

Implementation of Classroom Assessment Techniques and Web Technology in an Operations Research Course

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Abstract

This paper introduces the process and discusses the analysis for upgrading a course, Operations Research. The direction for upgrading the course was based on the objectives of the department, the requirements by employers, and the new Accreditation Board of Engineering and Technology (ABET 2000) criteria. This course is a senior level course for Industrial and Manufacturing Engineering students. The course was upgraded in two directions: (1) implementation of a classroom (course) assessment portfolio, and (2) implementation of web technology. Details of the assignments and tests, used as pedagogical tools in this course, are explained. The collection of these assignments and tests in a self-assessed and nonselective/working portfolio are described. The second direction for upgrading the course was utilizing Web-based tools as another computer-based instructional tool. As the first step in this direction, part of the information for this course was provided on the Internet, as well as utilizing a threaded message board. The concerns in design of web pages are explained. Instructor's perception is that the upgrading directions for this course were effective in the learning process, improved some of the required skills, provided feedback for future improvements of the course, and enhanced efficiency of the class sessions. Feedback from the students was generally positive and indicated considerable achievement of these objectives.

1. Introduction

In recent years, there have been many tools proposed for improving the outcome of the educational process in the classroom. Outcome is defined as the amount of knowledge and skills that are obtained by the students. Some of the proposed tools stress on incorporation of web-based technologies. At the same time, many techniques have been suggested for assessing the learning process. Classroom assessment techniques are considered powerful tools for enhancing learning.

I have selected to upgrade a course, Operations Research I, which I have taught for several years. This is a senior level course that covers Linear, Integer, and Goal programming as well as Transportation techniques. The course is being offered in a ten-week quarter system. At the time I started this experiment, I had some students who had neither used email nor searched the Internet. Some students had problems with required background knowledge and skills, such as mathematical techniques, writing, communication, and computer technology. I started with identifying the most important objectives that were critical for our students' needs. These objectives were based on the objectives of the department, the requirements by employers, and the criteria for ABET 2000. Based on the selected objectives, the course was upgraded in two directions: (1) implementation of a classroom assessment portfolio and (2) implementation of web technology.

The following provides details on the objectives for this course that is based on preparing students to be competitive in the workplace. The paper overviews the methods used to conduct the course, evaluate the students, and the incorporation of portfolio process. Please refer to the course web page at <<http://www.csupomona.edu/~sparisay/websima/ie416/index.htm>> for more details. The utilization of the web as a source for course information, research for other sites, and a threaded message board is explained as the first step in this direction. Students' feedback is presented as the outcome of this experiment.

2. Implementation of Classroom Assessment Techniques

As Angelo and Cross¹ (1993, page 4) stated, "Classroom Assessment is an approach designed to help teachers find out what students are learning in the classroom and how well they are learning it. This approach is learner-centered, teacher-directed, mutually beneficial, formative, context-specific, ongoing, and firmly rooted in good practice." They further explained that the first step in Classroom Assessment is to identify and clarify the teaching goals. Furthermore, they provided a tool, "Teaching Goal Inventory", to assist teachers in selecting suitable teaching goals.

The main course objectives were obtaining knowledge, applying computer technology, utilizing application, enhancing critical thinking, and improving communication skills. Figure 1 is a copy of these objectives with a list of the intended tools to be used to achieve these objectives. This information was stated in the "First day" web page for the course (Figure 2).

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), occasionally attending seminars, problem formulation skill
Apply computer technology to this area	Email, internet, spreadsheet (i.e.: Excel), O.R. software (Quant or Lindo)
Utilize application and critical thinking	Project, sensitivity analysis, development of concepts and mathematics used in techniques
Improve communication skills	Writing reports, team work, email and discussion board, participation in class, on time attendance and deliveries, portfolio, and occasionally presentation/lecture

Figure 1: Course Objectives for Operation Research I Course.

The main classroom assessment technique was portfolios prepared by the students. The design of the portfolio process was in relation to the objectives of the course and the pedagogical tools used to achieve those objectives. The pedagogical tools used for this quarter-long course include a self-confidence survey, quizzes, a team project, homework assignments, and a mid-term and a final exam. The following explains how each pedagogical tool is applied. Later, the portfolio process is elaborated.

