A Case Study of Using the Web to Teach Civil Engineering Ethics, Professionalism and History

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Abstract

This paper shares the experience of the author in developing and using the World Wide Web as a teaching-learning aid in a three-credit hour, required junior level course in civil engineering that covers the topics of engineering economics, ethics, professionalism, case studies, and civil engineering history. The course is taught in one large section with 70 to 100 students. The author has taught the course over nine years, but use of the Web to assist in teaching the course was begun in the mid-1990's. In 1998, the course was migrated to WebCT, a very popular and powerful commercial course management software that limits access to those officially associated with the course. All course "lectures" were given live by the instructor or guest lecturers, but made use of the Web in real time in the classroom to access relevant materials. The instructor used collaborative learning procedures for both in-class and out-of-class exercises. Students submitted homeworks electronically through the Web site. Grading consisted of attaching grades and electronic notes to the files similar to grading notes applied to assignments submitted on paper. The graded assignments were returned to the students through the Web site thus giving both the instructor and the student graded copies of the assignments. Even the final exam was given electronically and it was partially graded automatically (multiple choice, matching, simple answer questions) by WebCT. The instructor and teaching assistant graded the essay questions. The software allows the student to see his/her grades on all assignments, exams, and other categories at any time from anywhere there is access to the Web. Likewise the instructor has access to the course web site from anywhere he/she has access to the web. Overall, the process took more time to set up, but allows for very effective access to information, some of which is exceptionally instructive. Students like to use the technology, but don't use it as effectively as they could. The author, while still having much to learn about effective use of this technology, will continue to use it in all his courses in the future.

I. Introduction

This paper is about the use of the World-Wide Web in a three-credit hour course required for junior civil engineering students at Purdue University. The course covers engineering economics for half the course and the remaining portion of the course covers engineering ethics, professionalism, case studies, and history. Several sessions of the course are reserved for one or two engineering case studies, usually presented by an engineering practitioner. The course enrollment is typically in the range of 70 to 100 students each semester and the course is taught in one section. About twenty percent of the students are from other engineering disciplines who choose this course as an elective. The author teaches the part of the course dealing with ethics,

Proceedings of the 2001 American Society for Engineering Education Annual Conference & Exposition Copyright

professionalism, etc. while another faculty person teaches the engineering economics portion of the course.

In the mid-1990's, Professor Jeff Wright, a faculty colleague taught the engineering economics portion and introduced the use of the Web for the course. All web materials at that time were written in HyperText Mark-up Language (HTML). The author jumped at the chance to learn about this new vehicle for use in teaching and with the leadership of Professor Wright, they put forth a modest web page (by today's standards) that provided students access to course information, course calendar, assignments, and reference materials for course topics. Each semester from then on, the web page would be updated and expanded to provide more information, especially detailed examples of engineering economics concepts and links to source and reference materials throughout the world.

In 1998, Jeff Wright and the author moved the web materials to WebCT[1] (version 1.3.1, our current version of WebCT is 3.1.2), a commercially available courseware that restricts access to course faculty, teaching assistants, and enrolled students. WebCT has features that allows for a course grade book that lists each student, can hold a digital photograph of each student, and allows for posting homework and other grades as they occur. Instructors and TA's have access to all information in the grade book, but each student has access only to his/her information. WebCT also features a bulletin board and a closed e-mail system. The latter facilitates communication with fellow students, with instructors and TA's, and can be used for threaded discussions. The e-mail system allows for attachments, which greatly facilitated submission of homework assignments by the students and the return of graded assignments to the students. The class web site was a very good way to post homework solutions. WebCT also has a powerful quiz feature that allows for generating quizzes and exams. The feature will automatically grade those questions that are multiple choice, matching, or simple answer questions.

The course instructors, met the class for each session, provided lectures on the material, and utilized in-class discussion. Frequently, students were engaged in collaborative learning and role playing. With the introduction of LCD projectors and Internet connections in the classroom in 1998, instructors accessed all lecture materials and links in class directly from the class web site. The ability to post word processor (MS WORD), spreadsheet (MS Excel), PDF (Adobe Acrobat), and presentation (MS PowerPoint) files made the web a much easier and more powerful tool for course materials. The availability of such web authoring software such as MS FrontPage, Netscape Composer, etc. made it much easier to post materials to the class web site.

