to take the first and third exam online, but were required to come to campus for the second and final exams. Sue reported that the mean test scores were higher for face-to-face students on all exams. Online student performance on the second and final exam, the two taken on campus, was significantly lower than for the two exams taken online.

Gratton-Lavoie and Stanley (2009) looked at 8 sections of introductory macroeconomics across four consecutive semesters; a total of 156 students. There were 98 students in what is described as an in-person classroom experience with minimal computer supplements. The online sections consisted of 58 students. Students were allowed to self-select the desired mode of instruction. Online sections used a LMS and only "came to campus" three times to take exams. The face-to-face sections met 2.5 hours per week. Gratton-Lavoie also controlled for a variety of factors including age, gender, marital status, number of children, hours worked per week, hours studied per week, and parents with a college degree. Utilizing a univariate probit framework, the authors found that the raw data suggested a higher mean score for the online students. When taking into account the age of the students and GPA, online teaching had a narrowly insignificant or even negative effect.

DATA AND METHODOLOGY

Data for business statistics were collected for students in blended and online sections over four semesters; fall 2013, winter intersession 2013, spring 2014 and summer 2014. Data for principles of microeconomics were gathered from students enrolled in summer, fall, and winter intersession 2014 classes. The winter intersession and summer session were four weeks in duration as compared to16 week fall and spring semesters. All sections of the business statistics and principles of economics classes were taught by the same instructors.

The instructor for business statistics classes used MyStatLab (Pearson) as the CMS. Principles of microeconomics classes were taught by a different instructor and with Connect (McGraw-Hill) as the CMS. All courses utilized the same LMS. The text and other supporting materials were standardized across each individual course as were the methods of evaluation. Essentially, the only difference between the blended classes and the online classes was the use of "seat time" in the blended classes.

The primary data for the study is student academic performance as measured by the final course grade. There are, however, individual specific covariates which might influence the academic performance of the two groups of students. Failing to control for these factors could lead to biased estimates. In accordance with previous studies, data for the following variables are included in the model: declared major, GPA, age, socioeconomic status, gender, race, Scholastic Aptitude Test (SAT) scores, class (freshman, sophomore, junior or senior), and part time or full time enrollment status.

Specifically, the model takes the following functional form:

$$GRADES_i = \alpha + \beta_1 ONLINE_i + \beta_2 X_i + \varepsilon_i \quad (1)$$

Where $ONLINE_i$ is the main explanatory binary variable taking a value of 1 if student i is enrolled in an online course and 0 if enrolled in a blended class. X_i includes the individual-specific covariates stated above. The main dependent variable ($GRADES_i$) is the measure of student academic performance in the form of course grades obtained. The dependent variable of grades was the letter grade obtained in the business statistics course[i] while total points accumulated were used for principles of microeconomics. Equation 1 is estimated using OLS regression analysis.

An analysis of the data was performed using two different estimation methods. The first method is a simple comparison of descriptive information using a t-test to observe how the outcomes differ between the two groups (online and blended format) in the study. Secondly, the data was analyzed using multiple regression analysis controlling for factors which might affect the course grade other than the mode of course delivery.

For the business statistics courses the sample consists of 93 students. Of this total, 32 students were enrolled in the online classes and 61 were in the blended classes. Figure 1 below shows the grade distributions across the two formats. Since the total number of students enrolled in the blended sections was significantly higher, it is important to look at the proportion of grades for the two groups.

FIGURE 1
BUSINESS STATISTICS GRADE DISTRIBUTION

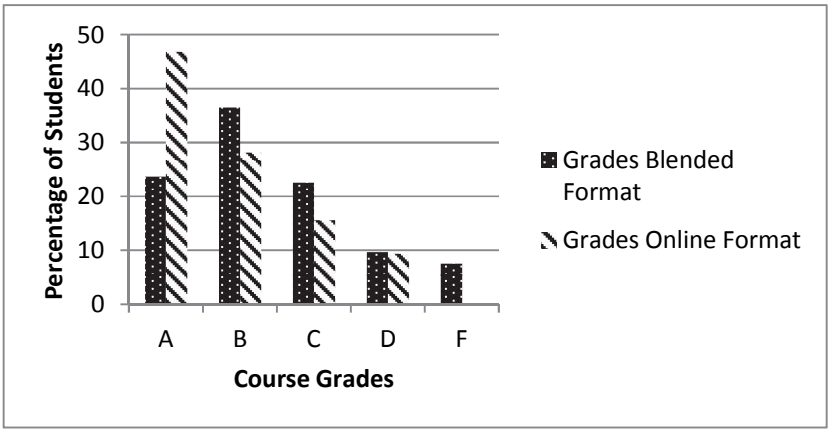

Table 1 provides the grade distribution for each group. The results show a higher percentage of students (46.88) in the online version of the course obtained an A, compared to the blended sections (11.48 percent). The proportion of students with grades of B and C are higher in the blended sections. Another notable difference is 6 percent of students failed in the blended format compared to no students failing in the online version of the course.

