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DIFFERENCES IN STUDENT PERFORMANCE IN ONLINE VERSUS TRADITIONAL QUANTITATIVE COURSES

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ABSTRACT

Online course enrollments have grown tremendously in recent years, but little research has examined the difference in student performance between traditional courses and their online counterparts. This research explores factors affecting student performance in online courses, compared to what they would likely have experienced in an equivalent traditional course. The results of the analysis of two sets of quantitative courses (undergraduate business statistics and operations management) indicates that grades are significantly lower (by about half a letter grade) for a student in an online course compared to a similar student in the same course taught by the same instructor with a traditional format. These results support the authors' contention that online delivery is not suitable for all courses. Student learning style, as measured by the Felder-Solomon Index of Learning Styles, was not a statistically significant factor influencing student academic performance.

JEL: A2, C1

KEYWORDS: Felder-Solomon ILS, Pedagogy, Online Success, Business Students

INTRODUCTION

Online learning has become increasingly popular among college students and many colleges and universities try to offer more online courses to meet the demand from students. Students have become more interested in taking online courses as information technology has rapidly developed. The 2010 Sloan Survey of Online Learning (Allen and Seaman, 2010) reveals that over 5.6 million students were taking at least one online course during the fall semester of 2009, an increase of nearly one million students over the number reported the previous year. The 21% growth rate for online enrollments far exceeds the less than 2% growth rate of the overall higher education student population and nearly 30% of higher education students took at least one course online (Allen and Seaman, 2011). Demand for online learning is growing as non-traditional students return to school in search of new job skills or with hopes of updating their current skills.Students demand more online course offerings for several reasons. One of the reasons is that online courses provide flexible access to content and are available anytime and anywhere (Angiello, 2010; Coyner and McCann, 2004). For that reason, online courses tend to be popular among students with jobs and families (Allen and Seaman, 2006; Lyons, 2004).

Online courses are appealing to some students due to convenience, however, the responsibility that comes with online courses can be quite challenging. Jenkins (2011) suggests that educators think hard about teaching courses using online delivery and what types of students should take online courses. He argues that online courses are not for everyone and not every course should be taught online given the fact that success rates in online courses are only 50% as compared to 70–75 % for comparable face-to-face (i.e. "traditional") classes. The authors' online teaching experience also indicates that the student failure rate is significantly higher than that of the same course taught face-to-face. Most students fail to recognize the fact

that the level of difficulty for online courses is more or at least the same as face-to-face courses. Students unprepared for that challenge often fail the course. This leads to two broad questions: is online learning less effective than traditional learning when measured using students' course grades? What factors can help identify which students are most likely to succeed in online courses? In this exploratory research, the authors wish to identify characteristics of students that predict academic success in online quantitative courses. The organization of the remainder of this document is as follows. The next section provides a review of the relevant research and the corresponding findings. This research is composed of two parts. The first area covers research that explores differences in student performance in online classes versus traditional classes. In this setting, "online" and "traditional" refer to two distinct methods of the delivery of course content to students. For this research, "online" refers to any course in which more than 50% of the course content is online. In other words, the authors do not attempt to further delineate between "hybrid" (more than 50% of course content delivered online) versus "online" (more than 80% of course content delivered online). The second area covers research that examines students' learning style as a factor in academic success. The remaining sections describe the methodology used in this research, the results of the experiment, discussion and conclusions, and limitations of this research and ideas for further study.

LITERATURE REVIEW

Since this research seeks to identify factors affecting student academic performance, relevant literature reviews are in two separate sections. The first section reviews research comparing student success according to the course delivery method (either online or traditional), without regard to learning style. The second section reviews research comparing student success based on student learning style.

