

Chemistry Connections

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Category of Submission:  
Design and Implementation of a New Course

Submitted October 14, 2005 for implementation  
Fall 2006

Signed:

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James W. Hunt, EdD, Provost

## 2. Summary

This project addresses the growing need for scientific literacy on the part of all informed citizens. In today's society, numerous issues of government, security, communications, health, economics and education cannot be successfully approached and resolved without an understanding of the basic process of scientific decision-making. While not all Southwestern students will become scientists, all of our students can learn the principles of scientific inquiry and understand their application to the political and societal issues of our times. Such preparation fits them for lives as informed citizens in our democracy.

The goal of this specific project is that students will become familiar with important scientific and chemical principles and their application to real world issues and problems. The objectives that will further this goal are: to develop 5-7 interdisciplinary course modules on chemical topics, to incorporate these modular concepts into a new course for non-science majors entitled *Chemistry Connections*, to track the success of the course by using established evaluation instruments, and to present our successful model of course design and assessment to interested parties through a variety of presentations and publications.

The outcome of this project will be a course model for preparing today's students to take an informed place in the political and scientific debates of our day, while at the same time preparing them for successful careers and work lives, at a time when success in virtually every professional field depends on understanding the impact of science.

A collaborative program assessment will take place using the Science Values Inventory created in part by Dr. Donald Deeds of Drury University. Results will be reported back to him for use in his ongoing development of the assessment project and for comparison with student responses elsewhere.

### 3. Project Description

**Goals and Objectives.** The anticipated outcome of this project is that students will become familiar with important scientific and chemical principles and their application to real world issues and problems, through learning how chemistry is used to create objects of art, study ancient or prehistoric cultures, develop new drugs to cure disease, and contribute to many other endeavors. Moving from an engagement with abstract principles in the classroom to their use in solving concrete problems, students will gain a more sophisticated understanding of the role that science can play in business, government and the professions. After completing this course, students should be better prepared to read articles related to scientific problems in newspapers or other outlets of the popular press, to understand the content, and to critically evaluate those articles. Thus, we anticipate that the students will grow to have an appreciation of how chemistry impacts their personal lives, whether it is in their careers or as informed citizens.

The objectives for this grant are:

1. Develop 5-7 interdisciplinary modules incorporating chemical principles;
2. Incorporate the modular concept into a new course for non-science majors, *Chemistry Connections*;
3. Track the success of the course by utilizing the Science Values Inventory survey and a modified Southwestern University course evaluation; and
4. Present our ideas in course design and assessment measures to interested parties through presentations or publications.

The modules will be introduced in a new course scheduled for the fall of 2006. The success of the modules and changing attitudes of the students will be evaluated by posing survey questions to the students on the first day of class and the final day of class. The Science Values

Inventory noted above was developed, in part, by Dr. Donald Deeds at Drury University.

**Background and Significance.** As part of our general education program, different departments at Southwestern University offer courses designated as Perspectives on Knowledge (POK) courses. Students are required to take a certain number of courses within different areas – Values Analysis, Social Analysis, American and Western Cultural Heritage, Other Cultures and Civilizations, The Aesthetic Experience, The Natural World – to complete their general education requirements. All graduating Southwestern students are required to have completed two courses in the area of The Natural World, one in Physical Science and one in Life Science.

For many years, the course *Chemistry Appreciation* at Southwestern University has been taught as a traditional chemistry course for non-science majors. The course meets the general education requirements noted above as one of the POK courses in the natural sciences, and many students register for *Chemistry Appreciation* with less than enthusiastic attitudes. Using the resources of an ASC mini-grant, we would like to design a completely new course that will both meet the requirements of our university and address the needs of our current students more relevantly. A partial model for our project exists in a second chemistry course recently developed for non-science majors, a one-semester topical course titled *Chemistry in the Environment*. This course has been well-received by students, and we propose to build on this success by creating a new course composed of four interdisciplinary modules per semester, with the intent of connecting the science of chemistry to disciplines not usually regarded as scientific.

We believe there is a demand for a course like *Chemistry Connections* on our campus. As one of a relatively few number of courses in our Natural Sciences Division designed specifically for non-science majors, *Chemistry Appreciation* has strong enrollment. The course has been traditionally taught from textbooks that are specifically written for a non-science major

chemistry course. An example of a particular text in recent use is *Chemistry for Changing Times* by Hill and Kolb. While such texts do a good job of presenting chemistry at a level suitable for non-science majors, they do not present chemistry as linked to the types of careers our non-science majors may choose. In contrast, modules in the new course will focus on the role of chemistry across a wide spectrum of disciplines. We will present to the students how chemistry is utilized or is important to particular occupations or in situations related to those occupations. We think that this will provide a stronger interest “hook” for students as they see how chemistry is related to their advanced study and career choices.