TABLE 1
BUSINESS STATISTICS GRADE DISTRIBUTION (PERCENTAGES)

Course Format		**Course Grade**				
	Obs	**A (%)**	**B (%)**	**C (%)**	**D (%)**	**F (%)**
Blended	61	7 (11.48%)	25 (40.18%)	16 (22.23%)	6 (9.84%)	7 (11.48%)
Online	32	15 (46.88%)	9 (28.13%)	5 (15.63%)	3 (9.34%)	0
Total	93	22 (23.66%)	34 (36.56%)	21 (22.58%)	9 (9.68%)	7 (7.53%)

The sample for principles of microeconomics consisted of 108 students with 37 enrolled in the blended version of the course and 71 enrolled online. Unlike the business statistics course, the majority of the students were enrolled online (65.6 percent) when compared to the blended section of the course (34.4 percent). Figure 2 shows the grade distribution of students enrolled in the principles of microeconomics courses for the two different formats. As in the business statistics course, the percentage of students obtaining an A in the course is higher for the online classes compared to the blended format courses.

FIGURE 2
MICROECONOMICS GRADE DISTRIBUTION

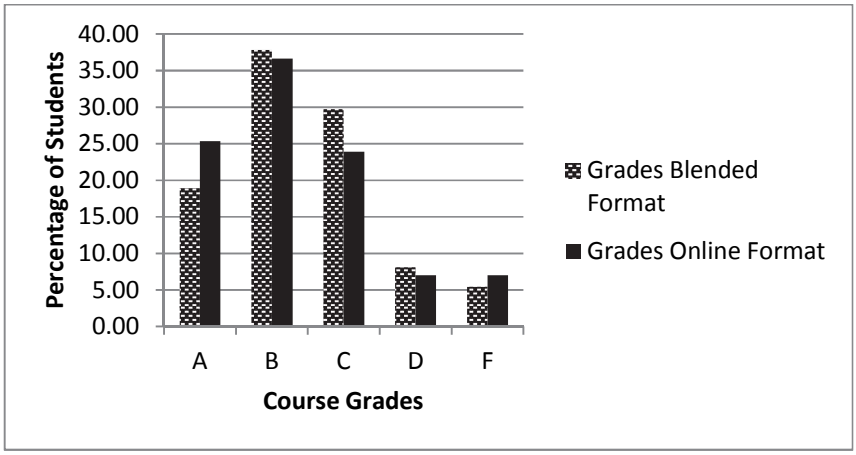

Table 2 shows the grade distribution for the two different groups for the principles of microeconomics courses. The results show a higher percentage of students (25.35) in the online version of the course obtained an A, compared to the blended section (18.92 percent). The difference however, is less varied when compared to the business statistics courses. The proportion of students with grades of B and D are fairly similar across the two formats. However, unlike in the business statistics courses, there is a higher percentage (7.04) of students who failed the principles of microeconomics courses offered online, compared to the blended format (5.41 percent).

TABLE 2
MICROECONOMICS GRADE DISTRIBUTION FOR BLENDED VERSUS ONLINE GROUPS

Course Format		**Course Grade**				
	Obs	**A (%)**	**B (%)**	**C (%)**	**D (%)**	**F (%)**
Blended	37	7 (18.92%)	14 (37.84%)	11 (29.73%)	3 (8.11%)	2 (5.41%)
Online	71	18 (25.35%)	26 (36.62%)	17 (13.94%)	5 (7.04%)	5 (7.04%)
Total	108	25 (23.15%)	40 (37.04%)	28 (25.93%)	8 (7.41%)	7 (6.48%)

RESULTS

Table 3 provides descriptive statistics for the sample used for the business statistics courses. The standard deviations are reported in parenthesis. The first column reports the means for the entire sample, whereas the second and third column outlines the results for the online and blended sections respectively.

