The Internet As a Course Support Tool in Pharmaceutical Sciences Education: A Primer

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SUMMARY. The move toward increasing student-centered learning efforts and improving students' cognitive interaction with the course content is becoming increasingly evident in U.S. higher education. Pharmacy education is not an exception. However, such interactive learning may require consideration of alternative ways to deliver course content, especially for the large lecture class. For these and a variety of other reasons, pharmaceutical sciences educators have started looking to the Internet to support or supplant traditional instructional methodologies. The integration of Internet-based elements into pharmaceutical science course offerings familiarizes students with technologies and behaviors that are likely to persist and improve throughout their ca-

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reers. In addition, the Internet provides students with enhanced opportunities to contact their instructors and augments the traditional audible form of content delivery. When lectures are supplemented with slide shows, animation, video clips, etc., students have the opportunity to receive visual information that complements what is being said. And when instructors make the supplementary information available within a course web site, students can access those resources as often as they wish, whenever they wish. Such repeated exposures may ensure that students have an opportunity to explore and absorb material according to their preferred style of learning. This article presents a variety of options available to pharmacy educators interested in establishing an Internet presence for their pedagogical pursuits. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-342-9678. E-mail address: getinfo@haworthpressinc.com <Website: http://www.haworthpressinc. com>]*

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INTRODUCTION

The move toward increasing student-centered learning efforts and improving interaction between students and course content is becoming increasingly evident in U.S. higher education. The image of the student as a passive receptacle for the deposit of information is being replaced by an image of the student as an individual who is actively responsible for his or her own learning. This transition is a natural fit for pharmacy education, which seeks to produce competent professionals who are equipped to be life-long learners capable of adapting to the dynamic changes occurring in pharmacy and health care. However, this enabling of greater access to such interactive learning may require consideration of alternative avenues of course content delivery, especially for the large lecture class.

Where does actual learning take place for students in schools and colleges of pharmacy? How should students "practice" learning behaviors that will be useful throughout their careers? What methods of teaching can address multiple learning styles simultaneously in the diverse pharmacy student population so all students in a class are able to capitalize on the style that best suits them? There may be no single instructional methodology that provides the optimal answer to all of these questions, but using the Internet in the delivery of course materi-

als is an inexpensive way to address each of those questions in a way that supplements and enhances student learning.

Much of the learning that takes place during pharmacy school occurs outside of the traditional lecture hall. The "classroom without walls" concept has been in place for some time, as students have engaged in field exercises, externship opportunities, and discussions on the sidewalk after class. However, there can be no doubt that adding the Internet to that list of learning environments expands the "classroom" to include far more resources than might have been possible previously. You may then use actual contact hours in the lecture hall differently-perhaps for discussion, exploration, or analysis. The potential for interactive learning is expanded to include other settings and other schedules, thereby allowing students to explore course material in ways that foster deeper absorption and retention.

Your inclusion of Internet-based elements in course delivery acquaints students with technologies and behaviors that are likely to persist and improve throughout their careers. A familiarity with computers and with open access to information will contribute to the formation of technical and information-gathering skills that will be useful in many aspects of their professional futures. Much of their success in education and in pharmacy practice may depend upon their knowledge of where and how to locate information.

Another positive behavior that you may encourage through the use of the Internet in courses is teamwork. Electronic mail (e-mail) and chat capabilities enable students to converse with their colleagues at virtually any time and from nearly any location with phone access. Individual time-management preferences are likely to differ given the diversity of pharmacy students, and this technology allows students to manage their time in ways that are most beneficial to them.

The Internet also allows students to interact with you, the instructor, in new ways. The potential for feedback exchange may be easily incorporated into a document (web page) on the World Wide Web (WWW) with or without anonymity. The student hindered by inability to meet with you during office hours may conference with via e-mail at the convenience of both parties. The perception of 24-hour contact with instructors and classmates also allows a student to postulate questions at the moment of curiosity, recognizing that for some people peaks in scientific creativity and discovery may occur at 2:00 a.m. There are benefits for nontraditional students as well. The deliv-

ery of materials or education by way of electronic media allows these students to participate while attending to job, civic, and family commitments.

Regarding learning styles, utilization of the Internet in a course has the potential to enhance the traditional audible form of content delivery. As you supplement lectures with slide shows, animation, video clips, etc., students have the opportunity to receive visual information that complements what you present verbally. If the supplementary information is available within a course web site, students can access those resources as often as they wish, whenever they wish. Such repeated exposures may ensure that students have an opportunity to explore and absorb material according to their preferred learning styles.

Given that using the Internet's capacity to enhance your course may have some advantages with respect to accessibility, fostering appropriate and useful behaviors, and meeting the needs of diverse learning styles, how then can you incorporate the Internet? You may include multiple elements from the classroom on a course web site, the technical complexity of which may range from a simple document style to a multimedia extravaganza. Course syllabi, goals and objectives statements, assignments, lecture guides, videotaped lectures, graphic supplements, reference materials, reading lists, and communication forums are just a few of the potential course elements that you may distribute using the Internet. Application of the Internet to instruction is limited primarily by your imagination and by the availability of other resources (e.g., time, equipment, technical support).

The Internet provides educators with a tremendous number of opportunities to support their educational efforts. These opportunities can range from the development of a page that can be accessed from the WWW to the use of electronic mail that can be used to communicate, from the provision of materials to interactivity among users. This article explores a few of the more salient options available to you as a pharmacy educator interested in establishing an Internet presence for your courses.

WEB PAGES

The use of the Internet as a course support tool is becoming more and more widespread in higher education. Although the Internet has

existed for many years, until recently it was limited primarily to text-based applications. The WWW is the fastest growing Internet application. It is estimated that there are between 400 and 500 million web pages in existence today (1). The WWW is appropriately defined as the universe of servers that allow text, graphics, sound, and other files to be linked together and shared by an audience worldwide. Web pages, which are the electronic documents found on the WWW, can contain not only text but also sound, graphics, moving pictures, and links to other WWW pages. WWW pages can provide a unified interface for valuable Internet resources. The pharmaceutical sciences educator is no longer restricted to text alone; interactivity, color, and depth can be added to course materials and are easily created and delivered when one takes advantage of modern, easy-to-use web development tools.

Web pages are written in HyperText Markup Language (HTML) which is the *lingua franca* for publishing hypertext on the WWW. It is a nonproprietary format based upon Standard Generalized Markup Language (SGML) and can be created and processed using a wide range of editing tools, from simple plain-text editors to sophisticated what-you-see-is-what-you-get (WYSIWYG) web page authoring tools.

