AC 2009-1254: ON-LINE DISTANCE EDUCATION AND STUDENT LEARNING: DO THEY MEASURE UP?

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On-Line Distance Education and Student Learning – Do They Measure Up?

On-line distance courses are becoming increasingly common, and although some educators still question their effectiveness, the literature shows that experienced educators are attesting to effectiveness. T.L. Russell of the Distance Education Certification Center reports that: computer technology "does not denigrate instruction." Rather, "it opens doors to employing technologies to increase efficiencies, circumvent obstacles, bridge distances, and the like."[14] Nonetheless, growing emphasis on program evaluation, institutional effectiveness, and accreditation often raises questions regarding the effectiveness of a particular on-line education offering compared to a particular counterpart traditional course offering.

Numerous foundational studies provide assurances, indicating that on-line education provides an educationally sound experience that students find acceptable.[1,4] However, these analyses also reveal variations in results at a micro-level, resulting in questions regarding the quality of particular on-line offerings. Thus, it is appropriate for accreditation bodies and academic departments to investigate the efficacy of particular on-line versus traditional offerings. This paper presents a case study that demonstrates a method for gathering data which can be used in this context. It can contribute to the development of on-line instruction and the understanding of its effectiveness for conveying different subject matter, such as quantitative versus qualitative content.

Members of the college Assessment and Continuous Improvement Committee at the University of Houston engaged faculty to devise a system that would enable descriptive comparisons of learning achievement in on-line versus traditional courses, with attention directed to student achievement of the core course concepts. The committee's starting goal was to provide assurance that the College is providing comparable and similarly effective courses in both delivery formats.

Multiple sections of a qualitative course and a quantitative course, taught in both face-to-face traditional (LEC) and on-line (WEB) modes, were selected for review and comparison. This paper reports the method and the results of the analysis. Specifically, it:

- presents a glimpse of the literature regarding comparison of on-line distance education to lecture/traditional education formats with respect to effectiveness,
- presents the procedures and findings of the case study,
- suggests conclusions for local use,
- and suggests research extensions.

Review of Literature

With a substantial portion of university campuses and their faculty now participating in distance education endeavors, a shift is evident in the professional literature. Numerous foundational

studies have provided reasonable assurances in the debate whether distance education is as good as traditional education. They conclude that the distance experience is educationally sound, providing both student satisfaction with the experience and student attainment of learning goals.

Overall, research indicates student satisfaction with the format. In a meta-analysis involving more than 400 studies, Allen compared student satisfaction with distance education to traditional classroom delivery. Results support the findings of researchers who argued that "distance education does not diminish the level of student satisfaction when compared to traditional face-to-face methods of instruction".[1]

With this background, researchers have also attempted to identify student attributes that make a difference in their learning or satisfaction based on course delivery format. Examples of studies that focus on how student learning style affects distance learning efficacy or student satisfaction include one by Henry[8], one by Aragon, Johnson, & Shaik[3], another by Nitsch[11], and one by Tucker.[15] Examples of studies with a focus on impact of motivation to learn are by Olmsted[13] and by Irizarry.[9] Examples of studies focusing on how student self-efficacy impacts the success of a particular learning format are studies by Deka and McMurry[7] and by Irizarry.[9] To elaborate, the study by Henry, for example, provides evidence of a positive correlation between preference for visual learning and satisfaction with themselves as learners when the course delivery is Web-based as opposed to traditional.[8]