Course grade is a categorical variable assigned a value of 4 to represent grade A, 3 to denote grade B, 2 to represent grade C and 1 to denote grade D. On average, the grades are higher for the online sections (3.13) compared to the blended classes (2.59). An alternative measure of student academic performance is the percentage points scored by students in the courses, based on which the course grades are awarded. The online students, on average, have a higher percentage points score (about 85 percent), compared to the students in the blended sections (77 percent). Among the demographic variables, the online courses

have, on average, a higher percentage of female students, are slightly older in age, and have a higher percentage of white students compared to the blended classroom courses. Among the categories of academic aptitude, on average online students have a higher GPA and lower SAT Verbal and Math scores compared to the blended class students. The blended classes have a higher proportion of freshmen compared to the online format, while the sophomore and junior enrollments are higher in the online classes. There was a higher percentage of transfer students enrolled in the blended format of the business statistics courses. All of the students in the business statistics courses are business majors.

TABLE 3
DESCRIPTIVE STATISTICS: SAMPLE MEANS AND STANDARD DEVIATIONS
(BUSINESS STATISTICS)

Variable	All	Online	Blended
Dependent Variable			
Course grades	2.59	3.13	2.31
	(1.17)	(1.00)	(1.62)
Percentage Points	79.84	84.98	77.06
	(12.39)	(9.98)	(12.75)
Demographics			
Female (%)	43.00	62.50	32.79
Age	21.12	22.19	20.54
	(3.88)	(6.09)	(1.73)
Ethnicity[a]			
White (%)	60.71	39.29	21.42
African American (%)	1.31	0.00	1.31
Asian (%)	25.00	0.00	25.00
Hispanic (%)	3.57	3.57	0.00
Academic Aptitude			
GPA	2.75	3.08	2.58
	(0.82)	(0.62)	(0.86)
SAT Verbal	481.05	477.00	483.24
	(66.43)	(61.31)	(69.76)
SAT Math	513.16	504.00	518.11
	(71.14)	(106.19)	(50.27)
Class level[b]	1.91	2.33	1.68
	(0.88)	(1.11)	(0.63)
Transfer (%)	35.48	7.5	27.96
Observations	93	32	61

a. Total observations with ethnicity information: 28
b. 1=Freshman; 2= Sophomore; 3=Junior; 4=Senior

Table 4 provides the descriptive statistics for the principles of microeconomics courses. The standard deviations are reported in parenthesis. The first column reports the means for the entire sample, whereas the second and third column outlines the results for the online and blended sections respectively.

Total points correspond to the overall point total earned by students in the course. The course grade was solely based on the total points accumulated. On average, total points are higher for students in the online sections compared to the blended classes. Among the demographic variables, student characteristics differ somewhat compared to the business statistics classes. The online classes in microeconomics have, on average, the same percentage of female students, are slightly older in age, and have a lower percentage of white students compared to the blended class students. Among the categories of academic aptitude, on average, online students have a lower GPA and lower SAT Verbal and Math scores compared to the blended class students. While the class level of students is comparable across the two different formats, a higher percentage of transfer students enroll in the online classes compared to the blended counterpart. Over 55 percent of the students in the microeconomics courses are business majors. Amongst the business majors, about 63 percent are enrolled in online courses and 37 percent in the blended format classes.

TABLE 4
DESCRIPTIVE STATISTICS: SAMPLE MEANS AND STANDARD DEVIATIONS (PRINCIPLES OF MICROECONOMICS)

Variable	**All**	**Online**	**Blended**
Dependent Variable			
Total Points	427.49	429.35	424.23
	(66.17)	(66.74)	(65.89)
Demographics			
Female (%)	51.40	51.47	51.28
Age	20.98	21.37	20.31
	(2.97)	(3.37)	(2.03)
Ethnicity[a]			
White (%)	61.29	19.03	32.26
African American (%)	3.23	3.23	0.00
Asian (%)	35.48	19.35	16.13
Hispanic (%)	0.00	0.00	0.00
Academic Aptitude			
GPA	2.86	2.76	3.02
	(0.69)	(0.70)	(0.64)
SAT Verbal	490.40	488.60	492.81
	(67.83)	(75.42)	(57.15)
SAT Math	503.73	499.30	509.69
	(62.66)	(67.41)	(56.14)
Business Majors (%)	55.14	63.00	37.00

Class level[b]	2.69	2.88	2.36
	(0.92)	(0.96)	(0.74)
Transfer (%)	30.84	23.36	7.48
Observations	107	68	39

a. Total observations with ethnicity information: 31
b. 1=Freshman; 2= Sophomore; 3=Junior; 4=Senior

A t-test was conducted to examine the equality of means of the online and blended groups. The results of the hypothesis testing (using a two sample t-test) are reported in Table 5 for the business statistics courses. The column "difference" indicates the difference in course grades and GPA between the online and blended format classes. The results indicate course grades are higher for the online classes compared to the blended class group for the business statistics courses. The results are statistically significant at the 1 percent level.

