Web Modules in the Emerging Areas of Chemical Reaction Engineering

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Abstract

We have developed web modules to present information in emerging areas and novel applications of chemical reaction engineering and linked with the appropriate chapters in the hybrid text to bring current research into the classroom. The modules are on molecular modeling, biochemical reaction engineering and computational fluid dynamics topics. They are encyclopedic in nature and are presented to students in an understandable and comprehensive manner keeping the Felder-Soloman learning styles inventory in mind. While the modules primarily target undergraduate students, they are layered so that parts of the web modules are a resource to high school students in an advanced chemistry course and perhaps also to graduate students in chemical engineering as a reference. Each module is a stand-alone unit that can be studied after the student has completed the chapter material related to the module. In addition to reviewing the fundamental principles of a topic, each module also contains living example problems, videos, photos, references and related links.

Introduction

It has been well documented that instructional technology enhances student learning, and that on-line students perform as well or better than the students in a lecture format. The effectiveness of the inclusion of web based instruction in both asynchronous and synchronous courses has also been documented.

Research has also shown that not everyone learns the same way. One of the more cited ways to classify the different learners is the Felder-Soloman Inventory of Learning Styles as listed in Table 1, which is based on a learning styles model formulated by Felder and Silverman.
Table 1. Felder-Soloman Inventory of Learning Styles

- Active Learners vs. Reflective Learners
- Global Learners vs. Sequential Learners
- Visual Learners vs. Verbal Learners
- Sensing Learners vs. Intuitive Learners

Web modules provide us a powerful toolset to address virtually all the learning styles in the Felder-Soloman Inventory to supplement course material. Hence, we have developed web modules in novel and emerging areas of chemical reaction engineering to bring current research into the classroom. These areas include molecular modeling, biochemical reaction engineering and computational fluid dynamics. Each module is a stand-alone unit that can be studied after the student has completed the chapter material related to the module.

In addition to reviewing the fundamental principles of a topic, each module contains living example problems, videos, photos, references and related links. For example, the Pharmacokinetics of Cobra Bites, shown in Figure 1, is so complete and authentic that it is referenced on the Canadian Zoocheck Site among suggested resource materials and is the definitive model for cobra envenomation and antivenin injection. This module is layered such that a high school student could obtain an understanding of the pharmacokinetics while at the same time an undergraduate could work with the coupled ODEs to learn various outcomes.

Figure 1. Cobra web module opening and reactions pages

Web Modules

The modules are mostly developed with the help of undergraduate researchers. Table 2 shows the general format in use. Standard HTML for layout and well-tested JavaScript code for interactivity are utilized to maximize the compatibility across different operating systems and browsers.
Quantum Web Module on Molecular Modeling

Quantum web module provides students with an introduction to the use of computational quantum chemistry to estimate reaction rate parameters. High school students can visualize processes through animations of the various reaction steps. Undergraduates can couple the computational software packages with transition state theory to estimate equilibrium and rate constants for elementary gas phase reactions. Most importantly, all students will gain experience with quantum chemical methods in chemical reaction engineering that will enable them to pursue potentially more complex computations in their future careers.

Figure 2. Quantum web module opening and reactions pages
Radial Effects Web Module on Computational Fluid Dynamics with FEMLAB™

Radial effects web module highlights the radial effects in a tubular reactor that are usually neglected to simplify the calculations. Also, the effects of parameters such as inlet temperature and flow rate are investigated. These effects can be readily studied using the software program FEMLAB™ in a very user friendly environment. The module is based on an example problem of Elements of Chemical Reaction Engineering (E. 8-8) where propylene oxide reacts with water to form propylene glycol.

Figure 3. Radial Effects web module opening and energy balance pages

Russell’s Viper Web Module on Biochemical Reaction Engineering of Venom

Figure 4. Russell’s viper web module opening and reactions pages
The Russell's viper is one of the most dangerous snakes in all of Asia, accounting for thousands of deaths each year. Once bitten, people experience a wide variety of symptoms including pain, swelling, vomiting, dizziness, blood incoagubility and kidney failure. The Russell’s viper web module examines the effect of the venom on the blood clotting mechanism and the kidneys in order to better understand how the venom kills and the best way to treat envenomed patients.

Discussion

The web modules are linked and integrated with the existing material on the fundamentals, yet they are stand-alone lessons that show different emerging areas and novel applications of chemical reaction engineering material. They bring current research into the classroom and are layered such that high school students, undergraduate students and graduate students can learn something critical from each lesson. Each lesson include background material, photos, videos, discussion of the fundamentals, simulations, self tests, hot buttons (e.g., derive, links). These modules serve as a well documented resource for those students from other disciplines searching the web for information, as was the cobra module. Because the topics are modularized, the instructors can pick and choose the ones they want to include in any particular term

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References


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