BioQUEST Notes

Volume 12 Number 2 | *A publication of the BioQUEST Curriculum Consortium* | Spring 2003

Items Of Special Interest In This Issue:

Using the 3 P's Approach and a Computer Simulation to Teach Science Process Skills

Rosalina V. Hairston and Aimée T. Lee
Department of Biological Sciences
University of Southern Mississippi

Introduction

The 3 P's approach formulated by BioQUEST introduces students to the processes of acquiring knowledge in science. The approach, which consists of Problem Posing, Problem Solving, and Peer Persuasion, engages students to generate questions, formulate hypotheses, design experiments, collect, organize, and interpret data, and communicate findings to peers. This is an empirical method of knowing about science. On the other hand, there are some problems in science that pose complications, such as, time duration, space, and complexity of experimental design. The emergence of educational technologies such as database and computer simulations offers possibilities to solve these types of problems.

continued on page 13

E^5

Enabling Exploration for Everyone, Everytime, Everywhere: Collaboratories, Digital Libraries, and Computational Biology Education

BioQUEST Summer Workshop 2003 Beloit, Wisconsin, May 31-June 3

John R. Jungck,
Beloit College and BioQUEST Curriculum Consortium

Thirty professors from twenty states will join BioQUEST Curriculum Consortium staff and Advisory Board members for a workshop designed to address the role of "Collaboratories, Digital Libraries, and Computational Biology" in biology education. The primary purpose of this workshop is to look ahead to the challenges and opportunities afforded by rapid changes in our technology, the social interactions associated with and enhanced by that technology, and the potential for "Enabling Exploration for Everyone, Everytime, Everywhere."

continued on page 6

Presentations and Representation

November

- SWOF: Scientific Workspaces of the Future, November 13, Argonne National Laboratory, Argonne, IL
- National Science Teachers Association (NSTA), *Using Investigative Cases in Introductory Biology*, November 14-17, Portland, OR
- SC2002: High Performance Networking and Computing Education Program, November 17-22, Baltimore, MD
- SC2002: EdGrid Panel, November 17-22, Baltimore, MD
- Committee on Undergraduate Science Education, *Evaluating Undergraduate STEM Programs*, November 19-22, National Research Council, Washington, DC

December

- 2002 American Society for Cell Biology (ASCB) Annual Meeting (42nd), Cell Biology Education Editorial Board meeting, December 14-18, San Francisco, CA

January

- LifeLines Workshop, *Investigative Case Based Learning*, January 4, Edison Community College, Fort Myers, FL
- Innovative Science Teaching - Enhancing Learning with Technology, January 4-10, DePauw University, Greencastle, IN
- BEDROCK Workshop, *Computational Molecular Biology and Molecular Bioinformatics III*, January 6-10, Suranaree University of Technology, Nakhon Ratchasima, Thailand
- Joint Mathematics Meeting: Panel, *The Intersection of the Life Sciences, Mathematical Sciences, and Computer Science*, January 15-18, Baltimore, MD
- Association for the Education of Teachers in Science (AETS) Annual Meeting, *Implementing Case Based Learning with High School and College Teachers*, January 31, St. Louis, MO

February

- Midwest Instructional Technology Center (MITC) Geographic Information Systems (GIS) Workshop, *Inquiry-Based Learning through GIS Analysis of Campus-Based Biocomplexity*, February 8, University of Chicago, Chicago, IL
- American Association for the Advancement of Science (AAAS) Annual Meeting, *Educating the Next Generation: Making Science Relevant to Undergraduates*, February 13-18, Denver, CO
- National Center for Case Study Teaching in Science, *Case Studies Teaching in Science*, February 15, Carroll College, Waukesha, WI
- Meeting the Challenges in Emerging Areas: Education across the Life, Mathematical and Computer Sciences, February 27-March 1, Bethesda, MD
- Instructional Technologists at Liberal Arts Colleges: Exploring Our Dynamic Roles, February 27-March 1, Ann Arbor, MI

March

- Partnership for Advanced Computational Infrastructure (NPACI) All-Hands Meeting, *Inquiry-Based Learning through GIS and Computational Analysis*, March 18-21, University of California, San Diego, CA
- BEDROCK Workshop, *Bioinformatics in the Undergraduate Curriculum*, March 21-22, Dickinson College, Carlisle, PA
- National Association for Research in Science Teaching (NARST) 2003 Annual Meeting, *Excellence in Science Teaching for All*, March 23-26, Philadelphia, PA
- National Science Teachers Association (NSTA) national convention, *Resources for Investigative Case-based Learning*, March 27-30, Philadelphia, PA
- The 13th Annual Girls and Women in Science Conference, *Elements to Elephants: Science is Everywhere*, March 28-29, Beloit College, Beloit, WI

April

- On the Cutting Edge Workshop: Teaching Biocomplexity in the Geosciences, *Biocomplexity in Undergraduate Education*, April 2-6, Montana State Univ., Bozeman, MT
- Virginia Community College System (VCCS) New Horizons Conference, *Building Learning Communities*, April 3-5, Virginia Community College, Roanoke, VA
- BEDROCK Workshop, *Bioinformatics in Biology Education: Working with Sequence, Structure and Function*, April 3-6, Univ. of Vermont, Burlington, VT
- Council on Undergraduate Science Education (CUSE) Committee Meeting, April 11-13, Irvine, CA
- Alliance (PACI) All Hands Meeting, April 30-May 2, Univ. of Illinois, Champaign-Urbana, Champaign, IL

May

- NSF - Chautauqua Short Course, *Evolutionary Bioinformatics Education: A BioQUEST Curriculum Consortium Approach*, May 14-16, Clark Atlanta University, Atlanta, GA
- 10th Anniversary of the ASM Undergraduate Education Conference, May 16-18, University of Maryland, College Park, MD
- BioQUEST Workshop, *Enabling Exploration for Everyone, Everytime, Everywhere: Collaboratories, Digital Libraries, and Computational Biology Education*, May 31-June 6, Beloit College, Beloit, WI

2003 FACULTY DEVELOPMENT PROGRAM

NSF SHORT COURSES FOR COLLEGE TEACHERS

www.chautauqua.pitt.edu

CHAUTAUQUA

Evolutionary Bioinformatics Education: A BioQUEST Curriculum Consortium Approach

John R. Jungck and Sam Donovan

May 14-16, 2003, Atlanta, GA

Course Overview:
The short course will focus on several different ways that the analysis of molecular data is being applied to solve current biological problems in areas such as medicine, agriculture, conservation, and evolution. The relationships between evolutionary theory and the analysis of molecular sequence and structure data will be addressed. A wide range of subdisciplines that use bioinformatic analysis will be drawn upon. The focus will be on learning about the causal bases for bioinformatic analyses along with a philosophy of education: problem posing, problem-solving, and peer review/publication (BioQUEST's three P's).

