Using Living Materials to Teach to Science Standards

Our goal is to provide the strongest support available for science teachers in our rapidly changing world.

- Both government agencies and professional organizations agree that changes are necessary in the way we educate our students. Science teaching should become more active, inquiry and problem-solving based.
- Living specimens are ideal for engaging the interests of students of all ages, so they actively question and explore more concepts within life science.
- At Ward's Science, we strive to provide the healthiest and most appropriate living specimens to serve your needs, as well as provide useful information to help you achieve your teaching goals easier.

We hope that our continued commitment to supply ideal teaching specimens and practical, teaching-related information make it easier for teachers to achieve this shift to a more active approach. We welcome your comments and suggestions for ways we can strengthen this support. We can be reached by e-mail at living.wards@vwr.com

National Standards

To quote (in part) from the National Science Education Standards – there should be a shift in emphasis in the way we teach science:

LESS EMPHASIS ON	MORE EMPHASIS ON
Presenting scientific knowledge through lecture, text, and demonstration	Guiding students in active and extended scientific inquiry
Focusing on student acquisition of information	Focusing on student understanding and use of scientific knowledge, ideas and inquiry processes
Knowing scientific facts and information	Understanding scientific concepts and developing eight abilities of inquiry
Studying subject matter disciplines (physical, life, earth sciences) for their own sake	Learning subject matter disciplines in the context of inquiry, technology, science in personal and social perspectives, and history and nature of science
Activities that demonstrate and verify science content	Activities that investigate and analyze science questions
Investigations confined to one class period	Investigations over extended periods of time
Emphasis on individual process skills such as observation	Using multiple process skills—manipulation, cognitive, procedural or inference
Science as exploration and experiment	Science as argument and explanation
Doing few investigations in order to leave time to cover large amounts of content	Doing more investigations in order to develop understanding, ability, values of inquiry and knowledge of science content
Concluding inquiries with the result of the experiment	Applying the results of experiments to scientific arguments and explanations

Here are some websites that more fully describe the recommended shifts in science teaching emphasis on both process and science content standards:

http://books.nap.edu/catalog.php?record_id=4962#toc National Science Education Standards from National Committee on Science Education Standards and Assessment, National Research Council, 1996.

http://www.nagb.org/ National Assessment Governing Board's (NAGB's) web site. Congress created the 26-member Governing Board in 1988 to set policy for the National Assessment of Educational Progress (NAEP)—commonly known as the "The Nation's Report Card."

http://www.nagb.org/publications/frameworks/science-09.pdf Science Framework for the 2009 National Assessment of Educational Progress from the NAGB and the US Department of Education.

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http://www.project2061.org/publications/sfaa/online/sfaatoc.htm Project 2061's 1989 publication, Science for All Americans. Science for All Americans defines science literacy and lays out some principles for effective learning and teaching. From the American Association for the Advancement of Science (AAAS).

State-specific standards can be found online using the search terms: "state science teaching standards education" in most search engines (Google, etc.).

A short summary of the General Content Standards for different grade levels is reproduced from the National Science Education Standards below. We have reproduced grade level detail in topics related to life science that would benefit from the use of living organisms in classroom activities.

ALL GRADES	Grades K–4	Grades 5–8	Grades 9–12
SCIENCE AS INQUIRY	**LIFE SCIENCE**	**LIFE SCIENCE**	**LIFE SCIENCE**
Abilities necessary to do scientific inquiry	Characteristics of organisms	Structure and function in living systems	The cell
Understandings about scientific inquiry	Life cycles of organisms	Reproduction and heredity	Molecular basis of heredity
	Organisms and environments	Regulation and behavior	Biological evolution
UNIFYING CONCEPTS AND PROCESSES		Populations and ecosystems	Interdependence of organisms
Systems, order, and organization		Diversity and adaptations of organisms	Matter, energy, and organization in living systems
Evidence, models, and explanation			Behavior of organisms
Change, constancy, and measurement	**SCIENCE IN PERSONAL & SOCIAL PERSPECTIVES**	**SCIENCE IN PERSONAL & SOCIAL PERSPECTIVES**	**SCIENCE IN PERSONAL & SOCIAL PERSPECTIVES**
Evolution and equilibrium	Personal health	Personal health	Personal and community health
Form and function	Characteristics and changes in populations	Populations, resources, and environments	Population growth
	Types of resources	Natural hazards	Natural resources
HISTORY AND NATURE OF SCIENCE	Changes in environments	Risks and benefits	Environmental quality
EARTH AND SPACE SCIENCE	Science and technology in local challenges	Science and technology in society	Natural and human-induced hazards
PHYSICAL SCIENCE			Science and technology in local, national, and global challenges

Science as Inquiry

The "Science as Inquiry" standard is often found confusing. To quote from the National Science Education Standards: "Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including

- asking questions,
- planning and conducting investigations,
- using appropriate tools and techniques to gather data,
- thinking critically and logically about relationships between evidence and explanations,
- constructing and analyzing alternative explanations,
- and communicating scientific arguments."

