

Comparing Web-Based Content Delivery and Instructor-Led Learning in a Telecommunications Course

K. Russell Jones

Farhad Moeeni

Paula Ruby

Computer and Information Technology

College of Business

Arkansas State University

State University, AR 72467

rjones@astate.edu moeeni@astate.edu pruby@astate.edu

ABSTRACT

This study compares the achievement of students enrolled in two sections of an undergraduate telecommunications course. One class was conducted in an instructor-led classroom and the other utilized a web-based content delivery method. Students were unaware of the difference in delivery methods at the time of registration. Identical pre- and post-tests were administered to the students and a statistical analysis was performed. While in a practical sense, the instructor-led classroom generated much higher average performance, the difference between the two methods was not statistically significant.

Keywords: Instructor-led learning, Web-based content delivery, Distance learning, Telecommunications

1. INTRODUCTION

The use of traditional instructor-led teaching for the delivery of collegiate level courses is being replaced by Internet-delivered courses, computer based training (CBT), and other alternative methods of delivery. Universities around the world are even rewarding faculty for developing alternative methods of course delivery. The increased usage of these types of delivery methods should raise the question as to the level of student learning and retention that is being maintained with this shift. While it is reasonable to make learning more available to students regardless of location or time, the possible tradeoff of reduced student learning and retention should be considered.

Studies aimed at performing a comparison of the achievement of students who have participated in alternative course delivery methods have received extensive treatment (Abraham 2002; Cooper 2001; Dick and Hanna 2002; Hyllegard and Burke 2002; Kleinman and Entin 2002; Thirunarayanan and Perez-Prado 2001-2002). The consensus among these studies was that there was no statistically significant difference between the achievements of students in instructor-led courses when compared to distance learning courses. However, distance learning, in these cases, still allowed for substantial interaction between the instructor and the students. Distance learning is only one of the non-traditional methods used for course delivery. A recent trend in course delivery has been in the area of web-based content

delivery. In a web-based content delivered course, there is no regular interaction with a faculty member or facilitator. This study compares the achievements of students in an instructor-led course versus a web-based content delivery method that does not provide an instructor for normal interaction. In the web-based course, students navigated through the material, demonstrations, and exercises without the intervention of an instructor. This article reports the quantitative results of the study.

2. LITERATURE REVIEW

Many terms related to learning with technology abound and no one definition comes forth as clearly the best. Some of these terms include online learning, distance learning, Web-based learning, Internet-based learning, and asynchronous learning. Traditional classroom learning definitions have been established over many years of study and theory and the basic term that will be used in this research is instructor-led learning. Instructor-led learning usually refers to traditional classroom delivery, in which an instructor teaches a course to a room of learners (ASTD 2003).

The online class in this research followed the "asynchronous learning network" model as opposed to the "mass market" model, whereby the instructor utilized true "anytime, anywhere" learning. The "mass market" model is defined by Hiltz (1998) as sending material to students, receiving back individual assignments or test materials, and providing some

means of limited one-to-one communication between the student and the instructor. This model follows the basic pedagogical model of the instructor-led classroom only using the Internet as a means of transfer as opposed to the classroom. The "asynchronous learning network (ALN)" requires students to take learning as a social process as opposed to the instructor-led learning whereby the students learn by receiving and assimilating knowledge. Research shows that online classes promote a transformation of the teaching/learning process with the faculty revising their teaching methods from an instructor-led didactic format to one that is student-centered containing active learning strategies (Hyllegard and Burke 2002).

Past research has been concerned that instructional quality may not be as high as that of instructor-led classrooms. However, the quality is based on having the right subject matter, the right instructor, and the right student (Cooper 2001). When these elements of "rightness" exist, online instruction can provide for a viable alternative to instructor-led classrooms. Participants in Cooper's study were enrolled in the Fundamentals of Computer Applications course. The students chose the online or traditional format. The data analysis was based on grade distribution and an end of semester survey. Students in Cooper's study stated they had more opportunity to ask questions online than in the instructor-led classroom. Students were also better able to manage their time between work and school, and enjoyed being able to learn in a self-directed fashion. Cooper's research shows that the primary reason students take online classes are for the "convenience" and "flexibility" and 81% of the online students reported that they would take more online courses. This was also confirmed in Hiltz (1998) who reported on previous research studies that shows that students have more interaction with their instructor and peers during the week and are able to learn at the pace and time best suited to their needs.