TABLE 5
HYPOTHESIS TESTING (BUSINESS STATISTICS)

Variable	Difference	Standard Error
Course Grades	-0.81***	0.24
GPA	-0.51***	0.17
Number of observations	93	

The results of the hypothesis testing (using a two sample t-test) for the principles of microeconomics courses are reported in Table 6. The column "difference" indicates the difference in course grades and GPA between the online and blended course group of students. As the results indicate, the course grades are higher for the online classes compared to their blended counterpart. The result, however, is not statistically significant. On the other hand, the GPA is higher for students in the blended classroom setting, and the result is statistically significant at 1 percent level.

TABLE 6
HYPOTHESIS TESTING (PRINCIPLES OF MICROECONOMICS)

Variable	Difference	Standard Error
Total Points	-5.12	13.34
GPA	0.27***	0.13
Number of observations		107

Examining the correlation coefficients for the business statistics courses, as reported in Table 7, it appears that grades are negatively correlated to age and the class standing of the student. Additionally, the results indicate that higher ages of the students are associated with lower GPA, and SAT scores. There

is a positive correlation between students' pre-college abilities as measured by the SAT scores, and their current performance in college as measured by GPA's. Also, there is a strong positive correlation between grades obtained in the business statistics courses and the GPA (0.79).

TABLE 7
CORRELATION MATRIX (BUSINESS STATISTICS)

	Grades	**Age**	**GPA**	**Female**	**Class level**	**SAT Verbal**	**SAT Math**
Grades	1.000						
Age	-0.23	1.000					
GPA	0.79	-0.08	1.000				
Female	0.09	-0.05	0.27	1.000			
Class level	-0.01	0.70	-0.01	0.10	1.000		
SAT Verbal	0.33	-0.22	0.20	-0.14	-0.35	1.000	
SAT Math	0.42	-0.47	0.18	-0.35	-0.31	0.58	1.000

The correlation matrix for the microeconomics courses (reported in table 8) indicates that performance in the course (assessed by total points) is positively correlated to all parameters including student's age, GPA and their SAT scores. The correlations are, however, weaker when compared to the business statistics courses.

TABLE 8
CORRELATION MATRIX (MICROECONOMICS)

	Total Points	**Age**	**GPA**	**Female**	**Class level**	**SAT Verbal**	**SAT Math**
Total Points	1.00						
Age	0.19	1.00					
GPA	0.65	-0.05	1.00				
Female	0.01	-0.17	0.24	1.00			
Class level	0.29	0.66	0.25	0.13	1.00		
SAT Verbal	0.23	0.12	0.46	0.25	0.32	1.00	
SAT Math	0.21	0.13	0.31	-0.03	0.21	0.58	1.00

As indicated earlier, there are several individual specific covariates which might influence the academic outcomes of these two groups of students, and failing to control for these factors might lead to biased estimates. Hence ordinary least squares (OLS) analysis of multiple regression was performed to control for demographic and academic variables which affect student grades. Table 9 below reports the

OLS estimation of equation (1) for the business statistics courses, with course letter grades as the outcome variable. Two different specifications of the model are estimated. These two specifications (results reported in columns 1 and 2 respectively), differ in that in the second estimation an indicator of whether the student was a transfer to the university was included.

The dependent variable is course grades and the main explanatory variable of interest is the binary variable online, which indicates whether the student was enrolled in the online format of the course. The estimated equations yielded a significant F-statistic and acceptable R^2 for the time-series data. The R^2 indicates that the variables used explain 57 percent of the variation in course grades for specification 1 and 51 percent of the variation in course grades for specification 2. The results confirm the findings indicated in the descriptive statistics. Students in the online courses outperform their counterparts enrolled in the blended sections of the course with respect to academic performance. In particular, after controlling for individual specific covariates, students in online courses earn 0.39 (about half of a letter grade) higher grade compared to their blended course counterparts (statistically significant at 10 percent level). Among other variables which have a statistically significant impact on course grades are GPA and SAT scores, both indicating a positive influence on course grades. Other demographic and academic aptitude variables do not have a statistically significant impact in explaining course grades in the business statistics courses. There is no statistically significant differential impact of a transfer student on academic outcomes in the business statistics courses.