While this was happening, Purdue University provided increased support capabilities through the Multimedia Instructional Resources Center (http://www.midc.purdue.edu/). The MIDC schedules numerous short courses throughout the year for all levels from introduction to advanced use. They provide direct personal assistance through telephone, e-mail, and walk-in.

II. Details of the Course Information and Operations

A link to *Course Information and Operations* is posted on the main page of the course Web site and the details are reviewed on the first class meeting. They are given here as a guide for others

who may be looking for ideas on how to adjust for use of this media in the classroom and a discussion of several key points follow their presentation.

Course Information and Operations

Catalog Description:

CE 394 Civil Engineering History, Ethics, Engineering Economic Analysis, and Case Studies:
Sem. 1 and 2. Class 3, cr. 3. Prerequisite or corequisite: MA 261.
Historical, aesthetic, and environmental considerations in civil engineering. Professional Engineering Registration Act, codes of ethics, environmental and computer ethics. Engineering economic analysis, including the time value of money, decision analysis, taxation, depreciation, inflation, and evaluation of alternative proposals. Presentation of several documented engineering projects illustrating the involvement of the civil engineer in planning, design, construction, and operation.

Time and Location: Tuesday/Thursday -- 12:00 pm - 1:15 pm; -- Civil 1144

Instructors: (Names, office addresses, personal web page links, e-mail links, and office hours of course instructors and teaching assistants)

Primary Course Goals:

By the end of this course, the student will be able to:
- *Begin thinking and acting as a professional person;*
- *Prepare profiles of simple and complex cash flows for an engineering task or project;*
- *Assess various alternatives from economic point of view;*
- *Compute the present value, future value, or annual equivalent cash flow for an engineering project;*
- *Compute the annual yield for various interest rate compounding approaches;*
- *Determine the present value for capitalization of projects with very long-term life;*
- *Select from a number of different cash flow alternatives, the one having the greatest economic value;*
- *Describe, model and develop decision strategies for a complicated multiphase with probabilistic elements;*
- *Apply and compare current and traditional depreciation methods;*
- *Evaluate various funding mechanisms, such as bonds, loans, sinking funds, taxes, etc.;*
- *Apply the principles and concepts of engineering economic analysis to personal financial decision-making;*
- *Solve ethical dilemmas by use of a systematic process that employs Engineering Codes of Ethics;*
- *Chart his/her path to professional licensure;*
- *Solve practical engineering problems associated with real projects;*
- *Discover how past engineers have developed the world's infrastructure.*

Secondary Course Goals:

- *Increase oral and written communication skills;*
- *Build a sense of professional community and enhance interpersonal skills through working in teams;*
- *Expand the ability of every student to use computers for calculations and communication;*

Attendance Policy:

Students are expected to attend all sessions of the course. Attendance will be taken at each class session by having each student sign his/her name on an attendance sheet within the first five minutes of the class period. Students arriving more than five minutes late will not be permitted to sign the sheet. For legitimate, excused absences (illness, family emergencies, job plant visits, official Purdue travel, etc.) students shall submit a written explanation of the absence both in hard copy and electronically. The explanation, signed and dated by the student, must be submitted within one week after the absence occurred. The written submission must be placed in the mailbox of the teaching assistant and the electronic copy must be sent to the both course instructors and the TA through WebCT e-mail. One of the instructors will review the request for an excused absence and respond electronically to the student, the other instructor, and the TA on whether or not it is approved.

Homework Policy:

All homework must be completed using the computers (Microsoft Excel, WORD, or PowerPoint). Homework must be turned in not later than the beginning of the class session on the day that it is due. Homework turned in late, but within 24 hours of this deadline will be penalized 20% of the grade earned. Homework turned in after that will receive zero credit. Submissions of homework assignments will be electronically, as attachments to WebCT e-mail to the TA. In the transmittal e-mail, the following statement must be included:

Attached is homework No. X. I am fully responsible for the preparation of the work presented in the attached file.

Your name
Date

For team projects, the following statement must be included:

Attached is homework No. Y. We, the team of (Name 1, Name 2, Name 3, etc.) are fully responsible for the preparation of the work presented in the attached file.

Team Leader name
Date

Any adjustments to homework grades must be resolved within two weeks of the day on which that homework assignment is returned. All questions about grades should first be directed to the TA.

