

Science Supporting Online Material
POLICY FORUM: **Scientific Teaching**

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References Directly Related to the Text

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Bibliography: Further Reading about Scientific Teaching

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

Changes in Reward System to Reinforce Teaching

<http://wiscinfo.doit.wisc.edu/secfac/divcomm/biological/TenureGuidelines.pdf>

www.ohr.wisc.edu/grants/facsabb99-2000.html

Table S1. Examples of Scientific Teaching Methods.

Method	References and Websites
Group brainstorming or problem solving in lecture	<p>(S1, S2, S3) ConcepTests http://mazur-www.harvard.edu/education/educationmenu.php Integrated Biological Science Courses Organized around Research Experience (IBSCORE) www.ibscore.org/courses.htm Workshop Biology http://yucca.uoregon.edu/wb/index.html</p>
Problem-based learning	<p>(S4, S5, S6) Problem-Based Learning www.udel.edu/pbl/ Case Studies in Problem-Based Learning www.microbelibrary.org/newsletter/nltrs00.pdf Student-Centered Activities for Large Enrollment Undergraduate Program www.ncsu.edu/per/scaleup.html Just-in-time Teaching http://webphysics.iupui.edu/jitt/jitt.html</p>
Case studies	<p>National Center for Case Study Teaching in Science http://ublib.buffalo.edu/libraries/projects/cases/case.html LifeLines Online www.bioquest.org/lifelines/ Harvard Medical School Case Studies http://brighamrad.harvard.edu/education/online/tcd/tcd.html</p>
Inquiry-based labs	<p>(S1, S2, S7) Biology Brought to Life: A Guide to Teaching Students to Think Like Scientists www.plantpath.wisc.edu/fac/joh/bbt1.htm The BioQUEST Curriculum Consortium www.bioquest.org/ Introduction to Biological Inquiry and Analysis http://campus.murraystate.edu/academic/faculty/terry.derting/ccli/cclihomepage.html Project IBSCORE, University of Montana http://biology.dbs.umt.edu/biol101/default.htm</p>
Interactive computer learning	<p>The BioQUEST Curriculum Consortium www.bioquest.org/ DNA Interactive www.dnai.org Technology Enabled Active Learning (TEAL) Studio Project http://evangelion.mit.edu/802TEAL3D/ http://ctools.msu.edu/</p>

Table References

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- S5. W. Wood, J. Gentile, *Cell Biology Education* **2**, 207-209 (2003).
- S6. www.preparing-faculty.org.
- S7. D. Udovic, D. Morris, A. Dickman, J. Postlethwait, P. Wetherwax, *Bioscience* **52**, 272-281.

Table S2. Teaching Materials and Online Resources.

Teaching Materials and Online Resources by Subject Area	URL	Type of Material or Resource	Description
Biology			
Biology Brought to Life: A Guide to Teaching Students to Think Like Scientists	www.plantpath.wisc.edu/fac/joh/bbtl.htm	Classroom activities, inquiry-based labs	These online book chapters offer ideas for cooperative exercises and inquiry-based labs that can be integrated into biology courses. Chapters include how-to instructions, rationale, and full-length labs with teacher guides.
BioQUEST Curriculum Consortium	http://bioquest.org	Multimedia	This collection of computer tools allows students to <i>pose</i> their own problems, solve these <i>problems</i> through investigations of their own design, and <i>persuade</i> their peers that their conclusions are correct: the BioQUEST "3 P's."
Concept mapping tool (CTOOLS)	www.ctools.msu.edu	Multimedia (assessment)	This Web-based concept mapping tool provides students and faculty with a visual representation of principles and relationships among concepts. It includes computer-based scoring capabilities.
DNA from the Beginning	www.dnafb.org	Multimedia	This technology-rich Web site includes concept lists, graphics, animations, and more for teaching about DNA.
DNA Interactive	www.dnai.org	Multimedia	This interactive Web site teaches students about the structure, function, and history of DNA through fascinating animations and problem-solving scenarios.
Frog Deformities	www.first2.org/resources/inquiry_activities/frog_activity.htm	Online activity	In this activity, students engage in experimental design and data analysis to understand complex interactions between environmental variables and frog populations.
Genetics Education Center	www.kumc.edu/gec/	Online resources	This Web site is designed for educators who are interested in human genetics and the human genome project. It includes links to lesson plans, the human genome project, networks, and programs.
Genome Consortium for Active Teaching (GCAT)	www.bio.davidson.edu/Biology/GCAT/GCAT.html	Online activities	This online resource brings functional genomic methods into undergraduate curricula through student research and is a collection of information and data for teaching genomics.
Guppy Simulation	www.first2.org/resources/inquiry_activities/guppy_activity.htm	Online activity	In this computer-based activity, students build understanding of natural selection, sexual selection, and fitness.
Integrated Biological Science Courses Organized around Research Experience (IBSCORE)	www.ibscore.org/courses.htm	Course materials	This course uses a teamwork approach that involves all students in a classroom, promotes critical thinking, and teaches communication skills in science.