Since the data utilized for the study is extended over multiple semesters, which includes summer and winter intersession, two other specifications of the model are adopted. These specifications include dummy variables indicating summer (specification 3) and winter (specification 4) sessions for the business statistics courses. This is to ensure there are no fundamental differences in the outcome due to differences in the student populations enrolled in the summer or winter intersession. The results are reported in columns 3 and 4 in Table 9 below. The additional specifications indicate there are no statistically significant differences in the academic performance outcomes based on the session in which students enrolled. The coefficients of the dummy variables summer and winter are not statistically significant.

TABLE 9
BUSINESS STATISTICS OLS RESULTS (DEPENDENT VARIABLE: COURSE GRADES)

Variable	Coefficient Estimates (1)	Coefficient Estimates (2)	Coefficient Estimates (3)	Coefficient Estimates (4)
Constant	-3.19 (2.08)	-2.92 (2.11)	-4.30*** (1.95)	-4.09*** (1.98)
Online	0.39* (0.25)	0.42* (0.26)	0.37 (0.32)	0.48** (0.26)
Female	-0.33 (0.24)	-0.29 (0.24)	-0.13 (0.23)	-0.13 (0.23)
Age	0.02 (0.09)	-0.01 (0.09)	-0.001 (0.08)	-0.001 (0.08)
White	-0.00 (0.28)	-0.05 (0.29)	0.13 (0.27)	0.13 (0.27)
GPA	1.17*** (0.17)	1.16*** (0.17)	1.15*** (0.16)	1.15*** (0.16)

SATVerbal	0.001	0.001	0.002	0.002
	(0.001)	(0.002)	(0.002)	(0.002)
SATMath	0.003**	0.004***	0.004***	0.004***
	(0.002)	(0.002)	(0.002)	(0.002)
Sophomore	0.03	-0.02	0.56***	0.56***
	(0.25)	(0.26)	(0.24)	(0.24)
Junior	0.21	0.02	0.69**	0.69**
	(0.29)	(0.29)	(0.36)	(0.36)
Senior	-0.29	-0.23	-0.12	-0.02
	(0.28)	(0.49)	(0.44)	(0.44)
Transfer		0.29	0.26	0.26
		(0.35)	(0.32)	(0.32)
Summer			0.11	
			(0.34)	
Winter				-0.12
				(0.34)
Observations	57	57	57	57
Adjusted R-squared	0.57	0.51	0.62	0.62
F-statistic	8.35	7.52	9.47	8.52

Standard errors are in parenthesis. *** denotes significance at 1%, ** denotes significance at 5%, * denotes significance at 10%.

Because of a possible concern that letter grades translated to a 4-point scale for the business statistics classes do not provide a continuous variable an alternative measure was utilized. Course grade was converted to the grade as a percentage. Table 10 below reports the OLS estimation of equation (1) for the business statistics courses. The two different specifications of the model above are estimated.

The estimated equations yielded a significant F-statistic, and acceptable adjusted R^2, which indicate that the control variables used explain 68 percent of the variation in the percentage grades for specification 1, and 69 percent of the variation for specification 2. Further, the results confirm the findings reported in the descriptive statistics. Students in the online courses achieved better academic performance compared their counterparts enrolled in the blended sections of the courses. In particular, after controlling for individual specific covariates that might affect academic performance, students in the business statistics online courses earned 4.76 percent higher than those enrolled in the blended courses. The results are statistically significant at 1 percent level. GPA and SAT scores have a positive and significant impact on percentage grades. A student's class standing also has a significant impact on the academic performance in the business statistics, with sophomores and juniors outperforming the freshmen students. Other demographic and academic aptitude controls do not have a statistically significant impact on the test scores in the business statistics courses.

Including dummy variables to estimate whether there are any differences across semesters in which the courses are taken, results from specifications 3 and 4 indicate no statistically significant impact of summer and winter sessions on the academic outcome of students. The coefficients of the dummy variables summer and winter are not statistically significant. As in specifications 1 and 2, the results indicate that after controlling for individual specific covariates, the students enrolled in online sections achieve about 5 percent higher in overall scores compared to their peers in the blended format classes.

