

Multimedia and Assessment Techniques in an Operations Research Course

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Abstract

This paper discusses the implementation of multimedia, and its effect on the learning process, in an Operations Research course. WebCT, a World Wide Web course tool, was used for the course web site. Web technology was applied extensively in the form of video lectures (that were streaming), course web pages, discussion board, email, and Internet search. Students were required to prepare an extensive portfolio that contained their comments about the pedagogy tools used in the course. The portfolio, along with other tools, was used to assess the effects of this new teaching and learning environment. The design of multimedia tools in this course was based on the objectives of the department, the requirements by employers, and the new criteria set up by the Accreditation Board of Engineering and Technology (ABET 2000).

The instructor's perception is that the video lectures enriched the learning process and enhanced efficiency of the class sessions, though they cannot completely replace every class sessions. The course web site is an excellent archive for course material and a tool for constant interaction with students. The portfolio improved some of the required skills (writing and critical thinking) and provided feedback for future improvements of the course. Feedback from students was generally positive and indicated considerable achievement of the objectives for this course.

1. Introduction

There are many web-based technologies for course enhancement and/or delivery. Discussion boards and email are used to improve communication among students and between students and instructor. Course management tools, such as WebCT, are applied to assist in structuring the course materials, quizzes, grades, and on-line communication tools. On-demand video and audio delivery became possible using streaming technology. However, not all universities are equipped with the state-of-the-art hardware and software in these areas, moreover, the faculty support system may not be as effective as needed to incorporate these technologies.

There are many papers on how web-based technologies were applied for course delivery. Many of these efforts concentrated on Internet distance learning and were mainly for graduate level courses. Hayes and Harvel³ described the use of streaming media, in conjunction with other web technologies, to offer courses in electrical and mechanical engineering for masters degree. They also discussed the importance of capturing classroom experience in this media.

There are few reports on the process of implementing a digitally enhanced course and its effectiveness on students' learning process. Evans, Daily, and Murray¹ studied the effectiveness of an on-line graduate course. They reported the similar performance of students taking Internet-based course and students taking a traditional course. They also concluded, "students tend to be

very skeptical of electronic lectures" and "learning styles play a role influencing student expectations regarding Internet-based education". Graybash² proposed a study for choosing technology for Continuing Professional Education. His proposal is based on the importance of understanding learner attitude and different learning styles on selected technology.

Implementation of web technology should be performed step by step with assessment tools in place to monitor the effect of this tool in the learning process. This is especially important for undergraduate courses with the possible resistance of students to new ideas and tools. Students' background will also affect the pace and direction of web technology incorporation.

The specific course under study in this paper is Operations Research (I) which was taught during summer quarter of '99 as a Digital Summer School (DSS) course. This course covers Linear, Integer, and Goal programming as well as Transportation techniques. The course is offered as a senior level course, for four units, in a ten-week quarter system, in the Industrial and Manufacturing Engineering Department.

The most important objectives of this course are explained in a previous paper⁴ to be obtaining knowledge of some areas of Operations Research, applying computer technology, stressing application and critical thinking, and improving communication skills. These objectives are based on the objectives of the department, requirements of employers, and the criteria for ABET 2000. Appendix A contains a list of these objectives and the tools applied to achieve them.

Some of the students in this class did not have the required mathematics, writing, and computer technology skills. Based on the identified objectives and lack of required skills, computer technology was gradually incorporated to enhance the teaching and learning environment over the past two years. Moreover, as the main assessment technique, a portfolio was required that was a collection of all assignments and quizzes in a self-assessed approach.

The URL address for the course web site is <http://webct.csupomona.edu/public/ie416/index.html>. The User Name and Password for this site is *guest*. An alternative web site can be accessed at: <http://www.csupomona.edu/~sparisay/websima/ie416/>

2. Applied Forms of Multimedia

WebCT, a World Wide Web course tool, was used for the course web site. This tool integrated several web-based teaching features in order to facilitate course preparation and improve students' learning experiences. Some of the WebCT features were not utilized for this course (such as conducting multiple choice questions) because they were not appropriate for this course.

Multimedia technology was incorporated in this course as an archive for course materials, a communication tool, and for streaming video lectures.

The course web site is the archive for this course. The site contains information that is organized in five different major web pages. The "First Day" page contains the instructor's contact information, the grading policy, general information, course objectives, textbook, prerequisites and requirements. The "Schedule" page indicates the course schedule and assignment due dates. The "Homework" page explains different homework assignments and their requirements. The

"Class Notes, Transparencies, and Videos" page organizes different links to transparencies, video lectures, and some notes and examples from different chapters covered in this course. The "Sample Exam and Quizzes" page provides several sample quizzes, one midterm exam, and one final exam. The design concerns for materials on the web pages are explained in a previous paper⁴. As a summary, the major design concern is to keep pages simple for faster retrieval. This concern resulted in avoiding images and frames. The focus was content and ease of navigation as well as appearance on screen and hard copy.

