Interdisciplinary, Web-Based, Self-Study, Interactive Programs in the Dental Undergraduate Program: A Pilot

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Abstract: The goal of this project was to encourage interdisciplinary, integrative health teaching and research in dental education through the development of web-accessible programs, collectively called the “StudyWeb.” The specific objective of the project was the construction and integration of a series of prototypes of self-study modules. Four pilot modules were developed using existing teaching materials in histology, pharmacology, prosthodontics, and oral radiology and utilizing a variety of widely available software programs, including FrontPage® and Photoshop®. Low-end technological choices were made in order to facilitate compatibility with a wide range of hardware, software, and types of Internet access. Modules were tested for functionality, usability, and ease of navigation. The scope of the initial project was limited to development and functionality testing of the original modules. The next phase of this project will involve testing of the effectiveness of these web-based self-instruction tools.

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Web technology permits the introduction of a flexible learning program without any pressure of time and place to student. It also allows for horizontal and vertical integration among disciplines. In this regard, one of the most difficult tasks facing dental educators—and probably others—is to stimulate students to see, appreciate, and understand the notion that all of what seem to students disparate subjects in both clinical and biological sciences actually have relevance to and impact on one another. In light of the fact that all of these related parts are typically taught as separate subjects, it is not surprising that students often find it difficult to synthesize and understand the relevance of, for example, microscopic anatomy of the tooth to restorative issues such as margin placement or to neurophysiological, endodontic, and periodontal issues of dentinal hypersensitivity.

Horizontal and Vertical Integration

In an effort to assist dental students in developing a broad-based understanding of dentistry, it is crucial that these relationships be clearly elucidated. In practice, this means that it is necessary to find some means of helping students to understand interrelationships between topics/courses taught in any given year of their training (horizontal integration). At the same time, the course information given in various years of the dental training program must also be somehow linked together by a process of vertical integration. How may one make practicable the goals of horizontal and vertical integration without creating a logistical nightmare? Web-based programs present an effective and plausible solution.

The D.D.S. program at the University of Toronto progresses from a mostly basic science curriculum in the first year to a mostly clinical focus in the fourth year, with each year’s materials building upon the previous (Figure 1). In the proposed model, topics are linked via interaction between the course directors in order to reinforce integration and reduce inappropriate redundancies of subject matter within a particular year (horizontal integration) and between particular years (vertical integration).

The programs highlighted in Figure 2 already have or will have web-based courseware. Thus, where possible, lectures can be organized in such a fashion as to enforce the concept of horizontal integration.
some reason, skeletal pathophysiology cannot be taught alongside in a timely manner, students can readily refer to the courseware using links set up between the topics. Hence when teaching about bone growth on the web in gross anatomy (or in lecture), students would come across linked sections that would send them to sites describing the cells of bone (for example, osteoblasts, osteoclasts) and also to areas related to regulation of bone formation and bone cell activity (physiology, biology), as well as links describing diseases associated with bone (again at the gross, microscopic, and biochemical/physiological levels).

Such horizontal educational grids encourage students to appreciate the complexities of the systems they’re being taught in preparation for their later clinical years of training. The fundamental concept to emphasize for dental students is that the clinical and biomedical sciences are inseparable. A concurrent understanding of both broad topic areas coupled with a reinforcement of information already taught in these areas will lead to better and sounder treatment of all patients and will also result in the development of dentists interested in lifelong learning.

The essential architecture of the Internet—using hypertext markup language to create cross-referenced links—provides a valid and reliable technological means for effecting interdisciplinary collaboration among overlapping fields within dental education. However, the effectiveness of web-based programs has been a matter of some debate. Various studies have been done to evaluate the effectiveness of such programs either as replacements for traditional instructional tools or as supplemental teaching and learning tools to be used in conjunction with more traditional modes of instruction. Generally, the studies have found that web-based instruction is as effective as other, more traditional forms of instruction, though it does not replace them, and it is welcomed by students.2,3 As well, there are some potential technological advantages to web-based learning, including universal accessibility, ease of use, hyperlinking capabilities that allow for cross-
referencing to resources from many other sources, ease of delivery, searchability, and ease in updating content. Additionally, student expectations in the area of technology have risen in recent years. Students have become familiar with the web as a means of delivering library resources and instructional tools, and there is a general push toward the exploration of the web as a means of instructional delivery.

All of these factors are combining to make web study more common, and there have been some studies on the effectiveness of various computer-assisted and web-based learning programs. However, insufficient attention has been given to the potential role of web study to improving the methods and practices currently employed in dental education.

