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Comparing Online with Brick and Mortar Course Learning Outcomes: An Analysis of Quantitative Methods Curriculum in Public Administration

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Abstract

Teaching graduate students in an intensive adult-learning format presents a special challenge for quantitative analytical competencies. Students often lack necessary background, skills and motivation to deal with quantitative-skill-based course work. This study compares learning outcomes for graduate students enrolled in three course sections (cohorts) taking a quantitative methods course in a public administration program. One cohort of students was taught online, while two student cohorts were taught face-to-face in a traditional classroom setting. Most of the online students resided in the same geographic location as the "brick-and-mortar' students. While student backgrounds and demographics were comparable, there were notable differences in their levels of self-directed learning readiness and persistence.

These differences illustrate both course design and modality features for a comparison between online and traditional brick-and-mortar learning environments. We find that predictors of student performance in an online environment are rather well described by the Self-Directed Learning Theory (SDL) and Self-Regulated Learning Theory (SRL). A statistically significant difference was found in the pretest-posttest mean scores, which indicates that students learned the course content for quantitative methods in the online section differently from those in the brick-and-mortar section. Overall, students enrolled in the online section (cohort) performed better on the posttest than did students enrolled in traditional "brick-and-mortar" classes. An age variable shows that older students performed much better than younger students on the posttest. Other differences in learning outcomes between the online and brick-and-mortar sections are analyzed in the study. Stakeholders in online education should be interested in these outcomes.
Keywords: online education, brick and mortar, learning, theory, students, public administration.

The Problem

Research is needed on how context influences learning (Garrison, 1997, 2003; Gunawardena & McIssac, 2003; Song & Hill, 2007). Higher education takes place in a variety of contexts, ranging from face-to-face classrooms to virtual classrooms. Within these settings, a variety of methods are used to enable interactions, including 100% physical classroom interactions and 100% online interactions. The issues and attributes in various learning contexts (i.e., physical classroom instruction, a Web-based course, a computer-based instructional unit, etc.), require further exploration (Song & Hill, 2007).

More specifically, the impact of course content, such as quantitative analysis and research methods, on student motivation and success, and faculty effectiveness in a variety of contexts is drawing scholarly attention in different academic journals, such as JPAE, TPA, Public Administration Review, and other publications. The revised National Association of Schools of Public Policy and Administration (NASPAA) standards and the quest for better student learning assessment and experiences continued by most accrediting bodies in the U.S. contribute to the academic and scholarly interest, as well as the sense of urgency, in the area of teaching and evaluating student quantitative knowledge and performance. Analytical skills comprise one of the five principal competencies continuously assessed by the Western Association of Schools and Colleges (WASC). They remain perhaps the most important skills for overall student success and job marker performance. Yet, they are rather difficult areas of instruction and assessment (Wright, Manigault, & Black, 2004)

The need for empirical research on online student learning competencies, such as quantitative skills, is recognized. Unfortunately, recent academic literature is replete with accounts of personal learning, teaching experiences, and anecdotal observations. Empirical

research into online learning is at the cutting edge of pedagogical innovation (Bonk, Kim, & Zeng, 2006; Boyer & Kelly, 2005; Dzuiban, Hartman, Moskal, Sorg, & Truman, 2004; Hiemstra, 2003; Ya Ni, 2012). Previous research on learning outcomes in the cognitive domain usually measure factors, such as course performance, content processing, levels of student interaction, and retention.

Research has also been conducted to analyze various socio-demographic characteristics of online learners. Those characteristics include personal demographic characteristics, learners' experiences and satisfaction with e-learning and prior experiences in computer-related activities, such as electronic mail, online course work, and Internet use. Learning styles and the quality of learners' social interactions in an online environment were commonly investigated (Bee & Usip, 1998; Gunawardena & Duphorne, 2001; Mortensen & Young, 2000; Muilenburg & Berge, 2005; Neuhauser, 2002; Swan, Polhemus, Shih, & Rogers, 2001; Wells, 2000).

Some scholars found independent variables that statistically significantly affected student perceptions of e-learning; the variables included gender, age, ethnicity, type of learning institution, self-rating of online learning skills, effectiveness of learning online, online learning enjoyment, prejudicial treatment in traditional classes, and the number of online courses completed. These findings show that people with more prior experience and training in computer-related activities reported more satisfaction and comfort with the online environment (Muilenburg & Berge, 2005; Swan et al., 2001; Wells, 2000).

