

Enhancement of a Core Electrical Engineering Course Using WebCT

David Harding
United States Naval Academy

Abstract

WebCT was used to enhance an electrical engineering survey course at the United States Naval Academy. WebCT is a suite of HTML based course tools which can be used to provide Web based content. It is a commercial product created at the University of British Columbia. The course authoring tools are free to download and use. A modest fee is paid to site license it for student use. The course in which it was used is the second in a two semester sequence taken by Juniors and Seniors in non-electrical engineering majors. The second course emphasizes applications, while the first course emphasizes basics such as DC and AC circuit theory. One objective of each course is for students to acquire the ability to answer conceptual and short answer questions. Short answer questions are a significant component of each hour exam. WebCT was used to help students learn short answer material through the use of on-line, multiple choice quizzes. Quizzes on computational material were used in a mastery learning mode. WebCT allows quizzes to be taken multiple times. Each time a quiz is taken, the component values can be varied. This allowed students to make mistakes, go back and ask questions or review the text and then retake the quiz for a better score. Student reaction to this use of WebCT was positive.

I. Introduction

During the fall semester of 1999, Web Course Tools, which will be referred to as WebCT¹ in the text below, was used to supplement an electrical engineering survey course at the United States Naval Academy. Many schools are currently using WebCT including the University of Maryland² where it was chosen after comparison³ with other web based course packages. This electrical engineering course is the second in a two semester sequence which provides both electrical engineering fundamentals and applications to non-electrical, engineering students. WebCT is a commercial product which provides HTML based course support and tools. Using WebCT, an instructor can post course notes and documents. Students can then access these materials using a browser such as Internet Explorer.

Quizzes can be written and delivered in a very flexible manner using WebCT. Some of the details of how WebCT was used to construct and administer quizzes are discussed below. The primary use of WebCT quizzes was to provide the student with another tool for learning. Students were allowed to take quizzes multiple times, making their use a form of mastery learning. Traditional in-class quizzes and hour exams remained the primary means of student evaluation.

Several features of WebCT quizzes are crucial for student self evaluation and feedback. The instructor can allow a quiz to be taken up to five times and the highest score reported. Also, the

online quizzes are graded immediately and the student finds out which of his answers are correct and which are wrong. This allows a student to learn from his mistakes, and come back and take the same quiz again without direct instructor involvement. Of course, this makes it easy for a student to eventually home in on the correct answers for multiple choice questions. But this is OK, because it forces the student to learn short answer questions and concepts without direct involvement of the instructor. It is very important for the student to be able to answer conceptual questions as well as solve computational problems. Often instructors feel they do not have the time to collect and grade the answers to short answer questions in addition to the already heavy load of grading computational homework. The use of WebCT quizzes to cover conceptual material helps to solve this problem.

WebCT computational quiz questions can be varied. This means that a student will not know the correct numerical answer when a quiz is retaken. The student must go back and review and learn more before retaking a quiz. WebCT varies the parameters in a problem and uses a formula specified by the instructor to calculate the correct answer. When a student retakes a quiz, the circuit and question will look the same but one or more values will be different. This very powerful feature encourages a student to correct his mistakes.

Other characteristics of WebCT quizzes can be varied. The period of time during which a quiz is available can be specified as anything from a few hours to several days. The time a student has to take a particular quiz can also be specified as anything from a few minutes to several hours. The number of points each problem is worth and the point total for the whole quiz is specified by the instructor through the use of the WebCT quiz editing feature. A student's score can be the first score achieved, the highest score or an average score.

The course and student management features of WebCT allow the instructor to track student progress including quiz averages and statistics. Examples of how WebCT quizzes can be constructed will be discussed in the Method section below.

II. Method

WebCT provides the instructor with flexible authoring and editing tools for creating Web pages and links. Much of the course material used was available in WordPerfect files from previous semesters and simply had to be updated and saved as HTML documents. Usually the HTML files were then reformatted and polished with Microsoft FrontPage. Once the documents were created and stored locally on a PC, they were uploaded to the WebCT Server at the Naval Academy. WebCT provides an easy to use File Manager for carrying out these uploads. Lecture material was not provided on WebCT. The lectures were delivered in the standard manner in the classroom. The use of WebCT to provide some lecture notes, examples, hints for homework and tutorials would be an important addition. This will be done during subsequent semesters.

Some of the course enhancements provided by WebCT were more or less standard. Course materials such as the syllabus, course objectives, answers to homework assignments and sample

short answer questions were posted on separate pages which could be reached by links from the WebCT home page.

Other course enhancements were made possible by the nature of the online medium. One of these was the delivery of quizzes in a very flexible way, which allowed for student self review and mastery learning. Quiz questions of several different categories are first written and stored in a question bank. The questions types used most extensively in our EE survey course were Computational and Multiple Choice. Examples of each type are discussed below.

An example of a multiple choice question used in our EE survey course is shown in Figure 1 below as it would appear to a student on his computer screen.

Close

Given that a 1000 Hz pure tone is audible at the output of a commercial AM Radio,
we can conclude that:

- 1. A multitude of frequency components over the range of 450 kHz to 460 kHz is present at the output of the IF stage.
- 2. Only three frequency components at 455 kHz, 456 kHz and 454 kHz are present at the output of the IF stage.
- 3. The RF Bandwidth of the station to which the radio is tuned is 1 kHz.

Grade

Figure 1

Radio buttons are provided by which the student makes his choice for the correct answer. One and only one answer is selected. Upon completion of a quiz, the student can have each question graded and get immediate feedback.