There are precedents for the development and evaluation of courseware in dental education specifically. Some date back a decade or more; some are quite recent. These include the development of self-instructional materials to aid in the teaching of clinical decision-making, geriatric dentistry, endodontic diagnosis, oral anatomy, and cephalometrics, among others. It is interesting to note that, over a decade ago, Puskas et al. observed that students evaluating self-instructional materials felt there was a need for innovation in the dental curriculum. Many others have noted that students frequently respond positively to computer-based instructional materials. Yet adoption has been sporadic. In 1997, Fouad and Burleson noted that “computer-based and other self-instructional technologies have gained considerable popularity in dental education. However, despite the explosion in computer usage in secondary and post-secondary education, a survey among sixty-five dental schools in the United States and Canada revealed that computer-based technologies are underutilized in dental education.” There is, therefore, a critical need to increase the number of computer-based dental educational media and to evaluate their potential in expanding and enhancing dental education.

Whether the use of the term “critical” is perhaps slightly overenthusiastic is a matter for debate. Chumley-Jones et al. note that web-based learning (WBL) “is a valuable addition to our educational armory, but it does not replace traditional methods such as text, lectures, small group discussion, or problem-based learning. Educators still must define WBL’s unique educational contribution. Evaluation of WBL is in its infancy.” However, the fact remains that rising student expectations and skill levels, along with the increasing adaptability of technology to supplementary educational purposes, are among several factors driving an increase in the usage of courseware across many disciplines. However, despite many innovations (especially in recent years), dental education appears to have made less use of courseware than some other fields.

The goal of this particular project was to encourage interdisciplinary, integrative health teaching and research in dental education through the development of web-accessible programs, collectively called the “StudyWeb.” The objective of this paper is to describe the construction and integration of a series of prototypes of self-study modules.

### Methods

Four pilot modules were developed using existing teaching materials from the participating fields and a variety of widely available software programs, in particular, FrontPage® and Photoshop®. Choices for software were all made on the basis of general availability and ease of learning and use, to facilitate the involvement of multiple creators and users. Thus, we chose FrontPage® for two reasons. One is that, in surveys, faculty indicated that they felt FrontPage® had an easy learning curve. The second reason was that FrontPage® allows the creation of discussion groups, online forms, and even database connections through the use of wizards that even a novice can understand. Other authoring environments have strengths in managing graphics and may generate more elegant code, but ease of use allowed us to give faculty a feeling that they understood what the program was doing and could do it themselves.

Choices regarding screen size (800 x 600 dpi), image complexity (72 dpi), and various other aspects of the project were likewise deliberately kept to the low end of available technologies to accommodate the largest potential number of users. This is in keeping with the general philosophy espoused by the University of Toronto Libraries, which is to attempt to support the widest feasible variety of technologies and modes of access. The University of Toronto Libraries must allow for a broad range of technological facility and tools. While students, faculty, and staff have access to the latest technologies on campus, the diversity of modes of access from other locations is great. Students and faculty are likely to use anything from dialup connections and older computers to state-of-the-art wireless technology (in
Figure 3. Histology module

Figure 4. Pharmacology module
Mandibular Border Movements in the Sagittal Plane

The letters along the diagram are highlighted to correspond with the associated movements on the image of the skull (far right).

Legend:
- CO = Center Occlusion
- B = Center Relation
- C = Rotational Range Movement Opening
- D = Maximum Opening
- E = Maximum Protrusion

* These border positions are tooth-determined.

Note Postural Rest (PR) and the path of Habitual Motion (H) are not located on any of the borders, and so are not active in this web study.

Figure 5. Prosthodontics module

Figure 6. Radiology module
newer residences). The general policy is to attempt to accommodate a reasonable range of hardware, software, and types of access. In terms of courseware development at the University of Toronto, no hard and fast restrictions are imposed.

Results

Four self-study modules were created, one in each of the following fields: histology, pharmacology, prosthodontics, and oral radiology. Various means for self-study were developed according to the learning objectives of each module. In each case, a concerted effort was made to use standard sets of HTML or DHTML features as the interactive elements. In the histology module, a slide of a sagittal view of an embryonic palate was rendered as an image map. Students were prompted to find several key histological features (enamel matrix, stellate reticulum, etc.) on the image on the left side of the screen from a list on the right side of the screen. Clickable links were used to permit students to test their accuracy; clicking on the correct area in the slide image revealed links to answers in the form of highlighted text on the right side of screen. Figure 3 shows a screen from this module.

The pharmacology module included a prescription-writing exercise. Students were presented with clinical case examples and asked to write prescriptions. They were specifically prompted to answer the following questions:
1. Which size dose should be dispensed?
2. How much do you wish to have dispensed?
3. What information would you like put on the label?