A designed **Self-confidence Survey** was distributed on the first day of class. The Survey contained several terms related to this course. Each student provided a definition for each term

and identified the degree that he/she was confident on the definition. These questionnaires were completed anonymously. A copy of the students' replies to these surveys was retained for later analysis, while the students kept the originals. At the end of the quarter the same Survey was distributed and the process was repeated.

The Self-confidence Survey at the beginning of the course provided information about the students' current knowledge. The class pace was adjusted based on the results of this information. Students' feedback on the effect of this Survey varied, yet they realized how much they had forgotten from the prerequisite courses. The comparison of the distributed Survey forms at the beginning and the end of the course indicated the degree of improvement of students in learning the material for this course.

I started each class session with a five-minute **quiz** that was based on the previous session. Quizzes were randomly collected for grading. My intention was to increase class participation and efficiency by encouraging students to attend classes on time, to be prepared for the class, and more importantly, to concentrate on the class. On many occasions, the quiz served as a basis for linking previous material to the new class materials and motivating discussions. Commuting and working students were not comfortable with these quizzes. Regardless of several complaints, 82% of the students recommended repeating these quizzes in the future. Midterm and final **exams** tested students on their grasp of theory and foundations of this course. Exams stressed problem formulation and sensitivity analysis skills.

Several **homework** assignments were specified on the web at the beginning of the quarter and the rest were assigned based on class progress. The purpose of most of the homework was mentioned in order to increase the interest of the students and to display the relevance of each homework assignment to the general objectives of the class. One assignment, called "Internet homework", required searching the Internet and posting a comment on a threaded discussion board. The idea for this homework assignment was for all students, not only myself, to read what their classmates thought about a subject, while presenting their individual feedback. Several assignments required using different modules of the Quant software. One assignment required performing sensitivity analysis and drawing a sensitivity graph using Excel.

Some of these assignments received considerable positive feedback from students. One such type of assignments was to write a report for a manager, who is not familiar with Operations Research (OR), explaining the output of the Quant software on different OR problems. Students were not allowed to use the terms specific to the OR field. They had to explain the situation and provide comments. Based on students' feedback, this was an excellent exercise in critical thinking, communication skills, and writing a report.

A team **project** was assigned with the intention to improve students' communication skills (teamwork, preparing professional report, and planning), as well as dealing with a more complex case and applying software.

Students were required to prepare a **portfolio** from the collection of their assignments and quizzes. Furthermore, they were required to discuss the relation of each assignment, or pedagogical tool, to the course objectives. Furthermore, they could state how that assignment

assisted them in their learning process. The portfolio requirements and layout is in Appendix A. The portfolio was ten percent of the final grade. The grade for student's portfolio was based on having a complete collection in their portfolio, moreover, having solid and thoughtful comments.

Students' comments in their portfolios challenged my assumptions about the effect of each activity as mentioned by Angelo and Cross. This feedback assisted me with the future direction of improvements in this course. I tried to analyze the students' learning process and knowledge on material not only through quizzes, exams, and project but also through their feedback and comments in their portfolios. I clearly noticed an increased level of involvement in learning from the students. I believe this process also improved students' communication, writing, and critical thinking skills.

The students' feedback on the portfolio process was much better than my expectation. Most of the students liked the experience and considered it helpful in organizing their work and providing a good review source for the exams. Several students mentioned that the portfolio process helped them to become aware of their performance and/or weaknesses. One student observed, "In my human factor class IE 255, our instructor told us that if we want to improve the performance of a job we should ask the people who are performing the job how to improve it. The same way, it would be really good that all instructors would ask the students' opinion since the students are the ones who are "performing the job" of learning." Other students' comments on this process were, "it is 'just in time' learning process ... and it sharpened my thinking and analytical skills", and, "The comments the student provides about the assignments provide an additional exposure to the concept the problem was based on." As a general comment, another student mentioned, "I feel that the portfolio idea is a good one and should be continued for the sole purpose that it enhances our communicative skills. Case in point, the explanations we have to give on the Quant printouts. We have to explain them in a manner where the average person who doesn't know a thing about goal programming can understand. This is the Achilles heel of many engineers, they can explain in great technical details to their peers but when it comes to explaining an idea or concept to a non-technical group or individual they do not know how to relate. The portfolio also helps to improve on our organizational skills. Once organized I feel that in the future if I ever have a question on goal programming I can go to my portfolio and find an answer to that question."