Other scholars have found no statistically significant differences in test scores, assignments, participation grades, and final grades based on gender, age, learning preferences and styles, and media familiarity (Neuhauser, 2002; Ya Ni, 2012). Evidence shows that student performance as measured by grade or score is not related to mode of instruction. Rather, lower

student persistence was found to be typical of educational performance in an online environment as compared to an in-class format. A generally higher level of interaction was observed in online courses, specifically those in research methods and quantitative analysis (Tallent-Runnels et al., 2006; Ya Ni, 2012). No consensus exists among researchers about relationships between demographic characteristics and learning performances in online courses (Tallent-Runnels et al., 2006). Therefore, further investigation is warranted.

Learning Theory

Self-directed learning theory (SDL) has been linked conceptually with Internet-based learning since the 1990s (Caffarella, 1993; Long, 2001; Monolescu & Schifter, 2001). SDL is defined by Conner et al. (1995) as "[l]earning initiated and directed by the learner" (p. 62); SDL includes self-paced, independent, individualized learning, as well as self-instruction (Caffarella, 1993). An SDL strategy is effective, as it forces the learner to take the initiative, resulting in a more active-learning process and a deeper understanding of the assigned course material (Brockett, 2001).

E-learning, by its very learner-centered nature, is where SDL can and does occur (Garrison, 2003; Gunawardena & McIssac, 2003; Shapley, 2000). Instructors teaching asynchronous online classes and providing guidelines for e-learning allow students to study at their own pace, in their own environment, and utilizing resources often found through self-guided research. Students work independently, by visiting virtual libraries, accessing online resources for the latest research, and participating in virtual interactive discussions from remote locations. SDL is embedded in the constructivist theory which describes the creation of knowledge in the classroom through collaborative learning.

Song and Hill (2007) provided a research-based framework for understanding SDL in any version of online context following a prominent line of SDL scholarship (e.g., Brockett & Hiemstra, 1991; Candy, 1991; Garrison, 1997; Guglielmino, 1977). Their framework incorporated SDL as a personal attribute and a learning process with a third dimension focused on the learning context, which emphasizes environmental factors (Song and Hill, 2007, p. 31). Hence, linkages between SDL attributes, learning processes, and learning contexts were established.

Guglielmino and Guglielmino (2003) say that while students' technical skills and attitudes are important for e-learning, self-direction is far more vital in a successful Web-based environment. The self-directed nature of web-based courses, with active participation in online assignments and feedback from fellow students and the course instructor contribute to a successful learning experience. The evidence for this conclusion is reported with measures of overall course satisfaction and student perceptions of success (Reece & Lockee, 2005; Tallent-Runnels et al., 2006).

Some of the studies in the broader field of cognitive learning theory and learning constructivism emphasized the concept of Self-Regulated Learning (SRL). SRL is related to SDL while occupying its own place in the hierarchy of learning theories. Although there are similarities between SDL and SRL, both concepts differ on important aspects, including the "self" aspect and main developmental processes of which learners are an integral part. SDL includes an additional premise of giving students a broader role in the selection and evaluation of learning materials. SDL can encompass SRL, but SRL is too narrow in many respects to do the same (Loyen, Magda, & Rikers, 2008). In contrast to SDL, SRL is "learning that is planned, assessed, and analyzed by the person doing the learning" (Moran, 2005, p. 17). Adult educators

have written about the importance of helping adults to become competent independent learners not only in formal education and training programs but also in the workplace and in other areas of adult life. Incorporating SRL research in the broader context of cognition and learning quantitative skills thus is an effective way to highlight some of the common as well as different functional and motivational issues that emerge in different instructional environments.

Research Methods

According to learning theory discussed earlier, online students should be both highly motivated and challenged by the medium of education. Our general hypothesis was that all of the participants would, on average, show an increase in learning as measured by changes in the pretest-posttest examination. Our specific hypothesis was that participants enrolled in online education would show improved performance on the pretest-posttest examination as compared with students enrolled in traditional brick and mortar classroom settings.

We expected that students enrolled in the quantitative methods courses would gain in their test scores, measured from pretest to posttest. However, we were unsure about the novel style of teaching a technical course online. To determine whether the online approach would be effective or not, a research design was developed to assess three cohorts of students, one online and two in traditional "brick and mortar" settings. Additionally, the second brick and mortar cohort was introduced to the rubric method of grading papers. Putting teaching into practice, we evaluated student learning outcomes in a quasi-experiment. The learning or treatment effect was measured with a pretest-posttest instrument of 52 true-false items that cover the educational content. Statistical models were specified to predict not only the expected learning outcomes, but also the differences among cohorts, based on their modes of instruction. We identified predictors

of the posttest outcomes with demographic and qualifications characteristics to include: pretest score, age, gender, race, and cumulative grade point average (GPA). GPA was accessible to students, prior to taking their quantitative methods course.

