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ABSTRACT

The design and implementation of a World Wide Web (WWW) based instructional tool titled Virtual Office Hours (VOH) is described as implemented in the Department of Chemistry and Biochemistry at the University of California Los Angeles. The project is designed to facilitate communication between faculty and students through on-line access to all instructional materials and on-line question and answer capabilities. The project serves more than 15 classes and 3,000 students per term, and it has generated more than 80,000 access hits in a single week of usage. Topics discussed include: project design and implementation; instructional materials; the question and answer interface; answering questions; submitting announcements; a reminder robot; measuring the impact of the service; and the distribution area, which allows other educators to download project materials. Contains 16 references. (Author/DLS)

Virtual Office Hours: A Communication Tool for Students and Teachers

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Abstract: The design and implementation of a World Wide Web (WWW) based instructional tool titled Virtual Office Hours (VOH) is described as implemented in the Department of Chemistry and Biochemistry at UCLA. The project is designed to facilitate communication between faculty and students through on-line access to all instructional materials and on-line question and answer capabilities. The project serves more than fifteen classes and three thousand students per term and it has generated more than 80,000 access hits in a single week of usage.

Introduction

The tremendous amount of public and commercial attention recently focused on the Internet [Segal 1995][Zakon 1996] and the World Wide Web (WWW) [Berners-Lee et al 1992] has stimulated interest in applying these technologies to improving educational services for students at academic institutions. At UCLA, this process has begun in earnest in the Department of Chemistry and Biochemistry. The WWW provides an excellent resource for facilitating student-faculty communication and for demonstrating graphical concepts in ways that are impossible with simple paper handouts or chalkboard demonstrations. The WWW provides today the ability to use full color real-time animation, extensive graphics, and hyperlinks to other resources. In the future, resources like Virtual Reality Modeling Language (VRML) [Bell & Parisi & Pesce 1996] will allow for full 3D representation of images moving in space. An important aspect of Internet delivery of instructional materials is that they can be shared worldwide, thus resource rich schools can assist less endowed schools. The goal is to enhance the learning potential for all students.

Project Design and Implementation

The Virtual Office Hours (VOH) project was conceived as a means for providing two principal lines of communication between faculty and students. First, instructional materials such as announcements, syllabi, practice old exams, exam keys, problem sets and handouts are placed on-line, organized by class, for remote access by students. This solves problems with lost or missed handouts, limited library hours, and checked out reserve materials. Second, students and faculty can directly communicate in an open forum, much like that of a regular office hour, but with many advantages. In particular, all questions and answers are publicly posted for the benefit of all students. Therefore, unlike traditional office hours where only those students who attend benefit from the student-faculty discussion, on-line forums can benefit all students in the class by making a written record of the dialog available on a twenty-four hour basis. For the instructor, this method provides relief from having to answer the same or similar questions repeatedly in several office hour sessions. For students, access to questions on-line

allows for better preparation for lecture and regular office hours, elimination of time conflicts, and the ability to post questions as they arise during studying.

Instructional Materials

The first component of VOH presents large amounts of textual and graphical data in an organized, usable, and easily accessible manner. Important issues include organizing the documents in such a way as to make access intuitive and quick, allowing for easy maintenance, accepting all types of documents from faculty, and keeping documents as true to the original as possible while minimizing data size.

A student arriving at the main VOH home page, finds three sections: the general information section, the class pages section, and the outside links section. The general information section includes links to an archive of exam pages which allows previously submitted exams to be searched and displayed; an instructions page which provides links to instructional documents specific to VOH and to on-line use guides for email, the Internet, etc.; a comments form; VOH from previous terms; a distribution section [Distribution Area], where all of the scripts that run the project can be found; and the "white page", or description of the project. The class section divides the term's classes into their respective fields of chemistry: General, Physical, Organic, Biochemistry, and Inorganic. These fields are displayed in a tabular format along with the specific classes available therein. Clicking on a field header takes the student to a page with links of interest to that specific field of chemistry. The final section, for outside links, provides access to information about the Department of Chemistry and Biochemistry, the main UCLA home page, and several other educational projects on the WWW that are relevant to chemistry.

A student pursuing the link to a specific class from the VOH home page is presented with the "basic class package" of documents. This includes: a link to departmental information about the instructor; a syllabus for the class; a frequently asked questions (FAQ) section comprised of the edited consolidated questions and answer sections from previous terms of the class; an announcements area [Submitting Announcements]; and a questions and answer (Q&A) section, see [Questions and Answer Section]. In addition, instructors may submit information such as old examinations, examination keys, handouts, problem sets, supplemental readings, animations, and links to outside resources, all of which can be added to their page to improve its usefulness to the student.