Different electronic communication tools and Internet resources were incorporated in this course. Email was applied as a tool to submit some of the homework assignments. Moreover, email served as extended office-hours for students' questions. Internet searches in relation to this course was required and the results had to be posted using a threaded message board. Students were asked to check each other's comments on a threaded message board and provide feedback.

A total of eight video lectures were taped and encoded for streaming. Basic concepts on each chapter were covered in video lectures. Videos were taped in a studio with no audience present. The total duration of tapes is about five and one-half hours. Creating the video lectures was a considerable challenge in the process of upgrading the course; it required major steps outlined below:

- Design the content: The goal for content was to be educational with efficient coverage of the concepts, clear, self-learning, attractive, and fits the available technology as much as possible. Technology limitations played an important role in the design of transparencies, hand written screens, pace of speech, and movement in front of the camera. The length of each video was on average 40 minutes to fit the concentration span of students.
- Tape the lecture: Taping required scheduling with different parties involved in this process. It was very time consuming and sometimes even frustrating! Retakes were often done due to realization of the technology limitations after the videos were taken. For example, images that were transferred directly from monitor to the video were very shaky.
- Encoding for the web: Cal Poly Pomona uses an Internet streaming compression technology at this time. With this technology video is gradually streamed to remote student sites. It means that the viewer of the video will receive images gradually and cannot download the video for later observation. The video lectures were encoded for two different settings, RealVideo and MediaBase. RealVideo (35 KB) has lower quality video, for dial-up 56 K modem users, and provides 15 frame per second. MediaBase (MPEG-1, 1.5 MB) has higher quality video, for on-campus use or where the user has a "fat pipe", i.e. capable of at least 2 MB/sec with minimal collisions. It provides 30 frame per second video and audio.

3. Course Structure

The first class session was an introduction to the new teaching environment and the sources of the materials. Initially, it was planned to replace one of the two-hour sessions each week with a video lecture that students could watch on their own time. However, there were changes to this schedule due to instructor's schedule (being out of country for the first two weeks) and students asking for more class sessions by the end of the quarter. The class session following a video lecture started with a simple quiz on the video to ensure that students have watched it.

Afterwards, the class focused on questions, problems, and extension topics in relation to that video lecture.

Students' learning process was monitored by means of different pedagogy tools such as assigned homework, self-confidence survey, quizzes, exams, anonymous questionnaires, discussions in class, and more importantly a self-assessed and nonselective/working portfolio. Details of these pedagogy tools are explained in a previous paper⁴. Portfolios, as the main assessment tool, are a collection of all quizzes and assignments with student's comment on the effect of each one on his/her learning process. Appendix B indicates the requirements for the portfolio. A sample student portfolio is available at <http://members.xoom.com/jmkord/ie416/>.

A new added feature to the assignments and exams was asking students to write a report for an imaginary manager on optimal solution and their analysis. They should have assumed that the manager is not familiar with this field and should not use terms that are specific to this field. This type of assignments proved to be very effective in the learning process of students as well as prepare them for their future.

4. Feedback from Students' Perspective

At the beginning of the quarter only the more motivated and experienced students were pleased with the new arrangement of conducting this course. In general students preferred personal contact with instructor through the class sessions. Students felt more motivated when attending class sessions and more at ease with immediate response to their questions. However, by the end of the quarter most of the students liked this arrangement. They were able to watch video lectures at their convenience and with their own pace with the added incentive of being able to replay the video as needed.

In general students were not satisfied with the quality of encoded videos on the web. The RealVideo had a very poor quality and the MediaBase required cable that students did not have. Students could watch the lectures with good quality on school's computers in labs, using MediaBase. However, they did not like the idea of commuting to school for this purpose. It was believed that the University did not have the state-of-the-art technology at that time for encoding videos and students did not have the suitable computers and modems.

Copies of the video lectures on videotapes were placed at the University's Library for checkout. Many students actually did check out the videotapes from the library. In general, students were satisfied with the quality of the content and design of the videos. Most of them believed the content was easy to follow, straight to the point, well organized, covered fundamentals, and carefully prepared.

One complaint was about the time it took from students to prepare the required portfolio. However, most students agreed that the portfolio improved their organizational and writing skills, critical thinking, as well as serving as a good source for exam preparation and a reference for future.

Some of the students' comments in relation to portfolio and video lectures are mentioned in Appendix C. The following table indicates some of the accumulated feedback from an anonymous questionnaire at the end of the quarter.