TABLE 10
BUSINESS STATISTICS OLS RESULTS (DEPENDENT VARIABLE: PERCENTAGE GRADE)

Variable	Coefficient Estimates (1)	Coefficient Estimates (2)	Coefficient Estimates (3)	Coefficient Estimates (4)
Constant	2.37	6.06	6.21	6.21
	(18.2)	(18.17)	(18.49)	(18.49)
Online	4.76***	5.23***	5.38**	5.15***
	(2.16)	(2.15)	(3.00)	(2.47)
Female	-1.98	-1.54	-1.55	-1.55
	(2.12)	(2.11)	(2.15)	(2.15)
Age	0.54	0.18	0.16	0.16
	(0.74)	(0.77)	(0.81)	(0.81)
White	0.52	-0.13	-0.13	-0.13
	(2.52)	(2.53)	(2.56)	(2.56)
GPA	12.23***	12.01***	11.99***	11.99***
	(1.49)	(1.49)	(1.51)	(1.51)
SATVerbal	0.02	0.02	0.02	0.02
	(0.02)	(0.02)	(0.02)	(0.02)
SATMath	0.03**	0.04***	0.04***	0.04***
	(0.02)	(0.02)	(0.02)	(0.02)
Sophomore	6.77***	6.77***	6.78***	6.78***
	(2.19)	(2.17)	(2.21)	(2.21)
Junior	8.38***	8.09***	8.13***	8.13***
	(3.34)	(3.31)	(3.38)	(3.38)
Senior	1.61	2.55	2.60	2.60
	(4.00)	(4.00)	(4.12)	(4.12)
Transfer		4.33	4.33	4.34
		(2.98)	(3.02)	(3.02)
Summer			-0.23	
			(3.22)	
Winter				0.23
				(3.22)
Observations	57	57	57	57
Adjusted R-squared	0.68	0.69	0.68	0.68
F-statistic	12.83	12.13	10.88	10.88

Standard errors are in parenthesis. *** denotes significance at 1%, ** denotes significance at 5%, * denotes significance at 10%.

Table 11 reports the OLS estimation of equation (1) for the principles of microeconomics courses. The outcome variable reported here are total points obtained by students in the courses. Similar to the

results discussed for business statistics, students in the online courses perform significantly better than students enrolled in the blended classes. In particular, students enrolled in the online courses earn an additional 22.84 points (or 4.2 percent higher total points) towards the overall course points compared to their counterparts enrolled in the blended format. Among other variables which have a statistically significant impact on course grades are GPA, and age; both confirming a positive influence on course grades.

In specification 2, reported in column 2, two additional variables are added to the model. The first variable introduced is exam time[ii], which indicates the length of time each students in the online classes spent completing the exam. This data was recovered from the LMS and CMS used for the courses. Interestingly, after adding exam time to the model, no statistically significant difference in test scores is evident between the two groups, online and blended formats, of students. While previous result indicated better academic performance of students enrolled in online courses, no such difference exists between online and blended groups when information on time spent taking exams is included. This finding is significant in that while students in the online classes were strictly limited on available time, they were not monitored while taking exams. Thus, while there is the possibility of students enrolled in the online courses spending some time looking up answers, no performance advantage is evidenced.

Secondly, in specification 2, as in the business statistics course analysis, an indicator of whether the student was a transfer to the university was included. Similar to the business statistics courses, there is no statistically significant differential impact of a transfer student on academic outcomes.

Further, dummy variables are included to indicate whether there are differences in the outcomes based on the timing of the sessions for the principles of microeconomics courses. Specification 3 includes a dummy for the summer session, and specification 4 comprises of a dummy for the winter intersession. As previously noted in the results of the business statistics courses, there are no statistically significant impact of the summer and winter sessions on the academic outcomes as measured by total points obtained in the microeconomics courses. The results are reported below in columns 3 and 4 of Table 11.

