Student Outcomes in Economics Principles: Online vs. Face-to-face Delivery

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ABSTRACT

This study looks at the performance of students in an online and face-to-face section of economic principles with the same instructor. After controlling for the bias of students selecting the online section and observable characteristics, we did not find any statistical difference in the exam performance of students across delivery modes of the course. This work contributes to the literature on student outcomes across delivery modes with the implementation of an experimental design in that the instructor purposefully made the sections as similar as possible including the same homework and exams.

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INTRODUCTION

Instructors often make changes to course design to improve student learning. However, the move to online courses has not always been motivated by the belief that students learn better online. In fact, online courses are often viewed as requiring additional work to produce inferior outcomes.

We set out to investigate student performance in online course with a unique experiment design. During the 2011-2012 and 2012-2013 academic years, our principles courses were taught online and face-to-face by the same instructor. Students in both sections were given the same exams and homework assignments as well as the same lecture content. With this similarity, we hypothesized that students would do equally well in the online and face-to-face sections of the course. At the end of the first semester in our sample, the exam performance in the two microeconomics sections was statistically different, and the online section scored lower. However, after controlling for the biases in selecting an online section and observable characteristics of the students, we find no statistical difference in the exam performance in the online and face-to-face sections of the principles of microeconomics or principles of macroeconomics courses.

The literature on student performance across delivery modes is split with researchers finding online students performed worse in some fields and as well or better than face-to-face students in other fields. In the next section, we present a review of the literature focused on student performance differences across delivery modes. Then, we discuss the initial student performance data and the characteristics of our sample. We finish with the regression results, possible explanations, and plans to extend the project.

BACKGROUND LITERATURE

Studies comparing course delivery modes have looked at differences in student satisfaction, student perceptions of quality, and student performance. Other studies have sought to ascertain whether the learning style of the student leads to different outcomes when students choose online or traditional courses. Our study focuses on student performance, differentiated by course delivery mode. Within this specific literature, there is not a consensus as to the impact of course delivery mode and student performance. We begin with papers finding generally inferior outcomes for online courses.

Brown and Liedholm (2002) find that online principles of microeconomics courses are inferior to traditional courses, and find that students who chose an online course would have scored significantly higher had they chosen the traditional mode instead. Crouse (2002) found that students in principles of agricultural economics scored generally lower on exams in the online section. Coates, Humphreys, Kane, and Vachris (2004) found, using two-stage least squares, that students who took principles of economics online scored lower on the Test of Understanding College Economics (TUCE) than students who took the same course face-to-face. They also noted that failing to account for sample selection bias in online and face-to-face sections biases this difference towards zero giving the appearance of no significant difference. Anstine and Skidmore (2005) find the online learning environment for M.B.A. courses to be less effective than the traditional classroom. They use a two-stage least squares analysis and a switching model to account for the fact that a student's choice of course delivery mode may be related to learning. The difference in student performance shows up only after accounting for the selection bias. Stephenson, McGuirk, Zeh, and Watts Reaves (2005) examined students in an introductory agricultural microeconomics course and found that students with average or below average aptitude test scores had worse outcomes in online sections. Ury, McDonald, McDonald, and Dorn (2006) looked at outcomes for students in computer science and information systems courses. After accounting for student characteristics, students in large courses serving several majors fared worse in online sections than those in traditional sections. Students in upper-level courses focused on a particular major show no difference. Farinella (2007) found that students in introductory finance online courses under-performed their counterparts in the traditional sections.

More recently, Gratton-Lavoie and Stanley (2009) found, after correcting for differences in student demographics, the online teaching mode had narrowly insignificant or negative effect. Howsen and Lile (2008) used a two-stage least squares model and found students in online sections of principles of macroeconomics scored almost two letter grades lower than those in traditional sections. Trawick, Lile, and Howsen (2010) studied macroeconomics students and found that not only did online students performed worse overall, but also found no selection bias for students choosing the online sections. Scherrer (2011) examines undergraduate statistics courses in traditional, hybrid and online delivery modes, and finds better performance from the traditional sections than in the others. Verhoeven and Wakeling (2011) look at students in an upper-level, quantitative methods, business core course and find students performed significantly lower in the online sections, regardless of their course grade in a lower-level statistics course.

