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Testing the Effectiveness of Online Assignments in Theory of Finance

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Abstract

We investigate the effectiveness of online versus paper assignments using final examination scores in three cohorts of Theory of Finance. In particular, two cohorts were exposed to online assignments while another cohort was exposed to traditional assignments. Our central result is that exposure to online assignments robustly leads to higher final exam scores, all else being equal. We also find a lower level of engagement as shown by low assignment completion rates for students exposed to online assignments.

Keywords: online assignments, paper assignments, learning

JEL Codes: A20, A22

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1. Introduction

The current trend for business courses is to integrate and incorporate different teaching and learning methods to attract, retain, and reach out to a diverse body of students. One of these methods is the integration of online systems as learning and assessment tools. Adding an online component to courses has become quite common within the field of finance. For instance, textbooks in finance courses usually comes with online assignments and interactive slides to reinforce teaching and promote learning. The idea is that incorporating online learning tools encourages students to take advantage of these materials to improve their academic performance.

Kennely, et al. (2012) has identified a number of ways online assignments can affect students' academic performance, specifically in the final exams. First, it is conventional wisdom that students who do well in assignments also tend to do well in the final exams. For bright students, one can find a positive correlation between performance with their online assignments and final exam grades. Second, online assignments may lead to poor performance in final exams. Students can react to a poor assignment score by studying the material in that section more carefully and put less emphasis on other parts. And finally, there can be a case where online assignments do not affect final exam performance. This can happen if the final exam is poorly designed or does not reflect learning outcomes of the course.

The current academic literature is less clear whether online systems are indeed effective in promoting learning in business courses. There are numerous studies that support the effectiveness of online testing and learning systems in business courses (for instance, see Agarwal and Day (1998), Wooten and Dillard-Eggers (2013)). On the other hand, there are studies like Self (2013) that found the exact opposite. While effectiveness of these online learning and testing systems has been well-studied in the fields of economics, business, and mathematics, little is known whether these systems are effective in the field of finance.

In this study, we conduct a pedagogical experiment where the effectiveness of online and traditional paper-based assignments is analyzed in a Theory of Finance course. Specifically, we used Maple T.A. as our online assignment application. Similar to other software applications, Maple T.A. has a randomization feature where it can turn one question template into hundreds or thousands of similar questions providing lots of practice questions for students. The subjects in our study were students enrolled in Theory of Finance offered by the Department of Economics and Finance at the University of Guelph in the winter 2014, fall 2014, and winter 2015 semesters. Students in winter 2014 were exposed to traditional (paper-based) assignments, while students in the fall 2014 and winter 2015 semesters were exposed to Maple T.A. assignments. We find that there is a statistically significant difference in the final exam scores between these groups. Remarkably, students exposed to Maple T.A. have higher final exam scores relative to students not exposed to the online assignment application. It is important to emphasize the robustness of our findings. The results are robust to the extent that our analysis takes into account differences in the characteristics of students (such as gender, employment, and race), the characteristics of

their respective cohorts (programs and semester), and the amount of effort made by students to complete the assignments. We also found that students in the online assignment semesters have a lower level of engagement as they missed more assignments than students exposed to traditional assignments.

The rest of this paper is structured as follows: Section 2 presents a brief review of the relevant literature. Section 3 presents an overview of the online testing and assessment tool used in our study. Section 4 describes the Theory of Finance course where the online assessment tool was applied. Section 5 discusses the research design and data sources. Section 6 presents the empirical results and analysis. Section 7 concludes.

2. Literature review

Do students benefit from the addition of online or computer-based assessment tools in the field of economics and finance? More specifically, does the introduction of an online assessment and practice tool to an undergraduate introductory finance class benefit a student in terms of higher exam results? There is a lot of recent research regarding the issue of whether the use or access to online assessment tools in the university classroom environment have a positive impact on student performance. Depending on the measure of student performance, online assessment tool used, and topic of the course, results are mixed with respect to the effectiveness of online assessment tools.