For:
- Biologists who are interested in implementing bioinformatics across their biology curriculum by incorporating bioinformatics into a variety of courses
- Mathematicians and computer scientists who are already involved in teaching bioinformatics or computational molecular biology and want to interact with biologists

The short course serves several purposes:
- As a learning resource for faculty across the biological sciences who are interested in developing their understanding of the biological (as compared to the computational or mathematical) aspects of bioinformatic analyses
- As a forum for undergraduate teachers of bioinformatics to collaborate in the development of biology or bioinformatics courses and/or curricula
- As an opportunity for developing undergraduate research programs in bioinformatics

BEDROCK Bioinformatics Education Dissemination: Reaching Out, Connecting and Knitting-Together

Citrus Canker Case Study Developed in Lifelines OnLine Workshop

Ethel Stanley, BioQUEST Curriculum Consortium

Brainstorming during the citrus canker case generated enthusiastic responses. Who says learning isn't fun?

Faculty members from Edison Community College met on January 6, 2003 at the Lee Campus in Fort Myers, Florida for a LifeLines workshop entitled Implementing Investigative Case Based Learning (*http://bioquest.org/lifelines/ECCWorkshop.html).* Margaret Waterman, Ethel Stanley, and Linda Weinland introduced cases developed by past LifeLines participants (*bioquest.org/lifelines*) and facilitated group work with an investigative case on citrus canker. Individual case writing experience for participants was limited, but most faculty drafted a case based on a topic they wanted students to investigate in one of their own courses.

The citrus canker case "Family Trees" was first proposed by Linda Weinland and then co-developed with Peter Woodruff and Margaret Waterman during the June 2002 Biocomplexity Workshop held at Beloit College. The case was read aloud and *Know/Need to Know* information was quickly generated by the participants who included a master gardener who was familiar with current control protocol, a homeowner who had a "sentinel tree" located on her property, and an anatomy and physiology professor with a penchant for reading about *Xanthomonas*. One new case resource, a collection of citrus products from the local supermarket, was used to emphasize global issues involved with citrus. Participants engaged in a lively discussion and quickly produced a series of questions for investigation.

The group considers the options for controlling citrus canker and what they need to find out before they can choose one.

A quick scan of the labels reveals the origin of these citrus products to include Florida, California, Texas, Mexico, Brazil, Argentina, Curacao, Portugal and China. (Yes, oranges do grow outside of Florida!)

Cardiovascular Function Lab
Now Available for Field Testing

The *Cardiovascular Function Lab (CFL)* is a software simulation that explores how the heart performs as a blood pump and how changes in the physiological environment can alter its performance. *CFL* is a completely redesigned version of the *Isolated Heart Lab (IHL)* simulation, with a new interface, additional models, and expanded compatibility with both Macintosh (OS X only) and Windows computers.

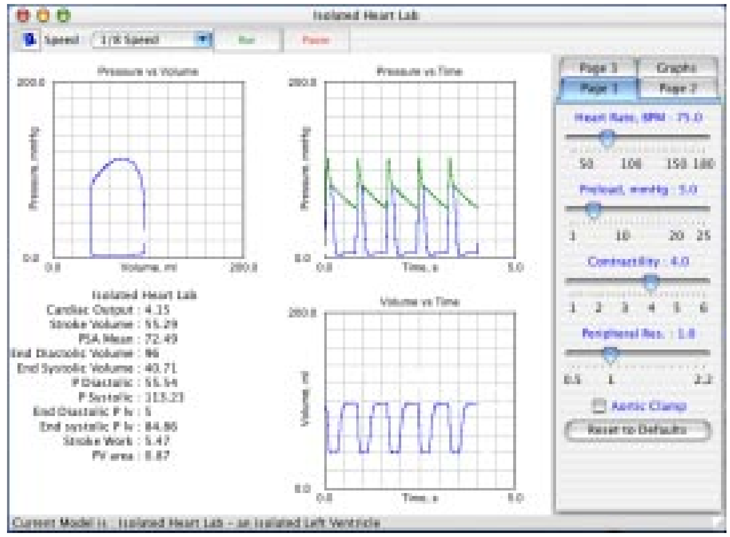


Figure 1. The Isolated Left Ventricle model, showing some of the input parameters that can be varied. Additional parameters are available on page 2 and page 3 of the parameter display.

The *CFL* simulation includes two models, the original "Isolated Heart Lab" (Figure 1), which models an isolated left ventricle, and a new "Closed Circulation Lab" (Figure 2). The "Closed Circulation Lab" models the entire circulatory loop–left ventricle, peripheral circulation, right ventricle, and pulmonary circulation.

Both models include numerous input parameters that can be controlled by the user. Some of these parameters are shown in Figures 1 and 2. By manipulating these physiological variables, students can design experiments to investigate a variety of questions concerning how changes affect the performance of the heart.

The *Cardiovascular Function Lab* is a new release that has just become available and has not yet been tested in the classroom. By becoming a field tester for this software, you and your students can provide the feedback essential to the creation of quality educational software. **In addition, you will have the opportunity to use *CFL* in your classroom for one year at no cost.** See below for additional details.

How do I become a field tester?