Question's Content	Feedback
Effectiveness of course material on web	60% very much, 30% to some extent, 10% not at all
Effectiveness of video lectures	80% very much, 20% to some extent, 0% not at all
Recommend repeating portfolio	77% yes, 23% no
Liked application of web technology	87% yes, 13% no

5. Feedback from Instructor's Perspective

In general redesigning the course and its material to incorporate multimedia was very time consuming. The course had to be more preplanned and organized compared to courses offered traditionally. Every aspect and every step had to be frequently checked such as the quality of video lectures on the web. Moreover, it required considerable patience at every step. However, this experiment and its output can be consolidated as an interesting endeavor that prepared students and myself for the future trends.

Even though WebCT was officially used as my course web site, at the time I was not very well trained and therefore I was uncomfortable using it. I did not have enough control on the WebCT environment to design the course. For example, I needed help to change icons. Moreover, I did not need many of the features available on WebCT for this course. I was not able to upload a folder efficiently to WebCT environment; the folders should be compressed and later unzipped for WebCT. Prior to this course, I had an extensive course web site that was working successfully, hence there was little motivation to try WebCT.

As a general rule, I do not trust computer technology to work properly all the time! I experienced students getting frustrated and discouraged about the course when computer technology did not work. Though the official course web site was at the WebCT environment, I had a backup of all the files in another web site on my own web directory. Moreover, copies of video lectures on tape were available at the University's Library for check out.

It was noticed that students in general were resistant to such major changes. Evans, Daily, and Murray¹ had also stated similar observation. The video lectures, when students adapted to them, were especially useful for international students, those with slow learning pace, and students who were working many hours and were commuting to campus. However, video lectures cannot completely replace the personal contact and classroom meetings for the type of this course and our students.

There were eight registered students and two visiting students in this summer course. The average final grade was 79% for registered students (higher for visiting students), which is higher than the grade for this same course offered in the previous winter and fall (76.5% and 72.3%, respectively). The quantitative data on this course, though indicating positive results,

cannot be used for a solid conclusion because there were not enough students (number of observations) and many factors can affect the output. Moreover, I am searching for a tool that can measure the acquired skills of students and the effectiveness of the pedagogy tools used.

In relation to the learning process of students, this effort is considered to be a successful one. Previously, students in class were at different levels regarding background knowledge and had different levels of learning capacity in class. A great amount of time had to be spent teaching most students the basics so that I could discuss more advanced topics and analysis later on. With this new course structure, students knew that there would be a quiz based on the video lecture and so they should watch it and learn the material. They could take time to fill the gaps in their required background for each video lecture. Therefore, students in class were at comparative levels of knowledge and it was possible to conduct analysis more frequently. The level of discussion in class noticeably was at a higher level as a result of students coming to class more prepared.

The students' comments in their portfolios challenged my assumptions about the effects of each pedagogy tool used in this course, including multimedia. This feedback assisted me with the future direction of improvements in this course. I tried to analyze the students' learning process through their comments in their portfolios. I clearly noticed an increased level of involvement in the course, specifically from the passive students. The benefits resulting from the portfolio process justify the time it takes students and instructor to accomplish the task.

6. Conclusion

There is a trend of incorporating multimedia and web technology into courses. Moreover, with the increasing need to continue education, there is a market for digitally enhanced courses for distance learning. Digitally enhanced courses can assist commuting and working students in further education. However, incorporation of multimedia into a course should be performed very carefully, step by step, with some assessment techniques in place that ensures achievement of the educational goals. The nature of subjects covered in a course and the students' background and their learning styles will also play an important role in deciding how much and in which manner we can incorporate multimedia in our courses. The issue is not only the incorporation of multimedia, but also how every pedagogy tool used in a course will weave together. Upgrading a course in this direction requires tremendous amounts of time and dedication from the instructor's side. Universities that are interested in moving in such directions should consider a systematic support and encouragement for faculty members.

7. Acknowledgement

I would like to thank the Instructional Technology and Academic Computing (ITAC) administrators and employees at Cal Poly Pomona for providing the opportunity for this digitally enhanced course during summer of '99. Special thanks are due to Ms. Josie Ventura at ITAC for her assistance. I also wish to thank my students for their cooperation with this experiment and their feedback.

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Appendix A: Course Objectives for Operation Research I

Course Objectives	Tools We Use
Obtain knowledge of several concepts in Operations Research areas	Some chapters of the text book (Linear programming, Integer programming, Goal programming, and Transportation), problem formulation skill
Apply computer technology to this area	Email, internet for lectures on video and information on web, spreadsheet (i.e.: Excel), O.R. software (Quant or Lindo)
Utilize application and critical thinking	Sensitivity analysis, development of concepts and mathematics used in techniques
Improve communication skills	Writing reports, email and discussion board, participation in class, on time attendance and deliveries, and portfolio

Appendix B: Portfolio Process

Portfolio

Due date: One week before midterm and final exams dates

The main purpose of the portfolio is to obtain the student's feedback on his/her learning process in order to improve this course. You are required to collect and organize all (both graded and not graded) your homework and quizzes in a three-ring binder. At the same time, you should comment on each one of the collected items. Moreover, you should comment on each video-lecture provided on the web. Comments and analysis that demonstrate critical thinking of the student will receive extra credit points. The portfolio will be collected and graded one week before the midterm and final exams. For better visualization of what is expected for the portfolio (Notice the requirements were slightly different then.), you can [click here for a sample](#).

