



Evaluation of Hybrid Instruction of an Introductory Electronics Course

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Abstract

Recent literature has indicated that students today are becoming more comfortable with using online resources and they may prefer many aspects of online instruction to traditional classroom instruction. They like the ability to learn from home at a time of their choosing and like the self-paced nature of online learning. Online instruction can be more student-centered and flexible. Personal contact with faculty, however, is still valued by students. To further study the concept of combined online and traditional lecturing, we have developed, delivered, and assessed a hybrid set of lectures for a course titled "Introduction to Electrical Circuits". This course is required of Civil, Mechanical, Environmental, and Electrical Engineering majors and is often chosen as an elective by other engineering majors. In the hybrid delivery of this course, a set of lectures were taped and presented to a class using Blackboard. The on-line lectures took place for one third of the class sessions while the other two-thirds of the sessions remained in the traditional face-to-face format. Assessment of the success of the program took place by a statistical comparison of common homework assignments, each of three common hour exams, and the common final exam for four sections from a single semester. Three sections received the standard lectures while the other one experienced the hybrid format. The hybrid section performed equally to the other sections in homework, hour exams, and in the final exam. Our conclusion is that the hybrid section is a more efficient use of professor time, allows the students to begin the process of life-long learning, and produces equal results to the more traditional offering.

Background

With modern technology, the concept of a hybrid course in which a portion is on-line and the remainder is face-to-face is growing in popularity. Aycock¹, et al, of the University of Wisconsin – Milwaukee, studied numerous hybrid courses and reported that the integration of on-line with face-to-face learning facilitates interaction among students and between students and their instructors. McFarlin² of University of Houston, found an increase by one letter grade in student performance from standard lecture to hybrid instruction. Riffell³ of Michigan State University found that minorities, in particular, increased their laboratory performance in a hybrid environment. Perhaps the most compelling argument can be made by Landers⁴ in his doctoral thesis where a large number and variations of hybrid courses were analyzed. He states (p. 61): "it appears that online instruction is more effective than traditional instruction when seeking knowledge and problem solving gains". Concurrent with our studies were two more examples. Azevedo⁵ found increased test scores in an electronic course with video lectures. In this study at San Jose State University, live lectures were replaced with a set of lectures developed by MIT.

Discussions were held during class time. Bowen, et al⁶ found outcomes to be equal between hybrid and traditional offerings of a statistics course. Although purely online instruction, when done well, can be more student-centered and flexible than traditional instruction, it should be noted that it can also lead to poorer performance⁷. The reasons may be due to the lack of face-to-face time with instructors and classmates. Hybrid instruction provides a blend of the traditional lecture style with on-line instruction and addresses the face-to-face time issue.

Introduction to Electrical Circuits is a large junior -level course that is taken by over 400 sophomore, junior, and senior students per year. It is a 3-credit hour course taught in a traditional MWF lecture format. The course is required of all civil, environmental, electrical, and mechanical engineering students and is often attended by other engineering majors. Because of the multidisciplinary backgrounds of the participants, the course material has two purposes. First, this course is a gateway course for electrical engineering majors for all more advanced courses. Secondly, the course helps to prepare the broad spectrum of students for the material that will be tested on the Fundamentals of Engineering Exam. Two of the co-authors have taught the course for many years.

Goals and Objectives

The main objectives of this study were to develop and to evaluate hybrid instruction methods for use in an Introduction to Electrical Circuits course. “Hybrid” in this paper means a course that is delivered partly using on-line, or web-based materials and methods, and partly using traditional face-to-face classroom settings.

Although improving student outcomes is the main goal of our effort, it is also possible that a hybrid course could lead to more efficient delivery of courses, and more efficient utilization of campus resources such as rooms and faculty. Of course, this is offset by the time and effort to develop online course materials. Online course materials can be highly sophisticated and can take many hours to develop. This may be one of the biggest barriers to developing hybrid courses. Due to the limited scope of this project we did not have the time or funds to develop much in terms of new online course materials. Therefore, we kept the initial experiment simple as described below, and concentrated on evaluation.