In addition to student satisfaction with distance education experiences, there are also questions concerning the effectiveness of the format to produce learning. Russell, based on a bibliography of 355 studies, reported no significant difference in learning outcomes based on delivery format.[14] A meta-analysis by Bernard, et al. found no statistically significant difference in overall student achievement.[4] The authors reasoned that the differences in individual measures from individual studies imply that the quality of web-based coursework is uneven, as it is with classroom instruction quality. The paper also noted that the measurement methods, necessary to account for all extraneous variables, are not available. Allen, et al. conducted a different meta-analysis and focused on the issue of effectiveness of distance education in terms of learning.[2] For purposes of the study, they defined effectiveness in terms of student performance scores on tests or in terms of grades achieved in a course. They focused on distance education studies and courses that employed modern technologies for the delivery format. In the analysis phase, recognizing that different subjects might require different instructional strategies, they considered content type as a moderating variable. The content categories included natural science and mathematics (including engineering), military training, foreign language, and social sciences (e.g., history, sociology, and communication). The analysis showed that there is no advantage or disadvantage for the distance education delivery format for natural science courses; there seems to be a disadvantage in the case of military training courses, an advantage in the case of foreign language, and a small advantage in the case of social science.[2]

Of course, there are also philosophical debates regarding whether delivery alone influences learning outcomes. Joy and Garcia indicate that instructional design strategies (for all delivery formats) are what make the difference in learning.[10] Similarly, Clark contends that media are simply the conveyors of instructional method and content, and he concludes that they do not directly influence learning in any way.[5]

If then, distance education is educationally sound, student perceptions are similar for distance and face-to-face learning experiences, and personal attributes may influence student experience, why is further investigation needed? Educators must always monitor their local offerings for quality, and it is appropriate that they investigate how to optimize the on-line delivery of their curriculum. Russell, in *The No Significant Difference Phenomenon* expressed:

> Technology does not denigrate instruction. This fact opens doors to employing technologies to increase efficiencies, circumvent obstacles, bridge distances, and the like. It also allows us to employ cheaper and simpler technologies with assurance that outcomes will be compatible with the more sophisticated and expensive ones as well as conventional teaching/learning methods."[14]

Assessment of student learning outcomes is one way to monitor the quality of educational programs and compare different delivery formats. In that context, this study examines not only variation in student performance based on course delivery format, but it also gives some consideration to variation in course content.

Background and Procedures

Multiple sections of two courses that were taught in both face-to-face (LEC) and on-line (WEB) modes during the 2006-2007 academic year were selected for review. Both courses are classified as junior level courses. One course was qualitative in nature with content directed at management and supervision (referred to as MGM). The second course was a quantitative and computer-based statistics course that used spreadsheet software extensively in the development of concepts and skills (referred to as COST).

The analysis was designed to consider the following questions.

1. What is the student performance in the quantitative course by format?
2. What is the student performance in the qualitative course by format?
3. For each course, does performance differ based on WEB or LEC formats – overall and within a specific format?
4. Does performance differ relative to individual assessment items and or types of assessment items?

Performance was measured using a set of course examination items. For each of the two courses, a set of 10 objective (multiple-choice) test items reflecting key course concepts was utilized to

gather data about how well students learned the key course concepts. The test items were developed at a departmental level by faculty teaching the course and were reviewed by an expert panel to verify their validity as a measure of student learning. Furthermore, faculty sought to ensure that the items (i) represented seminal course concepts and (ii) were at an appropriate level of difficulty for assessment of junior-level attainment of concepts

The items were administered at the end of the semester, as a component of the last course exam in all sections of each course, regardless of format. Thus, all enrolled students were required to answer the items, and student performance on the items was incorporated into the student's course grade to motivate student ownership of the importance of the items. The items were scored and analyzed apart from the process of individual student assessment for the purpose of awarding grades. In addition to determining if overall student performance differed on the basis of class format, differences based on course content (quantitative versus non-quantitative) were explored. Finally, individual items were reviewed to see if there were differences in performance based on individual items or content areas. Appropriate to the assessment design, descriptive methods were used to analyze the information. (Recognizing the existing confounding factors in the study approach, a deliberate decision was made to present a case study format with a descriptive analysis of the information.)

The research team recognized that multiple variables exist in the comparison of online and face-to-face modes of instruction. Differences and similarities were noted. The WEB and LEC sections of MGM were taught by two different professors. WEB and LEC sections of COST were taught by one individual with only one WEB section utilizing a second faculty member. In general, both LEC and WEB sections followed the same outline, covering identical content.

