Newsletter

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In this issue:

E-Learning Begins To Find Its Niche

Simulations and online tutorials to augment traditional learning are slowly being put to use

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Although e-mail and the internet are now an indispensable part of most people's lives, the use of these and other electronic tools for chemical education is just getting started. Some of the lab simulation software and online tutorial projects that have potential to revolutionized the way chemistry is being taught were presented in several symposia at the International Chemical Congress of Pacific Basin Societies (Pacifichem) held last month in Hawaii.

Many professors post a course syllabus, homework assignments, and study guides on the Web, and some ambitious faculty with large classes may even give exams online. But educators aren't ready to plunge completely into the electronic learning environment or self-guided online instruction, commented associate chemistry professor Brian F. Woodfield of Brigham Young University, Provo, Utah.

One reason is the time it would take for faculty to learn how to use new computer programs and to develop online materials to replace their current versions, he told C&EN. Another reason is that chemistry is a laboratory science that requires intuitive observations and a set of skills learned by hands0on experience, none of which can be fully imitated in the digital realm.

"Simulations are a bridge from the abstract to the real, combining old tech with new tech to connect theory in the classroom with real-world experience in the lab," Woodfiled said. " The purpose is to provide a creative environment to reinforce or enhance traditional learning, not to replace it."

At Pacifichem, Woodfield gave an overview of Virtual ChemLab, a laboratory simulation software package that he and his colleagues at Brigham Young have been developing since the late-1990s (chemlab.byu.edu).

Virtual ChemLab is probably the most sophisticated chemistry e-learning tool available so far, Woodfield noted. The software uses animation combined with photographs, video, and spectra from real lab experiments to create an interface that allow students to feel that they are part of an experiment, Woodfield explained. Virtual ChemLab currently has a simulation module for organic synthesis and qualitative analysis and a set of modules for general chemistry, including inorganic qualitative analysis, atomic theory and quantum mechanics, gases, calorimetry, and titrations.

For inorganic qualitative analysis experiments, Virtual ChemLab offers 26 cation solutions and 11 reagents that can be added to test tubes in any combination and as many times as desired by simply clicking on a reagent bottle. Other available lab steps include stirring, centrifuging, decanting, flame testing, measuring pH of solutions or emitted gases, and smelling.

That there are 10^{17} possible experimental outcomes in the qualitative analysis simulation and some 2.5 million reaction combinations in the organic simulation means Virtual ChemLab is really open-ended, Woodfield pointed out. This allows students to explore on their own and "get away from the cookbook culture" that has a tendency to lead them through experiments without critically thinking about what they are doing, he said.

And what about lab boo-boos? When a combinations of reagents leads to chemical muck, the simulation shows muck. When a dangerous mixture of chemicals is created, the program generates a simulated explosion for effect, complete with a recorded sound of glass shattering. This feature highlights one benefit of the virtual lab: Students can safely get as close as possible to real hands-on chemistry, even using toxic substances, without actually having to come into contact with the chemicals.

The system has a user's guide accessed via "tutorial TV," which also displays what is going on with a particular experiment in progress. There's also an electronic lab notebook that students use to record results and observations, get assignments of unknowns, and submit results for grading. The stockroom section can b used to created known mixtures, generate practice unknowns, or retrieve instructor-assigned unknowns.

How good is Virtual ChemLab? In one evaluation, students who noted that they had used the system performed 30% better on the lab final exam than students who said they hadn't used the system, Woodfield reported. The simulations, when used as a prelab assignment, also tend to help students finish real labs much faster, he added.

Prentice Hall sells the software along with workbooks for college and high school and, later this year, middle school. The workbooks contain tear-out lab worksheets that can be completed by using the software. A site license for a high school or university currently runs $600. Individuals can purchase various simulations and a work book for about $35each. Virtual ChemLab also is being packaged with several chemistry textbooks. About 150,000 U.S. high school and college students are using Virtual ChemLab, Woodfield noted.

A number of other innovative e-learning tools were presented during Pacifichem lectures and poster sessions. Lois M. Browne of the University of Alberta, Edmonton, described NMRTutor, an interactive online tutorial program to assist undergraduate organic chemistry students in learning the basics of proton nuclear magnetic resonance spectroscopy. Alberta chemistry graduate students J. James Bailey was a major contributor to the project, she noted.

The inherent difficulty associated with enabling large classes of students to acquire and practice interpretation of real NMR spectra presented an opportunity for Brown and her colleagues to develop NMRTutor, she said. The Alberta chemists had already prepared an online Organic Chemistry Lab Handbook that includes tutorial sections on separations and infrared spectroscopy (www.chem.ualberta.ca/~orglabs/Handbook.html).They simply expanded it ton include the NM tutorial. A section on ^{13}C NMR is in the works, as well as sections on chromatography and other techniques.