Order for the portfolio contents:

- ◆ Title page: contains course name, your name, instructor's name, and date.
- ◆ Table of Contents: there should be a table of contents listing all the contents of the portfolio in details.
- ◆ Section on Comments: This section contains all your comments.
 - Starts with comments on quizzes, whether graded or not. The comments should be organized regarding to the quiz date and the related comment. It is not necessary to have comments for each quiz, but there should be a comment for most of them. You need to have a general comment at the end of the quarter on quizzes indicating your opinion on the effect of quizzes on your learning process and whether you recommend its continuation.
 - Include your comments on homework assignments. The comment page should be organized as assignment's topic and related comments. In your comment on each one of the homework assignments, you need to specify which objectives of this course have been met, as well as its effect on your learning process.
 - Comment on the portfolio process: provide a general comment on the whole process with your suggestions for improvement. Has this process helped you in any way? Do you recommend repeating this process in future quarters?
 - Comment on the objectives met: create a table similar to the one in the "First day" web page about objectives for this course. The second column of the table should be replaced with your comment on how much do you think that the specific objective has been met.
 - Optional: argument on the grade that you feel you deserve in this course.
- ◆ Section on Quizzes: Contains all the quizzes, whether graded or not.
- ◆ Section on Homework: Assignments should be clearly separated from each other (i.e., by a blank sheet) and have a statement of the problem. All homework should be here whether they are graded or not.
- ◆ Section on Video lectures: Comment on each one of the video lectures. You need to specify the efficiency of video lecture on your learning process and any problem faced.
- ◆ Miscellaneous section: All other activities such as "Self-confidence Survey" will be included here.

Appendix C: Students' Comments from Their Portfolio

a) Some of the comments in relation to portfolio:

"portfolio process helped me keep my work more organized ... as a result ... my grade has improved." "portfolio gives me an opportunity to give feedback regarding assignment to the instructor ... prepare his or her documents in a professional manner that leads to the student feeling like a professional him or herself" "I was able to perform better when organizing my homework. ... This experience will follow me throughout the remainder of my courses here at Cal Poly. I have a skill now which will help me a great deal not only here at school, but also after I graduate and start working. ... concept of creating a portfolio is a very important way of learning from my own work ... by giving comments on my homework problems helps me understand the problem more than just doing it once " "Although it is extremely time-consuming, it has helped me to see that everything can be put into summarized form in a clear and concise format. It also activates my memory of IE 416 material and put it in long term storage because this process requires me to think and use analytical analysis."

b) Some of the comments in relation to video lectures:

"my overall experiences with the video-lectures have not been very successful over the web. ... I am unable to upgrade my computer at this time ... involuntarily, I have watched the videos at the school library. ... video was well paced and also well explained ... I also liked it when you appear in the right hand corner when you are explaining a transparency." "I love the ability to go at my own speed through each video ... my brain works a little slower than other's but I am much more capable when I am able to go at my own speed. ... allowed me to review a lecture at any time necessary ... They are well planned and thought out before being taped. They correspond well with the course material, internet notes, and homework. Using a modem at home, I am able to watch the video for about 20 seconds before it freezes. I then have to wait at least 45 seconds while RealPlayer buffers more data to play an additional 20 seconds of video. This is not practical. ... I am unable to read most text presented on the digitized video." "I like your videos a great deal ... I was able to take good notes from them because I was able to go back and rewind the video" "The TV screen did not cover all the areas that you were writing ... (video on web) the picture is poor and the text on the transparencies is small and blurry" "your process of explaining the subject is to the point and very selective. The yellow stickies do a great job in displaying data at the right time minimizing the changing to new overheads ... videos are an excellent source of information ... the overheads are an excellent complement to the video ... allows room for note-taking" "(web video lecture) The spoken words don't always correspond to the image on the screen ... It is distracting and annoying to wait for the buffering process. ... picture sometimes move in slow frames ... Its poor quality, speed, sound, and other viewing problems discourage me" "I was extremely frustrated by the entire DSS approach. ... I knew that I would not learn anything and I caught myself thinking that there is no point in having any questions, because there is no way of having them answered ... the videos are only beneficial when they are used in conjunction with regular class meetings" "easy to understand problem more than the normal lecture"