Class sections averaged approximately 50 students in size. LEC classes were characterized by traditional lectures using power point presentations, student presentations, readings, and class discussions with continuous opportunities for student questions and interaction. The WEB sections employed asynchronous interactions, predominantly. Students asked questions via the, discussion board and e-mail. A limited amount of interaction in the form of questions and answer sessions occurred synchronously in a chat room. An on-campus Instructional Students Services Laboratory was available to assist students with course content, deliver assessments (as needed), and generally facilitate the on-line experience. These services are available to students in face-to-face sections as well. Students in COST had opportunities for synchronous online tutoring in addition to tutoring in the ISS Lab.

Study Results

Review of Score Results Descriptive measures for each course type by format are presented in Table 1 and in Figures 1 and 2.

For the qualitative course (MGM), the data revealed that student performance was approximately the same across both formats. In WEB and LEC formats, the median scores were both 70, and the mean scores differed by approximately one point. Variations in scores were also close, with a standard deviation of 16.2 observed in the LEC course and a standard deviation of 14.8 observed in the WEB course. The similarity of the score distributions for the two formats of MGM can be seen in the box plots shown in Figure 1.

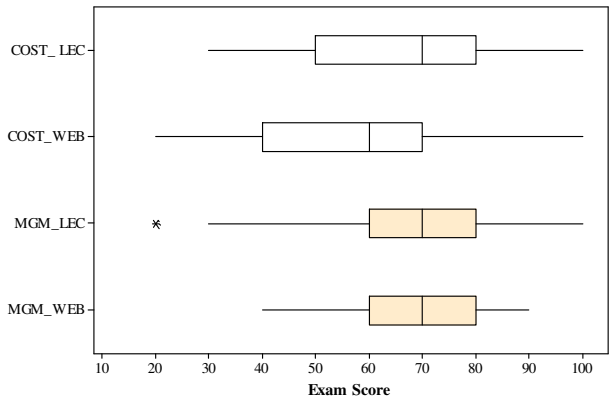
For the quantitative course (COST), the data revealed that average student performance differed by format. In the LEC format, the median score was 70 and the mean was 67 while the WEB course produced a mean of 55 and a median of about 60. Although there was slightly more variation present in COST course scores than MGM course scores, the variation in COST scores was about the same across WEB and LEC formats, with a standard deviation of about 20 observed for each format. For the COST course, the two distributions based on format appeared approximately symmetrical with equal variances (see Figure 1).

Table 1: Exam Scores Lecture vs. Web Delivery by Course Type

	COST		**MGM**	
	LEC	**WEB**	**LEC**	**WEB**
Mean	67	55	68	69
Median	70	60	70	70
Standard Deviation	20	20	16	15
Minimum	30	20	20	40
Maximum	100	100	100	90
Q1	50	40	60	60
Q2	80	70	80	80
n	58	83	57	43

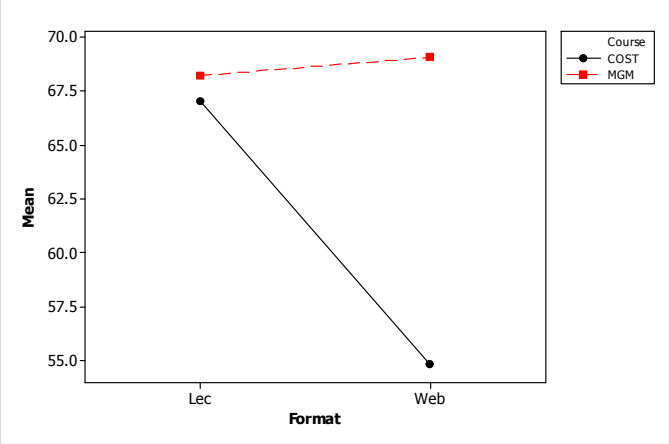
Thus, data revealed mean scores for the qualitative course at about the same level in the LEC and WEB formats and mean scores for the quantitative course at different levels, with scores in the WEB format slightly lower than those in the LEC format. Note that there is no interest in the mean score differences across MGM and COST since they are different courses.