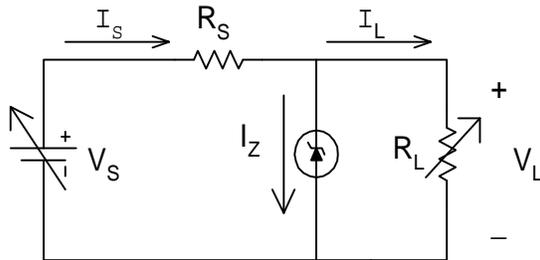
Creating a multiple choice question with WebCT was easy. An instructor can go to the question editing page, make a few selections such as the question title, and enter the text in HTML. To write the required HTML it is convenient to use a Web page editor. For our course Microsoft FrontPage was used to write and edit the HTML which was then copied and pasted into the WebCT question. Using this method, an instructor needs to know only minimal HTML. FrontPage makes available the usual text editing features such as subscripts, underlining, etc. and then provides a preview of its appearance in Internet Explorer.

Creating computational questions with WebCT is also very easy. An important difference from writing multiple choice questions is the need for variables and an equation. Computational

questions can be made very versatile. Parameter values in a computational problem are automatically changed from one instance of the problem to the next. Therefore, when a student retakes a particular question, it will have a different numerical answer. Figure 2 is a facsimile of one of the computational question used in our course.

Close

Given that the breakdown voltage is 8 V and the minimum Zener current to maintain reverse breakdown is 4 mA, find the minimum the source voltage, V_S , that will maintain 8 V across the load if $R_S = 0.11 \text{ k } \Omega$ and $R_L = 1.9 \text{ k } \Omega$.



Answer:

Units:

Grade

Figure 2

To answer this question the student had to do a calculation and then enter a numerical result in the Answer box and the units in the Units box. If a student made one or more mistakes and then retook a quiz containing this question, the values of R_S and R_L would be different. A student could not simply note the correct answer provided with the feedback and use it the next time the quiz was taken. He had to determine what was done incorrectly. In this way learning took place. The primary purpose of WebCT computational questions was not student evaluation. It was to provide a learning experience. In the case of a student who has already mastered the material, it will provide verification of his knowledge.

The values of R_S and R_L were specified to be variables at the time the question was written. These two variables also appear in the equation by which WebCT computes the correct answer. The Zener voltage and the minimum Zener current could also have been made variables.

A variable is identified by enclosing it in curly brackets. For example, {rs} was used for the series resistor and {rl} for the load resistor in Figure 2 above. Each time the question is used, WebCT fills in new values for {rs} and {rl}. Both {rs} and {rl} also appear in the equation which WebCT uses to calculate the correct answer. The range and number of decimal places for these variables can be specified.

Images can be included with computational questions. The example above uses the image of a circuit diagram. This image was created using VISIO and saved as a .jpg graphics file. This .jpg file was uploaded to a WebCT file directory using the WebCT File Manager. VISIO circuit diagrams created during past semesters were reused extensively. A diagram can be used for multiple WebCT quiz questions by leaving component values labeled, but not numerically specified.

It is easy to make a mistake when entering the equation for a computational question. This makes it imperative to thoroughly test a question before a student sees it. Questions with bugs will quickly turn off students to the use of WebCT.

Very flexible quizzes can be created. The instructor can specify the point value for each question, the period of time during which the quiz is available, the duration and the number of retakes allowed. Allowing a window of opportunity of several days seemed to work well. Quiz duration should be generous. More than enough time for even the slower students was provided to remove time pressure. The idea was to use the quizzes to promote learning, not to evaluate. Since the quizzes were used as a learning tool, multiple retakes were allowed and the maximum score recorded. This allowed the student to get help if mistakes were made and then to go back and retake a quiz for a better score.

III. Results and Recommendations

So far, WebCT has been used for only two sections of an electrical engineering survey course taken by non-EE engineering majors. The total number of students involved was 26. A student survey was taken mid way through the course and again at the end. The students were asked how WebCT had helped or hindered the learning process. They were also asked what changes they would recommend. Of the 26 students, 23 responded. Of the 23, 20 had very positive comments about the use of WebCT. They generally viewed it as a learning tool, rather than a tool for instructor evaluation of student performance. Like any other technique, not all students liked WebCT or benefitted from its use. The good news is that many did.

Several had constructive suggestions for improvements. One student suggested that WebCT should respond with a hint, an example or tutorial when a question is incorrectly answered. This is a very good idea but will require a lot more work and several more iterations of the course to fully achieve. Another suggestion was to provide some examples or hints for homework prior to a quiz on that topic.

In retrospect, it would have been useful to include a hit counter on each page. This would have provided a better idea of which pages and elements of WebCT were most useful to the students. I believe the use of WebCT had a positive influence on the learning experience of most of the students. I believe the use of WebCT will become more wide spread in the electrical engineering curriculum at the United States Naval Academy. This may take several years. Older faculty are more reluctant to use this new technology.

Bibliography

1. URL: <http://www.webct.com/>
2. URL: <http://www.courses.umd.edu/>
3. Hazari, S. I., (1998), Evaluation and selection of web course management tools, Retrieved from the World Wide Web: URL: <http://sunil.umd.edu/webct>

DAVID HARDING

David Harding is currently an Associate Professor in the Electrical Engineering Department at the United States Naval Academy in Annapolis Maryland where he has taught for the past 19 years. He has taught a variety of courses to electrical engineering majors and has more recently been very involved in a two semester electrical engineering survey course taught to non-EE, engineering majors. His main interest is in the area of Internet and computer aided engineering education.