However, a larger percentage of students in Cooper's study stated the instructor-led course met their expectations and had more positive reactions to teacher organization, pace of instruction, understanding the course layout and grading process. More students felt they learned more in the instructor-led class. Some disadvantages of online courses include limited bandwidth and the frustration of waiting to receive feedback from the instructor. Not having the "social presence" of the teacher and other students may lead to decreased motivation and involvement (Hiltz 1998).

A study conducted by Abraham (2002) compared two groups of students taking an undergraduate MIS course. The students chose which course they wanted to take; either the Internet-based or the instructor-led course. WebCT was the tool used for the Internet-based class. The data analysis was based on outcomes of tests, assignments, and participation. As well, the Internet-based students completed a satisfaction survey toward the end of the semester. There were no significant differences between the two groups of students. The results of the study revealed there was no statistically significant difference between the two groups even though the Internet-based students did not score as well on their

assignments. A follow up survey did reveal interaction through electronic means rated high but at the same time did not rate their interactions with their instructor at as high a level as their instructor-led counterparts. They also found it difficult to work through homework assignments electronically and through telephony as opposed to the face-to-face interaction the traditional students received.

During the fall semester of 1999 an Introduction to Computer Science course at a community college was taught with Visual Basic as the programming language (Kleinman and Entin 2002). The students chose the online or the instructor-led section. The online course was delivered through electronic mail. The data was analyzed from class attendance, grades, and a pretest-posttest demographic and attitudes questionnaire. In terms of significance, the online students were older with a mean age of 30.8 compared to 22.8 years. Overall, the online students were more positive than the students who took the instructor-led course and there was no difference in the learning outcomes.

True distance learning occurred when an instructor in Australia used WebCT, chat, and discussion boards to teach students at Georgia Southern University (Dick and Hanna 2002). The course was a senior level information technology management course for non-IS majors. When the decision was made to teach the course on-line the students were given the option to enroll in another class, but they all chose to remain. A questionnaire was completed both pre- and post-course. The data were compared to previous traditional courses and there was no statistically significant difference found. The study concluded that there is no academic difference between the two modes of instruction.

During the spring and fall semesters of 2001, 30 classes of multiple subjects at a community college were taught with Internet-based and instructor-led formats. The students were able to enroll in their desired classes. The data was analyzed using GPA, grades, demographics, and student satisfaction surveys. The results indicated very high attrition and failure rates with a disproportionate number of students earning high grades. This resulted in some students flourishing and others floundering (Hyllegard and Burke 2002).

In a study by Thirunarayanan and Perez-Prado (2001-2002) WebCT and live chat were used as the means of instruction for the Internet-based section of a senior level teacher education course for the ESOL program. During the fall semester of 1999, the instructor chose which students would take the Internet-based section and who would take the instructor-led course. The pretest-posttest design was employed and the results of t-tests revealed that there was no statistically significant difference in the achievement between the students in the two courses.

In summary, the reported studies found no statistically significant difference in achievement between the Internet-based and instructor-led classes. However, there were reports that technology problems persisted and caused some attrition. As well, several students reported they missed the socialization of an instructor-led classroom and had limited

communication with the instructor in the Internet-based classes.

The majority of the literature review deals with Internet-based classes where an instructor or facilitator is always present at some level. There is significantly less research available in the comparison of instructor-led courses versus web-based content delivery, where there is no instructor interaction. This study compares the level of student learning and retention for this type of delivery method. The primary null hypothesis of this study is to test if "there is no statistically significant difference between the level of student learning and retention in an instructor-led classroom environment and a web-based content delivered course."

3. COURSE DETAILS

Telecommunication management is a required course for most Management Information Systems majors. The course is three semester credit hours and is designed to acquaint students with the technical issues related to the design, operation, and maintenance of computer networks. Course topics include communication architecture, telecommunication hardware, popular protocols, and an in depth study of the TCP/IP protocol suite. This course has been offered each semester for the past five years. Two sections of the course were offered during the study period (spring 2003) with a different instructor managing each section. One section was scheduled to meet once a week for three hours with the other section scheduled to meet twice a week for ninety minutes. The latter section was selected for the web-based content delivery by random draw. As mentioned before, students had no prior knowledge that one of the two courses would be offered online. Therefore, a student's choice of a particular section was not based on the delivery method.

