Project Statement

Ed Grid Report Home

The Educational Grid (EdGrid) Biology Student Workbench (BSW) project is a growing collection of enhancements to the Biology Workbench including tutorials and inquiry-based materials, all of which help students and teachers conduct meaningful investigations in molecular biology. The project specifically addresses a pre-service teacher audience, and it supports the use of the inquiry-based learning and teaching approach to science education. The project objectives (which are inter-related) are to:

- Develop inquiry-based bioinformatics curricula in collaboration and cooperation with the faculty and students in the teacher certification programs;
- Integrate the curricula into science and math methods courses;
- Disseminate the curricula nationwide;

The project differs from projects where some widely used technology (say, PowerPoint) is to be integrated into all teacher education courses. For example, Biology Workbench is developed for use by scientists everyday. Tools such as Biology Workbench are changing how scientists (specifically biologists) do their work. To facilitate student experiences in classrooms to reflect what biologists do, we have been pursuing a three-part agenda during the first year (October 2000 to October 2001) of this project.

First, we have been actively working to build a community of inquiry focusing on the bioinformatics. This community includes a

diverse audience, such as teachers, teacher educators, and biologists. Second, we are actively building tools that support the creation and adaptation of inquiry units by any learner in our community. Third, we are actively organizing and participating in workshops where we invite learners in our community to collaborate and cooperate with each other to adapt and/or develop bioinformatics materials using the Inquiry page to facilitate integration into courses.

Through our project activities and interactions with people in the community, we are learning that there are different ways to integrate bioinformatics into K-12 and undergraduate curricula. These include the preparation of web-based resources as well as workshops, presentations, papers, posters, and ongoing face-to-face and online interactions.

In the coming year, we will continue to expand the communities of participation and document the work and materials that are growing out of project activities.

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Biology Student Workbench: An Inquiry-Based Learning Environment for Pre-Service Teacher Education

Moving K-12 Teachers into 21st Century Science with 21st Century Technology
Building the Educational Grid for Pre-Service Training
EdGrid

Preparing Tomorrow's Teachers to Use Technology

Department of Education
Illinois State Board of Education
National Science Foundation

More about Ed Grid Funded Projects

This is collaborative project between:

University of Illinois - Urbana Champaign
National Center for Supercomputing Applications
Beloit College
BioQUEST Curriculum Consortiuim

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- **Develop inquiry-based bioinformatics curricula in collaboration and cooperation with the faculty and students**

Bioinformatics and Biology Education

BioQUEST

NCSA

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in the teacher certification programs;
- **Integrate the curricula into science and math methods courses;**
- **Disseminate the curricula nationwide**

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New Communities

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The project has actively worked to build an inquiry community. The members of this community include teachers (pre- and in-service), teacher educators, curriculum designers, biologists, bioinformatics researchers and education researchers, as well as schoolchildren and their parents. The community is a result of multiple workshops in the past year.

- Using the Internet to do Biological Inquiry: Adventures in Bioinformatics (November 11, 2000, Beloit College, WI)

  The workshop focus was exploring biology through bioinformatics. Over 30 workshop participants included schoolchildren and parents, teachers, and biology and education faculty (http://bioquest.org/bioinformatics/edgridworkshop.html). Participants had opportunities to pursue biological inquiry using bioinformatics research and analysis tools. Sam Donovan and Kathy Greene directed the workshop.

- Inquiry Workshop on Inquiry Teaching and Learning (February 21, 2001, University of Illinois at Urbana-Champaign, IL)

  The workshop focus was inquiry teaching and learning across K-12 grade-levels, institutions, and disciplines using the Inquiry Page (http://www.inquiry.uiuc.edu). Over 70 participants attended the workshop, which was directed by Chip Bruce. Sam Donovan and Kathy Greene shared the project materials. Additionally, two collaborating teachers (Paul Lock from Urbana High School in Urbana, IL, and Sue Herricks from Central Academy in Champaign, IL) shared their

classroom activities. The materials shared are accessible via the Inquiry Page. For example, the Inquiry Page features the Biology Workbench in its "Inquiry in Action" section (http://www.inquiry.uiuc.edu/action/bioworkbench/bioworkbench.php3).