Field testers for the *Cardiac Function Lab* will have free use of the application in the classroom for up to one year. The application may be used with more than one class and can be installed on multiple computers. In return, field testers agree to provide student response, instructor concerns, and other feedback, including an evaluation of the module at the end of the test period. After submitting the final evaluation, testers will be given the opportunity to **purchase the full BioQUEST Library at a 50% reduction in the price.**

In addition to the *Cardiovascular Function Lab*, many other modules in the *BioQUEST Library* are also available for field testing. If you are interested in field testing *CFL* or one of the other BioQUEST modules, or if you would like more information about the field test process, please contact:

Virginia Vaughan
Managing Editor, The BioQUEST Library
vvaughan@hamilton.edu

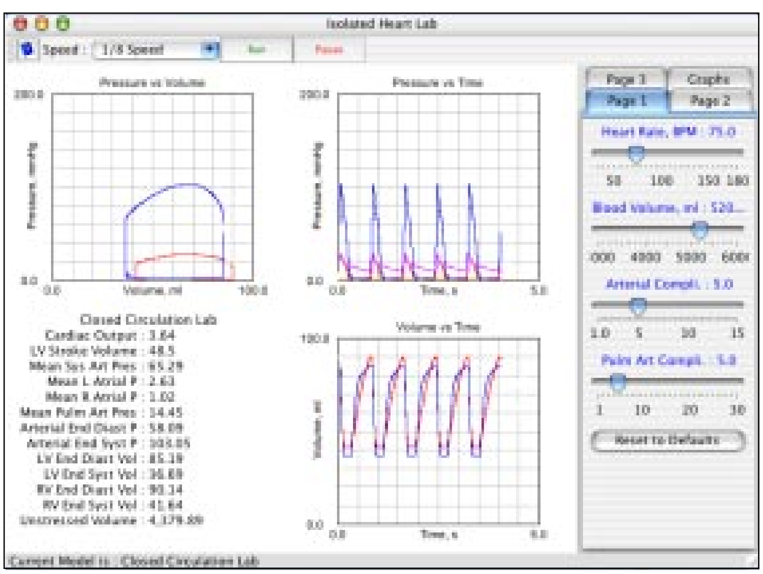


Figure 2. A sample screen from the Closed Circulation Lab.

BioQUEST Workshop

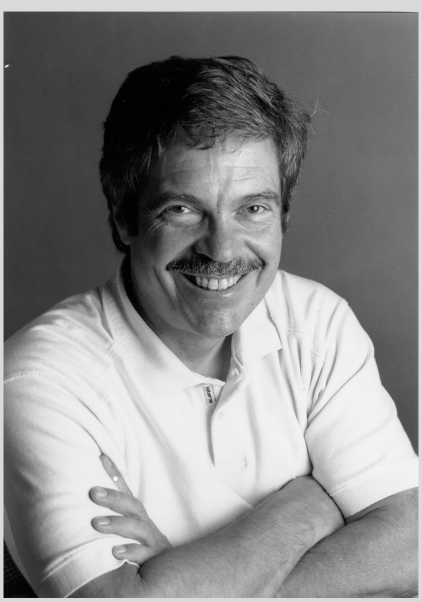
from page 1

We will begin by looking back at BioQUEST's seventeen years of design philosophy. This philosophy has been based on empowering learners to engage in the science research strategies of problem posing, problem solving and peer reviewing/persuading while simultaneously adopting pedagogical strategies of collaboration, communication, and computation in their use of powerful, open-ended problem-solving environments. On Saturday, May 31, Virginia Vaughan, Managing Editor of the BioQUEST Library for the past thirteen years and one of our principal software developers, will lay out the design criteria that we have employed for nearly two decades. In addition, she will describe how these were used as criteria by our Editorial Board to select quality undergraduate educational simulations and tools (the "QUEST" in BioQUEST) for publication and recognition in *The BioQUEST Library*. After her introduction, participants will have the opportunity to explore the use of several different kinds of BioQUEST modules in six different labs: (1) strategic simulations; (2) investigative case base studies; (3) real-time data acquisition, digital video microscopy, and image analysis; (4) bioinformatics; (5) digital library of primary data (Galapagos finches); and (6) biocomplexity and GIS/GPS applications. While the short time will be inadequate to explore any topic or module in depth, we hope that this showcase will provide a common experience that can inform the ensuing discussions. Following the software exploration, BioQUEST staff members Ethel Stanley, Sam Donovan, Robin Greenler, and John Greenler will join Virginia Vaughan in celebrating and critiquing this legacy. We will invite participants to help us adjust to contemporary challenges in maintaining and adding to a high quality collection of over eighty different modules that span the breadth of biology.

Our keynote speaker, Alan Kay, is well known for the idea of personal computing, the conception of the intimate laptop computer, inventor of the now ubiquitous overlapping-window interface and modern object-oriented programming, and developer of the smalltalk programming language. He has over thirty years experience in promoting creative use of computers, the importance of biology and mathematics, and the ability of students to rise to exceptionally challenging work if provided appropriate tools, sufficient freedom, and personal respect. He will describe enormous new opportunities for utilizing technology in very different ways.

On Sunday, June 1, we will focus on collaboratories and

continued on next page



Alan Kay

Before going into computing, Alan Kay was first educated as a molecular biologist, mathematician, and a musician; his undergraduate degrees were in mathematics and molecular biology at the University of Colorado. In 1969, he received his doctorate with distinction from the University of Utah for the development of a graphical user interface for a personal computer. (When did you get your first one?) He plays a variety of instruments and has collected some distinctive musical instruments including a classical pipe organ. He has been a professional jazz guitarist, a composer, and a theatrical designer. Thus, a virtuso! Currently he is a member of the National Research Council's Committee on Undergraduate Science Education, a Disney Fellow, and the head of the Squeak project to develop software that fosters childrens' learning (*www.squeakland.org*). Formerly, Alan was Vice President of Research and Development of the Walt Disney Company, a founder of the Xerox Palo Alto Research Center (where "he led one of the groups that in concert developed these ideas into modern workstations (and the forerunners of the Macintosh), Smalltalk, the overlapping window interface, Desktop Publishing, the Ethernet, Laser printing, and network 'client-servers'"), and a member of the University of Utah ARPA research team that developed 3-D graphics and designed the forerunner of the Internet, ARPANet. His numerous honors include the ACM Software Systems Award and the J-D Warnier Prix D'Informatique. Alan is a Fellow of the American Academy of Arts and Sciences, the National Academy of Engineering, and the Royal Society of Arts. Yet for all this, he still says that he is primarily driven by a "deep interest in children and education" and that these were "the catalyst for these ideas … [as well as] continuing to be a source of inspiration to him."

digital libraries. Neither sort of computational environment existed seventeen years ago when the BioQUEST Curriculum Consortium began. Today they are foundational in both the National Science Foundation's and the National Research Council's visions for the role of technology in undergraduate science, mathematics, engineering, and technology education.