Because portfolios cannot be anonymous, I occasionally distributed **questionnaires** in relation to pedagogical tools that were used in class and asked for anonymous student feedback. Some of the questions asked if the students recommended repetition of an assignment or activity in the future. For example, 73% of students recommended repeating the Email homework and the portfolio process. A question given on how much students learned in the classroom, as opposed to learning later through homework and self study, indicated that they learn about 50% of the material in the class.

I have collected feedback from students in different forms over the recent years. I would be glad to share students' feedback with a researcher in the area of engineering education. A sample feedback of a student on how much the course objectives have been met is in Appendix B.

3. Implementation of the Internet Web Pages

Bartz³ stated, "The utility of Web servers and browsers as a personal communication mechanism offers numerous opportunities for innovative instructional methodologies. In its simplest form, servers disseminate course material such as syllabi and homework assignments and solutions. In more sophisticated arrangements, the Web client/server relationship provides self-paced interactive tutorials or proctors regular examinations". He further mentioned, "There are limitations. Internet response time can be unpredictable and the requirements of a sophisticated personal computer raise the startup costs for students."

Baker and Chinowsky² mentioned, "The rapid expansion of multimedia technology including CD-ROM, World Wide Web, and video technologies is providing engineering educators with unprecedented opportunities to break away from the traditional blackboard-based education paradigm. However, this rapid introduction of technology into the classroom is not being accompanied by an equivalent level of concern for the impact of these technologies on the educational experience of the students." In addition, they were concerned about educational validity of these technologies, detracting from the overall educational goals, information overload, and leaving students with the impression that the graphic, and not the concept, is the essence of a particular lesson.

I utilized the web in its simplest form for the reason of the limitations mentioned above. In designing these web pages, I considered that not all students have state of the art computers, monitors, and modems. I paid attention to the appearance of information on monitor's screen as well as on paper after when they are printed out. I tried to avoid frames and images that reduce the speed of retrieval. Therefore, the pages were designed as simple as possible but as informatively as they need to be to try to keep the students' focus on the contents, not the art works; after all, this was not a commercial web page. I considered the consistency of pages to ease the navigation. All the second-level web pages have the same design to start the page as the first web page. Figure 2 is a copy of the first web page for this course.

The content of different web pages is as follows:

1. First day page: This page contains general information about the course that should be mentioned during the first day of class. It contains information such as the instructor's office location, phone number, email and URL, office hours, class location and hours, prerequisites, text books, course objectives, tools used to obtain objectives, basic assignments, grading policy, and computer labs and required accounts.
2. Schedule page: This page contains the schedule of topics to be covered in each session of the class, due dates for some assignments, midterm and final exam dates, as well as useful links for assignments.
3. Homework page: This page contains information that is useful in assignments entitled Email, Office hour, Internet, and Portfolio. For the Internet homework a threaded discussion board is used.
4. Project page: The project statement and expectations for the project report is provided here.
5. Class note page: This page contains the transparencies (html version of PowerPoint) used in class and some examples for class discussion.

6. Sample exam and quiz page: This page contains a number of sample quizzes, one sample from a previous midterm and a final exam.

Some of the students' feedback on the course web page included, "Organized material over the web is the best way for students to get information. Just by looking over the web page, I can easily picture the requirements of this course", and, "It is a source of constant information.", also, "The class web page displays a considerable amount of information for both the student currently enrolled and anyone else who would like to know more about the subjects within operations research. The site is easy to navigate through and is relatively plain with respect to graphics and other 'goodies' that are available on other web sites." Another student mentioned, "For someone who is not very organized and misplace my documents easily, I was able to retrieve any lost information easily. Because of your organization I was able to be more organized". A student commented, " My concern is that if everything is on the web site, the students will be forced to depend on the computer."