A pretest-posttest instrument consisting of 52 true-false items was administered to graduate students in three cohorts. The scale ranged from 0 to 52, with 0 being a minimum possible score and 52 being a maximum possible score. The instrument was developed by selecting among relevant test items for chapters in assigned readings in Essential Statistics for Public Managers and Policy Analysts (Berman and Wang, 2012). We also examined learning outcomes using a rubric-based assessment of this course offered in the two parallel modalities. We discuss both the evaluation design and unique elements of student performance in the two different learning environments. Notably, the importance of competency-based education was emphasized in the course design.

The three cohorts studied include: online, brick and mortar, and brick and mortar with rubric. The online cohort enrolled 12 students, but only 11 students completed the posttest. The brick and mortar cohort at one of the locations enrolled 12 students, and all 12 completed the posttest. The brick and mortar cohort with the rubric at another regional campus enrolled 11 students and all 11 completed the posttest. The total number of observations is 35. The method allows statistical tests to be conducted to determine whether differences exist in the posttest measure of learning outcomes for students enrolled in online education as compared with traditional brick and mortar classroom settings. The cutoff criteria for determining whether a statistical relationship is significant (i.e., alpha) was set at 0.05.

Variables were measured to predict the posttest scores. Descriptive statistics are provided in Table 1. Demographic predictors included: gender, race, and age. Online education is

anonymous for most participants. The students could see a picture of the instructor, but not vice versa. Student anonymity on gender, race, and age should help to reduce instructor grading bias. Race is important to this particular learning context, given that the University of San Francisco is nationally rated as the best private higher educational institution for minority students. Student race should not affect the learning outcomes. Race was measured as African-American (1) or other (0). Because duration of education varied among the cohorts, the number of days in the term was measured. For example, the online cohort had convened for two months, while the brick and mortar cohorts had convened up to 84 days. We controlled for the cumulative GPA at the point of convening the quantitative methods class at the term startup, but we lacked data for comparing student qualifications at baseline, when they had enrolled into the program.

The general null hypothesis was that no statistically significant relationship would be found between the pretest and posttest mean scores for all of the participants in the study. Our true expectation was that all of the students would show an increase in their mean scores, from pretest to posttest, regardless of which cohort they enrolled into. Our specific null hypothesis was that no statistically significant relationship would be found for the online cohort when predicting posttest scores. Our true expectation was that the regression coefficient for the online cohort would be positive and statistically significant. That is, a dummy variable indicating which graduate students were enrolled in either the online cohort (1) or the brick-and-mortar cohort (0) should support the learning theory.

Results

The results revealed that students in all three cohorts showed a statistically significant increase in mean scores on the pretest-posttest examination covering the assigned readings

(Table 2). A paired samples t-test (Table 3) shows the change in means is highly significant (p=000). A linear regression model was estimated to predict the posttest scores with demographic and academic variables. The model estimates are reported in Table 4. This model specification follows Mohr (1995) on impact analysis.

Goodness-of-fit statistics (F) show that the overall model is highly significant (p=.001), with about 44% of the variance in the regressand explained by the regressors (Adj. R^2=0.445). Three of seven independent variables in the model were found to be statistically significant predictors of the posttest score, including: pretest score (p=.018), online dummy (p=.000), and age (p=.039). Neither race, gender, nor GPA in the term prior to taking the quantitative methods course was found to be statistically significant. These results for gender and race (African-American) support the public rating of the University of San Francisco as best for minority students enrolled in higher education.

As expected, the pretest score predicts the posttest score. What is the impact of the online cohort on the posttest score? The impact on the posttest score by the online cohort was calculated for mean, minimum, and maximum values of the dummy variable. The four not statistically significant predictors were set to zero (0). By setting the pretest score (33.54) and age (35.83) to their mean values, we can then estimate the impact of online education on the posttest scores (Table 5). When the mean value for the number of students in online education is entered into the model, then we find that the predicted posttest score is 39.31. If we set the online cohort to 0, then the predicted posttest score is 37.05. If we set the online cohort to 1, then the predicted posttest score is 43.11. The difference in posttest scores, when the online cohort is either absent or present is 6.06. The range of the posttest scores is 18 (47-29), which means that about one-third of the change in scores is explained by the online cohort. Thus, the online students

performed much better on the posttest than did the other two cohorts of brick-and-mortar students.