Differences in Student Performance Based on Course Delivery Method

Some studies have attempted to examine whether the learning outcomes of students differ in traditional versus online delivery. For example, Du (2011) conducted a study of student performance in online versus traditional versions of an Introductory Principles of Accounting course. The final sample included 128 students across three semesters and concluded that no direct improvement occurred by switching from a traditional learning model to an online learning model. A similar study of graduating seniors found that students in a traditional accounting program (all courses delivered in the traditional format) did better than students in online sections (Adewara et al., 2010). This same study found that business administration students in the online program had better grades than in the traditional program. These differences indicate that student performance may differ based on academic major and the mode of learning: either online or traditional. A related question to students' performance in an online learning model is "Is the level of student course satisfaction generated by hybrid learning higher than that which is generated by traditional learning?" Nowell (2011) conducted a case study using an introductory management course that revealed there was no difference between online learning and traditional learning in terms of student course satisfaction. Similarly, DiRienzo and Lilly (2014) compared the learning outcomes on two different types of assignments within each of five separate courses (using two different delivery methods: online and traditional), and found no differences.

The five courses that were included are Principles of Financial Accounting, Operations and Supply Chain Management, Business Statistics, Principles of Economics, and Business Law. The fact is that online courses demand more self-discipline and the ability to study independently. Simon, Jackson, and Maxwell (2013) found that while 80% of the students in their online MIS course had passed the course, only 40% indicated that they would still take the same course online. This finding agrees with the authors' informal interviews with students in the online business statistics course. Specifically, while a majority of the students pass the course, their advice to other students is almost exclusively to avoid the online version of the course unless special circumstances prevent attendance in a traditional section. As a result, online instructors may need to do more to help students perform better in order to improve passing rates in online

courses. One of the things instructors can do is to understand how student learning styles relate to academic performance.

Differences in Student Performance Based on Learning Style

Markham (2004) concludes that classroom teaching improves when educators can identify student learning styles. More effective classroom teaching helps students succeed in their degree programs. Recent research suggests that the learning style by which students learn and apply knowledge is an important factor to consider when the quality of education is assessed (Graf, Lin and Kinshuk, 2008; Kolb and Kolb 2009). Certainly, having knowledge of learning styles is an attempt to understand the complex processes by which students acquire knowledge. The motivation of this study is very specific with regard to understanding how an individual's learning style affects their performance on online courses. Educators who are engaged in online teaching may better utilize the knowledge regarding learning styles as a way to enhance student performance. Sandman (2009) compares 25 different learning style models for insight into the academic performance of telecommunications students, and selects the Felder-Solomon ILS. The reasons for selecting this learning style assessment are the following: the tool is commonly used, is valid, is easy to understand and score, and is readily available. The study indicates that many different learning style profiles are present within a course, and that the instructor should alter their pedagogical techniques when it becomes apparent that certain learning styles are not performing as well as others.

Felkel and Gosky (2007) verify the reliability and validity of the Felder-Solomon ILS for calculus students at Appalachian State University. Litzinger, Lee, Wise, and Felder (2007) also confirm the construct validity and reliability of the Felder-Solomon ILS scales using Cronbach's alpha and factor analysis. Williams, Matt, and O'Reilly (2014) used the Felder-Solomon ILS to demonstrate a difference in learning styles among three generations of students: baby boomers (born 1943-1960), generation X (born 1961-1981), and millennials (born 1982-2001). A later study by Sandman (2014) determined that students utilized different learning styles for different courses. Additional studies have also utilized this same learning style model. Cegielski, Hazen, and Rainer (2011) collected data from 196 information systems majors and found that student performance increases significantly when the instructional methodology closely matches the student's learning style. Eom, Wen, and Ashill (2006) conducted an empirical investigation of the determinants of students' perceived learning outcomes and satisfaction. They found that the two factors, learning styles and instructor feedback significantly affect perceived learning outcomes. Hawk and Shah (2007) reviewed five learning style instruments and six learning style models. They believe that student performance improves if the instructor has the knowledge of the overall learning style profile of students and makes adjustments to his/her learning approaches as the profile changes from course to course. However, Bacon (2004) collected data from six sections of a traditionally taught marketing course and found that there was very little effect of learning styles on learning outcomes.