3.1 Instructor-Led Delivery Method

Both sections of the course utilized the same textbook, *Network+ Study Guide* (Sybex 2001), with the instructor-led section being provided a hard copy of the text and the web-based section being provided an online copy. The instructor-led section followed the traditional format with some hands-on exposure to relevant network components and systems. The instructor of this section had prior experience teaching the course using this delivery method.

3.2 Web-Based Content Delivery Method

The online section of the course followed the same learning objectives as those previously mentioned for the standard course. The students were provided with an electronic version of the textbook, visual aids, animations, practice exercises, glossary of terms, and practice exams. The program allowed access from any connection on the Internet at anytime of the day or night. The program also provided feedback to the instructor concerning the chapters/exercises completed, amount of time spent in the program, and scores of all practice exams. The instructor did not provide constructive feedback to the students regarding their exercises or practice exams they submitted. In addition, the students had no chat or e-mail interaction with the instructor.

The students were informed that this information was being collected and would be used to determine their participation grade component. The instructor/facilitator of this section also had prior experience teaching the course using this method.

3.3 Course Content

Both sections of the course were taught with the same course outline and textbook. As well, the student evaluation instruments were the same. All visual aids and animations that were available to the web-based students were also made available to the instructor-led section. Ironically, students in the instructor-led section barely utilized the on-line resources.

The web-based class met face-to-face with the instructor three times during the semester, once for the initial meeting and twice for written exams which were manually graded. The web-based students had comprehensive access to the Internet resources at any time.

4. RESULTS

This study falls under a single factor analysis of variance with two levels or treatments. The factor of interest is the delivery or teaching method with two levels: (1) Instructor-led and (2) web-based. This analysis is equivalent to comparing two population means. The primary objective of this study was to determine if there is a statistically significant difference between the two delivery methods.

The subjects in this study were enrolled in two sections of a telecommunication management course during the spring semester of 2003. Students were not aware, until the first day of class that an alternative method of delivery was going to be utilized. This approach was expected to greatly reduce the selection bias that will be explained later. Students in both sections had completed at least 54 hours of undergraduate coursework. This is required of all students in the College of Business before enrolling in any upper division course.

4.1 Data Collection Procedure

At the first class meeting, demographic data were collected in order to determine the possible differences in the background of the samples assigned to the two sections. The information could be used to determine whether or not the two samples belong to the same or similar populations. The demographic data for both sections are presented in Table 1. One student in the instructor-led section had taken one previous telecommunications course, while five students in the web-based course had taken one or two previous telecommunications courses.

During the first class meeting, both sections were also administered identical pretest instruments consisting of 67 objective (multiple-choice) questions that covered a wide range of fundamental topics. The instructor-led class began with 13 students. Two students dropped the course and one student did not take the final exam, ending with a 23% drop rate. The web-based class began with 20 students. Two students dropped, ending with a 10% drop rate.

Table 1. Demographic Data

Variable	Instructor-Led n=10		Web-Based n=18	
	Mean	SD	Mean	SD
Age	26.44	7.81	22.39	2.85
Work Hrs	22.00	12.80	17.06	13.03
Previous Courses	0.11	0.33	0.33	0.59
GPA	2.93	0.44	3.00	0.50

Fifteen weeks later during the final examination period, both sections were administered an identical posttest, in the same format as the pretest. Because of the final exam time constraint, the posttest instrument included half of the pretest questions selected randomly. Table 2 presents the pretest, posttest, and the level of improvement calculated by Posttest score – Pretest score for the instructor-led and the web-based delivery methods.

Table 2. Pretest, Posttest and Improvement Scores

Variable	Instructor-Led n=10		Web-Based n=18	
	Mean	SD	Mean	SD
Pretest	41.9	15.3	42.4	14.8
Posttest	57.0	15.0	48.1	12.4
Improvement	15.10	10.71	5.67	10.30

4.2 Findings

The hypothesis of interest is “no difference in the effectiveness of the two delivery methods”. The metric, improvement level (posttest score – pretest score), is used to measure “effectiveness” of each method. The hypotheses were tested under the assumption of equal population variances. Interestingly, the sample standard deviation of improvement level for both sections is almost identical (10.71 and 10.30). The formal hypothesis tested is:

H: Mean levels of improvement under the two teaching methods are the same

The result of the test is summarized in Table 3. As the Table shows, the p-value for the two-tail test is 0.03 indicating a statistically significant difference between the two methods.