While numerous studies have concluded online courses produce inferior outcomes, many others have found no difference, or even slightly superior outcomes for online courses. Navarro and Shoemaker (2000) looked at introductory economics courses and found cyberlearners performed as well or better than traditional students, regardless of student characteristics. Neuhauser (2002) found students in a principles of management course had no significant difference in test scores, assignments, participation and course grades. McLaren (2004) found, for business statistics students who persist, there is no significant difference in final course grade for online and traditional learners. McFarland and Hamilton (2005) found that students in a senior-level undergraduate MIS course had no performance difference in online and traditional sections. Unal (2005) found no statistically significant difference in student performance in an educational technology course. Bennett, Padgham, McCarty, and Carter (2007) examined online and traditional students in micro and macroeconomics courses. They found no difference in performance overall, but found student in microeconomics did better in the traditional setting, while students in macroeconomics had higher scores in online sections.

Daymont and Blau (2008) looked at outcomes for students in undergraduate management courses, and found that online students performed as well as traditional students, after controlling for student characteristics. Harmon and Lambrinos (2008) used exam questions rather than students as the unit of observation. In MBA introductory economics courses delivered in a hybrid format, they found students had a significantly greater chance of answering a question correctly if the chapter was taught online. For principles of microeconomics, they also found positive and significant results for the online sections. Bennett, McCarty, and Carter (2011) studied MBA managerial economics courses and did not find overall differences in final grades for online and traditional sections, but they did find that the difference between stronger and weaker students was larger in online sections. Student strength was measured by aptitude and effort. Ary and Brune (2011) found students in personal finance courses performed the same regardless of delivery mode, but that incoming GPA and ACT scores better predicted student success. Euzent, Martin, Moskal, and Moskal (2011) compared introductory economics courses with traditional and lecture capture delivery. Results demonstrated no significant differences in student performance across the delivery modes. Driscoll, Jicha, Hunt, Tichavsky, and Thompson (2012) studied students in online and traditional introductory sociology courses. They found the difference in student performance between delivery modes is accounted for by the presence of a selection effect, and the delivery mode does not have an impact on student performance.

STUDY DESIGN

The University of South Dakota is a mid-sized university located in Vermillion, SD. USD has enrollment of approximately 7,500 undergraduate students and 2,500 graduate students. Fifty-eight percent of students are full time students. We have 453 full time faculty members on campus. The Economics department is housed in the Beacom School of Business which is the only AACSB International accredited business school in the state. Beacom School of Business has approximately 1,250 undergraduate students and is now offering all business core courses online.

The school is one of six schools in a regental network with common course numbers that facilitates seamless transfer back to a student's home university. USD is not the only university in the system offering these courses online during the semesters studied. In addition, the face-to-face sections analyzed here were not the only sections of the course offered on campus during the semester. We only use student performance in courses with the same instructor to eliminate any instructor bias in the results.

The study includes data from four semesters (fall 2011, spring 2012, fall 2012, and spring 2013). ECON 201: Principles of Microeconomics was first offered online by USD in the fall 2011 semester during which one instructor taught both an online and a face-to-face section. During the spring 2012 semester, the same instructor taught both an online and face-to-face section of ECON 202: Principles of Macroeconomics. This was the first semester ECON 202 was offered online by USD. The combination of online and face-to-face by the same instructor was offered again in the 2012-2013 school year. Data from the spring of 2013 for the face-to-face course was excluded because the instructor took leave midway through the semester. The instructor continued to teach the online section during the spring 2013 semester.

Regardless of semester, the online and face-to-face sections had the same textbook, chapter coverage, exams, and web-based homework assignments. Exams were given using the Desire2Learn (D2L) learning management software and Respondus Lock-Down browser for all sections. In the face-to-face sections, students brought in their own laptops or used one furnished by the school. They were not allowed to use notes or books. Online exams were proctored to ensure students did not use any notes or books. Proctoring restrictions are managed through the Office of Continuing and Distance Education at USD. Students can use a pre-approved proctor site of which there are four in the state. Students can also have another individual approved as a proctor, or use a testing center on campus at another regental school. Individually approved proctors include librarians, members of the clergy, faculty at another institution, superintendents or principals of local school districts, or professional testing centers.