Figure 1
Exam Score Distribution by Course Content & Format



The difference in means for COST based on format compared to the same means for MGM is perhaps more clearly demonstrated by the interaction effects plot shown in Figure 2. The plot demonstrates that the mean exam score was approximately the same for the MGM course across WEB and LEC formats, while in the COST course there was a variation of over ten points.

Figure 2
Interaction Plot
Mean Exam Scores by Course Format and Content



Review of Content Areas To see if student performance differed on the basis of individual content areas, results for individual exam items were reviewed. For each item, the percentage of correct and incorrect responses was calculated. For both the MGM course and the COST course, individual items were compared by format.

MGM examines managerial processes as influenced by science, technology, and consumer economics with consideration of impact on individuals and families Two faculty members delivered instruction; however, it should be noted that there is extensive coordination between the two, and the courses are viewed as being more alike than may otherwise be the case when two sections of a course are taught by two different instructors. The instructors use exactly the same assignments, projects, content materials and supporting documents.

In general, it was observed that the WEB students seemed to do better than LEC students on "general knowledge" items, while the LEC students appeared to do better than WEB students on items that were classified as course specific.

The following was observed regarding content areas in MGM. Specifically, the differences between the percentages of correct responses for the WEB students versus the LEC students were greatest in the following content areas:

- Position differentiation

- Career stages
- Change management

The content of items dealing with career stages and change management was viewed as being more subjective than the content of the item on position differentiation. Students may have been influenced by opinion, general knowledge, preconceptions and prior knowledge rather than strictly by what they learned in the course. The content of the item on position differentiation is viewed as very course content specific. Thus, there may be variation in the way the two instructors covered this content. Although WEB students did better on the change management item than did LEC students, in general, this item had a very low correct answer rate, suggesting one of several possibilities: (a) content may not have been taught, and/or (b) the item may be poorly constructed.

The differences between the percentages of correct response for the WEB students versus the LEC students were lowest in the following content areas:

- Life stage transition
- Organization management/culture
- Employee supervision

The COST course provides an applied approach to the collection, analysis, presentation, and interpretation of numerical data including probability concepts, quality control and computer applications. It satisfies the quantitative reasoning component of the university core curriculum. One faculty member delivered the instruction in both LEC and WEB sections. There was one WEB section taught by a second faculty member.

The differences between the percentages of correct response for the WEB students versus the LEC students were greatest in the following content areas:

- Probability/probability distributions
- Confidence interval application
- Hypothesis test, fact

The differences between the percentages of correct response for the WEB students versus the LEC students were lowest in the following content areas.

- Descriptive methods, application and fact
- Hypothesis test, application
- Normal distribution, application

In general, both sections did well on items dealing with descriptive measures and with questions that were directed at measuring factual knowledge and basic calculations. Both seemed to understand descriptive techniques and applications of hypothesis testing. Students enrolled in the

LEC sections generally performed better on items dealing with probability concepts. It is possible that the written content materials for probability are not sufficient to convey the concepts the faculty want to convey. Perhaps some short video segments added to the on-line courses in the future would make a difference in attainment of these concepts. Such an effort is in line with the continuous improvement culture the Assessment and Continuous Improvement Committee wishes to develop through its efforts.

Discussion

Format (LEC versus WEB) appeared to make a difference in overall course performance for the COST course, which was quantitative in nature, while there appeared to be no difference in overall performance for the MGM course, which was qualitative in nature. In reviewing specific content in the qualitative course, WEB students performed best on "general knowledge" items, while the LEC students performed best on items that were classified as course specific. In the quantitative course, both WEB and LEC formats appeared to produce equivalent outcomes on items concerning descriptive measures and on those items that measured factual knowledge and basic calculations. Probability and some inferential concepts seemed to fare better in the LEC environment.

