Enhancing, Creating, and Providing Online Energy Instruction

Abstract
Existing Web-serving capabilities for delivering science content to high school teachers will be leveraged for the purpose of creating energy-content-specific learning materials. Two work products will be created. First, existing courses (CHEM 869) will be updated and revised to change the nature of the presentation of energy-related material. Second, a new Web-based undergraduate science course on energy will be created and tested at Concordia University. There are three especially attractive features of this project. First, the existing traffic at our site is very high and exceeds 30G/month. Second, all of the science teacher training materials developed by the proposers over the past 20 years remain accessible for teacher use. Our projects have significant staying power. Finally, all of the materials developed in this format offer learners immediate, performance-related feedback. This kind of feedback has proven especially important when learning difficult science content. A wide variety of topics will be introduced. Examples include the materials challenges in developing electroluminescent lighting to replace incandescent and fluorescent lighting, and the challenges to widespread implementation of fuel cells.
Enhancing, Creating, and Providing Online Energy Instruction

Introduction
For the past seven years we have offered four 1-credit graduate courses for high school chemistry teachers relating to energy: CHEM869M (Energy and Matter); CHEM869U (Oxidation and Reduction); CHEM869W (Thermodynamics); and CHEM869Z (Nuclear Chemistry). (We also offer a biochemical course entitled Energy and Metabolism, CHEM869P.) The Web traffic volume through our combined courses was 7 gigabytes during the week of 11/9-16/2006. Our courses are established, well recognized, and heavily trafficked.
The proposed project builds upon our previous success in Web-based science content delivery.

Project Goals and Objectives
Through this project we will:
  a) Enhance the four extant courses for high school science teachers including the incorporation of content related to the macroeconomics of energy issues
  b) Synthesize a new 2-credit Web-based general education course for undergraduates derived from extant and revised materials and begin offering that course in a pilot program at Concordia University (Seward, NE) during the Fall 2007 semester.

Project Justification
Placing energy content within conventional high school science courses gives this content a better focus than marginalizing it by incorporating it into either specialty courses or social science courses. The teacher materials originally developed centered on concepts of energy. These materials are rich with practical examples of energy issues and suggest numerous demonstrations and experiments for classroom use. There is emphasis on safety and environmental issues. Generally speaking, however, these courses do not include opportunities for teachers to become acquainted with materials that might prove
useful in connecting those concepts with global energy topics such as economic issues and conservation. Also, no attention is paid to highlighting career opportunities in this area. Finally, a general updating of the teacher materials is in order. For example, progress in the development of the chemistry of electroluminescent materials suggests that the amount of energy used for ordinary lighting, a major component of everyday household and business energy usage, will be reduced by over an order of magnitude during the next decade or two.

A specific example of areas in which enhancements will be made is that of fuel cells. Fuel cells are mentioned in several places in the original materials. However, they are not covered in a single, holistic treatment. Also, there are no demonstrations for teachers to use to demonstrate fuel cells (even though there are numerous other electrochemical experiment). Further, the practical aspects of energy generation from chemical sources are separated from the theory (Laws of Thermodynamics). Using the resource provide though this project, it will be possible to refocus old materials from a chemical to energy themes, and to create appropriate new materials to support energy themes.

To reach a broad range of college students, developing a separate energy issues course has some advantages. The science curricula in introductory chemistry and physics are crowded, and the audiences usually are restricted to science and engineering students. To increase public understanding of energy issues, general education courses may prove effective. It is key, however, that these courses be based upon solid science. The thinking of the average citizen does not always appear to be bounded by the first and second laws of thermodynamics leading to inappropriate views of solutions to energy issues -- for instance confusing the "hydrogen economy" with hydrogen as an energy source.

The difference between our products and those typically found on the Web involve learner response and feedback. Our materials will provide the learners with opportunities to check their knowledge and receive immediate feedback based upon their responses. In many cases, the responses are tailored specifically to the learner.

**Work Required**

The work required includes the revision of extant Web materials and the creation of new materials. As noted, the existing materials incorporate on-line practice and use a mastery learning strategy. That is, learners can continue working with and studying materials until
they are able to demonstrate adequate content knowledge. This project includes the creation of such practice and testing materials. [Ten item formats are employed. In addition to multiple choice, other formats include essays (graded by "hand") and short answer. The short answer questions are individually programmed and provide learners with detailed, worked-out solutions to problems. In some instances, millions of problem variants are possible, but the learner sees a solution based exactly upon the data that was included in his/her problem. One item format has learners interacting with images.]

**Outcomes; Work Products**

The courses produced will be housed on a UNL server (dwb.unl.edu) maintained in the Scott Engineering building. The proposers will control registered student access. After testing and revision, broader access will be made available throughout the region. All of the materials we have developed thus far are available to the public; no registration is required. (Our ability to sustain quality materials for continued teacher use has been especially noteworthy. For example, all of the materials developed and produced for science teachers under the *Doing Chemistry* project [NSF TPE 8470375] still are available on line, having been repurposed from original videodisc materials.) The only service that requires registration is that involved in the actual grading of essay response. Upon submitting an essay response, all users including public users are shown a model essay response. After testing and revisions, we will make the undergraduate course available to instructors who will be able to enroll their own students and manage the progress of those students.