Collaboratories

The term "collaboratory" was invented by William Wulf, President of the National Academy of Engineering, in 1989. Readers are recommended to examine two publications of the National Academy of Science: *National Collaboratories: Applying Information Technology for Scientific Research*, 118 pages, 1993, ISBN: 0-309-04848-6, Library of Congress Catalog #93-083795, and *Collaboratories: Improving Research Capabilities in Chemical and Biomedical Sciences: Proceedings of a Multi-site Electronic Workshop,* North Carolina Board of Science and Technology and National Research Council, 58 pages, 8.5 x 11, 1999, ISBN 0-309-06340-X.

BioQUEST was greatly influenced in our thinking about collaboratories by consultation with Daniel C. Edelson, developer of The Collaboratory Notebook Project at Northwestern University. As he wrote in 1995

> " The vision of networks enabling new forms of collaborative, open-ended learning activities is supported by recent educational research which focuses on the value of collaboration and of open-ended activity for learning. In science learning, open-ended activity often takes the form of project or inquiry-based learning in which learners conduct their own research on an open-ended question. Because learners acquire knowledge in context and employ that knowledge in pursuit of their goals when they are engaged in inquiry-based learning, they retain their knowledge in a form that lends itself to use in the future when it will be useful. In collaborative learning, distributed expertise and multiple perspectives can enable learners to accomplish tasks and develop understandings beyond what any could achieve individually. In addition, the communication that is required to support collaboration forces learners to articulate their understanding in ways that help them to organize their knowledge and acknowledge gaps in their understanding.
>
> As appealing and well-grounded as this vision is, it remains difficult to implement in practice. It is difficult to achieve because active learning and collaboration are complex behaviors that students need to learn, and because these behaviors go against the traditional culture of our educational institutions. Therefore, it is necessary to provide students with new educational environments that allow them to learn through (the same time they are becoming competent) collaborative, open-ended inquiry."

So, while the term collaboratory was coined in the context of national research laboratories, the distinctive potential of contributing to the collaborative learning process and promoting a collective virtual work/learning space was immediately recognized as a powerful educational tool. In this way, the collaboratory becomes a distributed research center enabling researchers, faculty, <u>and</u> students to combine knowledge, efforts, and levels of expertise to contribute to the overall synergy of a project. The collaboratory environment can be applied to diverse disciplines, a broad spectrum of technical and theoretical sophistication, and a wide array of institutions and styles of research.

In addition to the collaboratory web sites listed on page 8 and the original conception by Wulf and others, there has already been anthropological and social analysis of the impact of collaboratories and other technologically assisted collaboration among scientists. For a particular example, see *Coordination Theory and Collaboration Technology* (Volume in the Computers, Cognition, and Work Series)" by Gary M. Olson (Editor), Thomas W. Malone (Editor), John B. Smith (Editor), Lawrence Erlbaum Associates (June 2001), ISBN: 0805834036. They reported that the development of collaboratories allowed more junior level scientists (such as graduate students, post-docs, and assistant professors) to actively participate in research in areas where usually in the past only the senior investigators could play. For example, scientific work in and travel to exotic places such as Greenland and Antarctica precluded almost all but an elite few. However, with the development of remote sensing, public databases, and collaboratories, these areas of science have become much more democratized. The BioQUEST Curriculum Consortium seeks to explore how collaboratories could be extended to include undergraduates explicitly and often. Classroom and institutional barriers to serious scientific collaboration between and amongst undergraduates taking courses all over the US need to be overcome sociologically, culturally, and technologically such that students are: (1) empowered with access to colleagues, powerful technologies and data collection from remote sites; and, (2) less isolated in individual classrooms in individual institutions that screen them off from inclusive cultures and peer review of students with great variation in perspectives, disciplinary backgrounds, and talents.

continued on page 10

Collaboratories

The EMSL Collaboratory

<http://collaboratory.emsl.pnl.gov/docs/collab/index.html>

Development of the EMSL Collaboratory is a symmetric collaboration between computer scientists, domain scientists (physical and biological sciences), and sociologists. The Collaboratory relies on the development of new communications technologies - shared computer displays, electronic notebooks, virtual reality collaboration spaces - and an integration of these technologies with current videoconferencing and email capabilities.

Another necessity is the integration of these communications technologies with scientific resources such as instruments, data, analysis software, and the scientific literature. Researchers using these tools will need to change their current processes to take advantage of these tools to enhance existing collaborations. They must also discover new ways of sharing tasks between distributed collaborators that will make the best use of individuals' expertise and time.

Scientific Workspaces of the Future Grid Based Visualization and Collaboration Services

<http://www.mcs.anl.gov/fl/research/SWOF>

The Scientific Workspaces of the Future (SWOF) forms partnerships between technology developers and end users in order to deploy and further develop next-generation collaborative and network based scientific visualization tools and systems for distributed communities. A primary focus is to develop and deploy user level tools that will enable significant use of the TeraGrid for collaborative science and distributed visualization. SWOF is a project of the Partnership for Advanced Computational Infrastructure (PACI).

Research Collaboratory for Structural Bioinformatics (RCSB)

<http://www.rcsb.org/index.html>

The Research Collaboratory for Structural Bioinformatics (RCSB) is a nonprofit consortium dedicated to improving our understanding of the function of biological systems through the study of the 3-D structure of biological macromolecules. RCSB members work cooperatively and equally through joint grants and subsequently provide free public resources and publications to assist others and further the fields of bioinformatics and biology.