The instructor worked to insure delivery of the material in the two course sections was as similar as possible. The instructor in the sample has extensive prior experience teaching completely online and has participated in multiple extensive online training seminars/courses. The online sections had either weekly virtual meeting times during which the instructor would give the same lecture as in class using the Collaborate web conferencing software or prerecorded lectures which students could watch at their leisure. When prerecorded lectures were used, the online conferencing software was used to conduct office hours. Collaborate allows students to ask question using a microphone, webcam, and chat messenger. The online course was completely online – designed to be online – not simply a repository of the face-to-face information. Online students also participated in threaded discussions to simulate the type of student-student and student-teacher interaction that happens in a face-to-face class.

For this project, we have matched student exam and homework performance with information from their institutional records such as age, gender, ACT scores, GPA, number of credits cumulative, number of concurrent credits, number of online courses, number of math/stat courses, home university, address, major, military status, and international status. We have two separate samples (see Table 1) to differentiate between ECON 201 (Principles of Microeconomics) and ECON 202 (Principles of Macroeconomics) sections. We could not combine the two samples with use of a dummy variable because our Principles courses are sequenced. Therefore, we have students who are in both samples. The hypotheses for this

Table 1
Study Samples

Principles of Microeconomics	Principles of Macroeconomics
Fall 2011, Online	Spring 2012, Online
Fall 2011, Face-to-face	Spring 2012, Face-to-face
Fall 2012, Online	Spring 2013, Online
Fall 2012, Face-to-face	

study are that students will perform equally well in online and face-to-face delivery modes.

DATA

Reviewing the scores for exam performance and homework performance in each section of the course, there appears to be a difference. Our null hypothesis is that students in the two sections perform equally well on exams and homework (as measured by % score).

Hypothesis 1: Exam performance in online sections of Principles of Microeconomics is the same as face-to-face sections.

Hypothesis 2: Exam performance in online sections of Principles of Macroeconomics is the same as face-to-face sections.

Hypothesis 3: Homework performance in online sections of Principles of Microeconomics is the same as face-to-face sections.

Hypothesis 4: Homework performance in online sections of Principles of Macroeconomics is the same as face-to-face sections.

Consider the data presented in Table 2. We can reject the null for Hypotheses 1 and 3. We cannot reject the null for Hypothesis 2 and 4.

The characteristics of the students in the sample are presented in Table 3. The students in online sections are different in four areas that we would have expected. These students are older, have a longer commute to their home university, are taking fewer credit hours concurrently, and have taken more online courses in the past. The differences in all of these characteristics are statistically different for online students, using a two-tailed T-test at the 0.05 level. We did not find any statistical difference in online students with regards to GPA, ACT Math scores, gender, or number of cumulative credits.

REGRESSION ANALYSIS

We use regression analysis to determine the marginal effect on homework or exam score of being in the online

Table 2
Descriptive Statistics on Course Performance

Scores by Course		Face-to-face	Online
Principles of Microeconomics	Exam score (% of total semester exam points)	0.7256 (0.1249)	0.6315[1] (0.2320)
	Homework (% of total semester homework points)	0.8094 (0.1321)	0.6854[1] (0.2427)
	Number of observations	109	60
Principles of Macroeconomics	Exam score (% of total semester exam points)	0.7053 (0.1423)	0.6594 (0.1791)
	Homework (% of total semester homework points)	0.8058 (0.1483)	0.7718 (0.1792)
	Number of observations	39	42

Notes: Standard deviations are in parenthesis.

[1] Null hypothesis that the mean score for the online class is the same as the mean score for the face-to-face class is rejected at the 5% level.

course compared to the face-to-face course after controlling for student characteristics. Two of the most significant factors in student performance in economics courses is math ability indicated by ACT Math score and exposure to math courses prior to taking economics (see Elzinga and Melaugh (2009), Ballard and Johnson (2004), Durden and Ellis (1995), Williams, Waldauer, and Duggal (1992), Anderson, Benjamin, and Fuss (1994), and Brasfield, Harrison, and McCoy (1993)). On these ACT Math and previous math courses, students in online and F2F courses are similar which allows for the counterfactual consideration inherent in regression analysis.