Web pages (or HTML files) are simply plain ASCII text files with special formatting tags inserted; for instance, these tags tell how to format text, how to link to other documents, and which multimedia objects to incorporate. Given this description, the only requirement for one to create web pages is a working knowledge of HTML tags and a text editor (e.g., WordPad®, Notepad®), making the startup investment relatively low for beginners. You may choose to adopt programs specifically designed to create, edit, and maintain HTML documents, but they are not absolutely necessary. Finally, you may want to use standard word processors which include a "Save As HTML" or export feature.

Users and creators of HTML documents (web pages) should be aware that HTML is an evolving language. The version of HTML that is in use now is version 4.0 (2). Because HTML is evolving at a rapid rate, web page authors should give careful consideration to accessibility and compatibility issues. People browse the web using software packages called "browsers," which interpret the HTML language and display the files present at a site and linked to a given page. By exploiting the latest and greatest HTML features, you may create

access problems for visitors with older browsers; specifically, the older browsers may not recognize the newest HTML tags. If these newer tags are essential to your WWW offering, browser upgrades might be necessary for students to take advantage of your materials. Some of the most popular web browsers (e.g., Netscape Navigator®, Microsoft® Internet Explorer®) are currently available without charge to students and others associated with academic institutions. This should limit problems with browser incompatibility. However, if the general public is part of your intended audience, then older browsers may be more prevalent, and you should be more cautious about using the newest HTML features.

Basic HTML Elements and Design Issues

The construction of a web site is more than merely stringing along a series of web pages. Much like approaching the authorship of a paper, chapter, or book, WWW site creation requires forethought and planning. One of the primary goals in web site construction is to provide the user with a structured site and good navigational controls to move within it (3). The process for creating a web site follows the basic design principles of analysis, design planning, development, testing, implementation, and feedback (3).

In the analysis (profiling) phase, you will identify the potential users of your web site. There is the possibility that your audience could vary widely on a variety of characteristics, including demographics, technical skill, and computer (hardware and software) capabilities. The more you know about the intended user of your web site, the more likely you will be to provide a valuable site. Try to gain an understanding for what users will want to accomplish, what questions they will ask, and what answers they will expect. Resist the temptation to organize content around your hierarchy; rather, organize it according to anticipated user needs. This step provides most of the information that will be used to guide the design phase.

Just as outlining a paper before writing it can facilitate a coherent and suitable end result, outlining a web site can go a long way toward creating an effective and efficient site. Begin the design phase by identifying the major high-level topics, then break the topics into groups, then break the groups into subgroups of information. Think about how pieces are related and how to enhance the content with multimedia components (e.g., graphics, video, and sound). Consider

ways to break apart topics to exploit the power of hypertext, which allows you to link text and objects to other files and programs. Think about practical issues such as how much content can be used on a single page without overloading users. Solicit input and feedback from your colleagues. This might save a lot of time in editing and upkeep later and/or also provide insight for enhancing your site.

The development phase actually entails the creation of the pages on the basis of the topics that you identified in your design stage. Try to create stand-alone pages centered around each topic and then set up hyperlinks to indicate relationships between topics or pages. Build in all multimedia elements to meet the specifications in the design phase.

Once constructed, test your web site by enlisting people with diverse backgrounds and experience levels. Begin with immediate colleagues or graduate students first to avoid excessively embarrassing moments. Use people with a variety of characteristics matching your intended audience and look for different responses–don't simply try to validate your own expectations. Make sure the web site works for you, novices, experts, casual users, and the hard-core web surfer. Make sure the web site works for a variety of screen resolutions and Internet connection speeds.

After testing is completed, launch your web site with the understanding that your venture into this medium signifies only the beginning of your commitment to maintaining, updating, and improving your site. The presence of new materials and improved functionality will encourage students to utilize your page. Many web authors start with a simple but accurate site and let it develop over time. Provide users with a variety of feedback mechanisms so you may gain their input and insight as to how the site can be improved. Don't become attached to any particular idea. The objective is to reach your user base; therefore, users' needs should be the focus of your efforts.

HTML Editors and Converters

Creating material in HTML can be as easy as you want to make it. For those who already have material in some word processor format and need to place this material on the web, several of the more popular word processing packages offer tools to translate your documents into HTML documents. Prepare materials as you would for normal paper distribution and use the appropriate feature within your word processor to save the file in HTML format. This is easy, as it often simply

involves clicking the appropriate button. Two of the more popular word processing packages, Microsoft Word® and Corel® WordPerfect®, have this capability in their latest software offerings. If you have an older version of word processing software, visit the manufacturer's web site to ascertain whether a patch or upgrade, which will incorporate this feature, is available for your existing version of the product. Other word processing applications and software applications that have these capabilities are available on the web (4). Those who have experience using these converters describe formatting inconsistencies, especially with bullets and tables. You may have to make several attempts before you are satisfied with the final look and functionality of your site.

There are dozens of HTML editors available to the would-be web site creator. These consist of freeware versions (e.g., Netscape Communicator®, AOLpress®), shareware versions that allow free evaluation and subsequent purchase at the end of the evaluation period, and full-featured commercial HTML editor packages (Microsoft Front-Page98®, HoTMetaL Pro®). The choice of HTML editor will depend on availability of money to invest in a program, existing knowledge of HTML tags (some programs expect the user to possess some familiarity with HTML), dependence on WYSIWYG technology, and extent to which one expects to use certain features or the advanced features available in HTML. Familiarity with the programs that are available, as well as a good plan for what you want to produce for your students, is a good start.[1]

Basic WWW Page Design and HTML Formatting Tags

In addition to deciding on the content for your web site, you will need to decide on the layout or presentation format. Frames can be used to partition the screen into separate regions with each region displaying a different web page. Figure 1 shows an example of a page with frames. Each frame contains its own unique web address, allowing users to scroll through multiple pages simultaneously. This characteristic makes it possible for you to display banners, legends, and tables of contents all at once. Frames technology also reduces the need for the viewer to jump back and forth between windows, which can be a desirable trait in academic WWW offerings. For example, you may want to place a set of questions in one frame and answers in another.

Using frames may require more development effort, thought, and

coordination. You will need to consider the options that are available with frames and design your web site accordingly. For example, you have the option of configuring links to open in a full browser window or in a smaller frames window.

Although one might expect today's users to have access to the newest browsers, which have the capability to display frames, some may be using browsers that do not have this capability. In these situations it may be wise to offer a site that is free of the frames HTML tags (i.e., no frames). Figure 2 is an example of how the page shown in Figure 1 can be displayed without frames. As a compromise, you may elect to create two versions of your web site; a frames version and no-frames version. By doing this, you will accommodate viewers who cannot take advantage of the unique features offered by frames as well as viewers who do not prefer the frames format.