A budget of \$5000 was provided for this project. One thousand was spent on equipment including video camera, microphone, and a digital storage device. Another thousand was allotted to an undergraduate work study student for doing the recording. The rest of the budget was allotted to the three faculty working on the project. One was responsible for the logistics of the project, another to the lecture presentations, and the third to the project evaluation.

Implementation

During this study, one of the authors taught two sections with 60 students in each section. His methodology for the course used writing on a traditional blackboard/whiteboard. He has received excellent teaching evaluations from the students, and students regularly state that they like his clear handwriting, helpful explanations, and the many illustrative examples that he does in class. The other two instructors for the remaining sections were a Teaching Professor and an adjunct. These sections contained about 60 students each as well.

The three main tasks in this project completed were:

1. The initial planning stage was done over the summer, 2011 by the PIs. At this time we refined the plan for delivering the hybrid course, and developed the methods for taking and posting the videos. We used Blackboard for hosting the videos, as this allowed us to restrict access to the videos to the students enrolled in the “hybrid” section only.
2. The effort during the fall semester was to tape the lectures and post them online. We hired an undergraduate student to do this. There was ~~to be~~ little or no editing of the videos. However, we soon discovered that the video files took an unacceptably long time for the students to download. We then experimented with file formats and quality levels until we found a combination that had acceptable video quality and file size. However, by that time the fall semester was well underway, and so we decided to discard the fall semester and begin afresh in the spring. . The spring semester was then run as a hybrid course successfully.
3. Finally, we performed an assessment of the results of a hybrid course as opposed to a traditional course.

Videos of one-third of the lectures by the primary instructor were taken by a Canon Vixia HFM40 camcorder. The camera was placed on a tripod and panned manually. A wireless microphone (from Listen Technologies Corporation) was worn by the lecturer and the signal was recorded directly into the camcorder. To reduce the size of the files that had to be posted on Blackboard, the video was down-converted to a resolution of 1440x816 pixels, 15 frames/second, with a total bitrate of approximately 450 kbps. The videos were stored in “m4v” format and then posted on Blackboard. Each 50-minute lecture was stored as two files, each covering approximately one half of the lecture. The size of each file was about 80 MB.

Students in the hybrid section were given exclusive access to the on-line recordings of the lectures. The on-line lectures took place for one third of the class sessions while the other two-thirds of the sessions remained in the traditional face-to-face format. Three lectures (MWF format) were delivered each week. One of the traditional section lectures was videotaped and later the tape was made available to the students in the hybrid section. The remaining two lectures of the week for the hybrid section were presented using the traditional face-to-face format. Videotaping always occurred on a Monday, so the online component was uniformly interspersed throughout the semester.

Historically the introductory electrical circuits course offered at CSM was part of the “Distributed Core”. As a result, the course was traditionally designed to address the diverse needs of a largely non-electrical student audience, thereby requiring the introduction of a wide variety of electrical engineering topics. Even though the course content has evolved to better address the needs of electrical specialty students, the audience is still largely composed of non-electrical students. Table 1 below shows the percentage of students from various disciplines that were enrolled in the two sections taught by Dr. Ammerman. The enrollment in both sections consisted of exactly 62 students. As this table indicates the makeup of the two sections was remarkably similar.

Discipline Engineering	Traditional Delivery Section	Hybrid Delivery Section
Civil Specialty	12.9%	9.7%
Electrical Specialty	6.45%	6.45%
Environmental Specialty	9.7%	9.7%
Mechanical Specialty	56.45%	54.75%
Other Specialties*	14.5%	19.4%

*Metallurgical and Materials, Mining, and Petroleum Engineering

Table I. Multidisciplinary student population for Electrical Circuits course.

In order to check the statistical significance of the above results, a chi squared test was applied to the final exam grades for the two sections taught by the same instructor. No statistical difference was noted between the two distributions. The test showed the probability that the differences between the sets were simply due to sampling error with a value of 0.956. A probability of less than 0.05 rejects the null hypothesis and asserts that the two distributions are different. The result is that two distributions show no statistical difference. Table II shows the range of final exam results used for this analysis.

Score Range	Sec A	Sec C
90 A	2	2
80 B	18	21
70 C	15	15
60 D	12	9
1 F	6	6

Table II. Final Exam Scores for two sections.