Because of the large number of files necessary for each class, a rationally designed directory structure is crucial to the facile maintenance of the project. VOH's is simple and consists of a "root" directory called *uclavoh* with the following subdirectories: *docs*, for documents; *profs*, a secure area for instructor only access; *conf*, another secure area for configuration materials; *images*, for images on all project pages such as backgrounds and navigation icons; and *class*, where *class* is the designation of a class in the department supported by the VOH project. Each class directory contains subdirectories for images and questions along with its home page. Because of the consistent and modular nature of the directory structure, all of the class directories can, at the end of the term, be moved into a different directory, such as *winter96*, and maintained as a whole functional piece while new class directories are created under the project root for the current term. Hence, the current classes are always found directly under the root, *uclavoh*. To keep the Universal Resource Locator (URL) for the class as short and easy to remember as possible, we take advantage of a feature of the NCSA httpd server (version 1.4.1) [SDG 1995]. If a directory is specified in a URL, the NCSA server's index function will do one of two things: if a file called "index.html" is present, it will be displayed, otherwise an "ls-like" index of the directory will be generated and displayed. Therefore, if we name the VOH main home page "index.html" and place it in the root directory, the project can be referred to by the concise URL: http://www.chem.ucla.edu/uclavoh. The same holds true for individual classes which can be referred to by their directory name, e.g. http://www.chem.ucla.edu/uclavoh/10A.

The greatest difficulty in setting up class pages for instructors is reconciling the various formats of their existing data with the formats necessary for the WWW. Old midterm examinations are a particular challenge because of the wide variety of data formats (typewritten, hardcopy with "cut and paste" graphics, handwritten, or digital in one of many possible formats) and the frequency of special characters, special math symbols and graphical images, which are not directly supported by the WWW browser for viewing. We use a "text if possible, graphical interchange format (GIF) [CompuServe 1989]

otherwise" policy. If the information to be presented is primarily textual, such as a Microsoft Word [Microsoft 1996] document or a text file, it is manually converted directly to hypertext markup language (HTML) [Connolly 1995]. Otherwise, the document is converted into GIF graphics on a page by page basis. This was accomplished using two pieces of software. First Print2PICT [Raoult 1993] was used to capture print output as PICT format graphics. These were then converted with GraphicConverter [Lemke 1995] to GIF graphics. Old materials and handwritten materials were scanned with an Apple ColorOne scanner (at a resolution appropriate for viewing on the screen) and converted to GIF graphics. These GIF graphics are then individually "encapsulated" by automatically written HTML documents to provide for easy printing and navigation.

Question and Answer Section

Electronic student-instructor dialog can be accomplished simply by advertising the instructor's email address, but this method has several flaws. First, students as a group cannot benefit from a discussion that is conducted via personal email; second, the professor would be obliged to answer redundant questions inadvertently asked by multiple students; and third, this could produce an undue volume of additional email for the instructor. Therefore we created the second major component of the project, a form-based question and answer forum. Students clicking on the "submit question" link of their class's Q&A section are presented with an HTML fill out questions submission form (qsf). This form prompts them for their name and email address, and provides them with a field for entering a text question. The student may submit questions either for public consideration or "confidential" posting to the instructor. A public post is immediately accessible to all students through the "unanswered questions" link from the Q&A section of their class home page, thereby increasing the usefulness of asked questions, and reducing redundancy. The confidential channel still allows for private questions to be asked of the professor. Answered questions are viewed by selecting the "answered questions" link in the Q&A section.

To implement this strategy we designed a Perl [Wall 1991] common gateway interface (CGI) [CGI] script. The question submission form (qsf) script first verifies that the form has been properly filled out, and formats the question for output. Public questions are each saved as a separate file in the class's questions directory, named as the UNIX time (the number of seconds since January 1, 1980 [Wall & Schwartz 1992]) at submission. This nomenclature allows the questions to be concatenated in chronological order for viewing by another Perl CGI script (questions to be answered, qtba). Confidential questions are emailed directly to the instructor using the UNIX mail program. A serious security issue arises when passing form data directly from an HTML fill out form to a UNIX program. Because certain UNIX programs (such as mail) can send commands directly to the system, a student could inadvertently send a dangerous command to the system (such as the command to remove all of the files on the hard drive!) To prevent such a disaster from occurring, the form data is parsed and dangerous characters are removed.

Answering Questions

An important element of making the VOH project viable in the Department of Chemistry and Biochemistry at UCLA is making the project very easy and convenient to use by instructors. Our goal is to improve their ability to instruct without imposing significant additional demands on their time. To accomplish this goal, we created a script that allows the instructors to edit and answer student questions and post announcements for their class, without any knowledge of HTML. The instructor only needs to request a document (the questions answering and announcement posting form or "qaarf") in the *profs* directory, provide their username and password, and fill out this simple form. The form then asks to which class to post the information. Upon selecting "answer", the script retrieves the oldest unanswered question from the proper class's question directory and presents it in an editable field of a new form. Here the instructor may answer the question by simply typing in a reply into the answer field, or he/she may skip or delete the question. Upon submission of an answer, the script creates the necessary HTML and prepends it to the list of answered questions in the class's questions answered (qa) file. This prepending maintains a reverse chronological (most recent first) order of the answered questions, allowing newly answered questions to be quickly located by the student at the beginning of the qa file.