Another powerful HTML formatting tool is tables. Prior to the availability of tables, web developers had few options for maintaining a neat column presentation. While tables can be used to present information in traditional row/column format, they can also be used to create special formatting effects such as left or right alignment of a set of lines.

The choice of colors can significantly influence the success of your
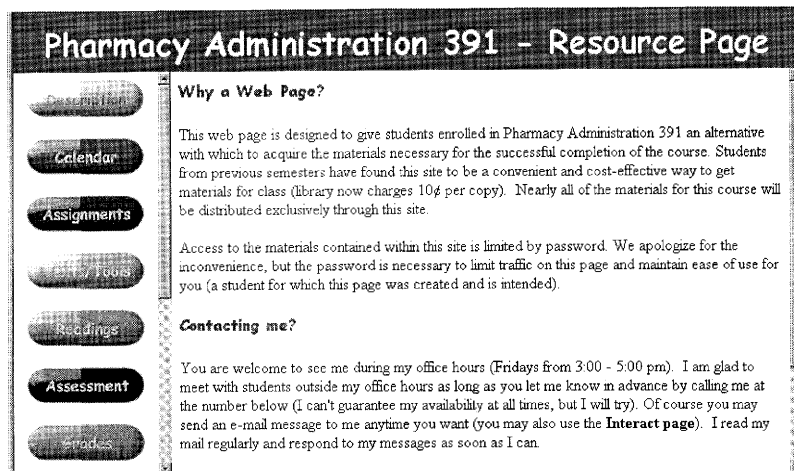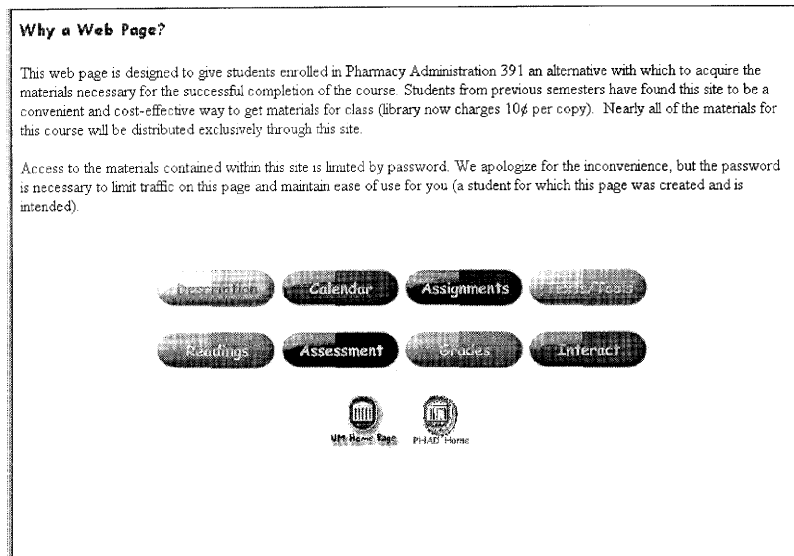
FIGURE 1. Web Page with Frames.

FIGURE 2. Web Page Without Frames.

Why a Web Page?

This web page is designed to give students enrolled in Pharmacy Administration 391 an alternative with which to acquire the materials necessary for the successful completion of the course. Students from previous semesters have found this site to be a convenient and cost-effective way to get materials for class (library now charges 10¢ per copy). Nearly all of the materials for this course will be distributed exclusively through this site.

Access to the materials contained within this site is limited by password. We apologize for the inconvenience, but the password is necessary to limit traffic on this page and maintain ease of use for you (a student for which this page was created and is intended).

web site. Choose color schemes that enhance text readability for the viewer. Colored text does not have the same legibility as black and white text. If you have a lot of text for your visitors to read, consider black and white first. If you insist on using colors for your site, choose colors with the most contrast possible (4). [For a more thorough discussion of WWW page design, refer to the Yale C/AIM Web Style Guide (5).] Plan your site so that colors are not essential to its design. Additionally, dark backgrounds present printing problems for your audience. Your site should be meaningful to visitors who are color-blind as well as to those who are using text-only browsers (e.g., Lynx®).

Every HTML document should contain certain standard HTML tags; you must write them into the file using an editor or use a program that generates the tags automatically. Most HTML documents that you create should consist of "head" and "body" text tags. The head contains the title and meta data (information about the web document), and the body contains the actual text, which can be comprised of paragraphs, lists, and other elements. In addition to these general HTML tags, there are several other useful tags for those interested in

web page construction. HTML includes support for unnumbered, numbered, and definition lists. You can nest lists too, but use this feature sparingly because too many nested items can get difficult to follow. Horizontal rules (dividing lines) are used by web page creators to separate major sections within a web document. You can vary a rule's size (thickness) and width (the horizontal percentage of the window covered by the rule). It is best to experiment with a variety of line options until you are satisfied with the outcome.

Hypertext

The chief power of HTML comes from its ability to link text and multimedia objects to another document or section of a document. This is referred to as a hypertext link or hyperlink. A browser high-lights the identified text or image in a special way (usually underlined and in color). A technique called image mapping is also available. With image maps, you can set up a graphic image so when users click on a certain region they are taken to another destination document.

The Internet uses URLs (Uniform Resource Locators) to specify the location of files on other servers. The URL is analogous to one's street address and is the standard way to give directions to any resource on the Internet that is part of the WWW. A URL includes the type of resource being accessed (e.g., WWW, gopher, File Transfer Protocol), the address of the server, and the location of the file.

Generally, any words, phrases, or graphics contained in your web pages can contain hyperlinks. You can set up hyperlinks so that the destination is another section within the current web page, another web page within your site, a web page on another server, a document or database to which you want users to have access, or another type of Internet resource such as an FTP site or telnet session. This can be accomplished by specifying the URL for the resource as the hyperlink target. A useful destination of a hyperlink is a "mailto" command. You can solicit feedback from web site visitors by making the target of a hyperlink a mailto. By selecting the marked text, the user can easily send e-mail to another specified address. You may even want to in-clude mailto's for all class members to further facilitate communica-tion.

You will need to specify *full* URLs in hyperlinks that point to destinations that are located on other web servers. It should also be noted that file names included in URLs may be case-sensitive depend-

ing on the operating system that is used to host the site. Pay close attention to case (upper or lower) when you are adding hyperlinks to web documents. In the event that you are providing links to outside sites, be sure to get in the habit of checking those frequently for changes and update your pages accordingly. Check with your network administrator about the capabilities/limitations of your own university or school system.

Hyperlinks can serve as important navigation aids. For example, you may want to include strategic links at the top of a long web page so users can quickly locate the sections that are of most interest to them, place a table of contents at the top of your web document, or include a ''home'' hyperlink in a consistent location on every page within your site so users can easily reorient themselves.