Introduction to Biological Inquiry and Analysis	http://campus.murraystate.edu/academic/faculty/terry.derting/ccli/cclihomepage.html	Course materials	In this course, students learn basic concepts in biology and engage in science as a process of active inquiry that serves as a framework for further study. The Web site includes 10 in-class assignments and an introduction to basic statistics.
LifeLines	http://bioquest.org/lifelines	Online activities (case-based learning)	This collection of online cases is designed by community college teachers and is based on real-life scenarios.
Microbes Count!	http://bioquest.org/microbescount	Multimedia	This collection of multimedia resources, simulations, and tools is an interactive, open-ended forum for learning about microbiology.
MicrobeLibrary	www.microbelibrary.org	Online activities	This searchable portal provides a peer-reviewed, Web-based collection of resources about the microbial world, including visual images and animations, curriculum activities for both classroom and laboratory, and articles. The collection is linked directly to a recommended core curriculum for introductory microbiology education.
Problem-based Learning	www.udel.edu/pbl/	Online activities (problem-based learning)	This collection of problem-based learning (PBL) activities challenges students to work cooperatively in groups to solve real-world problems.
Teaching Case Database	http://brighamrad.harvard.edu/education/online/tcd/tcd.html	Online activities (case-based learning)	This collection of online cases is designed for medical students at Harvard Medical School.
Teams and Streams	http://surf.to/teamstreams/	Inquiry-based labs	These labs provide a framework for teachers to move from traditional, confirmatory approaches to student-driven inquiry. Students post results on Web sites of their own design.
Workshop Biology	http://yucca.uoregon.edu/wb/index.html	Course materials, resources	This program is designed to improve biology teaching for non-biology majors. The Web site includes many resources, including a downloadable, 230-page curriculum development handbook, and more.
Chemistry			
ChemLinks	http://chemlinks.beloit.edu/	Multimedia	This collection of modules is designed to enhance the appreciation and learning of chemistry.
Peer-led Team Learning	www.sci.ccnycuny.edu/~chemwksp/	Classroom activities	This Web site outlines strategies for teaching in a “workshop format” where teams of students are guided by a peer leader. This model provides an active learning experience for students, creates a leadership role for undergraduates, and engages faculty in a creative new dimension of instruction.

General Science			
Calibrated Peer Review	http://cpr.molsci.ucla.edu/	Online activities	This Web-based program provides resources for implementing frequent writing assignments in large classes with limited instructional resources.
Just-in-time Teaching (JITT)	http://webphysics.iupui.edu/jitt/jitt.html	Multimedia	This program provides teacher resources and computer-based activities that use technology and problem-solving skills to improve learning. Students complete Web-based assignments prior to class so the instructor can revise teaching “just in time.”
National Center for Case Study Teaching in Science	http://ublib.buffalo.edu/libraries/projects/cases/case.html	Online activities	This Web site offers instructions and rationale for case-based learning, and includes a collection of online cases for many science disciplines.
National Institute for Science Education	www.wcer.wisc.edu/nise/	Online activities and assessment resources	This institute provides literature about teaching and learning, strategies for improving science education, and assessment guides for teachers and students.
Student-Centered Activities for Large Enrollment Undergraduate Programs (SCALE-UP)	http://scaleup.ncsu.edu/	Multimedia	This program offers pedagogical methods and classroom management techniques that include hands-on activities, simulations, questions, problem-solving scenarios, and hypothesis-driven labs.
Physics			
Activity-based Physics	http://physics.dickinson.edu/~abp_web/abp_homepage.html	Multimedia	This suite of textbooks, computer software, and other materials is based on physics education research. The activity-based materials help students learn difficult physics concepts.
Cooperative Group Problem Solving in Physics	http://groups.physics.umn.edu/physed/Research/CGPS/CGPSintro.htm	Teaching strategies and inquiry-based labs	This Web site contains information about how to implement cooperative group problem-solving into physics classrooms, as well as a downloadable lab manual.
Peer Instruction	http://mazur-www.harvard.edu/education/educationmenu.php	Classroom activities	This article suggests strategies that can be used to embellish lectures with activities where students teach each other, as well as rationale for these activities, and ConcepTest examples.
Physlets	http://webphysics.davidson.edu/Applets/Applets.html	Multimedia	This Web site and companion book contain physics problems with animated physics applets.
Technology Enabled Active Learning (TEAL) Studio Project	http://evangelion.mit.edu/802TEAL3D/	Multimedia	These computer simulations are designed to help freshmen develop intuition about and conceptual models of physical phenomena. The tools are based on an active-learning approach that merges lecture, lab, and discussion sections. Course notes, graphics, and animations are available.