Numerous studies have shown that the use of an online system for assignments have benefitted the students in business courses. Biktimirov and Klassen (2008) examined the relationship between student online activity, including access to specific course materials, and performance in an Introductory Finance course. They found that access to homework

solutions is positively related to student performance. Similarly, Smolira (2008) analyzed the impact of online assignments to student perceptions of learning in an Introductory Finance course and found that homework assignments increased students' understanding of the material. In a Financial Accounting course, Basile and D'Aquila (2002) found that students who used online course materials more frequently reported positive attitudes about the course. The pedagogical benefits of online assignments have also been examined at the high school level and various courses at the post-secondary level. Representative studies include: Agarwal and Day (1998), Lass et al. (2008), Collins et al. (2008), Doorn et al. (2010), Angus and Watson (2009), Mendicino et al. (2009), and Wooten and Dillard-Eggers (2013).

There are also studies which found that online assignments have a null effect on academic performance. Flannery et al. (2013) compared the effectiveness of online and paper-based assignments using summative assessment results in a Managerial Economics course. Among their findings is that paper assignments were generally more effective than online assignments in preparing students to answer exam questions. Kennely et al. (2012) conducted a similar study, but using a larger sample size of students in a Managerial Economics course. They found little evidence that the way in which one completes an assignment (traditional or online) has an effect on how one performs on a particular section of the exam. Finally, Self (2013) examined the impact of incorporating an online learning tool on student outcome in a traditionally taught Principles of Macroeconomics class. Self (2013) found that doing well in online homework assignments does not impact test grades.

3. The Maple TA system

Maple T.A. is one of many online learning tools that can be used to create custom-made questions and test banks. Unlike other online testing and assessment tools where questions are generated from a static question bank limited to multiple choice or fill-in-the-blank question types, Maple T.A. problems can be fully customized to be randomly-generated and mathematically-graded (Clement, 2011). Figure 1 shows an example of a randomly-generated question where students enter numerical information in the response (or "blank") fields. The numbers that appear in the balance sheet shown in Figure 1 are generated from a random distribution. Although the numbers are random, we designed the questions such that reasonable amounts are produced (i.e., non-negative amounts for cash, equity, etc.).

Figure 1 about here

Because numerical data in questions are randomly-generated, assignment problems become almost always unique for each student. Each time an assignment is accessed or whenever a question is refreshed students will receive a different version of the assignment from the rest of the class. There are several pedagogical benefits of having this random feature. First, since the students can access several versions of the same assignment, they can conduct several practice versions which helps achieve mastery by repetition. Second, academic dishonesty becomes more difficult because assignments have become unique for each student.

Maple T.A., just like other online learning systems, provides instant feedback with detailed solutions as soon as a student submits the assignment. Students can review previous answers from each attempt as well as the feedback. Moreover, the detailed solutions adapt

to the numerical values seen by the student in their version of the question. We have also allowed Maple T.A. to provide part marks for correct answers in each step, allowing students to find out where mistakes have been made.

At the beginning of each semester a teaching assistant conducts a tutorial about the Maple T.A. system and students are provided a Maple T.A. Syntax Sheet which provides information on how to correctly enter answers into the Maple T.A. system.

4. Course description

Theory of Finance is an introductory corporate finance course for second year students in economics in the University of Guelph. The first objective of the course is to provide the students with a general understanding of the time value of money; valuation of projects, firms, and securities; net present value; risk; and the capital asset pricing model. The second objective is to provide some insight into the financing decisions of the firm, including capital structure policy and dividend policy. To assist the students in their understanding of the many types of computations involved in this course, they are given recommended problems to do in the text.

The course is a required one for many students, and each semester there are between 300 and 540 students enrolled in the class. The large number of students makes it difficult to assign written graded homework problems. In the winter 2014 semester, prior to implementing Maple T.A., every three weeks the students were given six problems to prepare and then one of the questions would be given in class as a quiz. Starting with the fall 2014 semester the students have weekly Maple T.A. assignments to complete online.

In addition to problems and exams, students also complete a project in the course. In this project they collect data from a Canadian company and perform many of the calculations that have been covered in class and on the assigned problems. This project provides students the opportunity to become familiar with many online data sources, to experience some of the challenges in working with real data, and to become familiar with the use of a spreadsheet program.

The final exam for the course generally consists of a combination of true or false questions, multiple choice questions, and problems. The true or false and multiple choice questions test the concepts covered in the course and the problems, as well as some of the multiple choice questions, test the computations. Due to the large number of students taking the class in the winter 2015 semester, the final exam consisted only of 40 true or false and 40 multiple choice questions. The winter 2014 and fall 2014 final exams, however, had identical formats with 40 true or false questions, 35 multiple choice questions, and a choice of two out of three problems to complete. To minimize leakage of questions, students are required to return the exam questions to the proctor at the end of the exam.