- Biology Student Workbench Workshop: Integrating Bioinformatics into Biology, Science Education, Teacher Education, and Educational Technology Courses (August 3-5, 2001, Arlington, VA; August 3-4, 2001, University of Illinois at Urbana-Champaign, IL)

  The workshop focus was to bring together participants interested in integrating bioinformatics into their courses to engage students in inquiry learning and problem solving, and to support the adaptation and development of bioinformatics materials that participants can easily integrate into their courses (http://peptide.ncsa.uiuc.edu). The workshop was held at two sites (Access Center in Arlington, VA, and Beckman Institute in Urbana, IL). Over 40 participants attended the workshop at both sites. Pre-service and in-service teachers primarily attended the Beckman site, while a diverse audience that included teachers, teacher educators, biologists, curriculum developers, and education researchers attended the Access Center site. (Please see the attached participant lists.)

  The workshop was favorably received and included comments such as this from a pre-service teacher: "I want to try and incorporate this new technology [BSW] into my classroom as a future educator. New types of technology are a great plus in inquiry-based learning." All the project investigators directed the workshop. The workshop feedback is accessible (http://leep.lis.uiuc.edu/seworkspace/hbooth/AVERAGES.htm).

  News article about the workshop (http://access.ncsa.uiuc.edu/Stories/BroadBio/)

- Microbes Count: Problem Posing, Problem Solving and Peer Persuasion in Microbiology The BioQUEST Summer Workshop for Undergraduate Faculty (June 16-24, 2001, Beloit, WI)

  Interested in implementing new curricular resources in your undergraduate microbiology courses? Bioinformatics, digital libraries, and investigative case-based learning will be presented as well as the use of PC and MAC BioQUEST Library simulations, laboratory, and field resources designed to accompany the ASM "Unseen Life on Earth" video series. Faculty developed the following modules, … <http://bioquest.org/indexworkshop2.html>

- Bringing Bioinformatics to Biology Education: A Hands-on Workshop to Develop Labs for Introductory and Advanced Courses. A faculty development workshop co-sponsored by the Center for Science Education and Center for Behavioral Neuroscience at Emory University. Presented at Morehouse College, March 3 & 4, 2001.

- Informing Biology Education By Examining The Nature Of Evolutionary Inquiry. Presented as part of the Department of Biology Seminar Series on Science Education, University of Delaware, April 6, 2001.

- Bioinformatics Education Workshop (February 26, 2001), University of Wisconsin, Madison, Wisconsin.

  The workshop focus was to introduce bioinformatics education to student teachers in their secondary science methods course. The participants had opportunities to acquaint themseves with current issues associated with bioinformatics, to interpret raw sequence data and data representations, and to design an investigation using Biology WorkBench. Additionally, the participants discussed teaching and learning issues relevant to each section of the workshop, and completed a related homework assignment. One member of the class, Hillary Anderson, went on to prepare and teach a bioinformatics-rich HIV unit

at Monona Grove High School. Sam Donovan and Kathy Greene conducted this workshop.

Research notes on UW-Madison science methods work (http://bioquest.org/bioinformatics/EdGrid/uw_workshop.html)

Collaborative curriculum development with Hillary Anderson (anderson.html)

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New Directions

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As we continued our Biology Workbench efforts into teacher education, one of us (Bertram C. Bruce) identified a chain of use, which must not be broken if a technology is to be incorporated into teacher education. This chain includes at least the following:

- Teacher educator needs to understand and value the technology for her or his own use.
- Teacher educator needs to see the technology as one that can be "taught."
- Technology will not survive long in teacher education unless it is taken beyond the college classroom to the school.
- Finally, the technology must be one that students can use and learn from.

Although this chain is a simplified one, one consequence of insight about this was to see how the Biology Workbench is being integrated into high school biology curriculum. So, we decided to collaborate and cooperate with a high school biology teacher. (This classroom study is now part of an ongoing Ph.D. dissertation research by Jo Williamson under the guidance of Bertram C. Bruce. A paper about this research will be presented at the Internet Research 2.0 Conference.)