Answers were revealed by rolling the mouse cursor over black-out text on an electronic prescription pad. A sample screen from this module is shown in Figure 4.

A simple animation was used in the prosthodontics module, in which Posselt’s diagram of mandibular movements in the sagittal plane was made dynamic by using a three-dimensional model of a human skull that moved through the border positions on the diagram. The letters along the diagram were highlighted to correspond with the associated movements on the image of the skull. Animation of the skull, in the form of an animated GIF, was achieved by means of the animation tools available in PhotoShop®. Figure 5 shows a sample screen from this module.

Finally, in the radiology module, intrapage links were used as a means of linking questions and answers in a series of clinical cases. Students were presented with a brief case history and scanned images of clinical radiographs. They were invited to answer a number of questions, for which answers were supplied. Answers were accessible by clicking on intrapage links. In order to discourage students from inadvertently viewing an answer prematurely, 800 by 600 spacers were placed between answers. An intrapage link returned them to the questions. Figure 6 shows a sample screen from this module.

All modules were extensively tested for functionality and compatibility with several versions of the two most popular browsers, Netscape and Microsoft’s Internet Explorer. Modules were also tested on computers ranging from a 486 to a Pentium 4, with monitor sizes ranging from 15 inch to 17 inch. Currently, University of Toronto Libraries generally assume that students have access to a minimum of a 486 computer with a 15-inch monitor and do not support anything lower. The modules were also tested using various types of Internet connection, including a dialup connection with a 28.8 modem, a high speed cable connection, and a T1 connection.

Outcomes

The various modules, comprising an integrated whole known as the “StudyWeb,” have been developed and tested for functionality, navigability, and ease of use. Our intention is to test the effectiveness of web-based self-instruction tools; however, the scope of the original proposal was limited to development of the web program. Within this scope, significant progress has been made in the development of means of self-study. The initial phase of the project required approximately nine months.

The next stages of this project will be to conduct testing of the effectiveness of these specific modules as tools for self-study. The modules have been demonstrated to various students and faculty members; the process will now need to be formalized to achieve the goals of horizontal and vertical integration described previously. In regard to the latter aim, the pharmacology module provides a good prospective model, as the structure of the self-study element invites the inclusion of specific links to modules on related subjects. Thus, in attempting to answer the question “Which size dose should be dis-
pensed?,” students may be directed to a review of the criteria for pharmacological dosing. In answering the question, “How much should be dosed?,” they may be directed to a module on physiology and pharmacodynamics. Finally, in considering the question, “What information would you like to put on the label?,” they may be directed to review pathology and oral medicine and diagnosis. As regards the former aim, selection criteria and evaluation methods will be developed and implemented, utilizing methods and results of previous studies. Testing will be conducted with selected faculty members and students, and changes may well be implemented as a result of such testing.

There are some precedents for the development and evaluation of courseware in dental education. Types of materials developed range from modules requiring students to learn specific simple programming skills to more recent developments featuring hypertext tutorials and case reviews (similar to those developed for the radiology module of the StudyWeb). Evaluation of self-instructional materials in dental education has covered many aspects, including:

• any changes/improvements in testing scores among students;
• student perceptions and attitudes toward teaching and computers and toward the tools themselves;
• time required for instruction;
• retention of material; and
• tendencies of students to take advantage of opportunities for review and/or self-assessment (especially if the materials may be accessed remotely or in an easily accessible location such as a faculty library).

All of these aspects would be taken into consideration in evaluation and testing of the StudyWeb. It is anticipated that some problems that had been identified in previous studies, such as a lack of student familiarity with computers or discomfort with some of the technology, will have decreased. Students are undeniably becoming increasingly comfortable with utilization of web-based technology.

Concurrent with the evaluation of the StudyWeb will be an increased emphasis on marketing the potential value of such self-instruction to a greater range and number of faculty members, in hopes of broadening the adoption of the technology.

Dental education appears to have made less use of courseware than some other fields. There are undoubtedly many reasons, beyond the scope of this paper, for the slow adoption of web-based study materials in dental education. The lack of standards among educational technologies remains a long-standing complicating factor. Rada and Schoening note that “for most of its 50-year history, digital educational technology has been non-standard. However, the web provides a standard platform for educational technology that encourages the decomposition of educational technology tools into exchangeable components. . . . The problem is to know what methods and tools, if any, will establish themselves as international standards.”9 In the case of the StudyWeb, we have deliberately kept to the low end of available technologies. Hopefully, should future standards become established and adopted, the StudyWeb will prove easily adaptable.

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REFERENCES