### Inserting Images

Graphic images can greatly enhance your web pages. Not only can graphic images enhance the look and feel of your web site, but they can also add significantly to the functionality and meaning of the web site for your intended audience. With the emergence of newer versions of web browsers, visitors to your site can enjoy the added appeal offered by background images (for an example, see Figure 3). When used appropriately, background images can make your web site more attractive. If you use background images, choose a style that does not interfere with the readability of the text. Also, as a rule of thumb, if you choose to use an image as a background to your WWW page, do not choose an extremely large image.

The types of images that usually appear on the WWW include JPEG (Joint Photographic Experts Group) and GIF (Graphical Interchange Format). JPEG is preferred to GIF for photographic images. GIF, on the other hand, is a common format for image files containing large areas of the same color, such as logos and buttons. A GIF file of a simple image is often smaller in size (measured in bytes) than a JPEG file of the same image, but GIF does not store photographic images as well as JPEG (6).

Accessibility and usability are very important issues in web design. While elaborate graphics work well in printed media, this is not necessarily the case on the WWW. Few users (students included) will have the patience to allow complex (large) graphics to load before moving on to the next page. Visitors may become frustrated if it takes too long

FIGURE 3. Web Page with Background Image
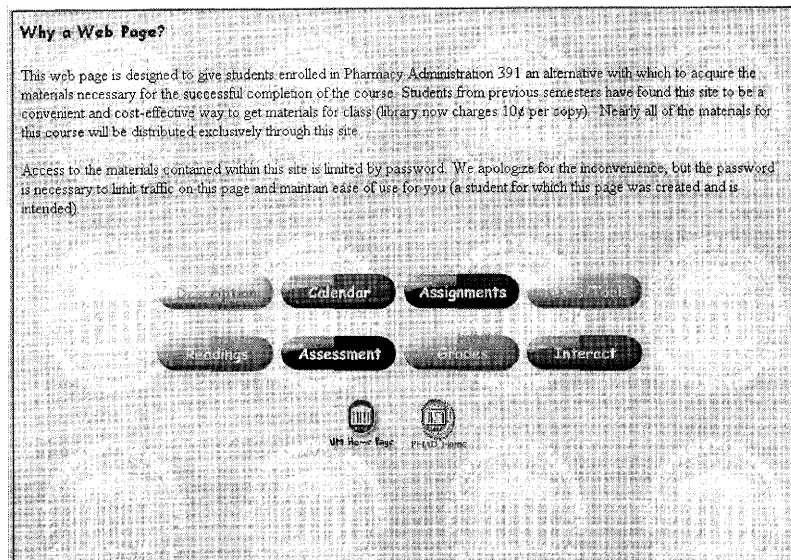
for web pages to download. A good rule of thumb is that the sum of the file sizes of the images included on a given page should not exceed about 50 kilobytes. In addition to size considerations, you should use only graphics that complement the meaning of your web pages. If you find yourself or any of your visitors asking the question "What does that picture have to do with the topic of this site?", then perhaps the page does not need the image. That said, would any page discussing the Krebs cycle be complete without a graphic image of the cycle? And how useful is a WWW page involving anatomy and physiology without dissection images? As a last recommendation, graphics should have adequate white space surrounding them for aesthetic quality (3).

Using Audio and Video

Audio and video technologies have tremendous potential for expanding the way that we teach and use the Internet. Where the Internet in its infancy allowed only text transmission, the WWW allows for much more. Given that individuals learn differently, being able to provide material in a variety of formats is essential (7). Some students

learn best from the written word; however, others might learn better from a presentation that is primarily audio, primarily visual, or an equal combination of the two. While the Internet cannot supply simultaneously an optimum learning environment for all types of learning styles, it can facilitate some.

One can readily place audio files on the WWW for students with the intent of reinforcing what they have learned during their first pass at the material. Traditional audio formats include AIFF, AU, and WAV sound files. AU is the file format common to most Sun UNIX workstations, AIFF is one of many Macintosh sound file formats, and WAV files are handled by the Microsoft Windows® Media Player. Most of these file formats can be played with the more popular web browsers that include audio plug-ins. Plug-ins and players are software packages that handle specific file types. Generally, these programs are launched automatically by the browser when it detects the file. Many course-related web pages contain links to sites that contain these plug-ins and players. Likewise, video can be used to enhance a course web site. Popular formats that can be placed on one's WWW page include AVI or MOV files. AVI (Audio Video Interleave) is a Windows platform audio/video (multimedia) file. It is a common format available for small movies and videos on the Internet. Because of the size (a 20-second movie clip in AVI format could be as big as 3 megabytes in size), these formats are not always feasible alternatives for instruction that is to be served over the Internet. In situations where on-campus, high throughput connections are available, AVI can be used. However, even in those cases, server storage space could become an issue. AVI is the most common format for audio and video data on the PC. The AVI file can be accessed by the student through a hyperlink created by you on your web page(s).

A Macintosh platform based audio/video (multimedia) file or MOV is available, and it does not lock out the PC-running viewers of your WWW page. The MOV file is playable on a PC running the Windows platform with the QuickTime® Movie Player. This application is freeware available for download from Apple®.

As with graphic images, audio and video file size is an important consideration. It is not uncommon for short audio clips (10 seconds) to be 150 kilobytes or more in size. Traditional audio/video files that result from recording and digitizing long lectures may be so large that they are untenable options for use on the WWW. The time it would

take to download these would be excessive for most users. In the past, the delivery of audio/video-based services over a network required a large amount of disk space, a lot of computer memory, and a high-bandwidth connection to achieve reasonable quality. In recent years, streaming technologies have progressed to the point where the provision of audio and video services over the Internet is a common occurrence. With streaming technologies, an individual can begin viewing an audio or video file as it downloads rather than waiting for the entire file to download. Also, the audio and/or video input is digitized using compression techniques that reduce the file created to a size that is smaller than traditional multimedia formats. This represents a real breakthrough given that the delivery of conventional audio and video formats over a dial-in connection might require a download time of 20 to 25 minutes for a presentation that lasts 5 minutes.

RealNetworks® leads the way in audio/video streaming with a strong suite of products including RealPublisher®, RealProducer®, RealAudio®, RealVideo®, and RealPlayer® (8). Your students can download a version of the RealPlayer free of charge from the RealNetworks web site (8). This player installs as a plug-in to many popular web browsers for seamless use when selecting RealAudio options on your web page (i.e., when the player is installed as a plug-in, audio and video files will begin playing as the result of a click on the link. To *deliver* RealNetworks audio/video files from your web site, you will need to purchase software from RealNetworks to encode your video or audio files. You may also want to consider purchasing server software. Licensing fees do apply to the use of RealNetworks products; however, academic versions are available with limited broadcast capabilities. Contact RealNetworks for details. The RealPlayer client has the ability to display both RealVideo files and RealAudio files, relieving students of the burden of installing two separate clients on their computers.