However, this preliminary result should be verified and fine tuned further for any systematic bias in the sample data as explained in the next section.

4.3 Uniformity of Samples

To make a meaningful comparison between the effects of two different treatments, one should make sure the underlying attributes of the samples assigned to different treatments are similar. Unfortunately, researchers do not

have the luxury of randomly assigning subjects to treatments in observational studies.

Table 3. Test of No Improvement Difference (H)

	Instructor-led	Web-based
Mean	15.100	5.667
Variance	114.767	106.118
Observations	10	18
Pooled Variance	109.112	
Hypothesized Mean Difference	0.000	
Df	26.000	
T Stat	2.290	
P(T<=t) one-tail	0.015	
T Critical one-tail (5%)	1.706	
P(T<=t) two-tail	0.030	
T Critical two-tail (5%)	2.056	

One of the major shortcomings of observational studies is the selection bias. There are at least three sources of selection bias in comparing different teaching methods: (1) The teaching method, (2) class time, and (3) the instructor. In this study, the first source of bias was eliminated since until the first class meeting, students were not aware that one of the sections was scheduled to be web-based. Fortunately, no students changed sections after they were informed of the two possible alternatives.

The effect of the other two sources of bias could still be mixed with the effect of teaching methods because a different instructor taught each section, and the instructor-led section met once per week at night while the web-based class was scheduled to meet twice per week in the afternoon. These factors could potentially influence the results of the study if they were correlated with certain demographic characteristics of the subjects.

One of those demographic characteristics was students’ initial knowledge of the subject. We attempted to eliminate this potential source of bias through the choice of metric, i.e., posttest – pretest scores. However, the number of previous courses (related to telecommunications management) could also be important. This attribute has also been included in the analysis.

In order to identify the presence of other sources of bias, the correlation matrix of the demographic characteristics and the dependent variable (improvement level = posttest score – pretest scores) was calculated and presented in Table 4.

The Table clearly indicates some two-way correlation, i.e., improvement-age (r=0.477) and improvement-work hours (r=0.311). In order to eliminate or to reduce these sources of bias, an analysis of covariance (ANCOVA) was performed.

Table 4. Correlation Analysis of Improvement Level and Demographic Characteristics

Student ID	Age	Work Hrs	GPA	Previous Courses
Pearson Correlation	.477*	.311	.011	.190
Sig. (2-tailed)	.012	.114	.959	.342
N	27	27	25	27

Table 5. Analysis of Covariance Results With the Four Covariates

Source	Sum of Squares	Df	Mean Square	F	Sig.
Intercept	187.954	1	187.954	1.811	.194
AGE	337.537	1	337.537	3.253	.087
Workload	32.737	1	32.737	.315	.581
Prior Course	66.607	1	66.607	.642	.433
GPA	119.321	1	119.321	1.150	.297
GROUP	318.738	1	318.738	3.072	.096
Error	1971.657	19	103.771		
Total	5189.000	25*			
Corrected Total	3340.000	24			

* There are three incomplete observations

4.4 Analysis of Covariance

The correlation analysis (Table 4) revealed a strong positive correlation between age and improvement level ($p=0.012$), which potentially generates systematic bias. A powerful technique for eliminating or reducing such a bias is the analysis of covariance (ANCOVA). The result of the ANCOVA on the same set of data is summarized in Table 5.

In Table 5, age, workload, prior course, and GPA are the covariates and "Group" is the factor under study. As before, the dependent variable is the *improvement level* measured by posttest score – pretest score. The result shows that the difference in the two teaching methods are (marginally) statistically significant ($p=0.096$).

ANCOVA is very useful when demographic variables are correlated with the dependent variable or when a complete randomized assignment is not possible. Nevertheless, we do not overemphasize the above result because of the concerns about the sample size in our study and because of the stringent assumptions associated with the use of ANCOVA models.

ANCOVA models should satisfy the assumptions associated with the ANOVA models. ANCOVA models should also satisfy additional assumptions, which include a linear relationship between the dependent variable and each of the covariates as well as the homogeneity of the regression slope for a covariate (Neter et al 1985).

Another important consideration relates to group sample size relative to the number of covariates. For small group sample sizes and large number of covariates, ANCOVA may result in estimates that are unstable from sample to sample. Some authors such as Huitema (Stevens 1996) suggest the following upper bound for the number of covariates:

$$C < 0.1 \times N - (J - 1)$$

Where C is the number of covariates, N is the total sample size and J is the number of groups. Accordingly, with the current data, we should not use more than *one* covariate ($0.1 \times 25 - (2-1)$). We repeated the calculations for one covariate (i.e., Age) and the result is presented in Table 6.

