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The Comparative Effectiveness of Web-Based and Classroom Instruction: Student Demographics vs. Learning Outcomes

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Abstract

This paper analyses how student learning outcomes are correlated to particular student demographics in the same business courses delivered with traditional classroom instruction and with asynchronous Web-based instruction. The student demographic variables included student learning preferences, gender, age, cumulative grade point average, grade level (year in school), employment hours worked per week and the American College Test (ACT) scores. Heckman's two-stage procedure was utilised in the estimation to eliminate selection bias possibly incurred from non-random data selection processes. The results show that prior academic achievement as measured by cumulative grade point average and ACT scores reveal statistically positive effects in learning outcomes in both Web-based and traditional instruction. For the other variables analysed, the learning preference for active experimentation had significant learning outcomes for students in the traditional classroom only; however, the Internet students achieved higher test scores than the traditional students.

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Introduction

There has been growing numbers of college students choosing Web-based courses primarily for the convenience and flexibility of online learning. While those who tend to be attracted to online learning are a very diverse group, two prominent reasons for the trend are increased demand by non-traditional students and the need to improve access for traditional students (Kriger, 2001). As a consequence, many universities have targeted Web-based courses and programs as key drivers of future enrolment growth (Gibson & Harris, 2008). Despite embracing the trend, however, colleges have been concerned about the comparability of student learning outcomes in Web-based courses versus traditional lecture courses (Allen, Bourhis, Mabry, Burell, &Timmerman, 2006). In fact, some research findings suggest that the learning outcomes of different course delivery modalities may be associated with individual learning factors (Barton & Pitt, 2003; Smith, 2005). In traditional classroom instruction, the learning pedagogy is instructor-centric and the majority of students are traditional college age, between the ages of 19 and 24 (Gibson & Harris, 2008). Students who prefer personal interactions, structured classroom

environments, and working in teams tend to choose traditional classes (Harris & Gibson, 2006).

In Web-based delivery, the pedagogy shifts more responsibility for learning to the student. Part of this responsibility is maintaining the motivation to keep up with course content and an appreciation for an independent and flexible learning environment. Internet courses with asynchronous delivery allow learners to complete work at their own pace and location rather than being at a physical location at a specific time. White and Ploeger (2004) suggested that while a traditional class is instructor-centric and sequential, an online class is learner-centric and more interactive in that students are able to non-sequentially review and refer back to class discussions thereby providing a richer experience designed to reduce the students' cognitive load. However, some traditional age students tend to value personal interactions with the instructor and classmates and may face difficulties with online courses (Jenkins & Downs, 2003).

This paper examines the learning outcomes of students in undergraduate business courses delivered with traditional classroom instruction and with asynchronous Web-based instruction. The hypothesis is that student learning outcomes are not only a result of the delivery mode but also individual learner factors. In order to compare the learning outcomes of the two delivery media, the same instructor taught the courses using the same textbook, materials, and assessments. The assessment measure used to define learning outcomes were multiple choice questions covering the same content from each course. Only students completing the course and all assessments including the learning style survey instrument were included in the study and no extra student participation incentives were offered.

The paper is organised as follows. In the next section, we review the literature on the effectiveness of online versus traditional in-class instruction. Section 3 presents the methodology of the research and section 4 contains a discussion of the data and empirical estimation. The summary and conclusions are presented in section 5.

Literature review

Empirical studies comparing the learning outcomes of students from online and face-to-face instruction have produced mixed results. While some case studies confirm no significant difference in learning outcomes between the two formats of instruction, other findings show higher test scores for Internet students. Chernish, DeFranco, Lindner, and Dooley (2005) compared three delivery methods (classroom, TV and Internet) and found the delivery method did not contribute to any difference in the learner's achievement level. Jahng and Krug (2005) performed meta-analysis on twenty case studies from 1995–2004 and also found no relationship between academic performance and content modalities.

Zhang (2005), on the other hand, showed that Internet students had higher learning outcomes compared to face-to-face students, confirming the findings of Vasarhelyi and Graham (1997), Gubernick and Ebeling (1999) and Poirer and Feldman (2004). Shachar and Neumann (2003) studied eighty six cases from 1990 to 2002 and also found Internet students scored higher on tests as did Bernard, et al.,2004) after reviewing 232 cases from 1985 to 2002.