Uploading Web Site Materials

To make documents available on the WWW, you must place them on a machine that functions as a web server. The logistics of where the files should be placed will vary from site to site. The most common scenario is for each instructor to have a separate account on the web server, although some universities may have other policies. Once your web pages have been created, you can transfer them to the web server

using an FTP program-WS FTP® for the PC or FetchIt® for Macintosh systems. The FTP program will allow you to copy a file from your local system to a remote system and vice versa. There are a variety of FTP programs. Public domain versions are available; these have the same look and feel of Windows-based file management systems.

Those choosing Microsoft FrontPage as their web authoring program might have the ability to bypass the process of transferring their files with a separate FTP program by using built-in FrontPage features. If your server has the FrontPage server extensions (contact your network administrator or webmaster), it is possible to create and edit your web pages on the server itself rather than on your local machine. In any event, you always have the option of creating your pages on your local computer and uploading them using FTP software or other file transfer programs. Contact your local technology support group to find out which option is best for you.

Document Presentation/Distribution

Graphics, audio, and video make great additions to web pages, but one must consider also the content of the site. Syllabi, lecture guides/ outlines, lecture notes, student grades, reading lists, and articles can be distributed through a course web page. These materials can be presented in a variety of formats. Determining which is best for you will depend on your needs. HTML is an easy way to get documents to your students. As mentioned, you can use your word processing software to convert course materials to HTML files. This option requires no knowledge of HTML and quickly converts previously created material for use in web pages. An additional advantage is that HTML files can be downloaded into a student's word processor and supplemented or augmented as the student sees fit. And because HTML is not platform specific, students will have equal access to course information regardless of whether they use Macintosh or PC systems. A disadvantage of using HTML is its limited support for formatting. HTML is designed for on-line presentation with the objective of supporting a variety of screen sizes and resolutions. As a result, it is somewhat limited in terms of support for printed output.

A good choice for maintaining the integrity of formatted documents is the Portable Document Format (PDF). PDF is available from Adobe® Systems and has become somewhat of a WWW standard for

displaying and distributing web-based materials; it is second to HTML only. Using the commercial Adobe Acrobat® package, your word processing documents are "printed" electronically to a file (*.pdf) that can be linked in your course WWW page and made available to your students. An advantage of the PDF format is the quality of the document being provided to your students. When viewed on-line, PDF files look identical to printed copies. Likewise, when a student prints a PDF file, the formatting specifications will be maintained regardless of the printer brand that is used. Like HTML, PDF is not platform specific, so the type of computer used by students is not a consideration. PDF files do require a special viewer software package (the Adobe Acrobat Reader®). This software is free of charge and easily plugs into the student's web browser. One drawback is that the PDF files are fixed; that is, the Adobe Acrobat Reader does not allow the user to edit the content of the PDF file. The full commercial package (Adobe Exchange®) does allow for text editing using the "Touch-Up Text" tool as well as the ability to add annotations to PDF files.

Some faculty members post simple text files on the web for their students to download and use for class. Posting ASCII text files is a suitable choice also. Because an ASCII file is an actual text file, it affords students the opportunity to edit the file to a format that will facilitate their own learning. And due to the universal nature of ASCII, all students, regardless of the type of computer used, should be able to make use of any ASCII file that you produce.

Some faculty members have chosen to place actual word processor documents on the WWW for retrieval by students. WordPerfect or Microsoft Word documents can be placed onto the web page. Doing this causes issues of platform to become important. Current versions of Microsoft Word for Windows and Word for Macintosh can open files across platform, so regardless of operating system, students should be able to open, manipulate, and print your offered documents. Corel products do not have the same capabilities. PC users cannot open Macintosh WordPerfect files. However, Macintosh users can convert their files into a PC acceptable format for WWW-based sharing. Microsoft does offer, free of charge, the Microsoft Word viewer that will allow web site visitors to access your Word-created documents without having to own the program. In situations where word processing software is dictated for your student population, it is strongly

suggested that you purchase and use the required software for this type of document posting.

If you only want to distribute *existing documents* using Internet tools, then file transfer protocol (FTP) may be a better choice than the WWW. You can easily place materials, regardless of the document format, on an FTP site for download. Students can access these documents using FTP programs or their web browsers by simply clicking on the files they want using their web browsers and the files will be transferred to the local hard drive. Many universities support FTP sites for faculty to use. Alternatively, you can set up your own FTP site. Your network administrator should be able to provide advice on which option is best for you.

Web-Based Presentations

Web-based presentations are another alternative for distributing course materials to students. Used to supplant the traditional lecture or as a valuable resource for your students, many options exist when it comes to delivering a presentation using the WWW. Some faculty have found it useful to place copies of their in-class presentations on the WWW for students to view ahead of class time (to prepare the student for the day's lesson) or to use as a reference piece in preparing for later assessment.

There are many technologies associated with the Internet that make distribution of this type of material possible. Slide shows (e.g., lectures or tutorials) that are created using slide presentation software can be formatted for delivery through the WWW using an HTML converter much like those available with many of the popular word processing packages. Microsoft PowerPoint® comes with an Internet Assistant that creates HTML documents from your presentation. The conversion process is almost trivial, and once completed, documents are immediately ready to publish to the WWW (9). The Internet Assistant helps you customize your presentation. For example, you can include animations, use frames, choose the transitions between slides or documents, and select different button styles. To capitalize on all of the features associated with the Internet Assistant, your students must have the PowerPoint Animation Player. The Animation Player is a software package that integrates with browsers to play animated PowerPoint presentations and is available at no charge from Microsoft.

The Corel Presentations® program includes support for WWW dis-

tribution through the Internet Publisher component. With Internet Publisher, you can easily convert presentations to a suitable format for the WWW, e.g., HTML documents that include slide images can be converted to JPEG, GIF, or PNG images. An especially nice feature of Internet Publisher is the flexibility it provides in formatting presentations. You can select (a) single page output where all slides appear on one WWW page, (b) multiple page output where different pages, which are hyperlinked together, are used to display the slides, (c) frame-enhanced output where the slides appear in one or more of the frames, and (d) a thumbnail page, which is a page that contains small, low quality "thumbnails" of the slides or files linked to the page.