TABLE 11
PRINCIPLES OF MICROECONOMICS OLS RESULTS (DEPENDENT VARIABLE: TOTAL POINTS)

Variable	Coefficient Estimates (1)	Coefficient Estimates (2)	Coefficient Estimates (3)	Coefficient Estimates (4)
Constant	-52.51	-161.97	-161.42	-149.44
	(134.89)	(135.28)	(136.42)	(135.99)
Online	22.84**	-4.68	-5.29	-4.37
	(11.51)	(14.97)	(15.66)	(14.99)
Female	-9.89	-9.04	-9.08	-9.95
	(11.10)	(11.01)	(11.10)	(11.06)
Age	13.19***	13.77***	13.69***	13.25***
	(5.95)	(5.66)	(5.72)	(5.69)
White	-7.19	-7.06	-6.94	-5.96
	(13.47)	(12.78)	(12.91)	(12.84)
GPA	68.63***	65.47***	65.64***	65.84***
	(10.10)	(9.83)	(9.97)	(9.84)

SATVerbal	-0.09 (0.10)	-0.06 (0.09)	-0.06 (0.10)	-0.04 (0.10)
SATMath	0.01 (0.11)	0.17 (0.11)	0.17 (0.12)	0.16 (0.11)
Sophomore	9.55 (27.45)	8.76 (26.20)	8.26 (26.63)	5.83 (26.39)
Junior	-4.70 (27.09)	-6.22 (26.92)	0.29 (26.39)	-4.99 (26.59)
Senior	-0.90 (27.45)	1.46 (26.23)	0.38 (27.43)	-1.77 (26.46)
Exam Time		0.38*** (0.14)	0.38*** (0.15)	0.35*** (0.15)
Transfer		20.16 (13.88)	20.27 (14.01)	18.92 (13.95)
Summer			2.42 (16.33)	
Winter				18.93 (19.67)
Observations	75	75	75	75
Adjusted R-squared	0.46	0.51	0.51	0.51
F-statistic	7.30	7.52	6.84	7.01

Standard errors are in parenthesis. *** denotes significance at 1%, ** denotes significance at 5%, * denotes significance at 10%.

Additional analysis on whether a student's major influences their academic outcome was conducted for the principles of microeconomics courses[iii]. Students enrolled in the principles of microeconomics courses were from a variety of 30 different majors. Hence the data was segregated into business, and non-business majors[iv]. Specifically, a dummy variable was introduced with a value of 1 if the student was a business major, and zero otherwise.

The results reported in Table 12 indicate no statistically significant impact of being a business major on the academic performance of students in the principles of microeconomics courses.

TABLE 12
PRINCIPLES OF MICROECONOMICS OLS RESULTS INCLUDING MAJORS
(DEPENDENT VARIABLE: TOTAL POINTS)

Variable	Coefficient Estimates (1)	Coefficient Estimates (2)	Coefficient Estimates (3)	Coefficient Estimates (4)
Constant	-56.09	-165.10	-164.70	-152.63
	(135.76)	(136.13)	(137.32)	(136.89)
Online	21.92**	-5.21	-5.59	-4.89
	(11.54)	(15.09)	(15.76)	(15.10)
Business Major	6.66	6.33	6.23	6.06
	(11.55)	(11.03)	(11.18)	(11.05)
Female	-6.41	-9.78	-9.79	-10.64
	(11.59)	(11.15)	(11.24)	(11.19)
Age	13.82***	13.82***	13.78***	13.31***
	(5.95)	(5.69)	(5.76)	(5.72)
White	-5.75	-5.54	-5.48	-4.51
	(13.74)	(13.12)	(13.24)	(13.18)
GPA	71.63***	66.73***	66.82***	67.04***
	(10.41)	(10.12)	(10.25)	(10.14)
SATVerbal	-0.10	-0.06	-0.06	-0.04
	(0.10)	(0.10)	(0.10)	(0.10)
SATMath	0.07	0.17	0.17	0.16
	(0.11)	(0.11)	(0.12)	(0.11)
Sophomore	1.55	4.45	4.19	1.74
	(28.65)	(27.39)	(27.75)	(27.57)
Junior	-8.88	-1.64	-1.98	-3.33
	(27.46)	(26.38)	(26.84)	(27.08)
Senior	-7.24	-1.42	-2.07	-4.48
	(28.01)	(26.85)	(27.94)	(27.07)
Exam Time		0.38***	0.38***	0.35***
		(0.14)	(0.15)	(0.15)
Transfer		18.29	18.39	17.15
		(14.33)	(14.49)	(14.40)

Summer			1.56 (16.50)	
Winter				18.64 (19.79)
Observations	75	75	75	75
Adjusted R-squared	0.46	0.51	0.50	0.51
F-statistic	6.29	6.89	6.30	6.45

Standard errors are in parenthesis. *** denotes significance at 1%, ** denotes significance at 5%, * denotes significance at 10%.