5. Data

Data in this study were collected from students enrolled in Theory of Finance offered by the Department of Economics and Finance in the University of Guelph in the winter 2014, fall 2014, and winter 2015 semesters. The course was taught by the same instructor and the material covered was identical across semesters. The only exception was that students in the winter and fall 2015 semesters were exposed to online assignments. The overall sample

consisted of 440 students who were surveyed at the end of the semester. Summary statistics and definitions for all continuous and dummy variables are given in Table 1.

Table 1 about here

This paper considers a student's final exam grades as a measure of academic performance. As mentioned in the previous section, the final exams across semesters were similar in design and difficulty. A test of the difference between the average final exam scores across semesters is reported in Table 1. The average final exam score for the semester where assignments were paper-based is lower than in semesters where assignments were online. In comparison to the traditional assignment semester, the differences in final exam scores were statistically significant for the fall 2014 semester (at 5% level of significance), winter 2015 semester (at 1% level of significance), and fall 2014 and winter 2015 semesters combined (at 1% level of significance).

The number of subjects in the study is also reported in Table 1. The number of students enrolled in Theory of Finance is usually different between the fall and winter semesters because of differences in course sequencing among academic programs. Some programs require their students take Theory of Finance in the 4th semester, while others recommend it in the 5th semester so enrolment numbers are lower in the fall semester than in the winter semester. Furthermore, since the target instructor taught all of the sections in Theory of Finance in the winter 2015 semester, there were more subjects from that semester compared to the winter 2014 semester. As shown in Table 1, the winter semesters contained a significant proportion of students in the Management, Economics and Finance (MEF) program. Also, there were more females in the fall semester. Other than gender and

programs, there is not much difference in terms of personal characteristics of students across semesters.

We also gathered information on the amount of time spent on completing assignments in a typical week, which is summarized in Table 1. Nearly half (45%) of students in the paper-based term work requirements semester spent two hours or more completing their assignments per week. In contrast, only 22% of students in the online assignment semesters spent two hours or more completing their assignments in a typical week.

6. Empirical strategy and results

6.1 Baseline regression results

Our basic econometric approach is to test the following relationship:

$$\text{FE}_i = \beta_0 + \beta_1 \text{MAPLE}_i + u_i \qquad (1)$$

where FE_i is student *i*'s final exam mark (in percentage), MAPLE_i is a dummy variable equal to 1 if the student was enrolled in a semester with online assignments and 0 if the student is enrolled in a semester with traditional assignments, and u_i is the error term. The main variable of interest in equation (1) is the sign, magnitude, and significance of β_1, the coefficient for MAPLE_i.

Our objective was to estimate the relationship in equation (1) using ordinary least squares regression. We ran the regression model three times conditional on the semesters included in the analysis. The first regression includes students from all three semesters, the second regression includes only winter and fall 2014, and the third regression includes only the winter 2014 and 2015 semesters. The baseline cross-sectional regression results are

reported in Table 2. Results in column (1) for the full sample indicate that the estimated coefficient for MAPLE_i is positive and statistically significant at the 1% level. The results show that, on average, the final exam scores for students who were exposed to the online assignment are higher by 11.43 percentage points relative to students who were exposed to paper-based assignments, *ceteris paribus*. However, the impact of online assignments is small for the regressions with the winter 2014 and fall 2014 sub-sample as shown in column (2). The regression results in column (2) suggest that the final exam scores for students exposed to the online assignment are higher by 4.27 percentage points and this estimate is significant at the 5% level. Column (3) reports the regression results for the winter 2014 and winter 2015 semesters. The estimated coefficient for MAPLE in column (3) is positive and remarkably larger than those reported in columns (1) and (2), and is significant at the 1% level.

Table 2 about here

A concern is that the results from Table 2 may be confounded by sample selection. It is possible that, depending on how courses in a program are sequenced, students who believe that traditional assignments are difficult could strategically enrol in a semester where term requirements are online. However, sample selection should be less of a concern as students are not aware prior to enrollment whether term requirements for the course would be paper-based or online. Moreover, the following measures were put in place to mitigate the possibility of sample selection bias: the students were taught by the same instructor; the final exams were designed to be similar in content and difficulty; and the questions were not made available to the students after the final exams.