Many groups have varying definitions of what inquiry-based teaching means (see http://www.aaas.org/programs/education/about_ehr/pubs/inquiry.shtml and http://www.nwrel.org/msec/science_inq/index.php). In general, inquiry is an approach that shifts more of the responsibility for investigations from teachers to students, thereby making the students more active participants in their own education. Inquiry-based teaching does not require choosing just one approach.

"Structured inquiry" is similar to traditional teaching methods that use hands-on demonstration activities that are planned and directed by the teacher. In "Guided inquiry," the question is framed by the teacher, but students have more responsibility for conducting investigations as well as critically thinking about evidence and explanations, with more limited input from the teacher. In "Open Inquiry," the teacher's role is more as a facilitator, with the students taking responsibility for all levels of inquiry including framing a question, designing and executing investigations, and scientifically defending an explanation. Most teachers prefer to tailor a mix of the above styles of inquiry to their specific classroom situation. For example, earlier grade-level teachers tend to teach the majority of lessons using more structured inquiry methods and mix in a few guided inquiry style lessons. Later grade-level teachers may utilize more guided inquiry lessons and then facilitate one or two open inquiry projects.

Guided inquiry covers a large range of teacher involvement, but the teacher's role is largely to get an investigation moving towards a learning target and to make sure that students do not reinforce their own misinterpretations of any evidence. Teachers answer fewer questions, and instead they ask questions to help lead students down the most valid interpretive path. This contains a large element of the classic Socratic teaching method and provides a model for students of how to focus and generate relevant questions. However, it also creates opportunities for teachers to answer questions and provide factual, content-based information in a context where it is useful (and therefore meaningful and memorable) to the student for problem solving. Many traditional, structured classroom activities can be modified to be taught in a more guided inquiry fashion. The easiest way to do this is to re-frame a demonstration activity as a problem to be solved.

Ideas for classroom activities can be found in many places, but here is our short list of favorite sites with free teaching resources:

http://www.free.ed.gov/?sid=8	Federal resources for educational excellence
http://www.nsf.gov/news/classroom/biology.jsp	National science foundation biology classroom resources
http://nsdl.org/	National science digital library
http://www.sciencenetlinks.com/	Science net links—lessons, tools, and resources aligned with project 2061 grade level benchmarks—Maintained by AAAS
http://www.biosciednet.org/portal/	BioEdNet—Resources for Biology Teaching —Maintained by AAAS
http://www.nsta.org/	National Science teachers association (NSTA)
http://www.nabt.org/	National Association of Biology Teachers (NABT) instructional materials
http://www.hhmi.org/biointeractive/	Howard Hughes Medical Institute site for free teaching resources including virtual labs and animations.

Ward's Science is committed to supplying high quality specimens and creative learning supplies to support the wide variety of classroom activities that teachers may wish to use. Many of our kits and activities include all the classroom materials you need to lead students in hands-on activities, including problem-solving. Each experiment and demonstration can also be easily adapted to the various types of inquiry. For the full collection of our lab activities and kits for all sciences, look online or call to request our most recent catalog.

The simple introduction of living organisms into the classroom is an excellent way of engaging students in active exploration of life science learning goals. The organisms stimulate students to ask questions and initiate investigations that test biological concepts in a standard, guided, or open-inquiry teaching setting.

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Living Organisims—Where to Find the Information You Need

Care sheets – Practical and Standards-Based Information

We have provided simple, standardized care sheets to help teachers:

- Select the most appropriate organisms to engage students of different skill levels in actively reaching the standard learning goals.
- Practically plan for the receipt and care of their selected organisms.
- Have all the information they need for a basic understanding of the organism, as well as information that helps explain possible relationships between the organism and teaching standards.

Each care sheet should list:

- Common Name of Organism: To place the organism in context of previous knowledge and experience
- Scientific name/classification: To address Standards - Unified concepts – systems order and organization
- Conditions of ownership: Practical information related to USDA permit requirements
- Primary Hazard Conditions: To determine if your students can safely handle the organism
- Availability: Learn details of the availability of organisms, links to on-line ordering information, what to expect and how to handle organisms when you receive them
- Captive Care: Guidelines on preparing for the needs of the organisms - classroom habitat, food and water
- Background Information: Facts related to standard teaching goals that can include:
  - Method of reproduction
  - Standards - Reproduction and heredity
  - Determining sex (if applicable)
  - Standards: Characteristics of Organisms, Unifying Concepts—Evolution, Structure and function, behavior
  - Life cycle/Span
  - Standards – life cycles, diversity and adaptation
  - Wild habitat
  - Standards: organisms and environments, resources, ecosystems
  - Special Notes: Additional information that may relate to other standards, such as behavior, natural resources, etc.
  - Disposition after class use: Suggestions about what to do with the organism after completion of classroom study

Many care sheet pages will be followed by a secondary piece of literature. This literature provides more detailed about the organisms and their long-term care. We will be continually updating and expanding our live material care guides, to make this the easiest to use and most current reference for teaching life science in an active, inquiry-based setting.

In addition to this resource, our Live Material Technicians, who contributed to the writing of this resource, are available to answer customer questions and offer help with any problems related to our live materials. Our Live Materials team can be most easily reached by e-mailing living.wards@vwr.com. They can also be reached by calling our Customer Service desk at 800-962-2660 during regular business hours.

Thank you for choosing Ward's Science as your source for quality live materials.

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