The implementation of information on web assisted with:

- a) Reducing the amount of handouts in class
- b) Helping the incoming students in understanding the different aspects of the course
- c) Encouraging current students to use the Internet as a source of information
- d) Motivating me to design the course more carefully and in a more organized manner.

1. Future Plans

I am planning to add to the utilization of the Web in all my classes based on students' feedback and as their access to computer and their background in this technology increases. My next plan is to develop lecture videos with some notes and assigned readings for students during this summer. The lecture videos will cover the required background and starting concepts for each chapter. Students can go over the lecture videos and assignments before each class. Therefore, I should be able to utilize the class time more efficiently with answering thoughtful questions, to spend more time for in depth analysis and discussions, to witness more students' participate in their learning process, and to add to learning from each other. I will employ the assessment techniques to monitor the learning effect of each web-based tool and pedagogy used in this respect.

2. Acknowledgement

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IE 416: Operations Research I						
Courses Taught Dr. Parisay Industrial and Manufacturing Engineering Department Cal Poly Pomona	Welcome to the IE 416 Web Page					
	first day	schedule	homework	project	Class note	sample exam & quiz

This page is a new attempt in design of this course in order to incorporate computer technology and classroom assessment techniques. My goal is to facilitate the learning process and benefit from the new computer technology. The content of these pages is designed to complement the course material. I will appreciate your comments for improvement of this page. Please email me your comments and suggestions at sparisay@csupomona.edu
 Last updated: August 1998

Figure 2: First (Index) Web Page for Operations Research I Course.

Appendix A: Portfolio Process

Portfolio

Due date: Midterm exam and final exam 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, quizzes, and the first report of the project in a three-ring binder. At the same time, you should comment on each one of the collected items. Comments and analysis that demonstrate critical thinking of the student will receive extra credit points. The portfolio will be collected and graded on the day of the midterm and final exams. For better visualization of what is expected for the portfolio, 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 Quizzes: starts with comment pages and is followed by quizzes, whether graded or not. The comment page should be organized regarding to the quiz date and 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 this section indicating your opinion on the effect of quizzes on your learning process and whether you recommend its continuation.
- ◆ Section on Homework: starts with comment pages and is followed by homework assignments. 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. Hard copy of "email homework", "office hour homework", and "Internet homework" should be included. 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.
- ◆ Miscellaneous section: all other activities such as initial report on project and "Self-confidence Survey" will be included here with any comment that you might have. Also, you will include the followings:
 - ◆ 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: log of your time spent for this course. It contains date, duration of time in hours, and activity (read book, did homework, worked on project, and so on). This is optional for extra credit.
 - ◆ Optional: argument on the grade that you feel you deserve in this course.

Appendix B: Comments on Course Objectives by a Student

Course Objectives	How much achieved
Obtain knowledge of several concepts in Operations Research areas	At the beginning of this class we completed a self-confidence survey and I have to admit that I was not familiar with about 70 to 80 percent of all the terms included in the survey. Now I am proud to say that if that survey were given to me again I am almost sure I could complete at least 99% of it. This class has given so much information about OR that I am sure I will use in the future. I have to say that the objective for this course was met at least in my case.
Apply computer technology to this area	Besides using and learning the required software for this course I had much practice using Microsoft office software as excel, word etc. Also the using the internet gave me a good idea where I can find any information about OR whenever I need it. Also, the email is very helpful whenever I have any question about the class, I don't have to wait till the next class session to ask the professor a question
Utilize application and critical thinking	The sensitivity analysis of each problem we solved helped me understand that it is not enough to input the information in the computer and let it do the work. I have to be able to understand what the result mean. This showed me how changes in one area of a problem could affect the whole system. Personally this was my favorite part of the course, now I am able to formulate a problem, solve it, understand what the results mean.
Improve communication skills	The fact that we were required to write reports and have discussions on various areas throughout the whole course made us get used to always do a professional job on anything we do. I believe that this more than anything prepared us for the real world.