It should be noted that this case study was undertaken to provide assurance that courses taught in both traditional and online formats were resulting in comparable learning outcomes. Thus, the case study results have limitations with respect to generalization; hence care should be taken in making inferences to larger populations of students and courses. Differences could have occured for reasons other than differences in instructional format. For example, different results could have occured because different instructors were involved in delivering the material; thus, there may have been different instructional styles that had an impact or perhaps there were different content emphases. The content areas were limited to two courses for the analysis. The time frame incorporated more than one semester so there may have been slight variations in content or type of content from one semester to another. Nonetheless, the results do suggest areas for additional analysis from an inferential perspective. More study is needed, providing randomization and control for semester, instructor, instructional methods and artifacts. Exploration of additional courses and the effect of student background are factors that should also be considered.

However, in terms of validating that particular on-line implementations of course delivery provide student outcomes that are in line with traditional course delivery, the study demonstrates that faculty can work together to assess student attainment of course concepts across course formats and content areas. Working together across course formats provides an opportunity to share class experiences and work toward individual courses that deliver the same concepts, skills and reinforcements to the students. This effort can result in program continuous improvement – something many of us are now trying to document.

References

1. Allen, M., Bourhis, J., Burrell, N., & Mabry, E. (2002). Comparing student satisfaction with distance education to traditional classrooms in higher education: A meta-analysis. *The American Journal of Distance Education, 16*(2), 83-97.

2. Allen, M., Mabry, E., Mattrey, M., Bourhis, J., Titsworth, S., & Burrell, N. (Writer) (2004). Evaluating the Effectiveness of Distance Learning: A Comparison Using Meta-Analysis [Article], *Journal of Communication*.

3. Aragon, S. R., Johnson, S. D., & Shaik, N. (2002). The influence of learning style preferences on student success in online versus face-to-face environments. *The American Journal of Distance Education, 16*(4), 227-244.

4. Bernard, R. M., Abram, P. C, Lou, Y., Borokhovski, E., Wade, A., Wozney, L., et al, (2004). How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. Review of Educational Research, 74, 379-439.

5. Clark, R. E., Media Will Never Influence Learning, Educational Technology Research and Development, Vol. 42, No. 2, pp. 21-29, 1994.)

6. Crooks, T. J. (1988). The impact of classroom evaluation practices on students. Review of Educational Research, 58(4), 438-481.

7. Deka, T. S., & McMurry, P. (2006). Student success in face-to-face and distance teleclass environments: A matter of contact? International Review of Research in Open and Distance Learning, 7(1).

8. Henry, P. D. (2008). Learning Style and Learner Satisfaction in a Course Delivery Context. Proceedings of World Academy of Science and Engineering Volume 28. ISSN 2030-3740

9. Irizarry, R. (2002). Self-efficacy and motivation effects on online psychology student retention. USDLA Journal, 16(12). Retrieved September 5, 2008, from http://www.usdla.org/html/journal/DEC02_Issue/article07.html.

10. Joy, Ernest H. and Garcia, Federico E. Measuring Learning Effectiveness: A New Look at No-Significant-Difference Findings. Journal for Asynchronous Learning Networks, Vol. 4, Issue 1, pp. 33-39, June 2000.

11. Nitsch, W. B. (2003). Examination of factors leading to student retention in online graduate education. Paper – ED 7212 Administration and Leadership of Distance Education Programs. Retrieved September 5, 2008, from http://www.decadeconsulting.com/decade/papers/StudentRetention.pdf.

12. Neuhauser, C. (2002). Learning style and effectiveness of online and face-to-face instruction. *The American Journal of Distance Education, 16*(2), 99-113.

13. Olmsted, J. L. (2002). Longitudinal analysis of student performance in a dental hygiene distance education program. *Journal of Dental Education, 66*(9), 1012-1020.

14. Russell, T. L. (2001). The no significant difference phenomenon, 5th ed. Montgomery, AL: International Distance Education Certification Center.

15. Tucker, S. (2001). Distance education: Better, worse, or as good as traditional education? *Journal of Distance Learning Administration, 4*(4). Retrieved September 5, 2006, from http://www.westga.edu/~distance/ojdla/winter44/tucker44.html.