NMRTutor's theory section contains a complete background on proton NMR at the beginner's level. To avoid overwhelming students new to NMR, "Tubie," an NMR mascot, was created. Fashioned after an NMR sample tube, Tubie pops in to provide background information and help students make sense of difficult concepts.

As students progress through the theory section, the can quiz themselves on what they have learned. In a virtual lab section, students learn how to construct a data table by using chemical shifts and coupling patterns from spectra of common compounds. Errors entered by the students are automatically corrected and highlighted in red. Once the table is complete, the student is directed to select the molecular fragment associated with an NMR signal, then assemble the fragments to form the molecule.

When NMRTutor was tested with 110 students in spring 2005, it performed with few glitches, Browne said. The tutorial is going full-scale with 1,100 organic chemistry students during the current winter term.

IT'S DIFFICULT to determine if the tutorial makes a difference in the overall performance of students, Browne pointed our. For example, students who said they used the tutorial performed only a few percentage points better in their course grades. But anecdotally, "we have found it helps accelerate learning by giving immediate feedback when a student makes mistakes," she said.

Another e-learning tool that is starting to catch on is remote access to analytical instrumentation. A student or researcher in one location can log in to a computer server in a distant location and drive an instrument as though it were in the same room. At Pacifichem, associate chemistry professor Gregory M. Ferrence of Illinois State University described one such initiative to help students learn about X-ray crystallography.

Routine X-ray crystallography has become essential for synthetic chemists, and structure determination have become much easier with faster computers and east-to-use graphical software, Ferrence noted. But students at most predominantly undergraduate universities, minority-serving college and universities, and community colleges have little exposure to crystallography.

Ferrence is on of the principals in a group of chemists that is reaching out to some 50 of these institutions so far through the STaRBURSTT CyberInstrumetation Consortium (starburstt.org). STaRBURSTT (Science Teaching & Research Brings Undergraduate Research Strengths Through Technology) includes five core instrumentation hubs at California State University, Fullerton; Central Connecticut State University; Southeast Missouri State University; Youngstown State University, in Ohio; and Illinois State.

The consortium team is developing online curriculum materials on crystal growth, data collection and refinement, structure determination, and how to use crystallographic databases for their own students and for students at member institutions. They also are facilitating local and remote access to X-ray diffractometers so students can practice or carry out research. Participating faculty at the instrument hubs make blocks of time on their instruments available for students to come in for hands-on work or to send samples and operate an instrument remotely.

The consortium's goals are simple, Ferrence said. The members want to increase crystallographic training opportunities and provide an infrastructure for broader use of university crystallography resources. "In the end, we want to increase the supply of aspiring crystallographers," Ferrence told C&EN. Crystallography happened to be the expertise of the consortium organizers, he added, but the consortium is currently expanding the project to include other instruments.

E-learning has great potential for chemical education, as the variety of initiatives presented at Pacifichem showed. Woodfield thinks broader use of e-learning will be driven by the next generation of students who will have had exposure to e-learning programs in high school and will start to ask for similar systems at the undergraduate level. E-learning also will likely be adopted more quickly for distance-learning courses or courses for which lab costs or lack of lab facilities may be a factor, such as those for nonscience majors of those offered by community colleges or high schools.

Two BYU professors named 2005-06 Fulbright Scholars

By Elizabeth Kasper

January 6, 2006

Two BYU professors received Fulbright Scholar Grants for the 2005-2006 academic year from the United States Department of State and the J. William Fulbright Foreign Scholarship Board.

Michael John Dorff, associate professor of mathematics, will conduct research on harmonic univalent mappings and minimal surfaces at Maria Curie-Sklodowska University in Lublin, Poland, until February 2006, while geology professor Alan L. Mayo continued his research on the optimization of groundwater development and protection at Charles University in Prague, Czech Republic, in December.

Dorr received a bachelor's degree in mathematics education from BYU and a master's degree in mathematics from the University of New Hampshire. Hen then completed doctoral work, also in mathematics, at the University of Kentucky.

Professionally, Dorff was a faculty member at the University of Missouri-Rolla and Purdue University before joining the BYU faculty as an associate professor in 2004. He is also currently studying geometric function theory, complex analysis and differential geometry.

Mayo received Bachelor's and master's degrees from San Diego State University and a doctoral degree from the University of Idaho. His professional experiences include working as a senior environmental planner for San Diego Country, an assistant professor at the University of Idaho and a senior hydrogeologist in Georgia.

Other research interests include both applied and theoretical research in solute and isotope hydrogeochemistry. He joined the BYU faculty in 1987 and began a research and teaching program in hydrogeology.
For more information on the Fulbright Scholar Program, visit www.cies.org.

2006 College Dinner

College Publications

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