Integrating Web-Based Learning Modules into a Traditional Course

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Abstract

Interactive delivery of content and assessment enhance learning for many students. Delivery of concepts solely through lectures and textbook readings limits interactivity and does not meet the needs of all learning styles. When interactive web sites are integrated into learning modules as part of a traditional course (for homework or laboratory assignments), students are provided a more engaging experience. Moreover, practicing engineers interact with large web-accessible databases for an increasing number of activities directly related to their engineering projects. Examples include databases related to patents, journal articles, genomic sequences, protein structure, or tables of empirically measured values. Leading students through structured experiences with such databases develops skills essential for productive utilization and work. We have selected and utilized web sites to be used as part of assignments for a biomedical engineering course in physiology. One module for this course utilized a web site that explained aspects of neural signaling using animations, artwork and text. Another module utilized web-based tutorials that required students to utilize genomic databases to investigate genes related to a ligand receptor interaction. In another module, the students investigated three-dimensional structures using a protein database. Other modules had the students read selected journal articles, answer questions, and look up related articles. These techniques could be applied to other engineering courses to utilize web resources within learning modules as a way to enhance student learning.

Introduction

Delivery of engineering and scientific concepts primarily through lectures and textbook readings has been sufficient for motivated students whose learning styles adapt to this format. For many students whose learning preference is something other than auditory, the struggle to learn from the traditional lecture and textbook reading format inhibits learning. Educational methods exist to reach more of these students and provide an engaging, relevant learning experience for the class as a whole. Interactive delivery of content and assessment enhance learning for many students. Additionally, utilizing a variety of assessment methods provides a more holistic view of a student's mastery of concepts. Interactive web sites can be integrated into learning modules utilized as homework or laboratory assignments within a traditional course. Another approach could involve interacting with large databases that are accessible on the web, such as databases related to patents, journal articles, genomic sequences, protein structure, or tables of empirically measured values. Exercises that lead students through structured experiences with such
databases are worthwhile for improved understanding and development of skills helpful for productive work as a practicing engineer. These exercises and activities make use of web resources that are widely available. Integrating such tools and links into course work can be done incrementally, and generally results in students becoming more engaged in course work.

A traditional course centered around lectures and textbook readings has many advantages for the structure of the concepts to be learned and face-to-face motivation of students. Within this traditional course structure, web-based learning modules can be given as homework or laboratory assignments. A learning management system, such as Blackboard (www.blackboard.com), helps to organize the assignment directions, submission of student work and grading. Such utilization of web-based learning modules has two main advantages. First, practicing engineers need to be familiar and competent at using certain web-accessible recourses and databases to effectively do their jobs. Second, the learning modules aid the understanding of the concepts to be learned within a course, especially for students whose primary learning style is not optimal for verbal or reading input. Additionally, learning modules provide a linear organizational structure to the content and resources; essentially a "learning path" for the different topics.

We have utilized web sites as part of learning modules for a biomedical engineering course in physiology. One module for this course utilized a web site that explained aspects of neural signaling using animations, artwork and text. Another module utilized web-based tutorials, which required students to utilize genomic databases to investigate genes related to a ligand receptor interaction. In another module, the students investigated three-dimensional structures of several proteins using databases. Other modules had the students read selected journal articles, answer questions, and look up related articles. These techniques could be applied to other engineering courses to utilize web resources within learning modules that enhance student learning.

Methods

Learning modules were assembled and assigned to the students as homework or laboratory assignments. The modules utilized tutorials and components that were web-accessible, including databases, tutorials for engineering tools, concept tutorials, and animations. A goal was for students to work on relevant course activities that build their skill-set to ensure success in the workplace.