6.2 Robustness

Controlling for socio-demographic characteristics is standard in online assignment effectiveness studies (for instance, see Agarwal and Day (1998), Wooten and Dillard-Eggers (2013), and others). There is evidence from the academic literature that socio-demographic characteristics of students, such as gender, immigration status, and ethnicity have measurable impacts on academic performance. Following the literature and building from equation (1), we ran another set of cross-sectional ordinary least squares regressions which include socio-demographic characteristics as additional control variables:

$$\mathrm{FE}_i = \beta_0 + \beta_1 \mathrm{MAPLE}_i + \beta_2 \mathrm{MALE}_i + \beta_3 \mathrm{FOREIGN}_i + \beta_4 \mathrm{VISMIN}_i + \beta_5 \mathrm{WORK}_i + \beta_6 \mathrm{COMMUTE}_i + u_i \quad (2)$$

where MALE_i is a dummy variable equal to 1 if the student is male and 0 if female, $\mathrm{FOREIGN}_i$ is a dummy variable equal to 1 if the student is an international student and 0 if domestic, VISMIN_i is a dummy variable equal to 1 if the student is a visible minority and 0 otherwise, WORK_i is a dummy variable equal to 1 if the student was employed part-time and 0 if the student was not employed, and $\mathrm{COMMUTE}_i$ is a dummy variable equal to 1 if the student commuted to and from the university and 0 if the student lived on-campus.

Table 3 about here

The results for the ordinary least squares regressions with personal characteristics are reported in Table 3. In column (1), MALE_i is the only significant variable among those variables that relate to personal characteristics. The results suggest that, on average, the final exam score for males is higher by 5.42 percentage points relative to females for the entire

sample, *ceteris paribus*. The estimated coefficients for MALE_i are positive and statistically significant at the 1% level in columns (2) and (3). The dummy variable for FOREIGN_i is statistically significant only in column (2). Our main interest in these regressions is the coefficient of the online assignment dummy. The results indicate that, controlling for personal characteristics, the effect of exposure to the online assignment is positive and statistically significant. On average, the final exam scores of students who were exposed to online assignment were higher by 11.47 percentage points for the entire sample. The estimated coefficients for the online assignment dummy variable are also statistically significant at the 1% level for all sub-samples.

An important determinant for final exam scores is previous academic performance. The usual approach in online assignment effectiveness studies is to use GPA or GMAT scores as control variables in the regressions. Unfortunately, we do not have such information for students in our sample. Absent this information, the closest proxy we have is the student's academic program. We admit that academic program is an imperfect proxy but it carries some information about the student's academic standing. For instance, students in the Bachelor of Arts Honors program must meet a minimum 70% cumulative average to be eligible to continue in the program. To control for program effects directly and previous academic performance indirectly, we ran another set of cross-sectional ordinary least squares regressions with the following specification:

$$\text{FE}_i = \beta_0 + \beta_1 \text{MAPLE}_i + \beta_2 \text{MALE}_i + \beta_3 \text{FOREIGN}_i + \beta_4 \text{VISMIN}_i + \beta_5 \text{WORK}_i +$$

$$\beta_6 \text{COMMUTE}_i + \beta_7 \text{MEF}_i + \beta_8 \text{BCOM}_i + u_i \qquad (3)$$

where MEF_i is a dummy variable equal to 1 if the student is enrolled in the MEF program and 0 otherwise, and BCOM_i is a dummy variable equal to 1 if the student is enrolled in the Bachelor of Commerce program and 0 otherwise. The reference category are those students enrolled in the Bachelor of Arts Honors program.

The ordinary least squares regression results with academic programs are reported in Table 4. The dummy variable for BCOM_i is negative and significant at the 5% level for the regressions reported in columns (1), (2) and (3). On average, the final exam scores for students in the BCOM program are lower relative to the rest of the other programs. The estimated coefficient for MEF_i is negative as well, but not significant. On average and for the entire sample, the final exam scores of students who were exposed to online assignments were higher by 11.31 percentage points. Results of the regressions from Table 4 are instructive in that, controlling for programs, the effect of exposure to the online assignments remains positive and statistically significant, *ceteris paribus*.