Another instantiation of this chain of use began at the November 11 workshop held at Beloit College and directed by Sam Donovan and Kathy Greene. Present were teacher educators, teachers, and

students. One of the participating teacher educators (Dr. Johnson, who is also a high school teacher) brought a fellow teacher and a student from her high school class. On February 26, we (Sam and Kathy) directed a workshop for student teachers at the University of Wisconsin, using similar materals and directing discussion about relevant teaching and learning issues. In April and May, one of the student teachers in that methods class, Ms. Anderson, was student teaching in Dr. Johnson's classroom. Under the supervision of Dr. Johnson, and in consultation with Sam and Kathy, Ms. Anderson designed and taught a complete HIV unit that drew heavily on bioinformatics and Biology WorkBench.

Summary of field notes and data collection from UW methods course (http://bioquest.org/bioinformatics/EdGrid/uw_workshop.html)
Collaborative curriculum development with Hillary Anderson (anderson.html)

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New Materials

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Interface development:

Home Page for SIB and other Bioinformatics information including the student interface to the Biology Workbench.

A new unique tool and two new search options have been added to SIB. It is now possible in SIB to Extract part of the Biology Workbench Sequence. Also, LocusLink and Online Mendelian Inheritance in Man search options have been added to the Ndjinn results (along with the PubMed and Google options)

http://deltas.animal.uiuc.edu/sibdoc/

Curriculum materials:

A. Tutorials, which are accessible online for interested students, teachers, and faculty via the BSW website (http://peptide.ncsa.uiuc.edu/tutorials)

B. HIV materials piloted at the Beloit College November 11, 2000 workshop

Conference Announcement (http://bioquest.org/bioinformatics/edgridworkshop.html)

Activities from: USING THE INTERNET TO DO BIOLOGICAL INQUIRY: ADVENTURES IN BIOINFORMATICS

I. Seven Scenarios: A Context-Setting Activity for Studying Bioinformatics & Biotechnology

II. Is He Guilty?: An Introduction to Working with Sequence Data and Analysis

III. Exploring HIV Evolution: An Opportunity to Do Your Own Research

IV. Background information on HIV biology

Workshop Activities
(http://bioquest.org/bioinformatics/edgridbeloit/activities.html)

C. HIV materials prepared and taught by student teacher Hillary Anderson at Monona Grove High School, Monona Grove, Wisconsin, Spring 2001.

1. Description of Intended Student Audience
2. Goals and aims of the nine week course
3. Description of the project assignment with Hillary's comments
4. Description of the project assignment without comments
5. Outline of the nine-week curriculum
6. Additional resources for teachers
7. Daily schedule with assignments
8. An introduction to using the Biology Workbench
9. Research questions and poster assignment
10. Quiz on sequence research interpretation
11. Project assessment criteria

D. Additional materials and resources

Bibliography for bioinformatics education

This collection of references is a useful starting point for anyone interested in learning more about bioinformatics education. The list was compiled for the "Biology Student Workbench Workshop: Integrating Bioinformatics into Biology Science Education, Teacher Education, and Educational Technology Courses" meeting.
(http://bioquest.org/bioinformatics/EdGrid/bibliography.html)

Introduction to bioinformatics talk

This slideshow provides a brief introduction to bioinformatics and some discussion of the role bioinformatics can play in biology education. (http://bioquest.org/bioinformatics/EdGrid/bioinformaticsed/)

Molecular forensics

This slideshow provides a brief introduction to the application of sequence analysis to forensics.You have just started as a technician at the National Fish and Wildlife Forensics Laboratory in Ashland Oregon. Your first assignment is to do a species identification on a shipment of salamanders that have just arrived at the lab. (http://bioquest.org/bioinformatics/EdGrid/salamander/)

Investigations of HIV-1 Env Evolution

This slideshow povides a brief introduction to a large HIV dataset and how it can be used to explore HIV evolution. (http://bioquest.org/bioinformatics/EdGrid/HIVtalk/)

Chimpanzee sub-species analysis by geographical region and molecular sequence data.

Because chimpanzee's are a threatened species and their habitat is rapidly being destroyed it is important for scientists to know as much as possible about the genetic relationships between both the wild and captive populations. Developing a conservation strategy requires careful consideration of when chimps should be brought to captive breeding facilities and with whom they should be mated. This data set includes sequences from 64 chimpanzees. (http://bioquest.org/bioinformatics/products/chimpdata/)

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Course Integration

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The project materials are accessible via the Inquiry Page, which performs two key roles. First, it helps to build a community of inquiry by involving all those interested in bioinformatics education. Second, it helps to foster the creation and adaptation of inquiry units for use in courses.