Submitting Announcements

One of the more difficult things for an instructor to do is circulate an announcement to the class in a timely manner, making sure that even absent students are notified. Because posting an answer to a question and posting an announcement are logically very similar, we modified the qaarf form to include an announcements option. Upon selecting "announcement" from the qaarf form, a new form is generated which prompts the instructor for the announcement text. Again the HTML is automatically generated and the prepended the class's announcements file, which is directly accessible by the students from the class page.

Reminder Robot

For the Q&A section of Virtual Office Hours to be successful, questions submitted by students must be answered in a timely fashion. However, because there is generally no need for the instructors to look at their class pages, it is inconvenient for most instructors to check for unanswered questions on a daily basis. Therefore, we developed a simple Perl script which, when executed on a daily basis by the UNIX cron utility (a program that executes commands at specified times), checks for unanswered questions and reports the number and age of waiting questions as an email message to the individual faculty. We find this vastly decreases the amount of time that instructors must spend using the system, and decreases the time between posting of questions and answers. The instructors appreciate only needing to access the system when notified of waiting questions, and students find a majority of their questions are answered within twenty-four hours of being posted.

Results

Quantifying the impact of a WWW site is a topic of much interest today and very soon we can expect to see better, more accurate tracking software emerge. Currently, however, we have applied only simple methods to examine the impact of our service at UCLA.

The first method is to simply consider the number of hits on our server due to access to the project. The Department of Chemistry and Biochemistry WWW server went into full operation in October of 1993 and receives approximately 20,000 hits per week. The VOH project began full operation in September of 1995 and resulted in a dramatic increase in server hits, rising to more than 100,000 in some weeks [Fig. 1][Wusage 1994]. It is interesting, but not surprising, to note that there are peak usage periods before midterm and final examinations as students access course materials. One could envision using VOH access patterns to study student study habits.

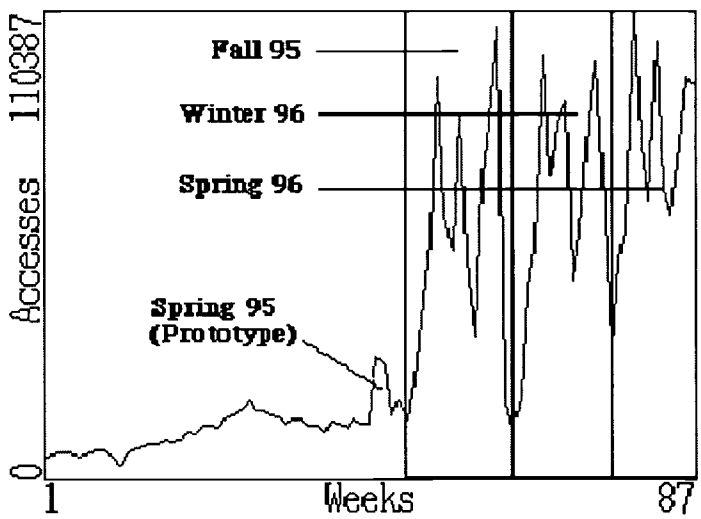

Figure 1: Accesses to the UCLA Chemistry and Biochemistry WWW server.

The second method that we used to measure our impact was to conduct a voluntary user at the end of school terms. The survey asks students questions about their usage of the VOH program and its usefulness for their studies. Many students responded that their typical usage was once or more per week and that they found it very useful as a supplemental educational resource. Sample student comments include:

"I think this is great. It's a wonderful resource for chemistry students."

"I get invaluable class material from VOH and I get to talk with the professor despite my busy schedule that doesn't allow for regular office hours attendance."

"This is a beneficial augment to live office hours in that each of us is able to access the questions and answers of all other students in the class."

"I sincerely hope that VOH will eventually be able to incorporate all courses and professors on the Web."

The completed project can be viewed at http://www.chem.ucla.edu/uclavoh. It is open for worldwide viewing.

Distribution Area

A link is provided on the main VOH home page to our "distribution area", which allows other educators to download our project materials. The main scripts that run the project can be found here along with examples for HTML documents, maintenance scripts and instructions for setting up a VOH site. We are currently working on porting these scripts to the Macintosh and Windows NT and these versions of the scripts, along with instructions, will also be available in the distribution area. See: http://www.chem.ucla.edu/uclavoh/dist.

Conclusions

The World Wide Web is an outstanding tool for the presentation of instructional materials to large numbers of students and for enhancing student-faculty communication. It crosses boundaries of all types by allowing students from all over the world benefit from work done by a small number of people. Posted class information not only benefits UCLA students, but can also be used as study aids by college, university, and even high school students worldwide. Student-faculty communication is promoted with many new advantages over traditional office hours.

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