

Using the Internet as a Teaching Aid

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Abstract

The World Wide Web (WWW) is available on our campuses, and can be used as an instructional device. We used the internet to supplement the Introductory Chemistry of Materials course at Rensselaer. Through a series of linked pages, as well as a newsgroup, students and faculty are able to access course material. The development of this material, the logistics of administering the homepages, and student and faculty interactions are discussed.

These pages are available for one to browse at:

<http://www.rpi.edu/dept/materials/COURSES/CHEMMAT1Fall95/Main.html>

Introduction

During the last seven years, Rensselaer has initiated many changes in its engineering curricula. Among these are, emphasizing interdisciplinary courses, bringing computers into the classroom, and bringing practical relevance to the course work. These initiatives have been especially prevalent in freshman year courses. As part of a continuing improvement of our curriculum we used the Internet as a teaching aid, in a six hundred student, interdisciplinary, freshman course. In this paper we examine the advantages and disadvantages of using the Internet, as a teaching aid, from the perspective of students and faculty.

Background of Chemistry of Materials Course

At Rensselaer, all engineering students take a common set of core engineering courses during their freshman and sophomore years. Roughly five years ago, a two-semester course sequence was created, namely Chemistry of Materials, that joined elements of previous courses



in General Chemistry and Materials Science and Engineering into a unified, two-semester course sequence. The two semester course emphasizes solid-state chemistry and materials properties¹. It has been taught with faculty from two schools, the Chemistry Department within the School of Science, and the Materials Science and Engineering Department within the School of Engineering, working together as a team. We have taught this course using the lecture-recitation format. The large lectures help ensure that all students enrolled in the course during a given semester are exposed to consistent material; the Internet can serve a similar purpose.

Use of Computer and the Internet

Computers have been used extensively in other freshman year courses at Rensselaer. MAPLE has been successfully integrated into the calculus course². Physics courses include MAPLE and other software to demonstrate abstract concepts³. Recently a new laboratory for the two freshman chemistry course was developed that uses LABVIEW for data acquisition, and Excel for data analysis.

When students are introduced to computer-aided instruction early in their undergraduate careers there are two benefits. The students learn course material better than they would have if the software had not been used. In addition they learn which computing tools are available, and how to make use of them. By the time the current freshman class graduates, the Internet will be an important resource for professionals. Incorporating the Internet into a freshman course is therefore a natural extension of widely accepted educational philosophy⁴.

Assessment of the "Net"

In this paper we will discuss how we used the Internet as a study aid in the Chemistry of Materials course. It is important to note that we used the Internet as a study aid to complement the text, lectures and recitations. The usefulness of the Internet as a study aid will be assessed by examining three factors, student satisfaction, effect on students learning course material, and required faculty effort. We will try to identify how to best use the Internet in a large course. Many people realize that publishing documents on the Internet is not a straight forward task. A significant amount of faculty time can be used creating web-pages. As faculty come under more pressure to work efficiently this cannot be ignored.

Setting Up the Web

It is important to design the set homepages carefully. In our course we wanted to make a



large amount of material available to a large number of students using the campus network. Since the students were using this as a supplement to the regular class, we paid careful attention to the content of each page. We recognized that, like everyone else, a student's time is precious, and we could not expect students to use the Internet if it was not useful.

One Reference Location

When one decides to make course information over the Internet one becomes a general information provider. The Chemistry of Materials I homepage contained links to other pertinent sites regarding the course. It was updated with new links at least once each week. Our strategy was detailed previously⁴, and exhibited as a demonstration at the MRS conference in November 1995. Our design is sketched in Figure 1 and elaborated upon below.

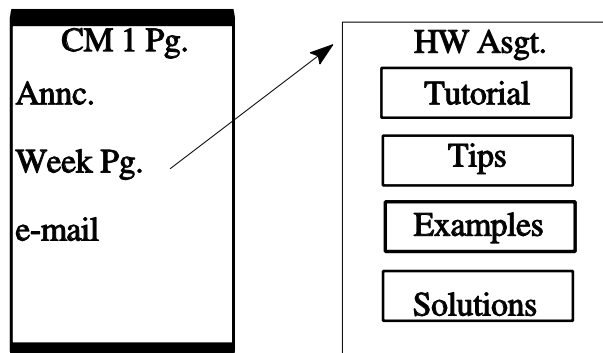


Figure 1: Schematic of Page Layout

Course Announcements - Tests, Administrative Deadlines

Course announcements were placed on the main homepage so that students could access this information 24 hours a day. We posted review sheets for each test in order to help students organize their time, and study more effectively. In addition the room assignments for common examinations were posted.