Hypothesis 5: The coefficient on the online dummy variable is zero.

The results from the Ordinary Least Squares (OLS) regression are presented in Table 4. For both samples, the coefficient on the online dummy is not statistically significant. We cannot reject the null for Hypothesis 5. This would indicate that after controlling for observable student characteristics, students perform equally well in an online or face-to-face environment. As the goal of the

Table 3
Descriptive Statistics

	Principles of Microeconomics		Principles of Macroeconomics	
	Face to Face Students	Online Students	Face to Face Students	Online Students
Female	33.9%	43.3%	43.5%	45.2%
Average Age	21.48 (3.4437)	27.95** (8.3573)	23.35 (5.4507)	28.76** (9.9089)
Business Majors	62.4%	50%	59%	61.9%
Commute in hours to home university	0.1261 (0.2978)	0.9166** (0.8667)	0.1923 (0.3267)	2.833** (5.218)
USD Students	100%	36.66%	100%	47.6%
Cumulative GPA	2.866 (0.9351)	2.844 (0.7025)	3.014 (0.5067)	2.777 (0.8489)
Number of previous online courses	0.2293 (0.5550)	4.150** (4.950)	0.3333 (0.5773)	5.166 ** (6.183)
Number of concurrent credits	13.88 (2.563)	10.48 ** (4.774)	13.51 (2.955)	10.81 ** (5.162)
Number of previous credits	40.00 (27.076)	70.78** (46.853)	59.66 (29.369)	63.52 (39.953)
Number of previous math and stats courses	1.358 (1.0410)	1.883 (1.4967)	2.231 (1.3171)	1.762 (1.6050)
ACT Math1	24.37 (4.066)	23.27 (4.806)	24.41 (3.295)	23.27 (4.415)
Number of observations	109	60	39	42

Notes: Standard deviations are in parenthesis. Null hypothesis is that the means of the variables are the same for the two groups.

** Null hypothesis is rejected at the two-tail 0.05 Type 1 error level

1ACT Math scores were not available for all students. For Sample A, N=101 f2f and N=41 online. For Sample B, N=34 f2f and N=29 online.

instructor was to make the courses as similar as possible, this indicates the goal was met.

For Principles of Microeconomics, the statistically significant predictors of exam performance are the student's ACT-Math score, their Aplia homework score, their major (business majors performing worse), and their previous experience with online courses. This coefficient is small, but the reduced magnitude may come from the exams being delivered online even for the face-to-face course. Principles of Microeconomics includes data from fall 2011 and fall 2012 semesters. The exams covered the same material in the same way but did not have the exact same wording which could account for the difference. The fall 2012 course was also scheduled earlier in the morning which could make a difference in the face-to-face exam results.

Table 4
Regression Results Using Ordinary Least Squares

	Principles of Microeconomics		Principles of Macroeconomics	
Independent Variable, Dependent Variable	**Exam Score**	**Homework Score**	**Exam Score**	**Homework Score**
Online Dummy (online = 1)	-0.1540	-0.3231**	-0.0502	-0.1665
	(-1.52)	(-2.37)	(-0.14)	(-0.78)
Gender (Female=1)	-0.0076	0.0282	-0.0472 *	-0.0425
	(-0.37)	(1.02)	(-1.94)	(-1.17)
ACT Math	0.0061**	0.0061 *	0.0070*	-0.0138***
	(2.54)	(1.88)	(1.94)	(-2.66)
Cumulative GPA prior to semester	0.0061	0.0268	0.0677*	0.1442***
	(-0.48)	(1.53)	(1.98)	(3.02)
Business Major (business = 1)	-0.0373*	0.0627**	0.0464*	0.0744*
	(-1.81)	(2.26)	(1.76)	(1.92)
Number of previous internet courses (courses, not credits)	-0.0129	-0.0288*	-0.0076	0.0201
	(-1.15)	(-1.91)	(-0.57)	(1.00)
Number of previous internet courses squared	-.0001	.0015	.0007	-.0010
	(-.91)	(1.20)	(0.78)	(-0.76)
Number of concurrent credits during semester	0.0012	0.0100**	-0.0047	0.0080
	(0.51)	(2.45)	(-1.37)	(1.63)
Cumulative number of college credits	0.0003	-0.0005	-0.0001	-0.0083
	(1.03)	(-1.10)	(-0.15)	(1.63)
Homework % score	0.6274***	-	0.5398***	-
	(9.79)		(5.85)	
Fall2012 Dummy	-0.0296*	0.0602**	Na	Na
	(-1.55)	(2.35)		
Spring2013 Dummy	Na	Na	-0.0247	0.0654
			(-0.59)	(1.04)
Constant	0.0714	0.3881***	-0.0369	0.5604***
	(0.91)	(3.80)	(-0.27)	(2.95)
F statistic	F(12,129)=21.51	F(11,130)=7.96	F(12,50)=10.84	F(11,51)=4.08
Adjusted R^2	0.6668	0.3517	0.6558	0.3537
Number of Observations	142	142	63	63