Table 4 about here

Time spent in completing the assignments can also play an important role in helping students prepare for the final exam. Students that spend a lot of time completing assignments may signal effort which could translate to higher final exam scores. However, longer assignment completion rates can also signal that students have difficulty with the material and may contribute to lower final exam scores. To account for effects related to effort in completing assignments and building on equation (3), we ran the following cross-section ordinary least squares regression model:

$$\mathrm{FE}_i = \beta_0 + \beta_1 \mathrm{MAPLE}_i + \beta_2 \mathrm{MALE}_i + \beta_3 \mathrm{FOREIGN}_i + \beta_4 \mathrm{VISMIN}_i + \beta_5 \mathrm{WORK}_i +$$

$$\beta_6 \mathrm{COMMUTE}_i + \beta_7 \mathrm{MEF}_i + \beta_8 \mathrm{BCOM}_i + \beta_9 \mathrm{ASSIGN1}_i + \beta_{10} \mathrm{ASSIGN2}_i + u_i \quad (4)$$

where $\mathrm{ASSIGN1}_i$ is a dummy variable equal to 1 if the student reported that his/her time to complete an assignment is one to two hours in a typical week and 0 otherwise, and $\mathrm{ASSIGN2}_i$ is also a dummy variable equal to 1 if the time to complete an assignment is 2 hours or more in a typical week and 0 otherwise. Thus, the reference category are those students who completed an assignment in one hour or less per week.

The results presented in Table 5 support the view that lower final exam scores can be associated with longer assignment completion times. The ordinary least squares regression results indicate that, on average, and for the full sample, the final exam score for students who take one to two hours completing their assignments in a given week is lower by 4.27 percentage points, *ceteris paribus*. For students who takes 2 hours or more in completing assignments, their final exam score on average is lower by 5.18 percentage points, *ceteris paribus*. It is very likely that students who take more time to complete an assignment are those that are struggling with the course material, thus their final exam scores are lower on average. More importantly, the results in Table 5 show that the effect of exposure to the online assignment on final exam performance remains positive and statistically significant, controlling for time spent completing assignments.

Table 5 about here

It is important to emphasize the robustness of our results. The estimated coefficient for the online assignment dummy is positive and statistically significant across different

samples and across regressions with different sets of control variables. Moreover, the estimated magnitude of the online assignment dummy from the baseline regression hardly changed as we controlled for differences in characteristics of the students, the characteristics of their respective cohorts, and the amount of effort made by students to complete the assignments.

6.2 Assignment completion rates

There are studies which suggest that exposure to online classes and testing could lead to modest student engagement (Robinson and Hullinger, 2010). We investigate whether this finding applies for our Theory of Finance course. It should be noted that students, in both the traditional and the online term requirement semesters, are allowed to drop one assignment. As shown in Table 6, we found that students in the online assignment semesters missed more assignments than students in the paper-based semester. About 63% of the students never missed any assignment in the winter 2014 semester. In contrast, 54% and 58% of the students in fall 2014 and winter 2015 semesters never missed an assignment, respectively. These observations hold even if we consider that students could drop one assignment. Only about 5% of the students missed two or more assignments in the traditional assignment semester, whereas this number increases to 18% in the fall 2014 semester and 9% in the winter 2015 semester.

Table 6 about here

7. Conclusion

This paper investigates whether online testing and assessment tools, such as Maple T.A., are effective in improving learning outcomes of students in a Theory of Finance course.

Maple T.A. can be made to randomly generate questions which brings numerous pedagogical benefits to the student. Students can work on different versions of the same question repeatedly which potentially can reinforce learning.

The results of the regression analysis reveal that students who were exposed to Maple T.A. received higher final exam scores than students who were exposed to traditional, paper-based assignments. Our findings are robust controlling for socio-demographic characteristics, academic programs, and engagement in online assignments. We also found a lower level of engagement in terms of completing the assignments for students who were exposed to Maple T.A. relative to students exposed to traditional assignments.

We acknowledge that our study would have produced better results if we had access to richer information about the students such as grade point averages or high school academic performance. Richer information would have enabled us to use methods than can control for selection bias directly and more effectively. The use of such methods and a richer data for Theory of Finance courses is left for future research.