Easy Contact with the Instructors

We placed e-mail links to various course instructors on the homepage. This made it easy for students to quickly communicate with instructors. Based on e-mail we received during the semester, several improvements to the web-pages and the course were made. The webpage administrator had an e-mail link on the main homepage. He found that his students preferred to contact him from this homepage, rather than through our usual e-mail system. A news group was also set up, so that students could communicate with each other about course related issues. This was barely used by the students.

Structure and Content of Weekly Pages

The main page contained links to "weekly announcements". It was through these weekly pages that most of the instructional content was located. In this course weekly homework, was assigned, collected and reviewed. During the week after a homework assignment was due,



there was a short quiz based on that homework assignment. Therefore, it was logical to organize the information based on the individual homework assignments.

Tutorials

Since this course is relatively new ¹, there is no single textbook that contains all the information relevant to the course. Therefore we provided the students with extra tutorials as needed. In the past, these supplemental materials would be handed out to the students, which are easily lost. Maintaining these on the internet allows the students to easily retrieve copies when they need them.

Tips

Many times students who are having difficulty with a homework problem only require a few hints to correctly solve the problem correctly. Students could get this assistance by going to a faculty member's office, however, many times faculty do not have office when students are doing their homework. "Tips" provide this electronic help. Each "tip" contains a list of hints related to the homework problem.

We have also tried to improve the students communication skills by including thought questions with each assignment ⁵. It is not usually possible to answer these questions by quoting directly from the book. Many students have trouble answering these questions, as texts usually contain few models for students to follow. The tips for a thought question, give students some hints as to how to organize a brief paragraph to answer a technical question, and what information to include in this paragraph.

Examples

Students also learn from model problems. These problems should not only show the student how to get the correct answer, they also should illustrate good problem solving technique and clarify the concepts presented in class. Using the Internet we have attempted to link example problems to the appropriate homework problem. On occasion students would look at these before class, and ask questions about them. Therefore in addition to assisting the students in the completion their homework, it helped prepare the student for class.

Solutions to Assignments

As stated earlier the homework was collected and reviewed on a weekly basis. Many of us who regularly assign homework, also post solutions that the students can photocopy. The Internet is a convenient repository for this type of material. The students can print out copies or simply review them.



Like the example problems the solutions were used not only to show the students the correct way to do the problem, but to illustrate good problem solving technique and clarify concepts. In this light, we posted acceptable answers to the thought questions were posted.

Mechanics and Logistics

The world wide web is basically a mechanism for retrieving information electronically. Web browsers, such as Netscape and Mosaic, provide the means to get this information. These browsers read text documents that conform to the HTML specification. This specification or language requires one to use formatting codes in the text. As such it is tedious to prepare these pages. Images which appear on Web pages are really separate files, which are linked to the Web document. Links to other files are embedded references.

In addition to preparing the HTML document one needs to transfer the document to a campus server. This requires either writing the document using the campus network, or transferring the file to the campus network electronically.

Preparation of Documents

The distinction between word processors and desktop publishers has become blurred. It is possible to prepare an attractive document using a commercial word processor such as WordPerfect, Word or Word Pro. These programs allow one to format text, include figures, special symbols, tables, and equations, and take advantage of such features as spell check. Unfortunately it is not as easy to produce such a document for display on the Internet. All our web pages were first produced on a word processor, WordPerfect for Windows.

As stated earlier a good word processing document does not directly translate into a good world wide web page document. The document has to be converted to HTML. This includes correctly formatting the text, and appropriately converting the graphic figures.

WP to HTML

The WordPerfect files were converted in two steps, first we copied a file into an HTML template provided by Internet Publisher for WordPerfect 6.1. Most word processors have such translators. These translators convert their own internal codes to HTML commands. This template allowed one to easily insert HTML formatting codes, such as links. For example *italicized text* , becomes `<i>italicized text</i>`. Not all formatting converts as easily. The HTML language, in its current version, only recognizes 127 ASCII characters ⁶. Greek letters, special symbols such as arrows, and most mathematical symbols, will not display in HTML. The converter simply ignores them. Instead of •H, one would see, H. Note the • simply disappears.



As superscripts and subscripts are not supported, this formatting disappears as well. Thus 10 becomes 108. Therefore before converting a word processor file to HTML we changed some of the formatting codes.