The case studies of business course delivery modes and student learning outcomes show mixed research results with many cases confirming the finding of no

significant difference. Shulman and Sims (1999) conducted a study that included three undergraduate business courses and found no difference in learning outcomes. However, they observed that online students scored higher on pre-tests and suggested that online students may be better prepared for course content. Subsequent business course cases that found no learning outcome difference were Gagne and Shepherd (2001) for a graduate accounting course, Clark, Flaherty, and Mottner (2001) and Priluck (2004) for marketing courses, Jagel, Washburn, and Tollison (2005) for business communication courses, and Shou (2007) for an introductory business statistics course. The study of Browstein, Brownstein, and Gerlowski (2008) in core MBA courses supported those who maintain that learning outcomes in online sections can be at least as robust as face-to-face outcomes.

Some studies, however, found higher test scores for business Internet students compared to their classroom counterparts. Johnson, Burnett, and Rolling (2002) showed higher learning outcomes for Web-based students in consumer economics courses after controlling for pre-test differences and found that Internet students spent six to ten hours per week on coursework versus only five hours for the traditional students. Basile and D'Aquila (2002) observed that accounting students randomly assigned to traditional and Internet classes who used a computer daily had more positive evaluations of the Web-enhanced course than students who used a computer weekly.

Though most of the research on delivery modalities and student learning outcomes found no significant difference, some noteworthy findings on student learning styles and online learning were observed. Diaz and Cartnal (1999) found that online students likely have different learning styles and are more independent learners than on-campus students. Altmyer and Mackin (2005) showed that Internet students were more successful if they preferred active learning over passive learning. Gibson and Harris (2008) noted that student learning preferences may be critical in students' choice of delivery mode. Watkins, Huggans, and Nystrom (2003) observed that instructors in Web-based learning courses can tailor courses to facilitate a variety of student learning styles including learning styles opposite that of the instructor.

Zhao and Tan (2004) studied fifty-one peer-reviewed articles published from 1982 to 2002 and concluded from a cross examination of the studies that interaction is a key to effective online learning and the right mixture of instructor-student demographics and technology can lead to the most effective learning outcomes for distance education. They implied that some learners may be able to better take advantage of distance education and achieve learning results as comparable to traditional face-to-face courses. Olsen and Wisher (2002) reviewed and tabulated 47 reports with evaluations of Web-based courses in higher education published between 1996 and 2002. They found that major differences in course delivery technology and presentation rather than instructional content can obscure the true relationship between Web-based instruction and learning outcomes.

The paradox of the conflicting findings on learning outcomes and delivery modes may be explained by the methodology used in the studies. Joy and Garcia (2000) illustrated the inadequacy of the methodologies and conclusions of the no significant difference finding in learning effectiveness between technology-based and conventional delivery media. Ungerleider and Burns (2003) posed that many cases had flawed methodology preventing valid statistical conclusions and cited experimental control, small sample sizes, lack of random assignment of students and poorly designed dependent measures as reasons for the mixed research results.

In an examination of the learning effectiveness on MBA students taking only online courses, Anstine and Skidmore (2005) showed that outcomes in the online learning environment can be inferior to the traditional format after controlling for possible sample selection bias. Harmon and Lambrinos (2007) argued that studies comparing courses between online and face-to-face formats without eliminating possible self-selection bias and bias of omitting variables can misestimate the learning outcomes of the two formats of instructions.

Research methodology

The objective of the study was to investigate the effects of content delivery modalities on student learning outcomes relative to specific student demographics. The data analysed were collected for undergraduate business students at a small mid-western university and included the following courses: Survey of Business, Principles of Accounting I, Principles of Accounting II, and Auditing. Specifically, we analyse whether particular student demographics correlate to academic performance in the same business courses delivered with traditional classroom instruction and with asynchronous Web-based instruction. The seven student demographical variables analysed were: student learning preferences, gender, age, cumulative grade point average going into the course, American College Testing (ACT) program scores, number of hours worked per week, and grade level (year in college).

Student learning preferences were determined using the Kolb Learning Style Survey (Kolb, 1985), in which students rank order nine rows of four words using a Likert scale that describe various learning abilities, i.e., watching versus doing.[1] After completing the survey, students identify the two learning abilities with the highest numerical scores. These learning abilities are referred to as dominant learning preferences and are used to determine ones learning style. The four specific categories of Kolb's learning preferences used in this study are:

1. Abstract Conceptualization (thinking)
2. Concrete Experience (feeling)
3. Active Experimentation (doing)
4. Reflective Observation (watching and listening).

The traditional lecture classes consisted of students meeting in a classroom several times per week with the instructor lecturing on content and demonstrating concepts and reviewing homework assignments. Interactions took place synchronously between the students and instructor and between the students themselves. Examination assessments were held every three chapters and included a comprehensive final examination.