BEDROCK Collaboratory

<http://www.bioquest.org/BEDROCK>

The BEDROCK Collaboratory will focus on providing an evolutionary bioinformatics workplace around open-ended problems with online tools for collaboration, raw and analyzed data sharing, multiple working hypotheses, virtual poster sessions, peer review, and investigation. Since we are early in the funding cycle of this project, participants will have an important role in shaping the design of this collaboratory so that it serves them and their students well.

AAEM TelePresence Microscopy Site Materials MicroCharacterization Collaboratory

<http://tpm.amc.anl.gov/TPMSelect.html>

The AAEM/TPM project is an ongoing R&D effort at Argonne National Laboratory to provide live video imaging and remote control of unique scientific instrumentation for collaborative research and teaching. Standard WWW browsing tools, such as NCSA Mosaic and its derivatives, do not provide the capabilities of presenting live video rate images from this site, nor the ability to operate instruments by remote control over the Internet. This WWW site will provide you with STILL video images which are automatically updated at preset intervals. You can envision how TPM would act on your workstation if you imagine each of the following images to be a TV rate image which is constantly updating without your intervention, rather than one which is updated every few minutes.

The AAEM/TPM project team is developing and will be providing tools for the scientific community in order to facilitate interactive real time collaborations on state-of-the-art research equipment such as the Advanced Analytical Electron Microscope (AAEM) system which is one of two TPM test bed sites at Argonne National Laboratory. You are welcome to monitor on this site for periodic updates on the project, or subscribe to the Microscopy & Microanalysis email Listserver(*Listserver@MSA.Microscopy.Com*) to be kept up to date on TPM. Please note that the Microscopy Listserver serves the world wide microscopy community on all aspects of microscopy and microanalysis.

continued on page 11

Digital Libraries Focusing on Science Education

BioSciences Network

<http://www.biosciednet.org/>

The BEN Collaborative, spearheaded by the American Association for the Advancement of Science (AAAS) and composed of 11 professional societies and coalitions for biology education, is developing a revolutionary approach for transforming biology teaching and learning in undergraduate and graduate institutions, as well as in professional schools.

Through the development of a BEN portal site, the BEN Collaborative is providing searchable and seamless access to the digital library collections of its Partners to provide users with accurate and reliable biology education resources.

Resources accessible through the site will impact the learning of the biological sciences by students with diverse interests and career aspirations. The materials will be collected and maintained by respected professional societies representing a broad spectrum of biological sciences. Over 680 resources covering forty-six biological sciences topics and twenty-five different types of resources ranging from journal articles to simulations from the AAAS, American Physiological Society, American Society of Microbiology, Ecological Society of America, and Society of Toxicology are now available

Biology Education Online

<http://www.accessexcellence.org/LC/BEOn/>

BEoN, a National Science Foundation (NSF) funded project of the National Association of Biology Teachers (NABT) and Access Excellence at the National Health Museum (AE@NHM) is a part of the National Science Technology, Engineering and Mathematics Education Library (NSDL). This peer reviewed e-journal is by and for those teaching K-16 life sciences.

Mathematical Sciences Digital Library

<http://www.mathdl.org/>

This is an online resource with funding by the National Science Foundation. The Library is hosted by the Math Forum. The site provides online resources for both teachers and students of collegiate mathematics, including:

- A new MAA publication, the Journal of Online Mathematics and its Applications (JOMA)
- A catalog of mathematics commercial products, complete with editorial reviews, reader ratings and discussion groups
- Digital Classroom Resources, a collection of mathematics instructional material with authors' statements and reader reviews

Digital Library for Earth System Education

<http://www.DLESE.org/>

DLESE is a grassroots, community-based effort involving teachers, students, and scientists working together to create a library of educational resources and services to support Earth system science education, at all levels, in both formal and informal settings. DLESE resources include electronic materials for both teachers and learners such as lesson plans, maps, images, data sets, visualizations, assessment activities, curriculum, online courses, and much more. Sponsored by the National Science Foundation, DLESE is being designed, built, and governed by community members from around the country. To this end, the DLESE Steering Committee has developed the DLESE Strategic Plan. DLESE supports Earth system science education by providing:

- Access to high-quality collections of educational resources
- Access to Earth data sets and imagery, including the tools and interfaces that enable their effective use in educational settings
- Support services to help educators and learners effectively create, use, and share educational resources
- Communication networks to facilitate interactions and collaborations across all dimensions of Earth system education

Science Math, Engineering Technology Education

<http://www.smete.org/>

The SMETE Digital Library is a dynamic online library and portal of services by the SMETE Open Federation for teachers and students. Here you can access a wealth of teaching and learning materials as well as join this expanding community of science, math, engineering and technology explorers of all ages. If you're a student, you'll have access to resources that can help you prepare for a class or exam. If you're a teacher or professor, you can find learning materials you can use in your classroom right away. SMETE opens up the worlds of

continued on page 11

James Myers

Dr. James D. Myers is a Senior Research Scientist leading the Collaboratory Development Group in the Computing and Information Sciences Department. He is a Principal Investigator on a Department of Energy (DOE) Distributed Collaborative Experiment Environment (DCEE) project and several internally funded projects to design, develop, deploy, and understand the use of the EMSL Collaboratory Software Environment and its integrated collaborative work tools. Dr. Myers joined the EMSL in 1993 to develop data acquisition, analysis, and visualization software for experimental chemistry projects. Soon after, he helped start research on an Environmental Molecular Sciences Collaboratory and is now leading the EMSL Collaboratory development efforts. He has experience in object-oriented software design, distributed computing, network and World Wide Web (WWW) communications, collaborative/groupware systems, and hardware interfacing, and is one of the designer/developers of the EMSL CORE software, including the EMSL Televiewer prototype, WebTour facility, and collaborative session management facilities. He is also a co-developer, at PNNL, of the EMSL Mercury software suite for the automatic extraction of biopolymer sequence information from mass spectra using fourier and wavelet-based analysis.

Dr. Myers has a Ph.D. in Chemistry from the University of California at Berkeley and a B.A. in Physics from Cornell University. His honors include being a 1996 Associated Western Universities Distinguished Lecturer.