1) Databases

Skill at finding and manipulating information in web-accessible databases is essential for becoming a productive engineer in many fields. Use of such a database may also strengthen the learning process and understanding of the underlying contents contained within the database. For example many practicing biotechnology and biomedical engineers regularly access biological databases, indexes of research articles and patents. Students should understand how and why to make use of such databases to be successful in their coursework and after graduation.
a) Biological and Engineering Databases

International public databases have been setup to organize and contain genome and protein information. The contained data is extensive. For example, many biology related journals require that any reported sequence of DNA, RNA or amino acids be entered into the appropriate public database. Engineering students being prepared to work in these fields should develop understanding and competency at utilizing the databases.

In a physiology class for engineering students, we assigned web-accessible tutorials that guided the students to search genome databases to investigate particular gene expressions and to answer questions. One tutorial was developed by Jonathan D. Monroe at Thomas Jefferson University (PA) (http://csm.jmu.edu/biology/monroejd/amcp/genome1.html). This tutorial guided the students through several databases sponsored by the National Center for Biotechnology Information (NCBI). The genes related to a particular disease were searched for in the Online Mendelian Inheritance in Man (OMIM) database. Information of a particular gene related to the investigated disease, which was found by using the OMIM, was investigated further in Entrez Nucleotide, an associated NCBI database. Here sequences of nucleotides for messenger RNA and sequence of corresponding amino acids were listed, along with other associated information. The tutorial led students to follow a line of investigation by searching for and using information in these databases.

Another assignment customized a tutorial obtained on the web, which guided the students to use the Protein Data Bank (PDB) database (www.pdb.org). Students were led to investigate and view 3D visualizations of the 3D structure of selected proteins.

Once students have become familiar with databases, individualized investigations could be assigned. One method to ensure each student or team has an appropriate individualized inquiry would for the instructor to post a list of possible topics or inquiries. The students choose from this list, with the first to choose a topic be allowed to investigate that topic. Each student team would submit the results of their inquiry, and potentially present their findings to the whole class.

b) Research Article Indexes

Engineering, science and medical research journal and conference papers are indexed in a number of large databases, including the NCBI associated PubMed (www.ncbi.nlm.nih.gov/pubmed/), ISI Web of Knowledge (www.isiwebofknowledge.com/), and IEEE Explore (ieeexplore.ieee.org/Xplore/). Assignments can be made to have students find appropriate abstracts for a particular topic or question. After selecting suitable abstracts, the students could be asked to obtain the full-text version of the article. A goal would be for students to become proficient at obtaining the Full-text and figure version of articles through all of the following methods in this ordered list, with lower listed methods to be used if an article is not obtainable by methods listed higher. Each method is within the context of the university library or library web-site. Obtain the full text and figure version of the paper as follows:

1) directly through an active link in the index database
2) from electronic journals available through the library
3) by making a copy of a paper journal available at the library
To be a productive professional in research and development (R&D), an engineer needs to be competent at finding all papers within the necessary set of relevant articles. Carefully constructed assignments could provide the structure and act as a guide for students to gain experiences in searching for articles relevant to a selected concept. The skills that would be developed by these experiences are a transferable skill-set that would enhance productivity as an engineer after graduation.

c) Patents

Other important databases for engineers are indexes of patents. Engineers designing devices or processes for commercialization need to be proficient at finding patents relevant to their design. Patent Offices of a country or international group have web-assessable databases in which patents can be searched for and full copies obtained. Patents relevant for design engineers include those for the United States (www.uspto.gov/patents/process/search/), European Union (www.epo.org), and Japan (www.jpo.go.jp/index_e/patents.html). Engineering students in design classes could be given assignments having them find patents related to their design.