### **Detailed Project Plan**

**Overview of the Course Modules.** The first module will consist of basic chemistry concepts. We will briefly cover the history of chemistry and from that starting point will develop the idea of chemical formulas and nomenclature. We will also cover simple equation balancing and definitions, building skills that we will need throughout the semester.

In the section on Art and Anthropology, we will cover the history of art, chemistry of colors, the nature of light and how humans perceive colors. Art restoration and forensics will be explored, and the unit will end with the history and chemical development of the methods of classical photography. Anthropology will be included in this module by surveying how art, in all its forms, developed and spread as different cultures evolved.

Archeology will cover the aspects of dating artifacts and the chemical analysis of artifacts to determine authenticity and age. We will explore techniques of restoration and preservation of historical artifacts. The Commerce module will include how chemicals and other value-added products are produced in a modern industrial setting and in developing countries. We will cover issues addressing the cost in both monetary and environmental impacts of chemical production.

Closely allied with those issues are current and future scenarios involving regulation of industries through governmental actions and policies. We will also include sections on energy, food, textiles, drugs and cosmetics.

The Environmental module will include coverage of natural and man-made pollution, including pollution of land, air and water, pollution controls, and “green” manufacturing. We anticipate that many of these issues can be tied with the Commerce module. Finally, we will address the issue of global warming and its consequences. The Forensic Chemistry module will cover the definitions used in forensic chemistry and include broad coverage of the methods of analysis, specifically the chemical methods of analysis of physical evidence. We also plan to address the uses of chemistry and the law in courtroom situations.

The Nanotechnology module will address the definitions of nanotechnology, the production of nanomaterials, and their use in a variety of products. Recently the environmental and safety aspects of nanotechnology have become popular issues and we intend to address those in this module.

Other potential modules could include Geochemistry and Natural Resources. Geochemistry would cover the issues of the chemistry of hot springs and volcanology. Natural Resources would address issues related to strategic materials such as petroleum and various metals – what they are, how they are obtained, and the world’s use of these materials.

At the conclusion of each module, the students whose interests match the module, will be required to present either a discussion or some other type of presentation to the class.

We plan to include other faculty members from across a wide spectrum of disciplines as guest lecturers in various modules. Planned partners include Dr. Victoria Star Varner, Professor of Art and Chair of Studio Art, an accomplished painter and printmaker; Dr. Patrick Veerkamp,

Professor of Art and a ceramicist; and Dr. Emily Northrop, Associate Professor of Economics specializing in environmental economic issues. An important aspect of this project is the forging of connections across campus that can lead to further interdisciplinary curricular partnerships.

**Laboratories.** Several existing laboratories from *Chemistry Appreciation* will work well to elucidate and clarify the subject matter from the planned modules. Our Chemical Stoichiometry lab will be suitable for the basic module, along with a Copper Reactions experiment. The Art module will utilize a lab based on simple darkroom chemistry and some of the chemical processes used in intaglio printmaking. Our current “Recycle Aluminum” experiment will be used in the Environmental module. The experiment addresses how aluminum can be recycled other than by simple melting and reforming. The students produce alum from aluminum cans by conducting a series of chemical reactions and crystallizations.

A new lab to be developed for the Environmental module will be a water quality lab, and requested laboratory equipment is listed in the proposal budget. The San Gabriel River near our campus can serve as a field testing site for introducing the needed technology. Our Polymer experiment will be used in the Commerce module. The Polymer experiment includes production of “Slime” by crosslinking household glue or polyvinyl acetate with borax. The students also make nylon using the classic Nylon Rope experiment and explore the methods of making and dissolving Styrofoam coffee cups. Existing Chromatography experiments will be used in the Forensic Chemistry module, along with demonstrations of some of our instrumentation such as infrared spectroscopy and UV/Vis spectroscopy. New labs will need to be developed for the Archeology and Nanotechnology modules.

**Field Trips.** A field trip to view the Gernsheim Collection at the Ransom Center on the nearby University of Texas campus will serve as an introduction to the work of conservators

there, who preserve and manage a large collection of rare and historic early photographs. A guided trip to the Gault Site, an important neolithic Clovis site in central Texas, will illustrate principles explored in the Archeology module. If this course is offered during our May Term, a summer term in which students are allowed to enroll in only one course, other field experiences would be incorporated (to the city of Georgetown's municipal water treatment facility or the Williamson County landfill, for example).