BioQUEST Workshop

from page 7

Jim Myers, Chief Scientist who leads the Collaboratory Development Group at Pacific Northwest National Laboratory in Washington state, will introduce their collaboratory on remote usage of a high end nuclear magnetic resonance spectrometer in chemistry and environmental science. He is a principal investigator of several projects that are aimed at realizing the potential of the collaboratory approach for research and education. His work reflects the premise that research and education must and can be deeply linked (*http://collaboratory.emsl.pnl.gov*). Fundamentally, he believes that the opportunity to interact remotely with national and international resources will encourage the development of many new partnerships and will allow scientists and students access to powerful tools previously unavailable or unaffordable to them. Furthermore, he believes that the use of collaboratories will change scientific norms of sharing raw scientific data. If data is more readily shared and available, this will give scientists and students alike the opportunity to reanalyze published papers by going back to the original data and using tools such as statistical and mathematical modeling packages to evaluate authors' claims or extend conclusions. We recommend that you read his article published by the Council for Undergraduate Research: "Collaboratories: Bringing National Laboratories into the Undergraduate Classroom and Laboratory via the Internet", Jim Myers, Norman Chonacky, Thom Dunning, and Eric Leber, *Council on Undergraduate Research (CUR) Quarterly*, vol. 17, number 3, March 1997.

After his talk we will have the opportunity to explore the remote use of five different collaboratories and hear from their developers. Besides Jim Myers, we will hear from Terry Disz of the Futures Laboratory at Argonne National Laboratory and collaborator with Scientific Workplaces of the Future (SWOF); from Chris Smith, of the University of California San Diego's Supercomputer Center, on the Research Collaboratory for Structural Bioinformatics (RCSB); Nestor Zaluzec of Argonne National Laboratory on the TelePresence Microscopy/AAEM Collaboratories; and from Tia Johnson of the BioQUEST Curriculum Consortium's BEDROCK .

Again, after separate sessions with participants, all workshop leaders will reconvene to discuss their commonalities and differences.

Digital Libraries

Another Internet environment unavailable seventeen years ago, but foundational to contemporary science education, is the digital library. The power of digital libraries lies in their ability to effectively convene, organize and make accessible resources otherwise unavailable by virtue of their dispersion. Digital libraries rely on the extensive network, massive capacity and accelerated computational power available in current computing technology. For

continued on next page

Collaboratories

from page 8

Scanning Transmission Electron Microscope Remote STEM Control and Data Analysis Project

<http://bnlstb.bio.bnl.gov/biodocs/stem/interactive.html>

The goal of this Collaboratory proposal is to improve the efficiency and effectiveness of the biomedical science accomplished at the NIH-funded BNL STEM Research Resource. This not only includes gains in our productivity, but also improvements in the productivity of the research of our user/collaborators (simply referred to as users henceforth). Their users span a broad range of scientific interests, but they all foresee immediate benefits to their research from on-line, real-time interactions with the STEM facility.

Collaboratory Project

<collaboratory.nunet.net>

The Collaboratory Project is a Northwestern University initiative that provides project consulting, training, technical advice, and web-based resources and services to K-12 teachers and their students who are interested in using Internet technologies to advance education.

The Collaboratory is an easy-to-use, web-based collaborative environment that teachers use to develop project-based activities that are linked to Illinois Learning Standards.

Digital Libraries

from page 9

science, mathematics, engineering and technology education to teachers and students anytime, anyplace.

MERLOT

<http://www.merlot.org/Home.po>

MERLOT is a free and open resource designed primarily for faculty and students of higher education. Links to online learning materials are collected here along with annotations such as peer reviews and assignments. The MERLOT website is a tool that provides faculty with:

* Free access to a large collection of high quality, online teaching and learning materials
* Information to help them evaluate the quality and appropriateness of the academic technology for their students and learning objectives
* Examples of how to use specific academic technology in teaching and learning

American Society for Biochemistry and Molecular Biology

<http://www.asbmb.org/>

The American Society for Biochemistry and Molecular Biology is constructing a Biochemistry and Molecular Biology Digital Library. Check ASBMB's home page for information as the library becomes available.

BioQUEST Workshop

from previous page

science educators, digital libraries will make it much easier to find peer reviewed and student tested computer simulations, tools, databases, case studies, open-ended problems, tutorials, animations, etc. that have been difficult to find for a long time. While we are in the infancy of these portals, digital libraries are receiving significant support from the National Science Foundation because of the widespread agreement that with the avalanche of information on the world wide web, there is unanimous agreement for the need of these and other innovations in information searching, retrieval, and evaluation.

Our workshop segment focusing on the use of digital libraries in education will start off with a presentation by V. Celeste Carter, an NSF Program Director for the Division of Undergraduate Education. Celeste is the PI of the NSF funded project Cases in Industry Practice in Biotechnology (ATE Program) and a leader in NSF's National Science Digital Library (NSDL) program (*http://www.ehr.nsf.gov/ehr/due/programs/nsdl/*).

Dr. Celeste Carter from NSF will describe NSF's initiatives in attempting to build a comprehensive science, mathematics, engineering, and technology education digital library. A recent NSF document states: "These projects are working with those funded in fiscal years (FY) 2000 and 2001 to build a national digital library of high quality science, technology, engineering, and mathematics (STEM) educational resources for students and teachers at all levels, in both formal and informal settings. By supporting widespread access to a rich, reliable, and authoritative collection of interactive learning and teaching materials and associated services in a digital environment, the National Science Digital Library will encourage and sustain continual improvements in the quality of STEM

continued on next page

BioQUEST Workshop

from previous page

education for all students and also serve as a resource for lifelong learning."

Following Carter's presentation, participants will have the opportunity to explore and hear from developers of several digital libraries. The Digital Library for Earth System Education (DLESE) will be presented by David Mogk of Montana State University and Cathy Manduca, Science Education Resource Center at Carleton College. Marlene Kayne, College of New Jersey, will acquaint us with the Biochemistry and Molecular Biology Digital Library. MATHDL, a digital library of the Mathematical Association of America will be represented.