Notes: t-statistics are in parenthesis. * Significant at the two-tail 0.10 Type 1 error level; ** Significant at the two-tail 0.05 Type 1 error level; *** Significant at the two-tail 0.01 Type 1 error level.

Principles of Macroeconomics had a few different and interesting results. One is the large and significant coefficient on GPA. Students who have a GPA one point higher (3.5 instead of 2.5) performed 14 percentage points better on the homework and 7 percentage points better on the exams in the Principles of Macroeconomics course. Additionally, the coefficient on the female indicator predicting exam scores was negative and statistically significant while the coefficient on the business indicator for both exams and homework were positive and statistically significant. Homework score also seemed to have a large and significant effect on exam score in Principles of Macroeconomics where it did not have a significant impact in Principles of Microeconomics; a 10 percentage point increase in homework score predicts a 5.4 percentage point increase in exam score.

The results in Table 4 highlight some interesting possible causes in the difference in student performance on exams. However, we know the OLS estimate of the coefficients are biased as students had the choice to select into either the online or face-to-face class with the same instructor. To account for this selection bias, we employ a two-stage technique using an instrumental variable. We acknowledge that these two-stage techniques impose distributional restrictions that may lead to more bias than our OLS estimates.

We use a two-stage procedure in which the first stage is a Probit estimation of the students' probability of choosing the online course. This follows with the method used in Anstine and Skidmore (2005), Gratton-Lavoie and Stanley (2009), Trawick et al. (2010), and others. In our descriptive statistics for each of the samples, online students are different from face-to-face students in terms of age, commute to home university, number of concurrent credit hours, and the number of previous online courses. As not all of the variables used in the Probit can be used in the second stage regression, we need to consider which of those four variables influenced a student's choice to take a course online instead of face-to-face but were not likely to influence their exam or homework score. A student's choice to take an online course is likely influenced by unobservable characteristics such as whether they work full-time or not and if they have small children at home and the observable variable commute to home university. In addition, if a student has had an online course before, they would likely feel comfortable taking another. All of those concerns likely also influence the student's choice about how many credits to take concurrently. It is not clear which variables would be the best instruments for unobservable characteristics. We suggest that age and commute to home university influence a student's choice about taking an online course, but do not influence their performance in the course. The number of previous online courses likely influences both their decision to take online and their performance in the course assuming they selected the online option.

We use three of these variables in the Probit estimation for the choice of the online course.

We decompose into exogenous and endogenous parts and construct a Probit estimation of the probability of taking an online class. This assumes to be normally distributed.

The second stage is an OLS regression using the predictions from the Probit estimation as a replacement for the dummy variable for online.

Hypothesis 6: The coefficient on predicted online variable is zero.

The results from the OLS are presented in Table 5. After correcting for the selection bias in the choice of delivery mode, the marginal effect of the online delivery method is not statistically different from zero in either sample. We cannot reject the null for Hypothesis 6. This is contradictory to the findings of Anstine and Skidmore (2005) but similar to the findings of Driscoll et al. (2012).