Validation

To validate our quantitative results, we used a qualitative rubric to assess the final research projects written by participants in the study (Table 6). The rubric was designed to measure both quantitative and qualitative analytical skills, the quality of research and richness of observations, upon which all students' final projects were graded. Only one of the cohorts (the brick-and-mortar one) was given an advance notice of the rubric's usage, which allowed them to review categories prior to the completion of their projects. A content analysis of the student projects showed no difference, especially in terms of quantitative skills, between all of the sections of the quantitative methods course, thus suggesting an equal level of the rubric's effectiveness as a learning and evaluation tool in different modalities. The only difference was recorded in the content richness and writing quality areas of the rubric, in which students in the online course section scored 28% higher on average compared with their brick-and-mortar peers. The result could be partially explained by the writing-centered nature of the online course format, which is necessary for completing assignments in lieu of the class discussion. The results of the rubric-based assessment are therefore inconclusive and would require another setting to collect and analyze the student performance data and the rubrics' impact on learning.

Limitations

As evaluators, we realize that our findings may be limited by uniqueness in our recruitment methods, type of higher education institution, and geographic location. The course is

a graduate-level required cognate taught in a professional masters' degree program populated almost entirely by adult learners. A convenience sample of students enrolled in a particular semester was utilized and while the demographics are reflective of the program, they do not represent either the region or even the university in general. The university is a mid-sized, private, faith-based institution of higher education with a uniquely diverse student population, which does not represent either the state or nation.

Conclusions

The results of this study show that age, gender, and race did not have an impact on the successful learning of quantitative analytical skills in either of the formats: online or on-the-ground. Our results are consistent with current literature on the subject that point out no such differences across age groups, genders, and racial groupings. We show that online students perform better than students in brick-and-mortar classrooms. We also show that mature learners display a higher level of motivation as reflected in final test scores. More studies in different educational settings may still be needed to assess demographic predictors of student performance with various learning formats.

Academicians and educational administrators often rely on research in the area of technology-enhanced learning and instruction of quantitative analytical skills. As an increasing number of courses, degrees, certificate programs, and entire colleges are transferred either completely or partially online, the educational issues related to these delivery formats require comprehensive and thorough assessment to be translated into practical recommendations. The demand for research on self-directed learning and its functionality within the online, brick-and-mortar, or hybrid (blended) delivery formats is growing. Such demand is broadening

acknowledgment of the central role that student learning autonomy currently plays in making online education a meaningful, effective, and rewarding experience for both students and faculty (Allen & Seaman, 2007).

Implications

The essential implication for higher education policy makers is that the online format is an effective method of teaching quantitative methods to graduate students. That online students performed better as compared with students in a brick-and-mortar variation of the quantitative methods course confirmed the results of previous research. That is, students' self-directed learning readiness predicts their success in e-learning formats. Students may anticipate a rewarding quantitative skills learning experience if the course's online discussion is well-designed, connected with the assigned course and session learning outcomes and materials. The faculty who taught the quantitative courses online found that assignments posted to fill in the time and space ("busy work") are detrimental to the success of the online learning of the analytical skills. One needs to be particularly selective about the reading materials posted online in connection with discussions to avoid visual and cognitive overload for students and to encourage their responses. Breaking online discussion assignments into manageable chunks would improve the response quality, frequency rate, and learning. Well-timed and pertinent online assignments are likely to make a positive contribution to the enhancement of student cognition, and for learning quantitative skills in particular. The increased written requirement may help explain higher performance indicators in the online class cohort.

Recommendations

We recommend that researchers evaluate the implementation of online courses to determine whether this modality is as effective as compared to the brick and mortar approach. Technology has made higher education more available to the non-traditional student through participation online. There are important learning challenges stemming from the different medium in online instruction. Students need to be self-starters, more motivated to tackle assignments, while instructors are less likely to lecture online and offer targeted one-on-one support that contributes to a more active curriculum design. Students do appreciate the asynchronous online formats which facilitate self-direction.

To address the instructional concern over the perceived "disconnect" between learners and instructors in an online quantitative course, the utilization of multimedia learning tools may be especially helpful. Such tools consist of course programming that incorporates elements of podcasting, short educational films, and video clips to add to the visual aspect of learning and synchronize it with other instructional tools. Both the online and brick-and-mortar courses in quantitative methods may benefit from having a balanced composition of asynchronous and synchronous online features to minimize the perceptions of "disconnect" from other learners and the instructor as evidenced by certain research and faculty experiences, including the ones described in this study.