Each inquiry unit starts with a guiding question and provides a space for activities of investigation, creation, discussion, and reflection. Units include: How are different organisms related? How can we use DNA sequence data to learn about HIV evolution? How do I use the Biology Workbench? (To review units, please search for "Biology Workbench" units on the Inquiry Unit Search Page.) The Inquiry Page allows teachers and teacher educators (and their students) to create their units using a web-based inquiry unit generator. In addition, if a teacher, student, or teacher educator wants to adapt an existing Biology Workbench unit, he or she can easily do this by using the Inquiry Page's "spin-off" feature.

Umesh Thakkar used the Biology Student Workbench this Fall in his course titled, "Emerging Technologies" (18 students) The course is designed for undergraduate students who are interested in examining various uses of emerging information technologies as well as identifying and assessing their social impacts.

More information on the course is avaible at (http://leep.lis.uiuc.edu/fall01/LIS250EMT/)

Course integration is well underway at Beloit College. During the current (Fall 2001) semester, over one third of the Beloit College

Biology courses (which serve educaton students and pre-service teachers) have content and activities directly related to this EdGrid project (sequence analysis, bioinformatics, Biology WorkBench). The faculty teaching these courses maintain ongoing consultation with project members, Sam Donovan and Kathy Greene.

Course Title (number of students)

Human Biology (51 students)

Introduction to Evolution (13 students)

Microbiology (19 students)

Environmental Biology (20 students)

Genetics (29 students)

Animal Behavior (19 students)

Independent Research in Biology (4 students)

Full list of Fall 2001 Beloit EdGrid courses and course descriptions

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Outreach

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The project outreach efforts include news articles, videos, papers, posters, and presentations, proposals and additional resources.

News articles:

- Early this fall, biology teachers from across the U.S. met in Urbana, IL, and at the Alliance Center for Collaboration, Education, Science, and Software (ACCESS) in Arlington, VA, to explore and expand their knowledge of a new classroom technology—Biology Student Workbench. (http://access.ncsa.uiuc.edu/Stories/BroadBio/)

- Using Biology Workbench, high school students learn to do bioinformatics like the professionals by Karen Green (http://access.ncsa.uiuc.edu/CoverStories/BiologyWorkbench/)

- Inquiry in Action featuring Biology Workbench by Paul Lock (http://www.inquiry.uiuc.edu/action/bioworkbench/bioworkbench.php3)

Videos:

- Inquiry Learning with Biology Student Workbench (accessible via Inquiry Page) (http://www.inquiry.uiuc.edu/action/bioworkbench/bioworkbench.php3)

Papers:

- Bruce, B. C., Williamson, J. Jakobsson, E. G., Thakkar, U., & Lock, P. R. (2001). Open-world Learning with Biology Workbench: A High School Biology Classroom Case Study. Paper presented at the Second

International Conference of the Association of Internet Researchers, October 10-14, Minneapolis, MN (http://www.aoir.org/2001/).

- Donovan, S., Greene, K. (in press). Ramping Up to Biology Student Workbench: A Multi-Stage Approach to Bioinformatics Education. Bioscene—Journal of College Science Teaching. Draft version of the paper (http://bioquest.org/bioinformatics/EdGrid/Bioscene_draft.html)

Posters:

- Jungck, J. R., J. Greenler, and S. Donovan (2000). Evolution as a basis for bioinformatics education. Molecular Biology of the Cell. 11:136, Suppl. S Dec. 2000.

  New Paradigms in Teaching Introductory and Cell Biology, Continuing the Dialogue on Genomics: A Revolution in Progress

  Symposium schedule

  Online version of the poster

- Bioinformatics In Your World - an introduction to some of the ways that sequence analysis can be used to address biological problems.

  Online version of the poster

- Bioinformatics Problem Solving: An Introduction to Bioinformatics Problem Solving - three short exercises using hemoglobin.

  Online version of the poster

- A High School Curriculum For Teaching About HIV and AIDS: Promoting Student Research on the Biology Workbench

Online version of the poster

Presentations:

- EdGrid BSW Project Team. (2001, May 31). Biology Student Workbench: An Inquiry-based learning environment for preservice teacher education. Presentation at the Annual Meeting of Moving K-12 Teachers into 21st Century Science with 21st Century Technology: Building the Educational Grid for Preservice Training, Alliance Center for Collaboration, Education, Science, and Software, Arlington, VA.

