Web Technology in Engineering Education – How and Why

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Abstract

Innovation in computer engineering and information technology has an impact on our traditional classroom teaching in engineering education. The evolution of Web-based instruction is certainly a revolution in classroom education and may set new standards in the new millennium. An emphasis is given in this paper to answer the question of why we need the web technology and how we can apply it to augment the classroom education. Application of a typical tool (Web CT) to an engineering course, the resulting experiences, and post-test statistical analysis are included in this paper. This approach is readily appreciated and welcomed by the present students, the engineers of next century.

Introduction

The objective of education is to impart knowledge and it remains constant through the entire millennium, whereas the pedagogical process changes with respect to time.   The modern developments in Internet began in 1969 with Arpanet[1]. In the early part of this decade, Gophers was introduced which is a menu based information system with text only version. Later, Mosaic was evolved as a viable information system with both text and graphics version. The technology has exponentially grown into the modern Netscape, Internet Explorer etc. Web-Based Instructional tools have been developed during the middle of this decade and it has been used primarily for distance education. However, it was not well received by the academic community since the user has to learn the Hyper Text Markup Language (HTML). Now, the recent developments in web technology has minimized or eliminated the need to know the markup language, HTML, and hence it has been favorably considered as a viable pedagogical process for augmenting the traditional classroom education.

Web Technology – Why ?

Information is the currency of Democracy – *Thomas Jefferson, 3rd U.S. President*

The remarkable, and partly fortuitous, coming together of the technologies that make up what we label IT – information technologies – has begun to alter, fundamentally, the manner in which we do business and create economic value, often in ways that were not readily foreseeable even a decade ago – *Alan Greenspan*, *Federal Reserve Chairman*.

In other words, Information is the currency of Economy. The economy has changed greatly during the decade, and engineers – the leaders in the new information technology revolution – are a major force in the new economic order[2]. In the pedagogical world, Information is the currency of Education. Web technology is a vital cog in engineering education. It can be effectively used not only for distant learning, but also for augmenting the traditional class room education.

Traditional classrooms have the advantage of creating an appropriate learning environment, and having an active (face-to-face) interaction between students and instructors. Some of the limitations in this process are, (1) difficulty in providing course information or handouts to every student including those who were absent; (2) inability to have office hours that is compatible with the schedule of every student, (3) difficulty in administering many quizzes and tests without increasing the workload of grading, and (4) complexity in obtaining a statistical assessment of class performance. Web-based instruction can be used to eliminate or minimize these limitations [3,4].

The success of Web-based instruction depends on the ability and efficiency of software tools. These tools in general can be categorized as, (1) Course Design Features, (2) Course Collaborative Features, and (3) Course Management Features. However, it is advantageous to have a single tool that integrates all three categories [5,6]. Some of the available Web-based courseware tools include, Course Info, Top class, Convene, Learning Space, Mentor Ware, Mallard [7], WebCT etc. Among these instructional tools, WebCT has been widely used by many academic institutions and has low cost [8].

WebCT

Web Course Tools (WebCT) has been developed at the University of British Columbia, in Canada[9]. It is a user-friendly tool and provides an environment for creating a complete sophisticated Web-based course or to develop materials to supplement existing courses. The course design feature limits access to only the students registered for the course. The course objectives, description, homework, test schedule, and handout materials can be created in a standard word processor and then transferred to the Web-course file. The students can access the course information at any time and from any place. If a student is absent from a class, he or she need not depend on classmate's notes that may be incomplete or unreadable. The information can be accessed in original format without any distortion. The instructor can reach out to the entire class and send course information without leaving the office.

The course collaborative features include discussion between student - instructor, and student - student by asynchronous (passive) method through electronic mail or by synchronous (active) method through virtual chat room. In the active discussion mode, the interaction requires the participants to be logged on to the same course and communicate at the same time. It can serve as virtual office hours for the students (part-time or employed at off-campus) who cannot physically reach the office of an instructor during the scheduled office hours. However, this method of interaction is not viable for a large class[10], since there is a possibility of many students trying to reach the instructor

simultaneously that could lead into chaos. The passive method of interaction eliminates the need for the participants to remain logged on at the same time. Each one can send questions or discussion materials through e-mail in their free time. The WebCT mail can be kept inside the course or it can be forwarded to an external mail delivery system. WebCT mail facilitates quick and easy access to course mails and avoids the clutter in campus e-mail boxes.

The passive method also facilitates to attach and send files (a paper or project report) through e-mail[5]. File sharing is a useful feature for students working in teams, especially if a team consists of dormitory (resident) students and commuter students. Bulletin Board is another collaborative feature that can be used for posting announcements and threaded discussion. It is an effective course conferencing system, which allows communication among all course participants including instructor, grader, and students. The participants can see what each person is contributing to the discussion. In the students' point of view, it is a virtual study group.

Electronic Whiteboard feature is very useful for engineering. It has a graphical paint interface and it can be used for visual representation of engineering diagrams, drawings, mathematical equations, and demonstration of problem solving steps. However, it is an active method of communication that requires the participants to be logged on simultaneously into the system.