Digital libraries that focus on science educational materials are transforming the way science is experienced by students and teachers at all educational levels, in all educational settings. The BioQUEST Curriculum Consortium has collaborated with three different major partners in NSF's Digital Libraries Initiative (*http://www.dli2.nsf.gov/*). These three are the National SMETE Digital Library Program, BEN, the Biosciences Education Network and Biology Education Online and National Association of Biology Teachers. The aim of these digital libraries to collect, catalog, and evaluate science educational materials that are unavailable in standard libraries. Such items include educational software, online journal articles, web resources, etc.

Celeste Carter

Dr. V. Celeste Carter, a Program Director in the Division of Undergraduate Education (DUE) of the National Science Foundation, is on leave from Foothill College, Division of Biological and Health Sciences where she is the Biotechnology Program Director. She received a BA from University of California-Berkeley in Bacteriology and Immunology; MS from Harvard University in Microbiology and Molecular Genetics; and Ph.D. from Pennsylvania State University in Microbiology. Her recent awards include: Student Success Award (1997) from the Board of Governor's and Chancellor's Office of California Community Colleges; and the Outstanding Biotechnology Faculty Award (2000) from the Economic Development Network, California Community Colleges. From 1997 to the present she has been PI of the NSF funded project: Cases in Industry Practice in Biotechnology (ATE Program).

Conclusion

Most contemporary college and university students already have access to some of the most powerful technologies that humankind has ever known; a typical laptop computer exceeds the speed, storage, and visualization capabilities of supercomputers of their childhood. Yet we have not changed much of our biology education to either take advantage of these powerful tools nor have we changed our laboratories sufficiently to accommodate the potential for deeper investigation within much shorter periods of time than in the past. With miniaturization we can take a microcomputer with attached 200X microscope, GPS, and numerous sensors for pH, temperature, reflectance, absorption, etc. right out into the field instead of having to bring biological specimens from their natural context back into the lab. Students can work collaboratively either synchronously or asynchronously. In the future, students will have remote access to national treasures in terms of equipment (synchrotrons, laser confocal microscopes, scanning tunnel electron microscopes, etc.) that are currently only available through a small smattering of sites. Technological visionaries presume that each of you will employ an intelligent agent (read software) that will try to constantly scan massive amounts of literature for you that employs not only specific terms, but also indirect relatives to your current work and interests and even be able to filter by your tastes. New ideas like "copyleft" wherein authors declare that their work must remain publicly available without the strictures of copyright, open source software, participatory design, and collaboratory writing projects are totally transforming our prior expectations about access, equity, and authorship of peer reviewed published primary literature in science. Will we face similar issues of "the tragedy of the commons" in information environments that we have faced in our biotic environments? What educational challenges lie ahead? We already recognize that our students have grown up with radically different expectations about the availability of massive amounts of information, but so far they still struggle with evaluating material once they have found it. Furthermore, the ability of students to conduct original research in classroom laboratory settings will be possible, and they will be able to evaluate inferences made by authors better in the future as many data sets become available such as is already occurring with genomic, remote sensing, epidemiological, LTER, and weather data. Thus, the challenges of collaboratories, digital libraries, and new computational environments to biology education seem well worth considering.

Poster presentation of the students' research

Teaching Science Process

from page 1

The increasing availability of computer simulations that represent complex processes, and yet allow users to interact with the dynamics of a model system, creates a unique way of helping learners conceptualize (Windschitl 1996). Windschitl and Andre (1998) contend that computer simulations used in a constructivist approach afford learners the opportunity to freely create, test, and evaluate their own hypotheses in a more richly contextualized environment. Furthermore, a well-designed simulation allows learners to choose their mode of informational representation on the computer screen, and it allows them to develop hypotheses about phenomena that accommodate their way of solving problems (Windschitl and Andre 1998).

Using the 3 P's Approach and a Computer Simulation

In this article we describe the use of the 3 P's approach and a computer simulation to teach the science process skills to introductory college biology students. Using the 3 P's approach as the pedagogical principle and the computer simulation, LateBlight (Arneson and Ticknor 1990) as the instructional material, we engaged the students actively in the learning of science processes. The computer simulation in this study depicts the story of the potato famine in Ireland in the 1800s. The organism responsible for the famine is a fungus, *Phytophthora infestans* (McGraw 2000). The zoospores become airborne and attach to the potato foliage forming lesions, and then spread rapidly to the tubers. The severity of the pathogenic infestation, referred to as late blight, depends upon 1) weather conditions, 2) fungicide application, and 3) placement of discarded rotten potatoes. The pathogen grows best in cool (<24ºC), moist conditions (Fry and Goodwin 1997). When fungicide is applied to potato plants, the percentage of blighted tubers decreases (Stanley 1997). Because zoospores rapidly disperse in moisture, spores from infected tubers that have been discarded too close to the field may easily infect new potato foliage, thus spreading the pathogen.

The 3 P's approach was integrated in the tasks assigned to the students. The tasks for this activity included the following: (1) learning and using the LateBlight computer simulation, (2) conducting library and online searches, (3) formulating hypotheses, (4) testing the hypotheses, (5) making generalizations and conclusions, (6) preparing a poster presentation to be used in the discussion of the results of the experiment, and (7) critiquing and evaluating one another's poster presentations.

In this activity, problem posing involved formulating a hypothesis from the information obtained from literature searches and the problem scenario presented in the computer simulation. The students worked in groups to conduct library and on-line searches pertaining to late blight or *Phytophthora infestans*. The instructors guided the students in conducting electronic searches, answered questions about searches, helped students access web sites and viewed students' search results.

Problem solving engaged students to work in groups of four to form a testable hypothesis that would enable them to obtain a high net profit. The students manipulated variables such as weather, fungicide spray, harvest season and resistance level of potatoes. After the groups chose the variable to manipulate, the program generated graphs and reports of completed seasons. Students interpreted the graphs to draw conclusions and related them to the hypothesis they had formed.

The peer persuasion consisted of a poster presentation of the students' research. They were also required to write a scientific report following guidelines provided by the instructor. Students worked on their poster presentations over the span of two weeks. Each presentation contained

continued on next page

Students conducting on-line literature searches.