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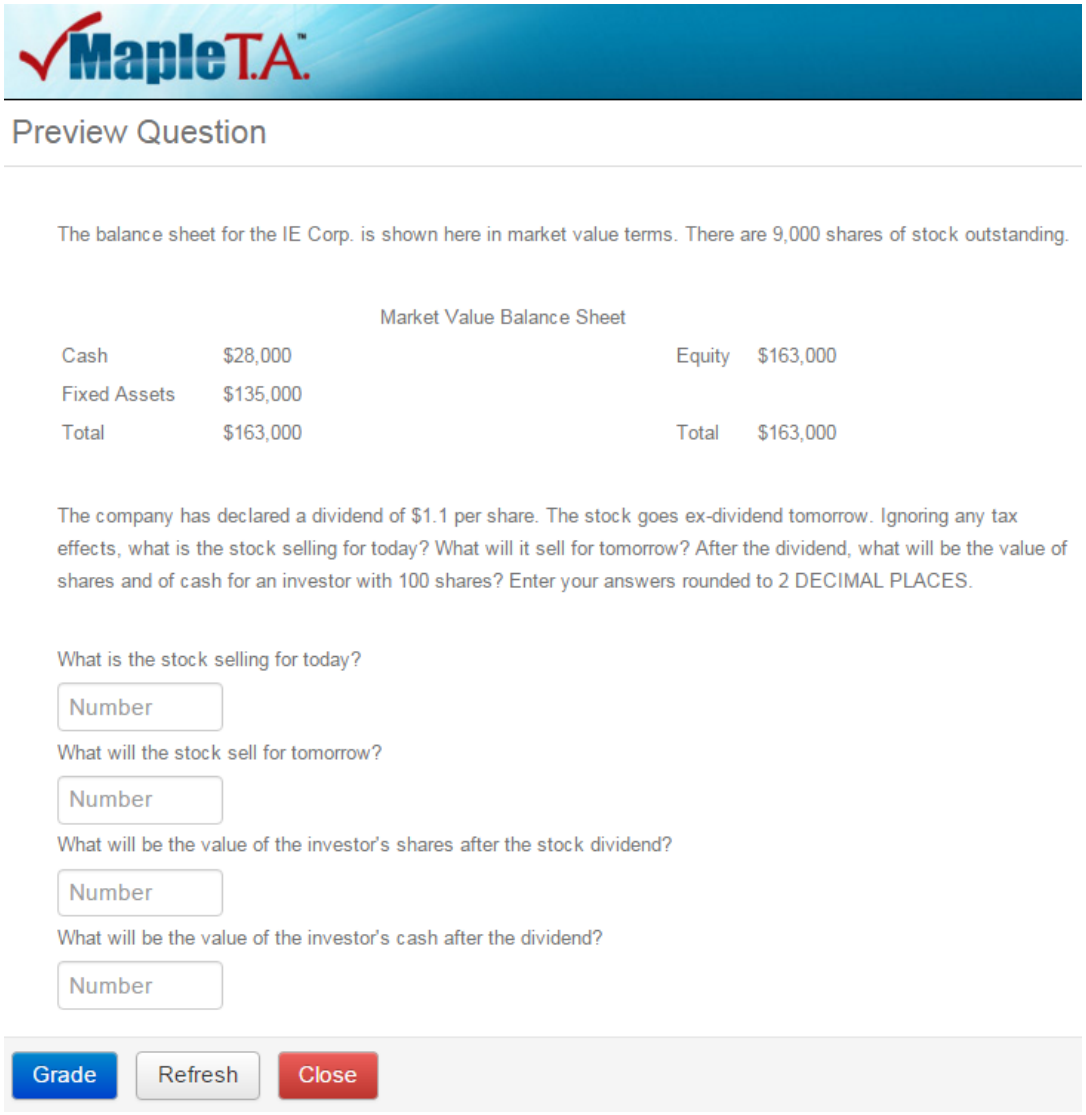

Figure 1: An example of an assignment question in Maple T.A.

Table 1: Descriptive statistics by semester and learning environment.