Students in the Internet courses connected to the WebCT learning management platform to access course content, quizzes, public discussions, and private email to the instructor. Student interaction was performed asynchronously on a threaded

[1] Kolb described learning preferences as the learning abilities one chooses to use when discovering new information and transforming the experience into long lasting learning. Loo (2002) found Kolb's learning style survey instrument an accurate measure of learning styles in his study of students declaring business majors.

public discussion board and a private mailbox tool to the instructor. Chapter assessments were timed multiple-choice online quizzes and a timed multiple choice mid-term and final examination. For all students, learning outcomes were measured by multiple-choice type assessments using a 0–100 per cent scale. Subjective assessments such as presentations, projects or homework assignments were excluded.

Data analysis and estimation

A list of the dependent variables with descriptive statistics is provided in Table 1.

Table 1: *Variable Descriptions and Summary Statistics.*

Variable	Description	Mean	Standard Deviation
OBJ	Percentage of correct multiple choice answers from the class	72.235	11.711
RO	Kolb Learning Preference: Reflective Observation	21.594	4.349
AE	Kolb Learning Preference: Active Experimentation	23.383	3.357
CE	Kolb Learning Preference: Concrete Experience	21.414	4.110
AC	Kolb Learning Preference: Abstract Conceptualization	23.511	4.007
GPA	Cumulative grade point average	2.615	0.633
AGE	1 if birth day is <1980, 0 otherwise	0.729	0.446
ACT	Number of hours working per week	21.429	3.432
LEVEL	Freshman = 0, Sophomore = 1, Junior = 2, Senior = 3, Others=4.	1.466	1.216
GENDER	1 if male, 0 otherwise	0.436	0.498

The model for performance objectives is first estimated using a cross-sectional sample with separate dummy variables for age and gender. Performance objectives are specified as:

$$OBJ_i = \alpha_0 + \alpha_1 RO_i + \alpha_2 AE_i + \alpha_3 CE_i + \alpha_4 AC_i + \alpha_5 GPA_i + \alpha_6 AGE_i + \alpha_7 ACT_i + \alpha_8 LEVEL_i + \alpha_9 GENDER_i + \varepsilon_i \quad (1)$$

where the performance objective for an individual student is modelled as a function of four learning preferences, including reflective observation (*RO*), active experimentation (*AE*), concrete experience (*CE*), and abstract conceptualization (*AC*), cumulative grade point average, classification of traditional and non-traditional status based on student age at completion of course, ACT scores, school level (year) in college, number of hours worked per week, and gender.

The estimation is applied into two groups of sample observations, students who took Web-based classes and those who took traditional lecture classes. This specification, by separating the sample observations according to the methods of instruction, allows the performance objective for an individual student to differ by the distinction of web-based and classroom delivery. By comparing the estimated coefficients between the two modes of instructions, it is possible to gauge whether the objective performance for an individual student diverge owing to specific learning preferences or individual student characteristics.

A misclassification may result in the OLS regression models with the assumption of exogenous selection on the mode of delivery. In particular, a student's decision in selecting a Web-based over face-to-face class can be contingent on the personal circumstances. Indeed, many students who are older in their age might have to devote more time to family or careers and thus lean toward choosing the flexibility of Web-based instruction. Consequently, the choice of the instruction variable should be treated as an endogenous variable in the performance objective equation. To remove such a bias, we apply a version of Heckman's (1979) sample selectivity procedure.

Table 2*: List the OLS and Heckit Estimates for each variable by course delivery modes*

	OLS		Heckit	
Variable	**Web-Based**	**Classroom**	**Web-Based**	**Classroom**
Constant	38.619	-22.508	58.353	-3.177
	(0.951)	(0.650)	(1.114)	(0.072)
RO	0.483	0.451	0.179	0.249
	(0.945)	(1.172)	(0.249)	(0.518)
AE	-0.642	1.259**	-0.935	1.050*
	(1.032)	(2.650)	(1.179)	(1.866)
CE	-0.112	0.174	-0.269	0.127
	(0.275)	(0.362)	(0.554)	(0.260)
AC	0.046	0.696	-0.076	0.715
	(0.081)	(1.564)	(0.126)	(1.599)
GPA	5.341*	6.752**	4.908	6.457**
	(1.725)	(3.367)	(1.533)	(3.141)
AGE	-5.620*	-5.084*	-6.568**	-5.768*
	(1.950)	(1.671)	(1.989)	(1.800)
ACT	1.340**	1.058**	1.238**	0.890**
	(3.130)	(2.946)	(2.671)	(2.057)
LEVEL	1.128	-2.127**	0.961	-2.424**
	(0.846)	(2.004)	(0.701)	(2.115)
GENDER	2.869	1.623	0.918	0.134
	(0.961)	(0.690)	(0.208)	(0.042)
λ			5.110	5.770
			(0.603)	(0.703)
Adj-R^2	0.245	0.333	0.233	0.329
Observation	52	81	52	81

Note: t-statistics are in parentheses; levels of statistical significance are represented by * (90%) and ** (95%).