Graphics • GIF/JPEG (via Bitmap)

Any image, including special characters which would have to be included as images, need to be converted separately. The converter does not recognize graphics, and ignores what it does not recognize. All images had to be converted to one of two formats, JPEG or GIF. After converting the image to an appropriate format, one must establish a link in the HTML document. Converting a figure, which appears in a word processing document, to GIF or JPEG is not simple. We had to save the file as a bitmap, so that it could be exported to the GIF/JPEG converter, namely LView 3.0. Note the image reference command in HTML identifies the file type, and it must have the proper extension. If a JPEG file has a GIF extension the interpreter will not recognize the file.

Equations • GIF/JPEG (via WPG • Bitmap)

Equations had to be treated as graphics as well, however converting equations was even more tedious. Each equation had to be saved as a *.WPG file. This allowed us to open the document in WordPerfect Presentations, and convert it to a bitmap file. Fortunately one can create a 1-bit (2 color) bitmap, this creates a much smaller file. The bitmap can then be converted to a GIF or JPEG file.

File Transfer

Once all images were converted to the appropriate format, and all files were converted to HTML, we were able to make the pages available for viewing. This required sending them to the campus network. We used WFTFTP a commercial FTP package that establishes a connection between one's personal computer and the campus network.

Discussion

Student Desires

To gauge student satisfaction we used three sources, e-mail, a survey, direct feedback in class. Because of the e-mail links we were able to learn as we went along. In one case we prepared a better sketch to illustrate that the net dipole moment in BF_3 was zero. Our survey was probably too detailed as less than twenty students responded. Those who did generally



responded favorably, saying that the Internet was useful. The negative comments focussed on computer accessibility and server reliability. Many more students responded favorably in class. End of semester evaluations indicate that students like having the Internet as a resource.

Students tended to use the Internet as a source of printed material. Almost uniformly students wanted a hard copy of most course related material.

Students Want Structure

The Web is by nature chaotic. There is no set hierarchy. However when using the Internet to provide reference material, students want to know where to look so they can quickly find information. One student suggestion, that we will be incorporating next term is that we include the topics covered each week in the text describing the link.

Students Dislike Graphics

As stated earlier, HTML, the language of the Web is very limited. In fact the character set is limited to the 7-bit (128 total) ASCII characters. To display anything other than these characters one must create graphic images. Using graphics, it is possible to create some nice looking web-pages. However, found that students dislike graphics, as they slow down the printing process, and increase the time required to view the document.

In response to student requests we reduced the number of graphics in each document. This meant changing the format of each line as shown in Table 1.

Table 1: Illustration of Formatting Changes Used for HTML

<u>Normal Format</u>	<u>Appearance on Web</u>
$2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \bullet 2\text{H}_2\text{O}(\text{g})$	$2\text{H}2(\text{g}) + \text{O}2(\text{g}) \text{-->} 2\text{H}2\text{O}(\text{g})$
$c=3.0 \times 10^8 \text{ m/s}$	$c= 3.0 \times 10^8 \text{ m/s}$
$\bullet \text{H} = \text{C}_p \bullet \text{T}$	$\text{Delta H} = (\text{C}_p)(\text{Delta T})$

It is difficult to illustrate good problem solving technique without making a graphical equation. In HTML, all formatting commands must be entered into a text line. Many



formatting commands are lost. For example as shown in Table 1, one could not write:
• $H=3.4 \times 10^6$ kJ/mole, unless one converted it to a graphical image. As Web text the previous equation would appear as $\Delta H = 3.4 \times 10^6$ kJ/mole. This makes it difficult to read. As such it becomes less valuable for the weaker students, or those who having difficulty with a subject. This is a major deficiency in the HTML standard. One needs to carefully balance the need to illustrate good problem solving with the student's desire to print out the results in a reasonable time.

When we felt it necessary to use graphics students preferred the JPEG format to the GIF format, even though the former appeared grainy. The JPEG format however requires more memory, sometimes twenty times as if the image were stored as a GIF file.

An alternative is to use the PDF format which can be accessed by Adobe Acrobat. One can convert a scanned document to this format very easily. Thus from the perspective of the instructor it is not time intensive. However, viewing these documents typically requires the student to configure their own viewer. Printing these documents takes longer than the graphic intensive Web documents.

Students Dislike Links

There is a tendency to place many links in web-pages. The students dislike this. One must remember that students are using the web to learn course material in a short time period. Moving from one location to another breaks the student's train of thought. A student struggling to learn a difficult concept may give up if they have to constantly jump from one page to another.