Teaching Science Process *from previous page*

the following sections: Introduction, Materials and Methods, Results, Discussion, and Literature Cited. During the presentations, each group of students stood by their poster while a designated reporter explained the experiment. A 15-minute time limit was enforced. The instructor and their classmates asked questions about the results of the experiment and evaluated the poster presentation using a rubric.

Upon completion of the presentations, students responded to a questionnaire designed to reveal their attitudes toward the use of computer simulations, poster presentations, cooperative learning, and the potential to apply what they learned about science process skills to another problem.

Student Attitudes

A. On a Computer Simulation

Student attitudes regarding the use of a computer simulation as a learning tool was generally positive. Students expressed the advantages of computer simulation in the following ways:

"You get results faster."
"It allowed us to run many different variables in a short time."
"It is a form of hands-on learning on variable manipulation."
"The use of this technology is great for learning methods of studying problems in science."

B. On Poster Presentation

Student attitudes regarding poster presentations reflected a variation of their responses that included:

"Poster presentations communicate results better."
"Visuals make me learn faster."
"Poster presentations are informative because I get to know the results from other groups' experiments."
"It is nerve wrecking."
"It is hard to schedule to work together as a group."
"I don't like public speaking."

C. On Cooperative Learning

Student attitudes regarding cooperative learning were generally positive. Their responses include:

"I enjoyed working as a team because I was able to work with more ideas contributed by members."
"There was better thinking on the problem."
"I like having different perspectives."
"The problem is a real life situation and working together to solve the problem built teamwork."

continued on next page

Teaching Science Process *from previous page*

"I understood better with help from group members."
"We got a lot more accomplished working as a group."
Those who had negative attitudes cited the following reasons:
"I prefer to work alone."
"The time schedule did not allow working together, thus, one person got stuck with the work."

Transfer of Learning

When questioned about subsequent investigations in which the students have to use their knowledge of science process skills, the majority of the students felt they would be able to apply what they learned to another problem. These students indicated that the knowledge they gained would enable them to test different variables in an experiment and better understand and enjoy working on an experiment. Some responses included:
"Now I know where to begin when conducting a science investigation."
"The lab activity in the computer simulation made me focus my thinking on the problem."

Later in the semester, the students conducted an open-ended investigation on plant growth and development. In this investigation, the students worked in groups of four and they used the 3 P's approach to identify the problem they would investigate, propose a solution by designing an experiment to manipulate the variables they believed affect the problem, and finally present their findings to communicate the knowledge they obtained from the investigation. They were required to write a scientific report which included an introduction, a statement of the problem and hypothesis, description of materials and methods, data presented in tables and graphs, accurate interpretation of the results, and citation of literature. This activity provided an objective indicator of student's ability to transfer the knowledge and skill about the processes of science learned with the computer simulation. From the instructors' evaluation of the students' reports on plant growth and development, 75% were able to write a satisfactory report.

Conclusions

A computer simulation is a powerful tool to enhance learning by providing opportunities for learners to develop skills in problem identification, seeking, organizing, analyzing, evaluating, and communicating information (Akpan 2001). The choices of different variables in the problem scenario of the Lateblight computer simulation allowed learners to work in cooperative learning groups using a variety of situations that resemble "real-life" problems. Students realized the benefits of cooperative learning in promoting positive interdependence, group accountability, and social interaction. However, group work has its drawbacks. Students who did not favor group work complained of the difficulty in scheduling meeting times. Despite minor drawbacks, students became aware of the nature of the work of scientists that they emulate in solving problems in the computer simulation. In addition, the 3 P's approach stimulated the students to experience a paradigm shift in their understanding of how science knowledge is acquired.

References

A 3 P's Approach to Science Education: Problem-posing, Problem-solving and Peer Persuasion. BioQUEST Curriculum Consortium. http://bioquest.org

Akpan, Joseph, P. (2001). Issues Associated with Inserting Computer Simulations into Biology Instruction: A Review of the Literature. Electronic Journal of Science Education 5(3): 1-32.

Arneson, Phil. And Ticknor, Barr, E. (1999). LateBlight. In Jungck, J. & Vaughan, V. (Eds.), The BioQUEST Library V, Vol. 5. San Diego, CA: Academic Press.

Fry, W. E., & Goodwin, S. B. (1997). Resurgence of the Irish potato famine fungus. Bioscience, 47 (6), 363 – 372.

McGraw, L. (2000). Potatoes' resistance to Late Blight may be in their Mexican genes. Agricultural Research, 48 (9), 8 – 9.

Stanley, D. (1997). Potatoes once again under fungal attack. Agricultural Research, 45 (5), 10 - 14.

Windschitl, M. (1996). Student epistemological beliefs and conceptual change activities: How do pair members affect each other? Journal of Science Education and Technology, 6, 24-38.

Windschitl, M., and Andre, T. (1998). Using Computer Simulations to Enhance Conceptual Change: The Roles of Constructivist Instruction and Student Epistemological Beliefs. Journal of Research in Science Teaching, 35, 145-160.

This study was supported by the National Science Foundation DUE-CCLI award # 9950724. Any opinions, findings, and conclusions are those of the authors and do not necessarily reflect the views of the funding agency.

The BioQUEST Curriculum Consortium

To contribute to the newsletter or to subscribe to *BioQUEST Notes*, please contact Robin Greenler, Editor (greenlrr @beloit.edu). For general information about the activities of the BioQUEST Curriculum Consortium, contact us at:

BioQUEST Curriculum Consortium

Biology Department
Beloit College
700 College Street
Beloit, WI 53511

(608) 363-2743
bioquest@beloit.edu
http://BioQUEST.org

Major support for BioQUEST development and activity has been provided by the Howard Hughes Medical Institute, the Annenberg/CPB Project and The National Science Foundation, with additional support from Apple Computer Inc., The Foundation for Microbiology, and The Center for Biology Education at the University of Wisconsin-Madison. Any opinions, conclusions or recommendations in these materials are those of the author(s) and do not necessarily reflect the views of the funding sources.

Beloit College
BioQUEST Notes
Department of Biology
700 College Street
Beloit, WI 53511

Non-Profit
Organization
U. S. POSTAGE
PAID
Beloit, Wisconsin
Permit No. 8