Semester:	Winter 2014		Fall 2014		Winter 2015		Fall 2014 + Winter 2015	
Learning environment:	Traditional assignment		Online assignment		Online assignment		Online assignment	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Final exam score (in percentage)	**53.76**	**14.57**	**58.03****	**14.10**	**67.75*****	**16.49**	**65.19*****	**16.44**
Personal characteristics dummies								
Male	0.53	0.50	0.31***	0.47	0.60	0.49	0.53	0.50
International student	0.08	0.27	0.12	0.33	0.05	0.21	0.07	0.25
Visible minority	0.24	0.43	0.24	0.43	0.16*	0.37	0.19	0.39
Employed during the semester	0.37	0.48	0.38	0.49	0.36	0.48	0.37	0.48
Commute to/from university	0.84	0.37	0.88	0.33	0.86	0.34	0.87	0.34
Program dummies								
Management, Economics, and Finance	0.22	0.41	0.07***	0.25	0.20	0.40	0.16	0.37
Bachelor of Commerce	0.74	0.44	0.77	0.42	0.72	0.46	0.74	0.44
Other program	0.04	0.21	0.16	(0.37)	0.08	(0.28)	0.10	(0.31)
Assignment time to completion dummies								
Less than one hour per week	0.25	0.43	0.30	0.46	0.39***	0.49	0.36**	0.48
One to two hours per week	0.30	0.46	0.43*	0.50	0.41**	0.49	0.42**	0.49
Two hours or more per week	0.45	0.50	0.27***	0.43	0.20***	0.40	0.22***	0.41
Number of observations	159		74		207		281	

Notes: See text for description of dummy variables. Asterisks indicate *t* test results comparing the average value of each variable in the online assignment and traditional assignment groups. *** Significant at the two-tail 0.01 Type 1 error level; ** Significant at the two-tail 0.05 Type 1 error level; ** Significant at the two-tail 0.10 Type 1 error level.

Table 2: Baseline cross-sectional regression results.

Model: FE = β0+β1*MAPLE	(1)		(2)		(3)	
Dependent variable: Final exam score (%)	β estimate	*t* value	β estimate	*t* value	β estimate	*t* value
Coefficients						
MAPLE (1=online assignment group)	**11.43**	**7.55*** **	**4.27**	**2.13** **	**13.99**	**8.60*** **
Intercept	53.76	46.57***	53.76	46.67***	53.76	46.55***
Sample:						
Winter 2014 (traditional assignment)	Yes		Yes		Yes	
Fall 2014 (online assignment)	Yes		Yes		No	
Winter 2015 (online assignment)	Yes		No		Yes	
Number of observations	440		233		366	
F statistic	56.95		4.55		73.94	
Adjusted R squared	0.106		0.015		0.162	

Note: *** indicates significance at the 0.01 level, ** indicates significance at the 0.05 level, and * indicates significance at the 0.10 level. FE is final exam score (%).

Table 3: Cross-sectional regression results with personal characteristics.

Model: FE = β0+β1*MAPLE+β2*MALE+β3*FOREIGN +β4*VISMIN+β5*WORK+β6*COMMUTE	(1)		(2)		(3)	
Dependent variable: Final exam score (%)	β estimate	*t* value	β estimate	*t* value	β estimate	*t* value
Coefficients						
MAPLE (1=online assignment group)	**11.47**	**7.79*** **	**5.30**	**2.67*** **	**13.67**	**8.50*** **
MALE (1=male)	5.42	3.51***	6.11	3.16***	4.86	2.88***
FOREIGN (1=international student)	1.87	0.66	9.22	3.03***	1.64	0.47
VISMIN (1=visible minority)	0.37	0.19	1.26	0.53	0.74	0.36
WORK (1=employed)	-0.59	-0.36	-1.65	-0.83	-0.31	-0.17
COMMUTE (1=commute to campus)	0.53	0.80	-1.61	-0.56	3.08	1.28
Intercept	50.43	18.90***	51.44	15.03***	48.40	16.66***
Sample:						
Winter 2014 (traditional assignment)	Yes		Yes		Yes	
Fall 2014 (online assignment)	Yes		Yes		No	
Winter 2015 (online assignment)	Yes		No		Yes	
Number of observations	440		233		366	
F statistic	12.96		5.32		14.82	
Adjusted R squared	0.124		0.079		0.175	

Note: *** indicates significance at the 0.01 level, ** indicates significance at the 0.05 level, and * indicates significance at the 0.10 level. FE is final exam score (%).

Table 4: Cross-sectional regression results with personal characteristics and program dummy variables.