Exam Policy:

There will be two in-class exams and a final exam. The final exam will be conducted during the final exam week. The in-class exams will be on engineering economics and will be of a format similar to that used for the Fundamentals of Engineering exam.

Grading:

Item	*Weight*
Economics Homework	*20%*
Two in-class exams on engineering economics	*30%*
Homework (Ethics, Professionalism, and Problems associated with Case Histories)	*30%*
Final Examination	*20%*
TOTAL	*100%**

**All unexcused absences during the course will cost 2.0 percentage points off your total course score (based on 100%).*

Student Conduct:

Students are expected to abide by the Purdue University Student Conduct Code. Further, it is assumed that each and every student subscribes to a personal code of ethics based on a value system that adheres to the highest standards of academic integrity. Any breach of academic honesty or disruptive classroom behavior will be handled in accordance with established university procedures. (This Student Code of Honor is analogous to the CODE OF ETHICS of the American Society of Civil Engineers that guides practicing professional civil engineers.) Interaction between the instructors and the students in this course will be similar to interaction among professionals.

Several items in the *Course Information and Operations* bear discussing. First, we found it important to discuss the Primary and Secondary Goals of the course with the class. Occasionally, during the semester, these need to be reinforced. It is difficult to write good course objectives[2], but once you have written them and share them with students, it moves the class away from "What's going to be on the tests?" It gives the student a broader perspective of what the course is about and what knowledge, skills, and abilities they are expected to obtain from the course. Course objectives also assist faculty colleagues who teach subsequent courses to know what they can expect from students who have taken your course.

Attendance Policy – With much of the reference material and class notes available on the Web, there is a strong tendency for students to skip class with the idea that they can get the notes on the web. However, when students are not in class, they cannot contribute to the class and lose learning opportunities, especially if collaborative learning techniques[3] are used in class. Hence,

we found it important to require attendance. It turns out that attendance, with this policy, was typically 90% plus. The vast majority of the students found that coming to class was a worthwhile and enjoyable experience. They also found that because the web was being used in class, the class was "open ended" in that we could never be sure where we would go because not all links were included in the course web page.

Another aspect of the attendance policy that needs to be mentioned is the policy on excused absences. Note that only an explanation from the student was required for a legitimate excused absence. Our statement to the class is that this course deals with ethics and that students are in the process of becoming professionals where ethical behavior is expected. Hence, the instructors will respect the word of the student on whether an absence qualified as an excused absence. Students truly enjoyed this level of trust placed in them and few ever violated it. In fact, when it was announced, students could not believe that note from a physician, coach, or other instructor wasn't required.

Homework Policy – Homework was only accepted electronically. Once received, it was graded by the TA's using the software in which the homework was submitted (mostly MS WORD and MS EXCEL) by utilizing the "Insert Comment" capability of this software. Occasionally, the voice recorder feature of this software also was used, but it is very memory intensive. After grading the assignments and recording the grades in the WebCT Grade book, the homework was returned electronically with an electronic copy of the graded homework kept in the course records. While the grading procedure might be a little more cumbersome and time consuming, no class time was required to either collect or return homework, and more importantly, the instructor had a complete copy of the graded homework. With this system, complaints about the grading and appeals for extra credit were less than normally encountered.

Student Conduct – The instructors explicitly state the expectations for student conduct. In teaching this course for nine years, it is very clear that students do not know much about the Student Code: many don't even know of its existence. It is important to introduce this topic at the beginning of the course and more fully develop it later in the course. The author draws parallels between the Student Code[4] and the Engineering Code of Ethics[5, 6].

III. Course Activities

Ethics – The author believes that ethics cannot be taught, but must be learned. The approach taken in the course is to establish the basis for ethical behavior and the ramifications of unethical behavior. An excellent approach to this was provided by Vesilind and Ende[7]; McCuen[8] also is an excellent resource. Next, a series of ethical dilemmas are presented, some dealing with engineering practice situations and others dealing with classroom situations. The videos *Gilbane Gold*[9] and *Academic Integrity: A Bridge to Professional Ethics*[10] provide significant food for thought. Two particularly useful web sites are the National Institute for Engineering Ethics[11] and the Applied Ethics Case of the Month Club[12]. After encountering these situations that present no solutions, students work in small groups to formulate a systematic approach to addressing ethical dilemmas. Group leaders share their group's findings with the entire class. Invariably, when all groups have reported in, a system emerges that has all of the aspects needed to effectively

address ethical issues. The system developed by the class is posted on the class web site for all to reference. The system usually has all of the elements of the system recommended by the Applied Ethics of the Month Club[13]. After this, the groups go back to selected cases and see how the system might work. Invariably, students tend to "go native" in trying to solve these dilemmas and have to be reminded to use the system they developed.