**Timeline**

Dr. Brent Royuk, Associate Professor of Physics at Concordia University, will conduct the project work during 9 summer weeks during May-August, 2007. The work will be conducted at 123A Henzlik Hall, UNL, and at 113 Science Hall, Concordia University, Seward, NE.
Budget

NCESR Research Grant Budget Request

<table>
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<tr>
<th>Item</th>
<th>FY2006/07</th>
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<td>Salaries</td>
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<td><strong>Total Request</strong></td>
<td><strong>$11,500</strong></td>
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Budget Justification

The equipment and software for developing course materials is in place. Most of the funding will be used for salary and benefits for Professor Royuk. Professor Royuk will receive a consulting stipend of $10,500 during the summer 2007 for 400 hours of work on this project. The additional $1,000 funding will be used for software updates and minor supplies.
DAVID W. BROOKS

PRESENT POSITION:
Professor of Teaching, Learning, and Teacher Education
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PROFESSIONAL INTERESTS:
Web-based Education, Chemistry Education; Science Education

EDUCATION:
Ph.D., Chemistry, Columbia University, 1965
M.A., Chemistry, Columbia University, 1962
B.A., Chemistry, New York University, 1962

EMPLOYMENT HISTORY:
Professor of Chemistry Education, University of Nebraska, 1984-
Professor of Teaching, Learning, and Teacher Education, University of Nebraska, 1981-
Professor of Chemistry, University of Nebraska, 1973-84
Freshman Chemistry Coordinator, University of Nebraska, 1973-83
First Year Chemistry Program Director, Texas A&M University, 1969-73
Associate Professor, Texas A&M University, 1970-1973
Assistant Professor, Texas A&M University, 1967-1970
Assistant Professor, University of Alaska, 1966-1967
Lecturer and Postdoctoral Research Associate, Columbia University, 1965-1966

BRIEF SUMMARY:
Over 160 papers; project director or codirector in over $3.0 million dollars in funded projects including Project TEACH and Doing Chemistry. Visiting Scientist Award, Western Connecticut Section, ACS, 1987; CASE Professor of the Year Finalist, 1982; Chemical Manufacturers Association Catalyst Award, 1980; NSTA Gustav Ohaus Award for Innovation in College Science Teaching, 1978; Faculty Distinguished Teaching Award, 1977; B.A., summa cum laude, with Highest Honors in Chemistry, 1962; American Institute of Chemists Medal, 1961. Other awards and prizes. Current research in developing computer-based tools for teachers. Recent developments in tools for chemistry teachers, student teaching supervisors. Also have successful writing program (ROBO-Writer) for learning disabled students in primary grades. Developer of the retrospective tutoring strategy, a dimension of electronic performance support systems. Prepared and currently maintain 17 Web-based 1-credit graduate courses for high school chemistry teachers (NSF - ESI-9819377)
**Relevant Citations:**


**Students:**

Recent PhD Graduates:

- Alan Runge, August 1997, Academic Dean, DeVry Institute, Houston, Texas
- Amjad Abuloum, August 1999, Assistant Professor, Hashemite University, Amman, Jordan
- Kent J. Crippen, December 2000, Assistant Professor, University of Nevada, Las Vegas, Nevada
- Alberta C. Sautter, August 2001, Assistant Professor, Southeast Missouri State University, Cape Girardeau, Missouri (Fall 05)
- Lynne Herr, December 2002, Technology Coordinator, Waverly Public schools, Waverly, Nebraska
- Bradley Barker, December 2002, Assistant Professor, 4-H Youth Development - Science and Technology Specialist, University of Nebraska-Lincoln
- Kent Steen, December 2002, Computer Teacher and Curriculum Coordinator, Riley School, Lincoln, Nebraska
- Carolyn Hardy, August 2005, Assistant Professor of Computer Science, Northwest Missouri State University
- Betty Elder, December 2005, Assistant Professor of Nursing, Wichita State University

I have supervised over forty non-dissertation masters students, all of whose work was defended in oral exams, and most of whom developed hypermedia materials as the summative component of their work. There are 18 doctoral students in progress.
Brent Royuk
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Seward, Nebraska  68434
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broyuk@cune.edu

Professional Experience

Concordia University  Seward, NE  August, 1995 to Present

Associate Professor of Physics

Courses Taught:

Metro-East Lutheran High School  Edwardsville, IL  August, 1988 to July, 1995

Teacher

Courses Taught:
Physics, Chemistry, Trigonometry, Analytic Geometry, Pre-Algebra, Earth/Space Science, BASIC Programming, Algebra II, Introductory Physical Science

Education

Concordia College  Seward, NE  1984 to 1988
BS Ed. 1988

Southern Illinois University  Edwardsville, IL  1992 to 1996
MS Physics 1996

University of Nebraska  Lincoln, NE  1996 to 2002
Ph. D. Curriculum and Instruction  2002

Extracurricular Activities

Coaching:
Football, five years
Girls Basketball: Head coach, five years
Athletic Director, one year
Other:
Bus Driver
Football Statistician
Bass Guitarist
Faculty Athletics Representative

Website:  http://royuk.com

Publications


Presentations
*St. John Lutheran Church Bible Class, June, 2006.* Science and the Christian Faith.

*Nebraska Association of Teachers of Science Fall Conference.* Hypotheses, Laws and Theories: Building a Color Model.


*Nebraska Junior Academy of Science, Fall, 1996.* Rainbows, Apples, and Big Bird: An Introduction to Color.

*Southern Illinois District Teacher’s Conference, 1995.* Hand-On Science Demonstrations