Scientific Reasoning
5 August 2008 [DRAFT]

Definition

Scientific reasoning includes the ability to solve problems through the analysis of quantitative empirical data. The methods of scientific inquiry help students answer questions in natural, behavioral and social sciences. The methods also help students understand how technology and science will affect their lives, the environment and their culture.

Scientific reasoning should provide experiences working with the methods science including hypothesis formation and testing, systematic observation and analysis of quantitative data.

The goal of SR courses should be to develop critical thinking skills for evaluating scientific information, which will enable our students to use these principles in making personal decisions and engage intelligently in debates about scientific and technological issues that will affect their lives.

Throughout this document, the word scientific is interpreted broadly to include the natural, behavioral and social sciences.

Rationale

There have been calls from diverse groups to improve scientific literacy for all college students. Project Kaleidoscope's vision is to help Science, Technology, Engineering and Mathematics (STEM) departments realize that they are a part of the bigger world and our job is to prepare all undergraduates to solve the complicated problems in a technological world. In the AAC&U document *College Learning for the New Global Century*, inquiry, analysis, and critical and creative thinking are given as intellectual and practical skills within the essential learning outcomes.

In short, to prepare our graduates for full participation in our society and to prepare our graduates to make decisions about their own lives, health and environment, we must provide those students with the skills and ability to solve problems by collecting and analyzing empirical data. The emphasis of the SR course requirement would be to build critical thinking skills as they apply to scientific information, but not to require students to learn specific scientific content.

Instead of having non-science majors take the introductory courses in a science major, the non-science majors will be better served in courses that are fundamentally interesting to them and use scientific reasoning to address relevant topics.

Criteria for Approving Proposals

The subject matter for SR courses can come from any field in the natural, behavioral and social science, and we expect there could be courses in biology, physiology, chemistry, physics, environmental science, psychology, sociology, education, political science, economics and others. The entire course will focus on the following activities.

Criterion 1: The course will give students experience in four of the following five activities:

- translate an understanding of scientific evidence into written or oral presentations;
- scientific problem solving;
- study and question scientific information from any media, popular or scientific;
- analyze and discuss scientific content as it applies to current issues; and
- discuss the ethical issues surrounding the collection and analysis of data.

Criterion 2: Courses designated as Scientific Reasoning (SR) courses will focus on solving problems using the scientific method. In particular, these courses will have at least one inquiry-based experience for the students where they address some issue by

- stating a hypothesis,
- designing an experiment,
- collecting and analyzing quantitative data and
- drawing a conclusion.

Criterion 3: Every SR course also needs to satisfy the Quantitative Reasoning requirements. This would require one-third of the content of the course to be quantitative in nature, experience in using formulas, graphs, tables, schematics and other mathematical models. Since each SR course will give students experience in analysis of quantitative data, this criteria for QR will not be difficult to satisfy. This will also make it easier for students who must take multiple science courses, such as pre-service teachers, to satisfy the QR requirements.

Source Information on Similar Requirements at other Good Schools

Many schools require a course in the scientific method, but generally require the courses in the natural sciences. Some schools allow the definition of scientific to be broader and to include the social and behavioral sciences.

Cazenovia College, www.cazenovia.edu

Bowdoin College, www.bowdoin.edu

Bates College, www.bates.edu/x164813.xml
FAQ for Bates Scientific Reasoning requirement

Examples of Classes

Current courses that may already meet the criteria or that may be modified to meet the criteria. This is a brief list and other courses could easily be included.

Biology 103 Environmental Issues
Biology 104 Human Biology
Biology 111 Principles of Biology II
Biology 225 Human Physiology
Biology 251 Microbiology
Biology 270 Basic Genetics
Biology 285 Developmental Biology
Biology 360 Molecular Genetics
Chemistry 101 Bonds and Structures

Chemistry 150 Consumer Chemistry

The subject matter for SR courses can come from any field, and we expect there could be courses in biology, physiology, chemistry, physics, environmental science, psychology, sociology, education, political science, economics and others.

New single discipline or multi-disciplinary courses could be added or modified to include work in the scientific method. We hope there will be courses that meet the criteria for SR in

- Biology and statistics,
- Political science and statistics,
- Entry-level psychology courses,
- Psychology and physiology,
- Health sciences,
- Computer science and environmental science and
- others.

It is expected that some LAS courses would meet the criteria for a designation of SR.

Teaching Resources

Problem-Based Learning Clearinghouse, https://chico.nss.udel.edu/Pbl/index.jsp

philosophy.hku.hk/think/sci/

An interesting resource about what SR is and resources for teaching.

seasproject.disl.org/curriculum.htm

Useful to help in determining when the scientific method is being employed.

Assessment Resources and further reading

Benchmarks for Science Literacy: A tool for curricular reform, The American Association for the Advancement of Science, 1996, www.project2061.org/publications/bsl/default.htm.

National Science Education Standards, National Committee on Science Education Standards and Assessment, National Research Council, 1996, www.nap.edu/catalog.php?record_id=4962.

Trefil, James, *Science Education for Everyone: Why and What?*, Liberal Education, Spring 2008.

Project Kaleidoscope, www.pkal.org/

Staffing and Costs

If we want to develop new single disciplinary or interdisciplinary courses that meet the SR criteria, then there will be a cost in the development of the courses both for time and for faculty development. We hope this will lead to the creation of more interdisciplinary opportunities for both faculty and students. This cost could be offset by the fact that students who are not science majors will now only take one scientific reasoning course instead of two science courses.

Implementation Challenges

Many of our current introductory science classes do not meet the criteria for an SR course, but students who do not specialize in science would be better served in courses that are specifically designed to help them with problem solving that has meaning in their lives rather than an introductory course to a major. Thus, implementation of this general education requirement would likely require the development of new courses.