Model: FE = β0+β1*MAPLE+β2*MALE+β3*FOREIGN +β4*VISMIN+β5*WORK+β6*COMMUTE +β7*MEF+β8*BCOM	(1)		(2)		(3)	
Dependent variable: Final exam score (%)	β estimate	*t* value	β estimate	*t* value	β estimate	*t* value
Coefficients						
MAPLE (1=online assignment group)	**11.31**	**7.87*** **	**4.82**	**2.36** **	**13.35**	**8.52*** **
MALE (1=male)	4.30	2.85***	4.16	2.18**	3.69	2.20**
FOREIGN (1=international student)	1.62	0.57	8.66	2.85***	0.89	0.25
VISMIN (1=visible minority)	.06	0.03	1.02	0.44	0.12	0.06
WORK (1=employed)	-0.08	-0.05	-1.42	-0.73	0.40	0.23
COMMUTE (1=commute to campus)	2.05	1.00	0.42	0.15	4.29	1.86*
MEF (1=MEF program)	-0.19	-0.06	-2.68	-0.62	-1.79	-0.48
BCOM (1=BCOM program)	-9.36	-3.26***	-11.92	-3.20***	-10.71	-3.17***
Intercept	56.56	16.12***	60.14	12.85***	56.23	13.34***
Sample:						
Winter 2014 (traditional assignment)	Yes		Yes		Yes	
Fall 2014 (online assignment)	Yes		Yes		No	
Winter 2015 (online assignment)	Yes		No		Yes	
Number of observations	440		233		366	
F statistic	13.14		6.77		14.78	
Adjusted R squared	0.179		0.161		0.230	

Note: *** indicates significance at the 0.01 level, ** indicates significance at the 0.05 level, and * indicates significance at the 0.10 level. FE is final exam score (%).

Table 5: Cross-sectional regression results with personal characteristics, program dummy variables, and assignment completion dummy variables.

Model: FE = β0+β1*MAPLE+β2*MALE+β3*FOREIGN +β4*VISMIN+β5*WORK+β6*COMMUTE +β7*MEF+β8*BCOM+β9*ASSIGN1+β10*ASSIGN2	(1)		(2)		(3)	
Dependent variable: Final exam score (%)	β estimate	*t* value	β estimate	*t* value	β estimate	*t* value
Coefficients						
MAPLE (1=online assignment group)	**10.55**	**7.24*** **	**4.87**	**2.39** **	**12.60**	**7.86*** **
MALE (1=male)	3.71	2.44**	4.09	2.15**	3.16	1.88*
FOREIGN (1=international student)	1.19	0.43	8.42	2.79***	0.87	0.25
VISMIN (1=visible minority)	0.11	0.06	1.00	0.43	0.21	0.11
WORK (1=employed)	0.22	0.14	-1.02	-0.53	0.57	0.33
COMMUTE (1=commute to campus)	2.17	1.03	0.36	0.13	4.18	1.77*
MEF (1=MEF program)	-0.58	-0.17	-2.86	-0.66	-2.14	-0.57
BCOM (1=BCOM program)	-9.50	-3.30***	-12.24	-3.27	-10.92	-3.21***
ASSIGN1 (1=1 to 2 hours per week to finish an assignment)	-4.27	-2.39**	-4.54	-1.98	-2.83	-1.45
ASSIGN2 (1=2 or more hours per week to finish an assignment)	-5.18	-5.18***	-2.89	-1.28	-4.31	-2.25**
Intercept	60.51	60.51***	63.06	12.50***	59.56	12.88***
Sample:						
Winter 2014 (traditional assignment)	Yes		Yes		Yes	
Fall 2014 (online assignment)	Yes		Yes		No	
Winter 2015 (online assignment)	Yes		No		Yes	
Number of observations	440		233		366	
F statistic	11.84		6.80		12.38	
Adjusted R squared	0.192		0.168		0.236	

Note: *** indicates significance at the 0.01 level, ** indicates significance at the 0.05 level, and * indicates significance at the 0.10 level. FE is final exam score (%).

Table 6: Assignment delinquency.

Learning environment:	Traditional assignment		Online assignment			
Semester:	Winter 2014		Fall 2014		Winter 2015	
Number of missed assignments	N	%	N	%	N	%
None	100	0.63	40	0.54	119	0.58
One	49	0.31	21	0.28	67	0.33
Two	7	0.04	7	0.09	17	0.08
Three	2	0.01	3	0.04	1	0.00
More than 3	1	0.00	3	0.04	2	0.01