One study attempted to measure the impact of both learning style and delivery method on the effectiveness of instruction. Kozub (2010) used 2-way ANOVA to study the effectiveness of web-based instruction compared to traditional instruction within the same course. (Note: web-based instruction is "online learning" for a single topic or unit, as opposed to online learning for an entire course.) The two factors used were learning style as measured with Kolb's model and content delivery method (web-based versus traditional). There were no significant differences in overall student performance among the four learning styles or the two content delivery methods. The present study expands on this idea by considering the difference between two separate course types: online and traditional.

Because of the common usage of the Felder-Solomon ILS and its measures of learning styles along four different scales, together with the reasons stated previously, the current study utilizes the Felder-Solomon ILS for identifying the factors most highly related to success in online quantitative classes. This study then uses this learning style model and focuses on three major research questions. These are 1) the differences

(if any) in the academic performance of students in online versus traditional quantitative business courses, 2) the impact (if any) of student learning style on academic success, and 3) the exploration of other factors that might contribute to the differences in academic success.

DATA AND METHODOLOGY

This study consists of students in four sections of two different courses in the spring 2014 semester. The same instructor teaches two sections of introductory business statistics: one is online and the other is traditional. The instructor uses the same assignments, same homework, and same exams in both sections. Two sections of operations management are also taught by the same instructor (not the same instructor that is teaching business statistics), and again the same assignments, same homework, and same exams are given to the students in both sections. Both instructors had previously taught these same courses online and in a traditional format prior to gathering the data for this survey. That is, the instructors were experienced, each having earned online teacher and online course designer certifications based on the Quality Matters Rubric and Sloan-C workshops, administered by their university's Distance Learning Office. In summary, instructors used the same set of pedagogical techniques and class activities for each of the two courses they taught. Sandman (2009) employed this same technique. Table 1 summarizes the distribution of students in each of the four courses.

Table 1: Number of Students by Course and Type

Course\Type	Traditional	Online	Totals
Business Statistics	34	17	51
Operations Management	53	17	70
TOTALS	87	34	121

This table shows the number of students enrolled in each of four sections of two courses.

To explore factors potentially affecting student academic success, the students took the Felder-Solomon Inventory of Learning Styles (ILS) survey. This survey consists of 44 questions, 11 within each of 4 sections or scales. For each question, the student chooses one of two options, each representing the opposite end of the scale. The scales consist of sensing/intuitive, visual/verbal, active/reflective, and sequential/global. Litzinger, et al (2007) summarizes the meanings of these scales as: 1.) *"sensing* (concrete, practical, oriented toward facts and procedures) or *intuitive* (conceptual, innovative, and oriented toward theories and underlying meanings), 2.) *Visual* (prefer visual representations of presented material, such as pictures, diagrams, and flow charts) or *verbal* (prefer written and spoken explanations), 3.) *Active* (learn by trying things out, enjoy working in groups) or *reflective* (learn by thinking things through, prefer working alone or with one or two familiar partners), and 4) *sequential* (linear thinking process, learn in incremental steps) or *global* (holistic thinking process, learn in large leaps)."

Tabulating the score consists of adding up the number of responses for each end of each scale and finding the difference between the numbers of responses. This produces a score for each scale that has one of the following values: 1, 3, 5, 7, 9, or 11 together with the indicator of the student's preference (the end of the scale for which the student gave the most answers) for one or the other end of each scale. In other words, these values are scores on a Likert scale, and the scoring of student responses produces a final score for each scale that is analogous to a correlation. For example, a student with a score of 9 on the sensing end of the scale would have a strong inclination to learn via sensing. Another student with a 5 on the intuitive end of the scale would have a moderate preference for learning via intuition. Students in the middle have no sensing/intuitive preference. The closer the student response is to either end of the scale, the stronger their inclination to learn in that manner. The dataset includes student scores on each of the four Felder-Solomon scales and the following demographic data: gender, age, number of previous online courses, academic major, distance from home to school, reason for taking an online course, and number of hours worked per week. The authors used SPSS version 19 to perform all statistical tests.

