

The BEDROCK Project Approach to Bioinformatics Education

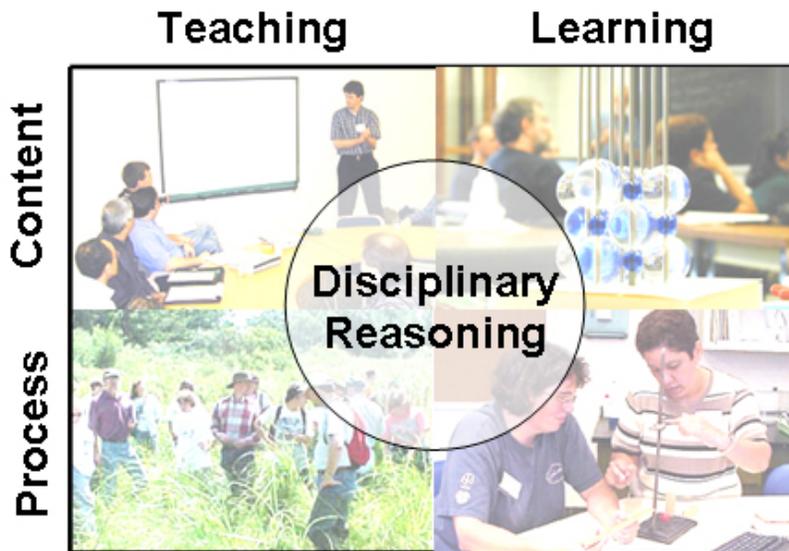


Figure 1. The BEDROCK focus on disciplinary reasoning blurs the distinctions between teaching or learning as well as content or process for the community of users engaging in a *Problem Space*.

Microbes Count! includes eight modules for investigating microbiology with bioinformatics resources developed with the BEDROCK Project (see facing page). BEDROCK *Problem Spaces* instantiate the pedagogical philosophy of BioQUEST's 3P's: Problem Posing, Problem Solving, and Persuading Peers. While a *Problem Space* defines an area of investigation and provides an initial data set and tools, students must still formulate the hypothesis that they will test, make decisions about a strategy of analyses that they will perform, and display their powers of communication rhetorically, aesthetically, and communally.

Problem Spaces more broadly consider the nature of problems and their solutions. Learners must move beyond the paradigm of simple problems with single unambiguous solutions to embrace a research model of science with creative opportunities and peer review defining the standard of significance and quality. Modules such as *Searching for Amylase* encourage users to seek creative solutions such as identifying a new microbial enzyme for industrial applications.

BEDROCK introduces bioinformatics by providing an area of investigation such as the variability of HIV strains within individual patients including an initial data set and tools within a *Problem Space*. Faculty members and students engage in focused inquiry using common data resources, access to analysis and visualization tools, reports of hypotheses, works in progress and findings. Knowledge claims are presented as the results of data-based arguments. As in any research community, users have opportunities to do new research and collaborate.

Each of the existing BEDROCK *Problem Spaces* provides an introduction, background on the area of study, collections of public data, information about and links to tools, bibliographic collections and curricular materials. These curricular materials act as resources for orienting new researchers (both faculty members and students) to the scientific community workspace.

Problem Spaces are designed to be open-ended and dynamic. Like the challenge of tracing the origin of the West Nile Virus NY99 strain, students have opportunities to grapple with analytical strategies for addressing emerging problems. *Problem Spaces* will provide opportunities to emphasize disciplinary reasoning and draw students into science instead of pushing them away.

The BEDROCK Project is a National Dissemination Project funded by the NSF Division of Undergraduate Education. BEDROCK is an acronym for Bioinformatics Education Dissemination: Reaching Out, Connecting, and Knitting-together. (For more information, see bioquest.org/bedrock.)

Descriptions of Bioinformatics Modules

<p>Searching for Amylase</p> <p>Keith D. Stanley and Ethel D. Stanley</p>	<p>An exploration of existing molecular databases and online bioinformatics tools to track down candidates for the next generation of industrial microbes.</p>	<p>p. 63</p>
<p>Molecular Forensics</p> <p>Sam Donovan</p>	<p>This activity is based on an actual case which broke new ground with respect to the use of molecular evolutionary analysis of evidence in a courtroom.</p>	<p>p. 129</p>
<p>Exploring HIV Evolution: An Opportunity for Research</p> <p>Sam Donovan and Anton E. Weisstein</p>	<p>Sequence evolution over the course of infection with HIV is examined phylogenetically within and between fifteen different AIDS patients.</p>	<p>p. 137</p>
<p>Proteins: Historians of Life on Earth</p> <p>Garry Duncan, Eric Martz, and Sam Donovan</p>	<p>Conserved regions, such as active sites, within multiple sequence alignments are visualized on three dimensional visualizations of proteins.</p>	<p>p. 181</p>
<p>Tree of Life: Introduction to Microbial Phylogeny</p> <p>Beverly Brown, Sam Fan, LeLeng To Isaacs and Min-Ken Liao</p>	<p>This activity familiarizes the student with the use of Internet-accessible bioinformatics tools, methods and data through an exploration of phylogenetic relationships and molecular markers.</p>	<p>p. 191</p>
<p>Tracking the West Nile Virus</p> <p>Erica Suchann and Mark Gallo</p>	<p>In order to determine the likely origin and epidemiological spread in the US, students compare viral DNA sequences from West Nile infected mammals and birds.</p>	<p>p. 203</p>
<p>One Cell, Three Genomes: Evidence for Endosymbiosis</p> <p>John R. Jungck, Sam Donovan, and John M. Greenler</p>	<p>Students develop and test hypotheses about the endosymbiotic theory of organelles and both horizontal gene transfer and protein trafficking between chloroplasts, mitochondria, nuclei in eukaryotic cells.</p>	<p>p. 207</p>
<p>Visualizing Microbial Proteins</p> <p>Ethel D. Stanley and Keith D. Stanley</p>	<p>Microbial enzymes serve as the focus of this student exploration of bioinformatics and visualization tools.</p>	<p>p. 235</p>