General Teaching			
The Active Learning Site	www.active-learning-site.com/bib1.htm	Bibliography	This comprehensive bibliography lists articles about active learning.
Center for Science and Math Teaching	http://ase.tufts.edu/csmt/	Teaching strategies and resources	This Web site provides references and software (microcomputer-based laboratory tools) that enable students to learn physical concepts.
Center for Teaching Effectiveness	www.utexas.edu/academic/cte/resources/teach.html	Teaching strategies and resources	This online, how-to guide offers advice for all aspects of developing a university course, including teaching strategies, references, media aids, advice about diversity, and more.
HHMI New Generation Program	http://newgenerationprogram.wisc.edu	Teaching strategies and resources	This program provides strategies for teaching graduate students and postdocs to teach and mentor, including syllabi, evaluation tools, and peer-review information.
KnowledgeRoom Networks	www.knowledgeroom.com/	Multimedia tool	This innovative Web site enhances classroom education by providing user-friendly, virtual space where students can research, explore, collaborate, and communicate.
Online Databases			
Biology Education Online (BEoN)	www.accessexcellence.org/LC/BEoN/		This is an online, peer-reviewed journal for K-16 educators in the life sciences.
BioScienceEdNetwork (BEN)	www.biosciednet.org		This digital, searchable database of biology instructional materials and resources is designed to help undergraduate educators to improve their teaching through resources, collaboration, and network building.
The Learning Matrix	http://thelearningmatrix.enc.org/		This site provides access to peer-reviewed digital resources that promote inquiry- and problem-based learning in college mathematics, science, and technology classes. Instructions are included for posting new instructional materials.
Multimedia Educational Resource for Learning and Online Teaching (MERLOT)	www.merlot.org		This electronic database is a “free and open resource” of instructional materials, including peer reviews and comments. Instructions are included for posting new instructional materials.
National Science Digital Library	http://nsdl.org/		This digital library contains resource collections and services for science, technology, engineering and mathematics education.
Science, Math, Engineering, and Technology Education	www.smete.org/		This digital library offers access to online teaching and learning materials for students and teachers.
Professional Society Web sites and other Publications			
American Association for the Advancement of Science	www.aaas.org/education/		Education homepage

American Association of Physics Teachers	www.aapt.org		Journals: <i>Physics Teacher</i> and <i>American Journal of Physics</i>
American Chemical Society	www.chemistry.org/portal/a/c/s/1/educator/sandstudents.html http://jchemed.chem.wisc.edu/		Education homepage Journal: <i>Journal of Chemistry Education</i>
American Physical Society	www.aps.org/educ/		Education homepage
American Physiological Society	www.the-aps.org/education/edu_ugrad.html		Education homepage
American Society for Cell Biology	www.ascb.org www.cellbioed.org		Online Journal: <i>Cell Biology Education</i>
American Society for Microbiology	www.asm.org/education		Journals: <i>Microbiology Education</i> and <i>ASM News</i>
Association of College and University Biology Educators	www.acube.org		Journal: <i>Bioscene: Journal of College Biology Teaching</i>
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National Association of Biology Teachers	www.nabt.org		Journal: <i>American Biology Teacher</i>
National Association for Research in Science Teaching	www2.educ.sfu.ca/narstsite/		Journal: <i>Journal of Research in Science Teaching</i>
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FURTHER READING ABOUT SCIENTIFIC TEACHING

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