Closure to this topic in the course is obtained by bringing a practicing professional into class with a series of real cases to share. Among the people brought in were James Lammie, Past President and CEO of Parsons Brinckerhoff[14] (numerous times) and Roger Boisjoly[15] (once) the person who tried in vain to stop the Challenger disaster.

Professionalism – In this portion of the course, the students are introduced to the steps to professional licensure. The National Society of Professional Engineers (NSPE)[16] and the National Council of Examiners for Engineering and Surveying (NCEES)[17] are excellent sites for information. Each student for this section of the course is asked to develop a personal plan, including dates, for becoming licensed as a professional engineer. Even if a student has career intentions that don't require licensing, he/she is asked to develop a personal plan as an "alternate". Dates for future exams are posted on the NCEES site. There are links as well to State Boards for many states and some of the states have links to the law establishing registration of engineers, e.g. Indiana[18].

Civil Engineering History – This portion of the course is especially adaptable to use of the web. The approach taken by the author is to start by asking "Why should we study history?" Again, students working in groups can collectively come up with some excellent reasons. Then we look at important periods in the history of civilization (see below). Emphasis is placed on people in each period, how they thought, and what contributions they made. Detailed sources for this portion of the course are beyond the scope of this paper.

Start of recorded history to about 3000 BC:
Food producing revolution

3000 BC to 2000 BC:
Appearance of Urban Society
The Fertile Crescent and Mesopotamia
Seven Wonders of the Ancient World
Egypt and the Nile Valley
The Pyramids

2000 BC to 1300 AD:
Code of Hammurabi
Greeks - science, architecture
Romans - architecture, city planning, roads, bridges, water distribution systems
Middle Ages - First Romanesque and then Gothic (12th to 14th Centuries) architecture, cathedrals, some road and bridge construction

1300 to 1900:
Renaissance - 14th to 17th Centuries
Rise of Modern Science - 17th Century

Steam and the Industrial Revolution - 18th Century
Electricity and Beginnings of Applied Science - 19th Century

1850 to 1950: The Golden Age of Engineering (Florman)[19]

1950 to 1970: The Age of Criticism and Self Doubt (Florman)[19]

1970 - present: The Information Age

Special Topics - Each semester, a special topic of current interest is chosen where the students must research and write a short paper (two printed pages, 12 pitch font). To obtain information on this topic, students are asked to attend the Professional Development Seminar[20] (if in the Fall Semester) or the Indiana Road School[21] (if in the Spring Semester) and interview at least two practicing professionals attending the program on the topic. The students must include in the report their perspective on the topic as well. A sampling of recent topics includes:

- *Should the Code of Ethics Be Changed to Include a Canon on Sustainable Development?*
- *What is the Policy of the Agency/Firm/Company Toward Accepting/Giving Gifts to Others Outside the Firm with Whom They Interact?*
- *Should the Master's Degree Be Considered the First Professional Degree in Engineering?*
- *What is the Role Played by Engineers in a Consulting Firm in Procuring Business for the Firm?*

Students receive complimentary registration to these programs and can attend all the sessions of each program free of charge. If they wish to attend a meal function, they must pay a nominal fee. This activity has been going on for nine years and the practicing professionals who are regular attendees look forward to being interviewed. The assignments not only cause students to interact with practicing professionals, but the interaction contributes increased understanding of the issues for both the students and the practicing professionals. More than a few students also get invited for job interviews as a result of this activity.