An alternative to Corel Internet Publisher is Corel ShowIt®. This software package allows you to publish your slide show to the WWW with full animation, transition effects, sound, and video support (10). This technology gives you the ability to play your slide show over the WWW just as you would from the computer where the presentation was created. Students can customize the delivery of the presentation by advancing slides at varying speeds. Corel ShowIt gives you the ability to create a self-running demonstration with full narration and automatic transitions. Unlike Internet Publisher, a special plug-in (available from Corel for free) is required to view Corel ShowIt presentations. Be aware that your local network administrator may have to configure MIME (Multipurpose Internet Mail Extensions) types on your local server to handle the ShowIt files. The instructions for these additions can be found at the Corel web site (11).

Macromedia® Authorware Attain® is another useful program for creating web-based multimedia presentations. The Authorware Attain program allows users to create and deliver high-performance, fully interactive, streaming rich media across Intranets (local or in-house networks) and high-bandwidth Internet links (12). Attain provides compression and streaming of sounds, animations, graphics, and text that lets authors deliver stimulating applications with interactivity. The Authorware® web player (needed to view Authorware media presentations on the web) is available to your students from Macromedia free of charge. Options are available for delivering the Macromedia web player free of charge from your local site, making access even easier for your students. Visit the Macromedia web site for more details (12).

Narration and heavy graphics do slow the rate at which students can receive and view (or hear) a presentation (particularly through a dial-

in rather than a direct network connection). The RealPresenter® application from RealNetworks addresses the challenges of delivering multimedia-rich presentations through the WWW by employing advanced compression and streaming techniques. RealPresenter converts Microsoft PowerPoint97® presentations, complete with narration and graphics, to streaming video files.

INTERACTIVITY

While multimedia techniques can certainly enhance a web site, interactivity, which includes ways for visitors to provide feedback and interact with each other, can make a site come to life. Internet tools and applications are progressing to the point where a "paperless" classroom environment is possible. Students can submit assignments, lab reports, and papers as electronic copies. In this way, instructors can manage a set of electronic materials rather than a potentially large set of "hardcopy" paper documents. Faculty members can seek feedback about course content, activities, or assignments through web forms on course web pages. Also, interest is increasing among pharmacy faculty in the delivery of quizzes and even examinations on-line. On-line practice quizzes, which can be repeated as often as necessary and at the student's convenience, can serve as useful learning tools. The WWW is also evolving into a medium that can support a variety of research projects and is specifically suited to support those projects that use self-report responses. Research using students as sample groups can be conducted with an expedience not afforded by many other data collection methods. In addition, the WWW can be used to perform exploratory investigations that will shape traditionally delivered survey instruments.

In addition to aiding with classroom management and research efforts, Internet tools can be used to promote interactivity and collaboration among students. This type of activity can play a vital role in virtually all classroom settings but most especially in pharmacy's academic environments, where peer assessment, case-based learning, and student collaboration are emerging as important components of the curriculum. Schools and colleges of pharmacy have invested and continue to invest a good deal of time and energy in the area of assessment, both formative and summative. Using a variety of technol-

ogies, faculty, departments, and institutions can implement assessment programs that include not only faculty assessment but also student assessment (peer and self-assessment).

Interactivity can be realized in a number of ways. A common technique is to allow users to provide feedback, using web forms or e-mail hyperlinks, as they work through the web site. E-mail based discussion lists (e.g., listservs) can be effective tools for promoting collaboration among students between class sessions. Adding interactivity to your web site might mean including web-based message boards where students can contribute to ongoing discussions centered around particular topics of interest. Web-based chat rooms are becoming popular and can be used for real-time, text-based, interactive discussions among class participants. A chat room might even be used as a substitute for face-to-face class meetings or to allow students to interact with a remotely located expert. Video conferencing applications are progressing to the point where their use in a classroom setting is feasible and functional. For example, applications such as Microsoft NetMeeting allow authors to coedit a document on-line (13).

A relatively new area of research is *adaptive hypermedia*. Adaptive hypermedia systems are defined as "externally structured systems which are explicitly based on hypertext (or hypermedia), and use a model of the user's knowledge or goals to modify links or content to present individualized instruction or guidance" (14). In this context, interactivity is realized by customizing the web site to each user's background, interests, and preferences. Ideally, the delivery and presentation of web documents would be customized automatically and dynamically according to a user's level of expertise, familiarity with web environments, and preferred learning styles. Another relatively new area of research is *dynamic hypertext*. In dynamic hypertext systems such as PEBA-II, text descriptions do not exist prior to a user's request; rather, they are generated dynamically using natural language generation techniques (15). Dynamic hypertext systems potentially can support the delivery of content in multiple languages and in alternative formats depending on the needs of the user.

The examples presented here represent a full spectrum of techniques for incorporating interactivity into a web site. Some of these suggestions are simple, such as incorporating e-mail responses into a web site, whereas others entail highly sophisticated work that relies on emerging areas of research. While conventional print technology is

rigid in the way that information is presented, hypermedia methods provide a more flexible way of organizing and presenting information. As these technologies mature, we will be able to offer an increasing number and variety of activities that were not possible prior to the Internet age and, in doing so, truly exploit the medium.

Electronic Mail

Electronic mail, or e-mail, is an excellent medium for enabling convenient interaction with and among students. While e-mail is not a substitute for face-to-face interaction, it serves an important communication function when face-to-face interaction is not possible. Despite the obvious advantages, e-mail will not work as a vehicle for class communication unless students make a habit of checking it. Posting a message to a class will serve no purpose if only 20% of the students regularly check for new messages. In addition to relaying class announcements and feedback through e-mail messages, e-mail provides another communication advantage: the attachment feature of e-mail enables faculty to distribute files to an entire class. Lecture guides, notes, exercises, and multimedia presentations can all be sent to your students to use on their own computers. In fact, if document distribution is your primary (or only) objective in using the Internet to support your course, you may wish to use e-mail instead of creating a course web page. Whether documents are linked from a web site or sent via e-mail, you need to make sure all students have access to the appropriate programs and viewers to make use of your material. Also, pay attention to the size of the document that needs to be distributed. Generally speaking, when you wish to send a large document to a group of students, the document is best distributed by a web site rather than an e-mail message.

In addition to e-mail, course coordinators can use electronic mailing lists to facilitate exchange with and between students. Not only do these methods facilitate communication, but they can also help identify potential problems with students' understanding of material. Electronic mail can be used to take corrective action before misinformation becomes ingrained as "fact." An electronic mailing list can be thought of as an e-mail reflector. Individuals subscribe to the list. When someone posts a message to the list, that message is automatically sent to all subscribers. In this way, people who have many different kinds of e-mail access can participate in discussions together. Electronic mail-

ing lists can be open or closed and moderated or unmoderated. With open mailing lists, anyone can subscribe, whereas with closed mailing lists the list owner must approve all subscription requests. With moderated lists, each posting must be approved by the list owner before it is distributed to the entire list. Two popular electronic mailing list servers are LISTSERV® and Majordomo. Contact your network administrator for assistance in setting up electronic mailing lists for your course(s).