The course management features are the most important of all the categories of the Web-based instructional tools. Preparation of tests, quizzes, and grading are usually time and energy consuming for the instructor. Web-based automation of these tasks can relieve the workload for instructors and enhance the quality of education. Tests can be used for grading as performance evaluation, or as self-evaluation measure of individual student. Multiple choice, True/False, Matching, Short answer are some of the categories of questions that can be easily created with WebCT. From a given set of questions, tests can be created by random generation so that no two students get the exact same test. This method is likely to minimize the possibility of sharing answers among students.

WebCT automatically grades the test and provides immediate feedback for both correct and incorrect responses. In addition to that the students' grades are transferred to a spreadsheet on the instructor's screen. It is a useful feature and eliminates the need for maintaining a grade book. The "Timed-Quiz" feature allows students to take tests on their own time within a preset time period[8]. The amount of time to complete the test begins when a student accesses the test, and accessibility is terminated at the elapse of test duration. This feature eliminates the pressure, or test taking anxiety on a student. Also, it relieves the instructor from test administration.

Post-Test statistical analysis is another useful course management feature for outcome assessment. The statistical performance of a class can be readily obtained and used as a feedback to revisit and emphasize certain concepts or theories that are poorly understood, by the students. Other auxiliary features of WebCT include Calendar tool, Progress Tracking, and Student Homepage.

The "Calendar" tool allows students and instructors to see an entire month of schedule. It serves as a daily planner and allows a student to plan ahead for course related events like homework, test, quiz, and project. The "Progress Tracking" tool allows the instructors to see how many bulletin board messages a student has viewed or posted. Also, instructors can track when is the last time a student has logged into the course. In general, it serves as an indication of course participation by the students. The "Student Homepage tool allows the students to place their work on the web in a collaborative nature. They can design and develop their projects on the web.

Web Technology – How ?

There are many ways one could use the web technology in the classroom. WebCT has been instituted as the standard tool for web based instruction at Saint Louis University[11] in 1997. Initially, web technology has been used in Social Work[12,13], Nursing and other non-engineering disciplines. In engineering, WebCT has been used for the first time in the course, ES P210 Statics. The course information was created on the "Web" using the course design feature. It includes course objectives, course description, course topics, textbook, homework problems, evaluation methods, assessment criteria, and final grade distribution[14]. This process does not require any knowledge of HTML. All the course information were created in Microsoft Word and then saved as *html* file. Then it has been uploaded into WebCT with the help of course design feature tool.

The *Calendar* tool is useful to post the due dates for homework and design projects. Also, the dates for the quizzes, tests and final examination can be marked in advance. This information is very valuable to the students. If a student forgets about the homework due date, or test date, one can readily access the information accurately from the web. This tool serves as a dedicated calendar for a specified course. It has an option for the instructor to classify some information as private, in which case the students won't be able to read them.

Bulletin Board tool is useful to send messages to entire class. The students used it for discussions on design project. The residential and commuter students were able to interact effectively and learn together when they study apart. Another interesting feature is that the students can be divided into some groups and each group can have independent discussion about a topic. In Mechanics of Solids course, an ethical problem is given as topic for discussion. One group discussed in management point of view and one group discussed public point of view. Students actively participated and discussion took place in a relaxed virtual environment.

E-mail tool is useful to send information to a specified student and no other student will have access to it. The *Chat Room* tool requires every one to be logged on to the computer and it is not popular among the students. *My Progress* tool is useful for online tracking of students and monitoring the frequency of their visit to the course homepage.

Path tool helps to post the lecture notes and *power-point* presentation materials on the web. However, it is difficult to create such materials for an engineering course, which is mathematically intensive and graphically complex.

The *Quiz* tool is extremely useful to the instructor. It creates a test from a data bank of questions and automatically grades the test. *My Record* tool automatically generates a grade book for the instructor. These tools can be used for outcome assessment and continuous improvement at each course level.

In both Statics and Solid Mechanics courses, at the end of each chapter, a random quiz is generated using the course management tool. The objective of the quiz is to test on principles and concepts as the outcome of each chapter. This information serves as a self-evaluation to the student and as a feedback to the instructor for continuous improvement of the course. However for each test and final examination, a portion of grade is taken from the Web- based test. These quizzes and tests are of multiple-choice type and they are primarily used to evaluate the level of understanding while the regular examinations, tests on problem solving skills. At the end of each quiz and test, a statistical analysis has been performed and the results were used as feedback to improve the course. Additional lectures, home works, and classroom discussions are used to improve the understanding in weaker areas and hence enhance the overall quality of education. The improvement in overall mean is given in the table below:

WebCT - Test Performance

TEST	OVERALL MEAN
Test I	90.3%
Test II	95.7%
Final Exam.	98.5%

Conclusions

Web technology has a positive impact on the pedagogical process and WebCT is a viable tool for web-based instruction in engineering. It has strong potential to augment the classroom education. Professors can use the web technology to bring a class together when the students work apart. Students can use the web technology to learn together when they study apart. The resident and commuter students are able to work together in a virtual environment and have better communication among them. The students can form virtual study groups and learn from their peers. Students welcome this technology because of its flexibility and accessibility to the extensive source of information. Instructors welcome this technology and the modern web based instructional tools because it is user friendly and does not require the knowledge of *HTML*. It can be creatively used for outcome assessment at the course level. Web based instruction has a great impact on engineering education and it is likely to change the present pedagogical process as we step into the new millennium.

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