

NSF Highlights

Projects Supported by the NSF Division of Undergraduate Education

The Study of Chemistry by Guided Inquiry Method Using Microcomputer-Based Laboratories

by Mary Ann Durick

edited by

Susan H. Hixson
National Science Foundation
Arlington, VA 22230Richard F. Jones
Sinclair Community College
Dayton, OH 45402-1460

The National Science Foundation gave a two-year grant to Bismarck State College for The Study of Chemistry by Guided Inquiry Method Using Microcomputer-Based Laboratories. Bismarck State College (BSC), a member of the North Dakota University System (NDUS), is a comprehensive two-year community college with approximately 2800 students. The results have been extraordinary, beginning with the college modernizing its chemistry curriculum and labs by introducing guided-inquiry-based instructional methods.

Computer-Interfaced Laboratory Experience

Through the acquisition of scientific and computing equipment, the college was able to integrate computer-interfaced equipment into its chemistry labs, providing students new opportunities. BSC students now use more current technology that provides practical experience with computational data acquisition and analysis. Students can conduct practical laboratory experiments as freshmen when they independently perform experiments such as water analysis. Students entering the workforce improved their technical literacy by using these computer-interfaced laboratory systems. Finally, students have the opportunity to design and conduct experiments that verify theory. This approach is widely used in the general chemistry "Project Lab". High school teachers also used the technology, when taking workshops on the BSC campus.

This Instrumentation and Laboratory Improvement (ILI) grant also benefited the students enrolled in all physical science classes, who have used this equipment. Because of the decreased cost of computers at the time of purchase, BSC used the savings to equip Vernier interface systems¹ for physical science classes to perform a variety of experiments in data collection and analysis. This allowed most science students at all levels at BSC to gain experience with more modern technology.

An unexpected outcome of this NSF grant was the development of a Tropical Biology course in which the students' classroom has been the field in Costa Rica, where they use the Vernier sensors and portable programmable calculators.

Outreach Programs

Because of the availability of computers and interfaced systems, the opportunity for outreach programs is tremendous, but not just for BSC. For the past two years, equipment purchased with NSF funds, supplemented by Eisenhower money, has been used to provide workshops for science teachers at all levels throughout the state of North Dakota. This is an extremely important benefit because many

small rural schools lack this kind of technology and do not have the money to purchase it. The Eisenhower workshops train teachers to use Labworks² and Vernier systems on the BSC campus. One of the BSC instructors visits the schools to reinforce their use. In addition, the ILI grant has made possible the purchase of laptop computers so that complete Vernier or Labworks interfaced systems can be loaned to rural schools for limited periods.

The faculty at BSC are particularly proud of this opportunity to train science teachers across the state. Neither the training nor the technology was available before the ILI grant. Many teachers return to the workshops year after year, and because communication is active and ongoing, the workshops are designed to meet their needs. The Eisenhower workshops were originally designed for high school chemistry teachers, but because of popular demand, the technology training has been expanded to science teachers at all levels. This is a very successful program, and an additional week has been added to the workshop because of the demand. The Eisenhower Grant has been awarded for the third consecutive year.

Vocational Technical Programs

Vocational technical students use the laboratory technology under two programs unique to Bismarck State College, Power Plant Technology and Process Plant Technology. The programs are popular because most of its students are immediately hired by the regional and national power industry at handsome salaries. Students enrolled in these programs often take a Survey of Chemistry class, their work involving analysis of feed water and boiler water and using computer-interfaced technology and Hach kits³ for water analysis, as needed in the power industry. This chemistry class is extremely useful and relevant.

Exposure to computer-interfaced laboratory experiments has been especially important for students in the Clinical Laboratory Technician Program (CLT). CLT students now have the opportunity to perform clinical chemistry experiments similar to those they would find in a clinical setting. After CLT students complete the program, they are expected to be familiar with computer-interfaced instrumentation, such as data collection from spectroscopy. BSC now provides that experience.

Project Lab

Freshman general chemistry students now have the unique opportunity to work independently for one-half semester on water analysis using several analytical methods for

each parameter, on a project called "Project Lab". Each team of students presents its results to fellow students in a PowerPoint presentation at the end of the project. Students enjoy this laboratory experience and spend a great deal of time in the laboratory. Their PowerPoint presentations are impressive. The Project Lab was so successful that the BSC chemistry faculty presented a poster titled "Practical Freshman Labs That Support Theory" at the Spring 2000 ACS National Meeting in San Francisco in the Division of Chemical Education poster session. Frank Koch presented the results from this NSF grant at the 16th Biennial Chemical Education Conference in Ann Arbor, Michigan, in August 2000 and at the Chemical Education Section of the Great Lakes Regional ACS meeting held in Fargo, ND, summer 2000, where he generated a tremendous amount of interest in faculty at other two- and four-year colleges and universities in the state. Koch was invited to give a workshop on water chemistry in collaboration with North Dakota State University's "Next Step Proposal", a grant on innovations in math and science education for the institutions of the North Dakota University System and the five tribal colleges within the state,⁴ so that all can consider adopting these methods in their chemistry classes.

The National Science Foundation granted new opportunities not only for BSC's students, but also for secondary school students, especially those in rural areas. Faculties from middle school to the university have benefited, too. The National Science Foundation encouraged and supported BSC,

and the faculty there strongly recommend that other community colleges participate in NSF programs.

Notes

1. Vernier Software and Technology, 13979 SW Millikan Way, Beaverton, OR 97005-2886; phone: 503/277-2299; fax: 503/277-2440; *info@vernier.com*; *www.vernier.com*.
2. Lab Works, SCI Technologies, 105 Terry Drive, Suite 120, Newtown, PA 18940; phone: 800/421-9881; *info@scitechnologies.com*; *www.scitechnologies.com*.
3. Hach Company, P. O. Box 389, Loveland, CO 80539-0389; *www.Hach.com*.
4. Colleges and universities in the North Dakota University System are North Dakota State University, University of North Dakota, Minot State University, Dickinson State University, Mayville State University, Valley City State University, Bismarck State College, Lake Region State College, North Dakota State College of Science, Williston State College, Minot State University, Bottineau Campus. The tribal colleges in the state are Sitting Bull College, Turtle Mountain Community College, Fort Berthold Community College, Cankdeska Cikana Community College, and United Tribes Technical College.

Mary Ann Durick teaches in the Department of Physical Science, Bismarck State College, Bismarck, ND 58501; MDURICK@gwmail.nodak.edu