Chat

E-mail and electronic mailing lists support asynchronous communication, whereas internet relay chat (IRC) supports synchronous communication, i.e., live, interactive discussions among many parties. There are many appropriate applications of chat services in an instructional environment. Chat services can be used to support on-line class sessions in which participants meet "virtually" at a given time. These sessions can be used to complement the face-to-face interactions that occur in on-campus classroom sessions. A guest lecturer or expert from another institution might be invited to interact with a class via a chat session at a specified time. A chat session can serve as a means for conducting on-line homework help sessions or focus groups. Faculty can set virtual office hours and groups can hold on-line meetings with colleagues at other institutions. Chat services can be particularly useful with groups of students who are completing in-the-field phases of degree programs. In these cases, students can meet with other students and the instructor, regardless of physical location, to discuss cases related to their work.

There are a number of major IRC servers around the world. These servers are linked to each other. Anyone can create a channel, and anything that is typed in a given channel is seen by all others in the channel. For the purposes of pharmaceutical science education, private channels can be (and are) created for multiperson conference calls. This option is of particular interest to faculty interested in or charged with distributed education. Discussion groups can be moderated by faculty regardless of physical location. Given the dynamics of pharmacy practice and the number of current practitioners interested in additional education (CE and advanced degree), this option provides a great deal of flexibility and convenience. Over time it could reduce the costs associated with such degree programs.

There are several chat servers available on the market, and pricing is quite variable (16). Some examples include ichat's Rooms®, Earth-Web's Moderator®, and eShare Expressions®. Some of these chat servers offer enhanced program abilities beyond IRC specifications. These enhanced capabilities only appear when students connect to the chat server with the commercial software; however, any public IRC client can connect and use standard features.

In addition to the IRC chat options, some programs allow interested parties to chat without the added expense of a chat server. Mirabilis' ICQ®, Activerse's Ding®, and Tribal Voice's PowWow® are a few examples. These instant messaging (IMing) products have the potential to supplant traditional IRC use for academe. Each has the ability for the user to engage in real-time chat sessions. Users can easily control whether or not other users will be able to join in on a chat session. One feature academicians might find useful is that some of these programs support save features that allow sessions to be saved as a text file for archiving, review, or assessment purposes.

HyperText Markup Language

The HTML standard includes support for interactive forms. An HTML form is nothing more than a collection of form fields on a page accompanied by instructions on how the collected information will be processed. Interactive forms are designated with a special "<FORM>" tag that includes an "action" parameter. The action parameter tells the web server the name of the program to use to process the information that is collected from the user. These programs are called common gateway interface (CGI) programs and extend the functionality of the web server by allowing the developer to create new ways to handle form information. Typical examples include sending form responses to a designated contact or inserting form responses into a database.

The HTML forms specification allows for a variety of form field types. Some of the options available are one-line and scrolling text boxes, radio buttons, check boxes, drop-down menu fields, and special submit and reset buttons. Figure 4 contains examples of these options. One-line text boxes are just that: single-line form fields in which your web page visitors can type text. This can be regular text or "password" text. The difference is that password text is displayed as asterisks (*) as the user types it. Scrolling text boxes consist of multiple lines into which users can enter many lines of text. These are particu-

FIGURE 4. HTML Form Example

larly useful for open-ended questions or for essay questions. Radio buttons present the user with several choices, only one of which can be selected. Selecting a second radio button field deselects the previous selection. Check boxes are similar to radio buttons in that the user simply places the cursor over the appropriate space and clicks it to select. One difference is that the check box field allows for simultaneous multiple selections. Drop-down menus present the user with a variety of choices in a convenient drop-down format in which one or more selections can be made. The submit field is probably the most important of all. It submits the form to a form handler. (Generally, this field is accompanied by a reset field, which resets the form to its initial state.)

When a user selects the submit button, the form responses are sent to the web server and the web server invokes the CGI program that is specified by the "action" parameter to process the data. CGI programs can be written in a variety of programming languages, both compiled and scripted, including C, C++, and Perl. The Perl scripting language is the most common choice. Many web site administrators make available general-purpose CGI programs for performing common tasks.

For example, a typical action is to send form responses using e-mail to a designated individual. One program, Microsoft Visual Basic®, now has the ability to create server-side ''classes'' that function similarly to CGI scripts (17). Contact your network administrator for assistance with setting up CGI scripts to handle output from your HTML forms.

Web-to-database applications are gaining popularity and have many uses in an instructional environment. With web-to-database applications, form data can be automatically stored in a back-end database. Another alternative is to construct web pages dynamically using data from a database. Most of the mainstream databases such as Oracle®, Informix®, and Microsoft Access® have well-established methods for creating web-to-database interfaces. Common schemes include creating CGI scripts or Java™ applets that access database data. Microsoft's Active Server Pages (ASP) technology provides a development environment in which web-to-database applications can be created quickly and easily. ASP supports open database connectivity (ODBC) compliant databases including Microsoft Access, Informix, and Oracle.

In addition to HTML forms for data collection, Adobe Acrobat 4.0 allows for the creation of PDF forms that can be viewed with most current web browsers. These forms use existing web server CGI scripts, allowing you to replace your existing HTML forms with Acrobat forms with little or no additional work (i.e., no need to change to existing scripts). Acrobat forms can also be linked to databases (Microsoft Access, Informix, and Oracle) using the Acrobat Forms Data Format (FDF) Toolkit provided with the Adobe Acrobat software (18).

OTHER TECHNOLOGIES TO ENHANCE WEB PAGES

More experienced individuals (those with programming expertise or the desire to become programmers) may choose to spice up their pages using other technologies. While they are not considered essential to content delivery, these technologies can satisfy one's need to be creative. Some examples are VRML, Java for Sun Microsystems, ActiveX® from Microsoft, and Macromedia's Shockwave®.

VRML, or virtual reality modeling language, is an open, extensible, industry-standard scene description language for 3-D scenes, or ''worlds,'' on the Internet. With VRML and certain software tools, you can create and view distributed, interactive 3-D worlds that are rich

with text, images, animation, sound, music, and video (19). This technology is considered to be in its infancy. However, its ability to design "real" experiences may lead to its expanded use in pharmaceutical science education. Possible uses of this technology are in the creation of virtual pharmacies or virtual labs. Hardware used by visitors to a web site limits VRML. Failure to have significant video RAM and a video card capable of 3-D rendering makes for slow processing (3).