2) Tutorials for Programming Languages

Practicing engineers as well as students often are required to learn how to use new programming languages or computer aided design (CAD) software tools. The providers of these languages or CAD tools have an incentive to help with this learning process, and thus may provide web-assessable tutorials which help a learner to use the language or CAD tool. For example, such a tutorial may help the student design, simulate and implement their first program or design using that tool. This completed program or design could be an outcome submitted for the assignment. Utilizing these web-assessable tutorials within a traditional engineering course has several advantages. First, practicing engineers regularly use particular programming languages and CAD tools to effectively do their jobs, and having the students become familiar and proficient with the tools would aid the transition from student to productive engineer. Second, over the course of the career of an engineer, there is a high likelihood that they will need to become familiar and learn new programming languages or CAD tools. Being familiar and skillful at using web-available tutorials to begin the learning process will aid their life-long learning strategies. In engineering design courses, to help the students begin the process of learning how to use the LabView (National Instruments, Austin, TX) programming language, several National Instrument provided tutorials (www.ni.com/labview/) were assigned. By following the tutorials, students were guided to implement and run several programs. As an outcome of the assignment, the students were instructed to customize the resulting program and submit the program files. Following assignments were given to have the students use the LabView language to develop computer programs to be used within the engineering design of their student team.

3) Concept Tutorials

Besides tutorials developing familiarization and skill with important databases or engineering tools, many other web-assessable tutorials are aimed at helping students learn specific concepts. Throughout a course, many specific concepts and related vocabulary and processes need to be
mastered. Once the instructor has identified an appropriate tutorial, an assignment can be made having the students access the site and go through the tutorial. Outcomes to submit for grading would enhance student focus and direction. Such outcomes would include answering a list of questions, or summarizing what was learned. Another outcome would be for each student to make up potential test questions with the correct answer indicated based on the material covered in the tutorial.

Within a physiology class for engineers, we assigned a tutorial on the functions of neurons, which was developed by the Medical School of the University of Toronto ([http://icarus.med.utoronto.ca/neurons/index.swf](http://icarus.med.utoronto.ca/neurons/index.swf)). For the outcome of the assignment, students were asked to make up multiple choice questions with the correct answer indicated. Questions were to be based on material in particular chapters of the tutorial. The submitted questions were edited by the instructor to ensure correctness and clarity. Then all questions were posted for all of the students to view. Within the following exam, a number of questions were based on this student generated list of questions.

More web-assessable tutorials are becoming available and could be integrated into traditional courses as homework or laboratory assignments. More and more, textbooks are coming packaged with interactive course content that aligns with the text. Such materials commonly include PowerPoint files, organized lists of quiz style questions, animations and software simulations. Another valuable resource for locating interactive course materials is the Multimedia Educational Resource for Learning and Online Teaching (MERLOT) ([www.merlot.org](http://www.merlot.org)) which includes learning objects related to engineering.

4) Animations

Animations often help a student visualize, understand and remember concepts, especially for ones that have dynamic and interrelated components. Such animations may be particularly important for students with certain learning styles that do not readily learn from verbal or text based descriptions. In a physiology course for engineers, a number of animations were used. Many of the animations were provided by the textbook publisher, and were web-assessable in a password protected manner. Other animations were found from other public web-assessable sites, such as YouTube ([www.youtube.com](http://www.youtube.com)). Once appropriate animations were identified by the instructor, some of the animations were included in lectures, and others were assigned as homework. The outcomes of the homework assignments were to answer questions about the concepts covered by an animation.

Results and Discussion

Web-assessable tutorials and animations were utilized within a physiology course and design course for engineers as homework and laboratory assignments. The assignments were organized and delivered using the Blackboard learning management system. Students were introduced to and undertook several investigations using NCBI associated databases, neural interactions were explored using a web-based tutorial, concepts were shown through animations, and a tutorial guided students to develop a computer program. The subjective feedback of the students was
generally positive. The tutorials and animations appeared to aid the learning objectives of the course and to better prepare the students to become practicing engineers. While this was a good first step, further development of such learning modules would enhance the learning by more of the students, and may help maintain the value and relevancy of the concepts covered in a course. Making use of additional features of the Blackboard learning management system including learning modules, discussion boards and group tools may increase student engagement. Undertaking a complete course re-design is a challenging task that may not be possible within time constrains. However, interactive web-based modules can be incrementally added as assignments within the structure of a traditional course. Step-by-step efforts to integrate interactive web-based course materials is a way to start transitioning to a more engaging learning experience for students.

Authors Biography

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