CONCLUSIONS

This report is a case study of business statistics and principles of microeconomics courses taught at a major public university in both online and blended class formats. The respective courses were taught by the same instructors utilizing the same LMS, CMS, course materials and pedagogy. The only significant difference between the two formats was the blended courses utilized a face-to-face classroom instruction component which the online courses did not contain.

The research question explored in this study is whether or not there is a significant difference in the academic performance of students enrolled in courses utilizing the two alternative modes of course delivery. Academic performance was measured using overall course grade data. The business statistics courses used the final course grade (as well as percentage points) as measures of academic performance. Principles of microeconomics courses used total points accumulated as data for the outcome variable. The estimated models were controlled for the individual specific covariates of gender, age, ethnicity, and academic aptitude.

Students in the business statistics courses, after controlling for individual specific covariates, earned 0.39 (about half of a letter grade) higher grade compared to their blended class counterparts. The results are significant at the 10 percent level. Considering the total percentage points earned in the course as an alternate measure of academic achievement, students in the online business statistics courses earned about 5 percent higher in overall course scores compared to their peers in the blended format classes. These results are statistically significant at 1 percent level. Among the specific covariates which have a statistically significant impact on course grades are GPA and SAT scores, both confirming a positive influence on course grades. Class level standing had a positive and significant impact, with the sophomores and juniors outperforming freshmen. Other demographic and academic aptitude variables did not have a statistically significant impact in explaining academic performance. Alternate specifications of the model included dummy variables for the summer and winter intersession classes. The results indicate no statistically significant impact of summer and winter intersession on academic performance of students. These results indicate less likelihood of selection bias (for instance, students of poorer academic ability enrolling in the non-traditional summer and winter sessions) in the data set.

In the principles of microeconomics, students enrolled in the online courses earned an additional 22.84 points (or 4.2 percent higher total points) when compared to their counterpoints enrolled in the blended classes. The results are significant at the 5 percent level. Among other variables which had a statistically significant impact on course grades are GPA and age, both confirming a positive influence on the total points. Different specifications of the model (including dummy variables indicating transfer status of the students, or the non-regular semester in which students were enrolled in the courses), indicates no statistically significant differences in student outcome between the online and blended sections of the courses. Similar to the business statistics outcomes, there are no statistically significant impact of the summer and winter intersession choices on student performances.

However, there are important changes in the results for the principles of microeconomics courses, when additional information is included in the model specifications. In particular, after the inclusion of the time spent taking the exams for the online course students (the variable exam time, which indicates the length of time each students in the online classes spent taking the exam), there are no statistically significant difference in academic performance between online and blended course format students. This result suggests that students in the unmonitored online exam environment did not benefit from "looking up the answers."

This case study presents clear evidence that there is a significant difference in the academic performance of the student population between those taking the courses in an online format and those taking the courses in a blended format for the business statistics courses. For the principles of microeconomics courses, however, there is no clear indication of either the online course students or blended classes students outperforming their counterparts. Of the covariates included in the model, only the overall GPA was significant across the data for both business statistics and principles of microeconomics courses.

As an efficient mode of delivery from the standpoint of academic performance, students in the online classes performed better than their peers taking the courses in a blended format with a face-to-face course delivery component in the business statistics courses. For the principles of microeconomics courses, online students performed at the same level as the students in the blended classes. This is compelling evidence that when utilizing the pedagogy adopted in these courses, online instruction appears to be at least an equally efficient method of instruction when compared to blended courses in achievement of student academic performance.

FURTHER ANALYSIS AND FUTURE RESEARCH

This case study looks at the relative effectiveness on online versus blended course delivery from the standpoint of student academic performance. Academic performance, however, is not an acceptable measure of the extent to which student learning is actually taking place. The next phase of the authors' research involves choosing clearly defined learning objectives and utilizing a variety of course embedded questions to access relative student achievement of learning outcomes between online and blended modes of course delivery. Only after the results of this second study are available will a more complete answer as to question of whether or not online course instruction is an equally effective mode of delivery when compared to blended courses.

ENDNOTES

i. In an alternate specification of the model, percentage points are used as the dependent variable for business statistics courses
ii. Information on the exam time variable is not available for the business statistics courses
iii. All of the students enrolled in the Business Statistics courses were business majors; hence the analysis could not be carried out for those data.
iv. At SRU, the economics majors are considered as business majors.

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