Appendix

Table 1. Descriptive Statistics

Variable	Mean	Minimum	Maximum	Standard Deviation	N
Posttest Score	39.29	29	47	4.59	34
Pretest Score	33.54	28	39	2.98	35
Term Days	61.15	21	84	17.92	34
Cumulative GPA	3.68	3.00	4.00	.28	35
Age	35.83	24	58	8.85	35
Gender (Male=1)	.37	0	1	.49	35

Race (African American=1)	.31	0	1	.47	35

Table 2. Paired Samples Statistics

Instrument	Mean	Std. Dev.	Std. Error Mean	N
Pretest Score	33.44	2.966	.509	34
Posttest Score	39.29	4.589	.787	34

Table 3. Paired Samples T-Tests

Instrument	Mean	Std. Dev.	Std. Error Mean	t	df	Significance (2-tailed)
Pretest-Posttest	-5.853	4.480	.768	-7.618	33	.000

Table 4. Linear Regression Model

Predictors	B	Std. Error	Beta	t	Significance
Constant	10.475	11.992		.873	.390
Pretest Score	.615	.244	.398	2.525	.018
Term Days	-.045	.038	-.174	-1.161	.256
Online Dummy	6.056	1.504	.627	4.027	.000
Gender	1.458	1.443	.157	1.010	.322
Race (African-American)	-2.188	1.578	-.220	-1.386	.177
Age	.166	.076	.324	2.171	.039
Cumulative GPA	.864	2.501	.053	.345	.733

Adjusted R^2=0.445, Std. Error of the Estimate=3.418, N=34, F=4.786, Significance=.001.

Table 5. Posttest Scores Predicted by Online Education

Posttest Score	Online Education
39.11	.34
37.05	0
43.11	1

Table 6. Grading Rubric for Technical Report

Grading Rubric for Technical Report			
	Basic (satisfactory)	**Proficient (good)**	**Advanced (excellent)**
Background	Overly brief,	Sufficiently elaborate,	Clear, elaborate,

[15 pts]	superficially addresses this segment of the assignment, insufficient research on the selected issue, content deficiencies and inconsistencies [10 pts]	complete and informative, demonstrates good background research, including mostly relevant data and information with few significant content deficiencies and inconsistencies [12 pts]	complete and informative, demonstrates excellent research with multiple references, including all relevant data and information with few significant content deficiencies [13-15 pts]
Problem Statement **[20 pts]**	Does not state the research problem in an articulate manner and/or concisely with no strong connection to the selected issue. [14-15 pts]	States the problem and purpose of the research concisely and in articulate manner with good connection to the selected issue. [16-17 pts]	Strong, articulate, and concise research problem statement provided with clear connection to the selected issue and all relevant and concisely stated supporting facts/ references included. [18-20 pts]
The Assessment Section: Quality of Quantitative Analysis & Critical Thinking **[30pts]**	Very few and/or not always appropriate quantitative assessment or evaluation tools and techniques utilized in the analysis. Very few and/or not always relevant concepts from the reading are applied. Response exhibits limited higher-order critical thinking and	Appropriate quantitative assessment or evaluation tools and techniques utilized mostly correctly in the analysis. Mostly relevant concepts from the reading are applied effectively and consistently. Response generally exhibits higher-order critical thinking and analysis. Paper shows some original thought.	Appropriate quantitative assessment or evaluation tools and techniques utilized correctly, effectively, and concisely. Consistently relevant concepts from the reading are applied effectively and consistently. Response exhibits

	analysis. Incomplete, inconsistent, and/or often erroneous stakeholder analysis presented. [21-23 pts]	Mostly complete, consistent, and effective stakeholder analysis presented with very few errors. [24-26 pts]	strong higher-order critical thinking and analysis. Paper shows original thought. Comprehensive, consistently effective and articulate stakeholder analysis presented. [27-30 pts]
Recommendations [20pts]	Very few and/or not consistently sound and relevant (tied to the research and findings) recommendations that may be lacking elaboration. [14-15 pts]	Consistently sound, relevant (directly tied to research and findings), and elaborate recommendations. [16-17 pts]	Multiple strong, sound, relevant, and elaborate recommendations that offer many new perspectives for solving problems identified. [18-20 pts]
Structure, Writing and Mechanics [40pts]	Generally unclear, often wanders or jumps around. Few or weak transitions, many paragraphs without topic sentences Some mechanics/format errors made more than once-mostly minor-no major mechanics of formatting errors.	Generally clear and appropriate, though may wander occasionally. May have a few unclear transitions, or a few paragraphs without strong topic sentences. Minor mechanics errors; demonstrates strong understanding of accepted rules of grammar, punctuation, manuscript formatting. [31-34 pts]	Evident, understandable, appropriate for thesis. Excellent transitions from point to point. Paragraphs support solid topic sentences. Virtually free of errors in grammar, spelling, and punctuation; follows APA format correctly.

	[28-30 pts]		[35-40 pts]

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