Presentation Issues

The HTML language does not allow for much formatting. When preparing technical documents, such as these pages, one often must incorporate figures, equations, special characters, sub/super scripts, and tables. Frequently one has to adapt what is a well planned document to the Web.

Indenting Text is Difficult

There are only two ways to make an indented list using HTML. This is to use the listing, or preformatted, styles. This is the only way one can use a tab⁵. However these styles print in 10 Point Courier or smaller. This is not very easy to read. In addition the number of spaces between tabs, depends on the browser and the monitor settings. A list that appears perfectly aligned on one VGA standard, could be misaligned on another.



Creating tables is also difficult. While Netscape 2.0 allows one to create tables, this is not yet part of the HTML standard. Thus those using other browsers will see a jumbled mess. Presumably, for this reason, the Internet Publisher (WordPerfect -to- HTML) converter will not convert tables.

Graphics

The conversion of graphics files is a serious drawback. One needs to realize that it is not always possible to align graphic along side text. This means, whenever one inserts a graphic image into a document, one increases the length of the document. Netscape allows one to align text along side an image, but this is not yet a universally accepted standard.

Difficult to Use Equations

For a technical course it is important to encourage the students to work neatly, organize their work, and show unit cancellations. It is very difficult to do this using HTML. Early in the semester we displayed every equation as a graphic image. This took a lot of time, and the students hated it. A page with many equations, could take as long as forty five minutes to print, on a network printer. To the students this was unacceptable.

When we used text to demonstrate problems solving, the effect was lost on some students. HTML 3.0 is supposed to include an equation specification. If it does it will be important that it be compatible with the equation editors associated with conventional word processors.

Time Consuming Conversions

To take a file that was prepared using a conventional word processor and make web page often requires creating several files. Each of these files can in turn, require numerous conversions. For example it can take up to seven minutes using a 33MHz 486 IBM computer to make convert a single equation. This time is not only due to the speed of the computer, but the number of steps required of the author. Of the programs used to create the web documents, only one, WordPerfect had a macro language. This meant that while we were able to automate the conversion of an equation to the *.WPG format, one still had to use the other programs, manually. It was not possible to automate the transfer of files between programs.

From an instructors perspective this means that the Internet is not a quick fix. Given that it takes time to create a good web document, especially when one considers the conversions, and file transfer time required, one needs to plan ahead.



Reliability

If one is to use the Internet as part of a large course, one requires a reliable campus server. The students frequently have to access a public terminal, and public printer, which could be in different locations. If they are going to take their time to access this information, they should have a good chance of getting it. Making sure the server is reliable requires that we know something about the machine itself. The first part of the URL, identifies the physical machine that one must go through to get the information. For example consider our URL,

<http://www.rpi.edu/dept/materials/COURSES/CHEMMAT1/Main.html>

www.rpi.edu represents a machine or set of machines which provide access to this information. Previously the first part of the URL was www.rpi.edu:80, this represented a different machine, with a smaller capacity. When 600 students tried to access it before an exam, it crashed. When one establishes the URL for their homepage, it is a good idea to check its capacity with the network manager.

Structure / Timing is Important

It is important to have the Internet resources ready to go at the beginning of the semester. Students will not use an unknown quantity. During the Spring 1995 semester we put some information on the Internet in the middle of the term. Very few students accessed it. Students quickly establish a semester routine, if they get used to looking on the Internet they will, if not they will not. This is good time management.

Conclusions

The Internet is a useful resource for teaching, a large course. We have found it to be an effective instructional supplement in a large course. However one has to carefully plan how to use the Internet. In this paper we have tried to explain how we designed our set of Internet pages. This structure was used so that students found a ready reference. In this regard it was successful. We also learned much about how students use the Internet. One has to be aware that students typically want hard copies in a reasonable time period. Each page has to be designed with this in mind. Quite often one has to balance the need for clarity with printing time.

With existing technology, placing information on the Internet is time intensive. The instructors must carefully consider how the information will be used by the students. If one simply rehashes information that is available elsewhere, chances are students will not use it. By tailoring the so that it helps the students outside of the classroom, the likelihood that it will



be used increases. We feel that some sort of network based learning environment will eventually be used. As educators we must keep abreast of this technology. Accordingly during the next semester we will continue to experiment with the layout, and will present these findings at the conference.

During the Spring 1996 term we are evaluating new programs to see if it is possible to increase the efficiency of creating web-pages for instructional use.

Biographical Information

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