- Thakkar, U. (2001, August 5-10). Using scientists' visualization tools in science education: Challenges and opportunities for technology-supported inquiry in classrooms. Poster presentation at the Gordon Research Conference on Science Education and Visualization: International, Mount Holyoke College, South Hadley, MA.

- Informing Biology Education By Examining The Nature Of Evolutionary Inquiry. Presented as part of the Department of Biology Seminar Series on Science Education, University of Delaware, April 6, 2001.

- Computational Molecular Biology: The Transition From Sub-discipline to Biological Revolution. Presented at Computational Sciences Across the Curriculum a Project Kaleidoscope Summer Institute. Snowbird, Utah, July 15 - 28, 2001.

Presentation abstract (http://www.pkal.org/curricul/2001si/a2_donovan.html)

- Bringing Bioinformatics to Biology Education: A Hands-on Workshop to Develop Labs for Introductory and Advanced Courses. A faculty development workshop co-sponsored by the Center for Science Education and Center for Behavioral Neuroscience at Emory University. Presented at Morehouse College, March 3 & 4, 2001.

Workshop pages

Upcoming presentations:

- Donovan, S. (2001, October 12) Bioinformatics: The Analysis of Molecular Sequence Data Provides Rich Opportunities for Student Inquiry. North Central Association for the Education of Teachers in Science (NC-AETS) Annual Fall Meeting, Madison, WI. October 11-13, 2001

  An introduction to the use of publicly available sequence data and analysis tools to create rich inquiry spaces for student investigations in to biological phenomena.

Full text of proposal (http://bioquest.org/bioinformatics/EdGrid/NCAETS.html)

Meeting schedule and information (http://www.uwm.edu/%7Ecaberg/ncaets/index.htm)

- Evolutionary Bioinformatics Education: A BioQUEST Curriculum Consortium Approach, Chautauqua Short Course, Spring 2002, Clark Atlanta University, Atlanta Georgia.

  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. It will address the relationships between evolutionary theory and the analysis of molecular sequence and structure data. A wide range of sub-disciplines that use bioinformatic analyses 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).

New Proposals:

- Brown, D. E., Bruce, C., Jakobsson, E., Braatz, R., & Thakkar, U. (2001). Learning High School Biology and Chemistry in Technology-Supported Inquiry Environments: Modeling and Visualization of Foundational Submicroscopic Processes and Structures. Proposal submitted to the National Science Foundation, Research on Learning and Education Program. (Not funded)

- Fletcher, L., Jakobsson, E. & Thakkar, U (2001). Integrating Technology Through Application. Proposal submitted to the U.S. Department of Education. (Not funded)

- Greene, K. and S. Donovan (proposed presentation) Encountering and exploring early entrenchment: pre-service teachers' response to a novel science teaching and learning space. American Educational Research Association (AERA) Meeting, March 2002. (In review)

  Our purposes for this study were to examine a group of preservice science teachers' response to inquiry activities that use a suite of web-based bioinformatics tools, the Biology WorkBench. We were most interested in exploring their views of students' ability to engage in theseinquiry activities, as well as in locating their attitudes toward teaching using this type of inquiry activity. We were interested, as well, inthe teachers' visions of technology use in their classrooms. We locate and organize their comments about the activities we designed and they executed, with respect to inquiry, to teaching inquiry, and to teaching teachers to teach inquiry. We embed in our discussion an exploration of the purposes of teaching inquiry and of teaching science, and, necessarily, to what is legitimate science teaching, learning, and knowledge.

  Full text of proposal (http://bioquest.org/bioinformatics/EdGrid/final.html)

- Submitted to DUE CCLI-ND June, 2001 Bioinformatics Education Dissemination: Reaching Out, Connecting, and Knitting Together (BEDROCK) (In review)

- Jungck, J. R., and S. Donovan (book in development). Evolutionary Bioinformatics: Making Biological Meaning from Molecular Messages.

Additional Resources:

- Greene, K., Binder of materials prepared and collected for Aug 3-5 and 3-4 EdGrid Workshops. (http://bioquest.org/bioinformatics/EdGrid/bibliography.html)

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