First, we performed probit regression analyses on the cross-sectional data to predict the choice of class mode conditioning on learning preferences, academic performance, school level and gender. Then, we computed an inverse Mill's ratio (IMR), a measure of the likelihood of student choosing web-based classes. This measure was an instrumental variable in the performance objective regression, necessitating separate models for respective Web-based and classroom instruction.

The second and third columns in Table 2 report estimates from OLS cross-sectional performance objective regressions for Web-based and classroom modes of delivery. Of the four learning preference variables, the coefficient of active experimentation is statistically significant at the 95 per cent level only for the classroom mode; the positive value implies that students who prefer active experimentation in learning tend to score higher with traditional lecture modes. No significant differences were noted with regard to overall student learning styles. However, the coefficients of cumulative grade point average and ACT score variables are positive and statistically significant at the 90 per cent level or higher, which indicate a positive correlation between students' overall learning outcomes and their prior academic achievement as measured by cumulative GPA or by national standardised assessments (ACT scores). The coefficients of the age variable are negative and statistically significant at the 90 per cent level, implying that older age students tend to outperform younger students. The coefficients of the grade level variable are negative and statistically significant at the 90 per cent level only for classroom instruction.

The fourth and fifth column in Table 2 present selectivity-corrected estimates for the performance objective equation with separate sample observations between web-based and classroom modalities. There is no evidence of selection of any sort for web-based and classroom modes given insignificant coefficients on the IMR variables and the estimation results appear to resemble the OLS estimates. Furthermore, the fitted value of academic performance as measured by objective assessments for the Web-based mode is 74.50 percent (100 per cent scale) while for classroom instruction is 70.80 per cent. On average, students who choose Web-based modes tend to outperform those who take classroom instruction by approximately 5 per cent.

Summary and conclusions

Like many prior research cases, our study found that student learning outcomes are not only a result of the delivery media but also individual learner factors. We found the learning factor of student grade point average and ACT scores going into the course as the best predictor of learning outcomes regardless of delivery modalities. The result is especially true for Internet students as higher grade point average students have shown evidence of good study habits and the ability to work independently, key drivers of successful Internet learning. In contrast, low grade point average students sometimes struggle in an Internet class and may need the structured format of traditional instruction with higher levels of instructor interaction.

In comparing the test scores of online and traditional students, the empirical result revealed that test scores for the Internet students were approximately 4 per cent higher than students receiving classroom instruction (74.50 per cent vs. 70.80 per cent). This finding confirms the studies of Zhao and Tan (2004) and Zhang (2005) that found Internet students who adapt well to learner-centric instruction have better learning outcomes. The result may be explained by the negative coefficients of the age variable implying that older age Internet students outperformed younger classroom students. Indeed, researchers have observed that many successful Internet students are non-traditional age, highly motivated, enjoy learning independently and appreciate the convenience and flexibility of Web-based instruction. Further, students choosing Internet courses may be better prepared, motivated and committed to learn, which is consistent with the findings of

Schulman and Sims (1999) that online students had higher pre-test scores and were better at selecting online instruction.[2]

With regard to the four student learning preferences, we found that the active experimentation preference correlated to learning outcomes in the traditional classroom only. One plausible explanation for this result is most college students have experience in active learning by doing homework assignments; a basic active experimentation learning ability; and most traditional classroom instruction includes varying degrees of homework assignments. For all other student demographics, no significant differences in learning outcomes were observed.

The interpretive results drawn from this study is by no measure conclusive evidence due to the sample size and limited number of courses. Nevertheless, the study is meaningful in that it contributes to the current literature on delivery modes and learning outcomes and confirms certain findings of prior research cases.

Future empirical studies are needed with more extensive demographic characteristics, larger sample sizes, random assignment of students and a greater variety and number of courses researching learning outcomes and course delivery modes. In particular, the discrepancy of future learning outcomes between traditional classroom instruction and Web-based instruction may be less subject to individual learner factors as technology improvements in the online learning environment offers more learner-content interaction.

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[2] Johnson, et al. (2002) also found that online students put more time into the course resulting in higher levels of psychological independence and a sense of ownership for their learning.

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