RESULTS AND DISCUSSION

Difference in Academic Performance

Several statistical tests addressed the research question regarding potential differences in student performance. The chi-square test evaluated the hypotheses:

H_0: there is no relationship between course type and course grade
H_1: there is a relationship between course type and course grade

SPSS produced the contingency table of grades by course type shown in Table 2. The "D or F" category combined the D and F grade categories (due to small cell frequencies).

Table 2: Contingency Table of Grades by Course Type

Course Type		Course Grade				Total
		D or F	**C**	**B**	**A**	
Traditional	Count	12	20	41	14	87
	% within Row	13.8%	23.0%	47.1%	16.1%	100.0%
	% within Grade	60.0%	58.8%	83.7%	77.8%	71.9%
Online	Count	8	14	8	4	34
	% within Row	23.5%	41.2%	23.5%	11.8%	100.0%
	% within Grade	40.0%	41.2%	16.3%	22.2%	28.1%
Total	Count	20	34	49	18	121
	% within Row	16.5%	28.1%	40.5%	14.9%	100.0%
	% within Grade	100.0%	100.0%	100.0%	100.0%	100.0%

This table shows the contingency table of final course grades classified by type of course. Row and column percentages are included to aid in the discussion of the chi-square test result.

The data in Table 2 produced a Pearson Chi-Square value of 7.949 with 3 degrees of freedom and a level of significance of 0.047. This indicates strong evidence of a difference in the distribution of grades by type of course. By examining the percentages for rows and grades in Table 2, the cause of the statistical significance is obvious. Specifically, 16.1% of students in the traditional courses earn a final grade of "A", while only 11.8% of students in the online versions earn an "A". This pattern continues with students earning a final grade of "B", since 47.1% of the students in traditional classes earn this grade, while only 23.5% of students in the online sections earn it. On the other hand, 23.5% of the online students earn a "D" or "F", compared to only 13.8% of the students in the traditional sections. The authors believed that the final course average in the traditional course would be greater than the final course average in the equivalent online course, based on previous experience with grades in traditional versus online courses. The variable "Course Avg" is the proportion of the total available points earned by the student over the entire semester, converted to a percentage, and so the values ranged from 0 to 100. The independent samples t-test evaluated the hypotheses:

H_0: "Course Avg" in traditional course $\leq$ "Course Avg" in online course
H_1: "Course Avg" in traditional course > "Course Avg" in online course

The data in Table 3 shows the output of the independent samples t-test performed on the variable "Course Avg".

Table 3: Descriptive Statistics from Independent Samples t-test

	Course Type	N	Mean	Standard Deviation	Standard Error Mean	t	df	2-tailed Significance
Course Avg	Traditional	87	80.78	9.102	0.976	2.609	119	0.01 ***
	Online	34	75.50	12.054	2.067			

This table shows statistics related to course averages for students in the traditional sections compared to students in the online sections.
**** The test of difference of means for Course Avg was statistically significant at the .01 level.*

The independent samples t-test produced a t-statistic of 2.609 with 119 degrees of freedom, which had a 2-tailed significance of 0.01. This indicated very strong evidence that there is a difference in course average between students in the two types of courses. Based on the descriptive statistics, the average difference was 5.28 points or approximately half a letter grade (both instructors grade on the scale: course average of 90-100 is an A, 80-89 is a B, 70-79 is a C, etc.) In summary, both the chi-square test for a relationship between course type and grades and the independent samples t-test for differences in course averages indicate a significant difference in grades between traditional sections and online sections of these quantitative courses.