**Prior Activities or Research Related to Proposal.** As noted above, the planned course draws upon the lessons learned through existing courses for non-science majors and uses accessible laboratory exercises that have served well for non-science majors. The difference consists in the real-world connections and concrete applications to the world of work that will be stressed throughout the semester. New laboratory exercises will be developed to illustrate principles important for understanding the subjects presented in the various modules.

**Projected Timetable.** Course design will take place during Summer 2006, with implementation of *Chemistry Connections* in Fall 2006.

**Requested Budget**

Course Development Stipends for Summer 2006

Dr. Kerry Bruns	\$2500
Dr. Willis Weigand	2500

Supplies and Materials

Vernier Water Quality Testing Instrumentation Starter Package 8 @ \$700 each	5600
Chemical supplies and reagents	3000
Resources (slides, audiovisuals) for Guest Lecturers	500

Equipment

Laptops to supplement existing computer lab (two)	<u>3000</u>
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**Total** **\$17,100**

The laptops will be used for data collection and analysis with the Vernier instrumentation that will be used in the Environmental laboratory.

**Context of Course in Curriculum.** *Chemistry Connections* will be incorporated into our curriculum as a POK course in The Natural World area. Southwestern is in the process of moving from the POK system toward a more standard system of distribution requirements, and the planned new course is designed to fulfill one of two distribution requirements in The Natural Sciences Division for non-science majors. We anticipate this new course will attract enough students to fill at least one course per semester (24 student limit due to laboratory space) and at least one section during May Term.

Southwestern's Provost supports the development of new courses to educate non-science majors in the area of the natural sciences. Non-science majors make up the largest part of our student body. The Provost recognizes that students must understand the sciences to be truly liberally educated, and that leaders in our society will need to understand scientific issues in order to make informed decisions related to complex issues facing future generations.

**Impact on the Institution.** As noted above, this project has important potential for creating bridges between the disciplines that can lead to further interdisciplinary collaborations in the coming years. The solutions to today's complex problems often do not lie within the confines of any one discipline, but in the area where disciplines overlap. Global warming for example is an economic and governmental issue as well as an environmental one. Addressing global health challenges requires geographical and political science perspectives as well as biological ones. This course represents an important step in cross-disciplinary cooperation and can lead to further collaborations in the future.

**Evidence of Institutional Support.** Southwestern University will provide basic

laboratory and equipment support to this project, including many chemical supplies for planned laboratories. Information technology staff will support multimedia classrooms and provide computer classrooms for the project. Southwestern faculty from disciplines outside chemistry have expressed their willingness to work in the development and presentation of guest lectures for the planned modules. Attendance at conferences by Southwestern's faculty and students to disseminate and share this project will be supported by Southwestern University.

#### **4. Evaluation, Dissemination and Continued Support.**

Southwestern University traditionally uses course evaluations at the end of each semester to determine student interest in a particular course, their perception of the course, and to evaluate the effectiveness of the instructor. Our evaluations have been standardized over all disciplines; however, the evaluations may be modified as the instructor sees fit. We anticipate modifying our course evaluations for this course by including questions that address strengths of the course and where modifications should or could be made. Our modifications and additional questions will be designed to provide information specific to the course's pedagogical approach to the subject of chemistry and to general perceptions of science in society. Having information from the discussions, from the course evaluations and from the Sciences Values Inventory (SaM-VI) will provide us with a dynamic and current perception of the course as it is delivered. Additionally, the Sciences Values Inventory will be given at the start of the course and again at the end to inform us of how perceptions and interests of the students change from the start of the course to its completion. We anticipate seeing an improved perception of chemistry and of science generally.

A further outcome would be dissemination of the course modules by publication or presentation to interested parties. Dissemination of this course will be through a number of

different methods. As opportunities arise we would present the concept of the modular course and the measures of student perceptions at conferences such as the Texas Academy of Science meeting, selected Associated Colleges of the South conferences or regional or national meetings, such as the American Chemical Society's regional meeting (Division of Chemical Education) in 2007. Of course, we would share our results with the Associated Colleges of the South, and with the people who developed the SaM-VI to help them complete their studies on the attitudes of students toward science and mathematics.