In the Principles of Microeconomics sample, the main predictors of a student's exam score are the students ACT Math score, major, previous experience with online courses, and homework score. Since the exams were given electronically, even in the face-to-face section, the statistically significant results on previous online experience was not unexpected, but the sign was unexpected. We had hypothesized that having had previous online experience would make students more comfortable with the online homework assignments and exams. It is reassuring to know that a student who performed better on their homework assignments would see an increase in their exam scores. The last surprising result was the positive and statistically significant coefficient on number of concurrent credits for the homework score. This coefficient indicates that a student with 13 credits (face-to-face average) instead of 10 credits (online average) would achieve a higher score homework assignments of 3.3 percentage points. This may be capturing an unobserved characteristic about the relationship between full-time employment and part-time enrollment while attending school.

In the Principles of Macroeconomics sample, the negative and statistically significant coefficient on gender persisted from the OLS results as did the positive and statically significant coefficient on the business indicator. The number of concurrent credits does not seem to have the same impact on student performance in the Principles of Macroeconomics course as it did in the Principles of Microeconomics course. This difference may be to do the familiarity with the instructor and format of the course.

Table 5
Regression Results
Using Two-Stages with
Maximum Likelihood Estimation
(Probit) in the first stage)

	Principles of Microeconomics		Principles of Macroeconomics	
Independent Variable	**Exam Score**	**Homework Score**	**Exam Score**	**Homework Score**
Online hat (predicted value of online variable using the probit model with online = 1)	0.1080 (1.51)	0.663 (-0.66)	-0.0041 (-0.06)	-0.0665 (-0.62)
Gender (Female=1)	-0.0061 (-0.30)	0.0345 (1.22)	-0.0456* (-1.91)	-0.0424 (-1.16)
ACT Math (score on the math portion of the ACT test)	0.0069*** (2.88)	0.0075** (2.30)	0.0073* (1.98)	-0.0138** (-2.64)
Cumulative GPA prior to semester	0.0145 (1.15)	0.0415** (2.42)	0.0739** (2.51)	0.1624*** (4.23)
Business Major (1 if business)	-0.0440** (-2.13)	0.0565** (1.98)	0.0460* (1.74)	0.0741* (1.91)
Number of previous internet courses (courses, not credits)	-0.0327* (-1.95)	-0.0437* (-1.90)	-.0080 (-0.45)	0.0280 (1.06)
Number of previous internet courses squared	.0009 (0.77)	.0021 (1.34)	.0007 (0.66)	-.0014 (-0.85)
Number of concurrent credits during semester	0.0018 (0.58)	0.0115*** (2.78)	-0.0046 (-1.32)	0.0092* (1.80)
Cumulative number of college credits	0.0000 (0.02)	-0.0021 (-1.72)	-0.0001 (-0.26)	-0.0001 (-0.21)
Homework % score	0.6417*** (10.21)	-	0.5428*** (5.89)	-
Fall2012 Dummy	-0.0294 (-1.53)	0.0585** (2.23)	Na	Na
Spring2013 Dummy	Na	Na	-0.0272 (-0.58)	0.0752 (1.07)
Constant	0.0113 (0.15)	0.2972*** (2.99)	-0.0622 (-0.53)	0.5024*** (3.09)
F statistic	$F_{(12,129)}$=21.51	$F_{(11,130)}$=7.20	$F_{(12,50)}$=10.81	$F_{(11,51)}$=4.05
Adjusted R2	0.6667	0.3259	0.6549	0.3510
Number of Observations	142	142	63	63

Notes: t-statistics are in parenthesis. * Significant at the two-tail 0.10 Type 1 error level; ** Significant at the two-tail 0.05 Type 1 error level; *** Significant at the two-tail 0.01 Type 1 error level.

These results continue to support our hypothesis that students perform equally well on exams in face-to-face and online courses with the same instructor. We cannot reject our original hypotheses that students perform equally well on exams in an online course and a face-to-face course. The observed statistical difference in exam performance across sections cannot be explained by the delivery method.

CONCLUSION

Past studies that show students perform equally well online while other studies that show students perform worse online. Research studies on the effectiveness of online courses continue to inform the discussion and movement toward more online course offerings. Looking at principles of economics courses, we show that students in the online environment perform equally well on exams after controlling for the students' individual characteristics and the choices to select into the online section. The result could stem from the strong effort by the instructor to make the courses as similar as possible in terms of content, assessments, and interaction. Further work is planned and to address issues of persistence and to expand the study to more sections and more instructors.

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