As the table shows, there is no statistically significant difference between the two methods ($p=0.13$).

Table 6. Analysis of Covariance Results With One Covariate

Source	Sum of Squares	Df	Mean Square	F	Sig.
Intercept	80.266	1	80.266	.806	.378
AGE	405.810	1	405.810	4.076	.055
GROUP	243.017	1	243.017	2.441	.131
Error	2389.745	24	99.573		
Total	5614.000	27			

5. CONCLUSIONS

Previous research reported contends there is no statistically significant difference in the achievement of students enrolled in distance learning courses and those enrolled in instructor-led courses (Abraham 2002; Cooper 2001; Dick and Hanna 2002; Hyllegard and Burke 2002; Kleinman and Entin 2002; Thirunarayanan and Perez-Prado 2001-2002).

In this study, the metric, posttest – pretest scores were used to compare the effectiveness of the two teaching methods: instructor-led and web-based. The analysis of covariance model was employed for the comparison. The results of this study agree with the literature that there is no statistically significant difference between the two methods based on the metric used (p=0.13).

Extrapolating the results of this study to other similar situations or to course topics other than “telecommunications management” should be done with caution. First, the sample sizes were not as large as one wished them to be. Unfortunately, the researchers do not have any control of enrollment and students’ registration. Second, the web-based content delivery method may be more appropriate for some subjects than others. This fact recommends that further research needs to be accomplished on a variety of subjects throughout the curriculum. Only after a large number of similar studies may one draw a general conclusion about the effectiveness of web-based content delivered teaching as compared to instructor-led delivery methods.

The precision of this analysis could have been increased if all of the pretest questions had been included in the posttest. Because of time constraints during the final exam, the posttest contained only half of the pretest questions selected randomly. Because of the concerns about sample size, we plan to consider the use of non-parametric tests (such as Mann-Whitney) in the continuation of this research. A Non-parametric test is preferred in certain situations because it does not require most of the assumptions that are needed under the parametric t-test or ANCOVA. Data is continuing to be collected for the web-based content delivery method and a longitudinal study is being planned. Also, since this study was conducted entirely on undergraduate students, future research should be conducted on graduate students to determine if a similar result would be obtained.

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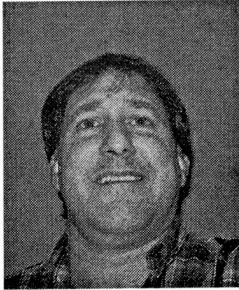
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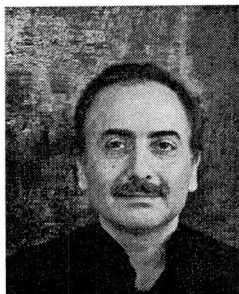
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AUTHOR BIOGRAPHY

Russell Jones is an Associate Professor of Computer and Information Technology and Director of the Master of Science program in Information Systems at Arkansas State University. Russell currently holds the Kathy B. White Endowed Fellowship in Decision Sciences and works on technology transfer between the university and area high schools, technical schools, and the 2-year branches of the university. His teaching interests are in the area of local area networks, telecommunications, and IT for strategic advantage. Research interests are in non-traditional course delivery methods, curriculum development, and network security. Russell has authored four books and has a number of proceedings. He has articles published in *Journal of Information Systems*, *Journal of Computer Information Systems*, and *Decision Sciences Journal*.



Farhad Moeeni is an associate professor of Computer and Information Technology at Arkansas State University. He holds a M.S. in industrial engineering and a Ph.D. in operations management with a minor in information systems, both from the University of Arizona. His articles have appeared in various outlets including *Decision Line*, *International Transactions in Operational Research*, *Southwestern Economic Review*, *International Journal of Production Research*, and *Decision Sciences*. Farhad's Research interests are currently in the area of enterprise information systems and the automation of data collection and identification.



Paula Ruby is an Assistant Professor of Computer and Information Technology at Arkansas State University. Paula has an Ed.D. from the University of Tennessee, Knoxville. Some of her teaching and research interests are programming, systems analysis and design, and e-learning. She has proceedings in several meetings including the Decision Sciences Institute and the Southeast Decision Sciences Institute.