Final Exam - In the Spring 2000 session of this course, the final exam was scheduled to take place in the last possible period in Final Exam Week. Students pleaded to have the date changed, but with such a large class, that was impossible to consider. Instead, the final exam was given on the web. The exam was constructed with the aid of Susan Slaybaugh in Purdue's Multimedia Instructional Resources Center (http://www.midc.purdue.edu/). It consisted of a mix of multiple choice, matching, simple answer, essay, and web search questions. Features in WebCT enabled the author to turn the exam on at a specified date and time, turn it off at a second date and time, track who took the exam, when they took it, and meter the time that each student used. The exam was set to become available at 1:00 pm on Wednesday and it was shut off at 3:00 pm on the following Saturday. Students were allotted three hours to complete the exam and they need not complete the exam in one sitting. To minimize cheating, each student had to complete a statement on the exam stating that the work on the exam was solely his/her own. Additionally, a feature in WebCT allows for scrambling the order of answers and having a series of different possible answers for each question. Further, one question on the exam was related to the student's answer on a specific homework assignment and one question required that the student do web-based research to obtain new information outside of information covered in class. Despite one minor glitch with the elapsed time counter, the process went exceptionally

well. Because the tests could be graded as they were submitted, and because some of the questions were graded automatically, final course grades were submitted within two hours after the exam was closed.

Student reaction to the experience of using the Web as we did in this course based on both anecdotal evidence throughout the course and anonymous course evaluations after the course was very positive. Students liked using up-to-date technologies. The author's assessment on use of this approach also is quite positive and he will continue to use it in all of his courses. It is too powerful to not use.

IV. Advantages and Shortcomings of Web Utilization

Use of the Web, even with modern courseware, is not a panacea. While it has tremendous benefits for learning and providing access to material, there are a number of shortcomings as well as benefits.

For effective use of the web, adequate computing facilities, Internet access, and classroom projection facilities are needed in addition to the courseware licenses and support personnel. All of these require significant ongoing financial commitments.

Another concern is the amount of time required of instructors to set up the course, especially the first time. (It is reasonable to have a reduced teaching load for the semester before or the semester in which a course is moved from classical lecture format to one that is web based. Taking a short course on the procedures for doing this is strongly recommended. Working with a colleague who is more experienced with the technology also is very helpful and prevents "wheel spinning." More material useable for courses is becoming available all the time. However, much of the material is not validated so the user must scrutinize it carefully. Some of today's students are of the opinion that "if it isn't available on the web, it doesn't exist." While most library catalogs are now web accessible, some library searching skills are not being developed.

Use of the web live in the classroom as a source of lecture material requires that servers and Internet access be fast and reliable. However, we are now approaching fairly reliable equipment and fast access. This may change with the Internet becoming so pervasive.

With information so readily available, students take fewer notes and rely more on accessing the information with their own computers from wherever they have access (computer labs, dorm rooms, home, work locations, etc.) whenever they need it. This leads to an interesting problem that is rarely discussed: archiving for future access. With fewer or no handwritten notes, students just expect that their access to the class web site will be there forever. This is typically not the case. In some situations, the course web site for a given semester is deactivated or revised and used for subsequent semesters where access is no longer available. We are still trying to address the best way of addressing this problem. Fortunately, mass storage is plentiful and inexpensive and solutions for this problem are on the horizon.

V. Summary and Conclusions

The author shares his experience with a junior-level civil engineering course on engineering economics, ethics, professionalism, case studies, and civil engineering history where extensive use was made of the Web for lecture materials, communication among instructors, students, and TA's, homework assignments, grade information, and exams. In this case, the author used WebCT, online course-design software. Use required significant time and effort, but the advantages of using this approach presents new possibilities for learning, access to information, and handling course operations. Students are quite receptive to making use these technologies, especially because they are being used in class and as a tool to augment learning outside of class. Similar technologies are becoming commonplace in industry today so use of these technologies is appropriate as part of the education process. Some shortcomings and advantages are discussed. After more than five years of experience in using the Web in increasing amounts, the author is convince that use of the technologies is worth the effort and far superior to conventional "chalk and talk" method of teaching.

Acknowledgments

The author wishes to acknowledge Civil Engineering Professors Jeff Wright, Milton Harr, Robert Whitford, and James Alleman and Susan Slaybaugh of Purdue's Multimedia Instructional Resources Center for their patience cooperation, and assistance as the author learned about teaching this course and the use of Web-based instructional technologies. He is especially grateful to the many teaching assistants, most notably Thomas Spriggs who "suffered" through the learning process with the author and finally, to the students who took the course during the development efforts.

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