Assessment

Both formative and summative evaluations were made. The formative evaluations focused on homework assignments while the summative focused on hour exams, final exams, and course evaluations. One professor taught two sections. One section was taught in the traditional format and the other in the hybrid format. Only the students enrolled in the hybrid section had access to the videos on Blackboard. The same exams and homework assignments were used for both sections. Based upon feedback through the homework assignments, adjustments were made to the on-line lectures. The failed first semester attempt received comments from students such as: "We should have been told we were registering for a hybrid class." "Don't do hybrid lectures. I like getting my tuition's worth, and I feel cheated out of my money with just a recording of an earlier class." In other words, the students were not happy! The students were informed of the format of the course in the second semester so the element of surprise was removed. A number of comments received from students at the beginning of the second semester focused on the quality of the videotapes. The quotation from a student that follows summarizes the frustration that some expressed. "I don't expect a Hollywood grade film but half the time I have no idea what is going on because you are writing someplace the camera isn't pointing at or I can't see what you are referring to on the board because the camera doesn't follow you." Based on this information, steps were taken to improve the quality of how the lectures were recorded. Other students really liked the self-paced nature of online learning. "I found the ability to pause your lecture or rewind your lecture was a very beneficial tool. I was wondering if there was a chance that all the lectures could be recorded?" Our summative assessment was based on a comparison of the homework scores, exam scores and final grades. We also used the information from the end-of-semester course evaluations to gain qualitative information to evaluate the program. A few representative examples of the comments student submitted are provided below.

"I really liked being able to see the video lectures. Sometimes I need to see things more than once."

"I have tried to make the video lecture work but thus far I feel it has been a hindrance to my learning compared to what I get out of the normal (traditional) lectures on Wednesdays and Fridays."

"The hybrid video lectures were in no way a substitute for live lectures."

The table below shows the mean average of each of the class assignments with equal weight as well as the mean of the means. The final grade is based upon this score. In general, an A is assigned to averages in the 90's, a B to 80's, a C to 70's, and a D to 60's. Averages below 60 receive an F and do not pass the course.

<u>Section</u>	<u>A (traditional)</u>	<u>B(traditional)</u>	<u>C (hybrid)</u>	<u>D (traditional)</u>
<u>Homework</u>	88.8	85.4	79.7	84.1
<u>Exam I</u>	71.0	70.0	77.9	75.1
<u>Exam II</u>	68.6	68.7	71.9	68.2
<u>Exam III</u>	78.0	77.0	76.4	70.2
<u>Final</u>	72.4	74.2	70.5	71.3
<u>Overall</u>	75.76	75.06	75.28	73.78

TABLE III. Results per section of homework and exam mean averages.

Although the on-line portion of the course was to be used exclusively by Section C, we inserted a question on the final exam to determine the extent of the use of the on-line materials. The question posed to all students in all sections was:

- Question 31. I have watched the EGGN 381 online lectures
- a) Regularly
 - b) Occasionally
 - c) Never

The results from this question appear in Table IV below.

Section	a) regularly	b) occasionally	c) never
A (traditional)	0	3	49
B (traditional)	2	4	47
C (hybrid)	34	15	4
D (traditional)	5	4	46

TABLE IV. Results of Question 31 on the final exam on use of online lectures.

It is interesting to note that of the traditional classes, 11% of the students watched the videos. Of the students participating in the hybrid course who were supposed to watch the videos, 7.5 % did

not watch. Although the on-line material was only available to those in the hybrid class, cross-section studying is taking place.

We were pleased that the hybrid course did equally well to the three traditional sections. We were surprised at how close the average was for the final grade for each section. A grade of C is meant to be interpreted as average and this was the case for each section. It appears that even though only the student in the hybrid section were given access to the video lectures, many of the students study in groups and used the videos even though they were in traditional sections.

We conclude that the hybrid section results are the same as the traditional sections. This leads the way to more use of video lectures and a more efficient use of instructors, classroom space, and class time. We encourage adoption of this approach in other courses at our university. Finally, we recognize that this project is very limited and we may find that better outcomes could be achieved by incorporating other technologies. Thus our preliminary results may be used as the basis for a follow-on proposal to develop new hybrid course materials. New platforms for distribution of course materials such as YouTube and iTunes University should be investigated.

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