## Additional Information

### 5. Literature Cited.

Chemistry for Changing Times, 10th Edition, John W. Hill and Doris K. Kolb, Pearson Prentice Hall, Upper Saddle River, New Jersey, 2004

Our questions and surveys will be shaped and informed by several sources:

Moore, R. W. and Foy, R.L.H, The Scientific Attitude Inventory: A Revision (SAI II), *Journal of Research in Science Teaching*, **1997**, *34*, 327-336.

Munby, H., Issues of Validity in Science Attitude Measurement, *Journal of Research in Science Teaching*, **1997**, *34*, 337-341.

Coll, R. K., Dalgety, J. and Salter, D., The Development of the Chemistry Attitudes and Experiences Questionnaire, *Chemistry Education Research and Practice in Europe*, **2002**, *3*, 19-32.

Science for All Americans Project 2061, American Association for the Advancement of Science, Oxford University Press, New York, Oxford, 1990.

Suggested Course Readings (to be placed on reserve at Southwestern's Smith Library):

Diamond, Jared, *Guns, Germs and Steel: The Fates of Human Societies*

McPhee, John, *Annals of the Former World*  
*Encounters with the Archdruid*

Reisner, Marc, *Cadillac Desert: The American West and its Disappearing Water*

Yergin, Daniel, *The Prize: The Epic Quest for Oil, Money and Steel*

### 6. CV's of Faculty Participants – Attached

**Kerry A. Bruns**  
**Department of Chemistry and Biochemistry**  
**Southwestern University**  
**Georgetown, Texas 78626**  
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**Academic Positions:**

Southwestern University

- Department Chair, 2000-present
- Professor of Chemistry, 2005-present
- Associate Professor of Chemistry. 1999-2005
- Assistant Professor of Chemistry: 1993-1999

New Mexico State University, Carlsbad, New Mexico.

- Assistant Professor, Science Department: 1991-1993

**Education:**

Postdoctoral

- Washington University in St. Louis Medical School  
Department of Hematology and Oncology July 2001-Dec.2001
  
- Iowa State University of Science and Technology, Ames, Iowa  
Department of Zoology and Genetics: 1989-1991
  
- University of New Mexico Cancer Research and Treatment Center,  
University of New Mexico, Albuquerque, New Mexico  
Department of Hematology and Oncology: 1987-1989

Predocctoral

- Department of Chemistry, New Mexico State University  
Ph.D. 1987

Undergraduate

- Western New Mexico University, B.A. Chemistry, 1981

**Recent Honors:**

- Who's Who Among America's Teachers 2003-2004, 2004-2005

**Publications:**

- 8 Articles in Refereed Journals
- 1 Invited Review
- 1 Invited Lecture

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## **ACADEMIC EMPLOYMENT**

Southwestern University

- Assistant Professor and Director of General Chemical Laboratories, August 2004 - present
- Visiting Assistant Professor, August 2002 – July 2004
- Adjunct Assistant Professor, August 1994-May 1997, January 2002-August 2002

Pennsylvania State University, Altoona College

- Assistant Professor, August 1997-June 2000

## **INDUSTRIAL EMPLOYMENT**

Halliburton Services, Duncan, OK, W. R. Grace, Cambridge, MA, Radian International, Austin, TX, May 1982-April 1995

Conley, Rose & Tayon, Austin, TX, June 2000-December 2001

## **EDUCATION**

Predoctoral

Department of Chemistry and Biochemistry, University of Arkansas, Ph.D. 1982

Undergraduate

Southwestern Oklahoma State University, B. S. A. C. S. Chemistry, 1977

## **HONORS**

Phillips Petroleum Fellowship, University of Arkansas, 1979-1980

## **PUBLICATIONS AND PRESENTATIONS**

4 Articles in Referred Journals

7 Presentations and Papers

8 U. S. and Foreign Patents

## **7. Disclosure statement.**

Two external grants are currently underway in the Chemistry and Biochemistry Department of Southwestern University. The Welch Foundation of Houston provides \$45,000 in annual support to the Departmental Research Program. The Departmental Research Program is conducted in the summer and supports student researchers working with faculty mentors on original chemical research. The Merck Foundation is currently providing \$20,000 annually to support interdisciplinary research in biology, chemistry and biochemistry. Most of the Merck research takes place in the summer, with the continuation of some student-faculty projects throughout the academic year. The Merck Foundation's grant is in its final year. These projects would not conflict with planned activities under this grant for non-science majors.

Willis Weigand is the recipient of a Cullen Faculty Development grant for 2005-2006. This grant provides funds for chemical research, which would not conflict with the planned delivery of the new course.