Impact of Learning Style

Two techniques were employed to determine whether learning style, as measured with the Felder-Solomon ILS, had any impact on academic performance. First, correlations between each of the four dimensions of the learning style instrument and student course average were calculated. No statistically significant results were found. Second, linear regression was performed using student course average as the dependent variable, and the four learning style scales and other demographic variables as independent variables. The only significant variable for predicting the student's course average was the course type: whether the course was traditional or online. Sandman (2014) used logistic regression with student age and course type (online or traditional) to predict student preference for each of the four scales of the Felder-Solomon ILS. He found that age was not a significant predictor, but whether or not the course was online was a significant predictor. The present research also used logistic regression to predict student preference for each of the four scales, with four independent variables. The four independent variables included gender, whether the class was online, student's final course average, and the number of previous online courses taken by the student. None of these independent variables was a significant predictor at the 0.05 level of significance.

Impact of Other Demographic Variables

The linear regression performed with learning style included the other demographic variables as independent variables. As noted in the previous section, none of these variables proved to be statistically significant. In other words, none of them was useful as a predictor (other than course type) of course average. There were an insufficient number of students to conduct the chi-square tests after separating males from females, so the effect of "gender" was not measured. This occurred because the chi-square test requires that no more than 20% of the cells in a contingency table have expected frequencies less than 5 (Burns and Burns, 2008).

CONCLUDING COMMENTS

The goal of this research is to identify whether online delivery and traditional course content delivery in quantitative courses are equally effective in terms of student course grades, and to identify the factors that determine student success. These questions were evaluated by examining student grades and demographics across two different sections of each of two different quantitative courses. Two separate instructors each taught one online section and one traditional section of their course, resulting in 121 students in four

separate sections of the two quantitative courses. Student success as measured by final course grade was compared, and learning styles and other demographics were examined. A chi-square test identified a significant difference in grade distributions between the two course delivery methods, and an independent sample t-test identified a significant difference in overall course averages between online and traditional students. However, no significant differences were found based on learning styles or other demographic variables. The findings in this research are consistent with those reported by Zhu and Stevens (2014), who utilized a simpler learning style model (the VARK model, based on learning style as primarily one of visual, auditory, read-write, or kinesthetic) to show that grades are better in traditional quantitative courses when compared to the same course taught online by the same instructor. As noted earlier, DiRienzo and Lilly (2014), did not find a difference in student performance between online and traditional courses, but their data consisted of five different courses, some of which were quantitative and others that were not. This collection of fundamentally different types of courses likely blurred the distinction between student performance in online and traditional styles.

Prior to this research, the authors had formed a common opinion about online courses: that not all courses should be taught online and that not all students should take an online course. The results of this study indicate that there is definitely a significant difference in overall final course average for students in traditional *quantitative* classes compared to their counterparts in an equivalent online course taught by the same instructor. The authors were hoping to demonstrate that other factors affected student academic performance, but learning style as measured by the Felder-Solomon model, and other demographic data included in this study did not support those hypotheses. In summary, this study addresses three sets of research hypotheses and there was sufficient statistical evidence to suggest that one of the three was true. The first hypothesis, that there is a difference in student academic success between online and traditional quantitative courses, was demonstrated. The second hypothesis, that student learning style has an impact on student academic success, was not demonstrated. Finally, the third hypothesis, stating that other demographic factors affect student academic success, was not demonstrated.

Because this study consisted of only four sections of students at one university, it would be of interest to compare data across multiple schools using similar courses. In terms of courses, since prior research has shown that learning styles differ by academic major and courses within that major, it would be of interest to perform a similar analysis using courses that are not quantitative in nature. Such "qualitative courses" are those in which formulas and algorithms are not significant topics. Students (especially those who do not enjoy mathematics) would identify these courses as the "easier" ones. In addition, the inclusion of other variables might help to identify the type(s) of students most likely to succeed in one course type compared to another. Such information, if available, could be of great use to academic advisors who could counsel students regarding the best path for their personal academic success. In addition, as noted earlier, students who succeed more frequently graduate sooner, have less debt, and are more satisfied with their educational experiences.

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