Java is a network-oriented programming language invented by Sun Microsystems. Java applets can be used as supplements to your WWW page. Some simple examples of Java applets on web pages are calculators, clocks, and language converters. Unlike CGI, Java applets are executed by the user's computer. Any browser that supports Java on any platform can access Java resources. Java resources, as supplements to your web page, can include just about anything, such as audio, video, animation, interactive applications, multimedia, and more. Java is a programming language based on "C"; thus many may assume falsely that you must be a sophisticated programmer to create Java applets. While a programming background may be an added advantage, a variety of programs exist that make the Java applet creation process accessible to nonprogrammers. Those programs include Symantec Visual Café® and Microsoft J++® (20).

In contrast to Java *applets,* which run on the computer of the user who visits the site, Java *servlets* run on the server computer. They provide an alternative to CGI scripting. Servlets allow the web server functionality to be extended in a modular way. An advantage to servlets over CGI programs is that they usually run in the same process as the web server, whereas CGI programs are usually launched as separate processes. As with CGI scripts, there are well-defined methods for handling form data and interfacing with databases using servlets.

ActiveX® is a programming technique, standard, and environment for creating interactive Internet and Intranet-based web applications. With ActiveX, adding multimedia effects, interactive objects, and sophisticated high-impact applications is within the grasp of any creator of WWW pages. Currently, ActiveX only works within the Windows operating systems, making it less desirable for situations where Macintosh or other non-Microsoft systems are being used. Creating your own ActiveX applications from scratch requires solid programming knowledge and experience (19).

Macromedia's Shockwave player series allows viewing of high-

quality, streaming content in a web browser. Shockwave content is created using one of three Macromedia products: Director™, Flash™, or Authorware. The use of Shockwave requires another plug-in for users of your WWW page; however, the plug-in is free of charge and available from Macromedia's web site (12).

WEB-BASED INSTRUCTIONAL TOOLS

Web utilization in higher education may take many forms (e.g., presentations, assessment, communication, etc.), and most of the classroom uses for the web discussed within this article can be conducted independently by separate software packages–for example, a spreadsheet program can be used to upload and post blinded grades on the web, a word processor with an HTML converter can be used to create a web-based course syllabus, and an external e-mail software package can be used to communicate with students. However, many educators have found value in overall course management tools that help to unify and organize web-based course elements. A new industry is rising to meet the challenge of simplifying web-based course delivery by producing software packages of web-based instructional tools (21). These are sometimes referred to as on-line educational delivery applications.

These tool packages come in a variety of formats and address widely differing course development needs. Features that are incorporated may include templates for easy and uniform development of course web pages, assessment options (course grade management and on-line quiz templates), and communication enhancements (organized e-mail, electronic bulletin boards, and chat capabilities). Some packages lock course authors into standard structure with little flexibility, and others allow for significant creativity and exploration. The packages also vary in ease of use. Some are quite user friendly (from both the faculty-author and student-user perspectives), while others are more complicated to manipulate. All of these factors should be considered if one chooses to pursue use of an instructional tool package to assist with web course development. The potential cost of these tool packages may dictate that the choice be made by a committee and that the product be adopted for multiple courses within a department or school.

Among those commercial web-based instructional tool packages

whose use in pharmacy education has recently been mentioned are WebCT® and Lotus LearningSpace® (22). These and similar products were recently reviewed by Sharon Gray and Bruce Landon (23, 24).

WORDS OF CAUTION

Lowest Common Denominator

When creating a web site for education, you cannot assume that you always have a homogeneous population. Situations will vary by academic institution, by department, or by course level. And the diversity of one's audience presents challenges for the web site designer.

There are several ways to approach the issues presented by a diverse audience. First, create with the lowest common denominator in mind. By doing this, you are likely to meet the display needs of your entire audience, but you eliminate the use of advanced web page options. Another option is to create the page for the majority of your audience, using enhancements that augment the message. The downside of this choice is that a percentage of your intended audience will not be able to take advantage of these enhanced features. Analogous to offering books of differing quality to enrolled students, this option might not be appealing. Providing two course pages-one with the enhanced features and one without-theoretically makes information available to any student. However, this creates more work for the author of those web pages.

Given that your web site is intended for students who are enrolled in a school or college of pharmacy, the cost of web browser technology should not be a deterrent to making enhancements to your pages. Often companies make their web browsers available on their web sites, and students can download and install them for free. Analogous to requiring a textbook for the successful completion of a course, web browsers (and other computer packages as well) are becoming required materials in courses that utilize the WWW as an instructional tool or supporting medium. Links to these free resources can easily be integrated into your web page for use by your students.

Copyright Issues

Publishing to the web is similar to publishing in any other arena. Copyright regulations apply and must be respected. Often much con-

fusion exists regarding what materials on the web are copyrighted, especially where images are concerned. Images on the web are easy to download and reuse as-is. When authoring web pages for your courses, you may be tempted to "borrow" from the web just as many are tempted to scan images for instruction from books or articles without permission. However, do not ignore copyrights just because the copyright symbol is not attached to an image. Consider as a general rule of thumb that unless a page, image, icon, or background, etc., states specifically that it has been released into the public domain, then it should be regarded as being copyrighted and you should seek permission to use it. Further information on copyright issues can be found at various web sites.[2] There is, however, no substitute for consulting your university counsel on questions concerning copyrights and fair use policy.

CONCLUSION

The material presented in this article is intended to be a primer and not a bible or cookbook for Internet-based instruction. Although it was the authors' intent to be thorough, it would be impossible to present all possible means of creating WWW pages or all potential uses of the Internet for enhancing your pedagogical efforts. Please confer with your colleagues[3] and local system administrator for direction and opinions regarding Internet-based instruction or instructional support.

The best piece of advice for those interested in using the Internet for instructional support is to start at a pace with which you are comfortable. A basic site this semester might be all that is necessary. You can incorporate new options as you become more familiar and comfortable with the various technologies and possibilities. The important point is that you start.

NOTES

1. For an overview of available HTML editors by platform, please refer to the web pages located at http://sdg.ncsa.uiuc.edu/~mag/work/HTMLEditors/ or http://www.Webcommando.com/editrev/index.html. Additionally, on-line magazines such as *PC Magazine* (http://www.pcmag.com), *PC World* (http://www.pcworld.com/), and *Macworld* (http://macworld.zdnet.com/) provide regular and timely reviews of web authoring tools.

2. The Copyright Website (http://www.benedict.com/), the Copyright Clearance Center (http://www.copyright.com/welcome.html), and Teaching on the Web: Copyright Resources (http://www.library.miami.edu/tools5.html) all provide important information about copyrights and the Internet.

3. One valuable source of collegial information can be found at the Electronic-Based Instructional Resources Special Interest Group of the American Association of Colleges of Pharmacy web site (http://gaps.cpb/uokhsc.edu/ebir/).

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