

How Can the History and Philosophy of Science Contribute to Contemporary U.S. Science Teaching

Friday, 07 December 2012

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The Contribution of HPS to Science Teaching: Past, Present and Future

**Michael R. Matthews
School of Education
University of New South Wales**

A Melancholic Observation

Proposals for weaving the history and nature of science into the teaching of science in schools and colleges have a history of more than sixty years.

Over this long period, various kinds of instructional materials which entwine science and the history of science were produced.

The historical accounts, lessons, or units usually served to convey a philosophy of science in which educators believed at the time. Their philosophy of science identified ideas about the nature of science which they wished students to understand or appreciate.

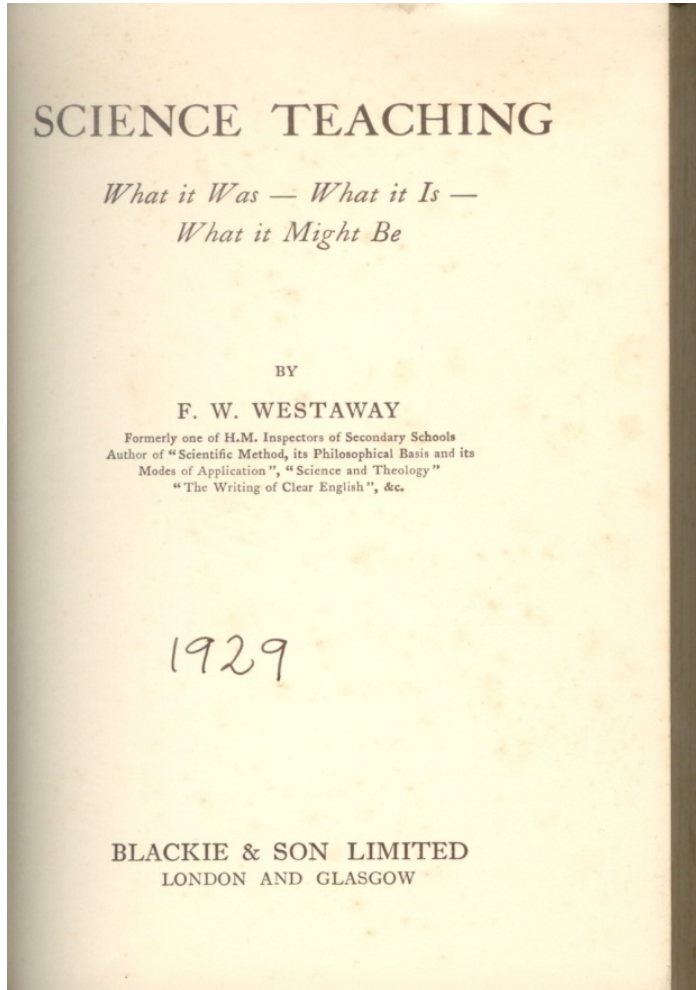
These ideas anchored a web, and the strands of science content and science history formed the web's pattern.

Yet each of these webs was fragile; they rarely persisted for very long and left little trace on the science education landscape.

(Leo Klopfer 1992)

The Past

F.W. Westaway: *Science Teaching: What it Was, What it Is, What it Might Be* (1929)



- Widely used textbook in UK graduate teacher training courses.
- Reprinted 1929, 1934, 1942, 1947.
- Argues for a broad HPS-informed science programme.
- Informed by 25 years of being a HMI:
'1000s & 1000s of lessons observed'

Westaway's Account of a Good Science Teacher: Still relevant? What changes are required?

- a **successful science teacher** knows his own subject . . .
• **is widely read in other branches of science** . . . knows how to teach . . . is able to express himself lucidly . . . is skilful in manipulation . . . is resourceful both at the demonstration table and in the laboratory . . .
is a logician to his finger-tips . . .
is something of **a philosopher** . . .
is so far **an historian** that he can sit down with a crowd of [students] and talk to them about the personal equations, the lives, and the work of such geniuses as Galileo, Newton, Faraday and Darwin. More than this he is **an enthusiast**, full of faith in his own particular work. (p.3)

British Association for Advancement of Science (1918)

“It is desirable . . . to introduce into the teaching some account of the main achievements of science and of the methods by which they have been obtained. There should be more of the spirit, and less of the valley of dry bones . . . One way of doing this is by lessons on the history of science.”

“Some knowledge of the history and philosophy of science should form part of the intellectual equipment of every science teacher in a secondary school.”

BAAS *The J.J. Thompson Report*, 1918

British Association for Science Education (1981)

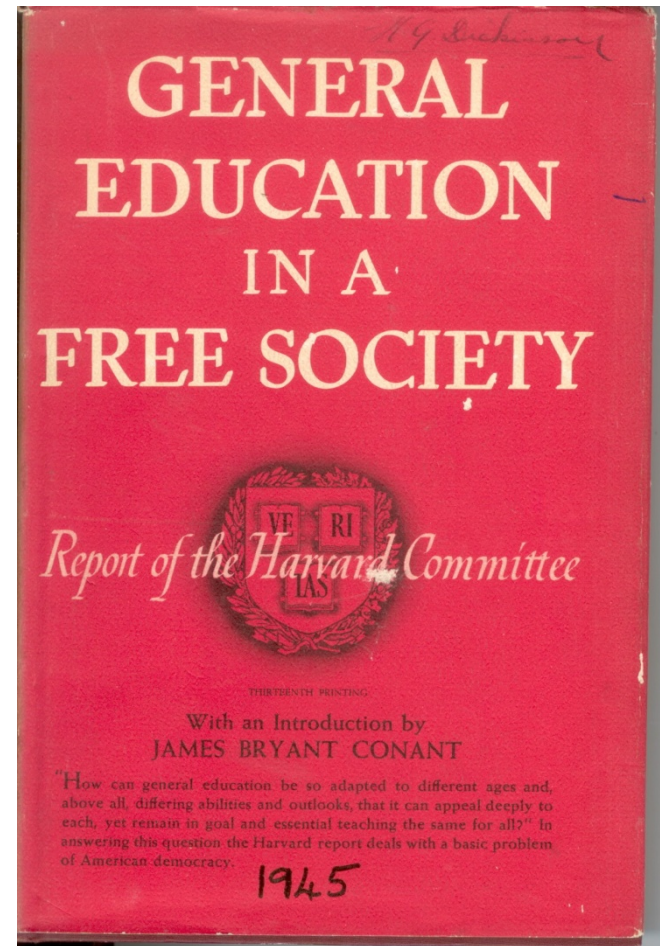
“Science should be taught as a cultural activity: the more generalised pursuit of scientific knowledge and culture that takes account of the history, philosophy and social implications of scientific activities, and therefore leads to an understanding of the contribution science and technology make to society and the world of ideas.”

BASE, *Education through Science* (1981),

Harvard Committee (1945)

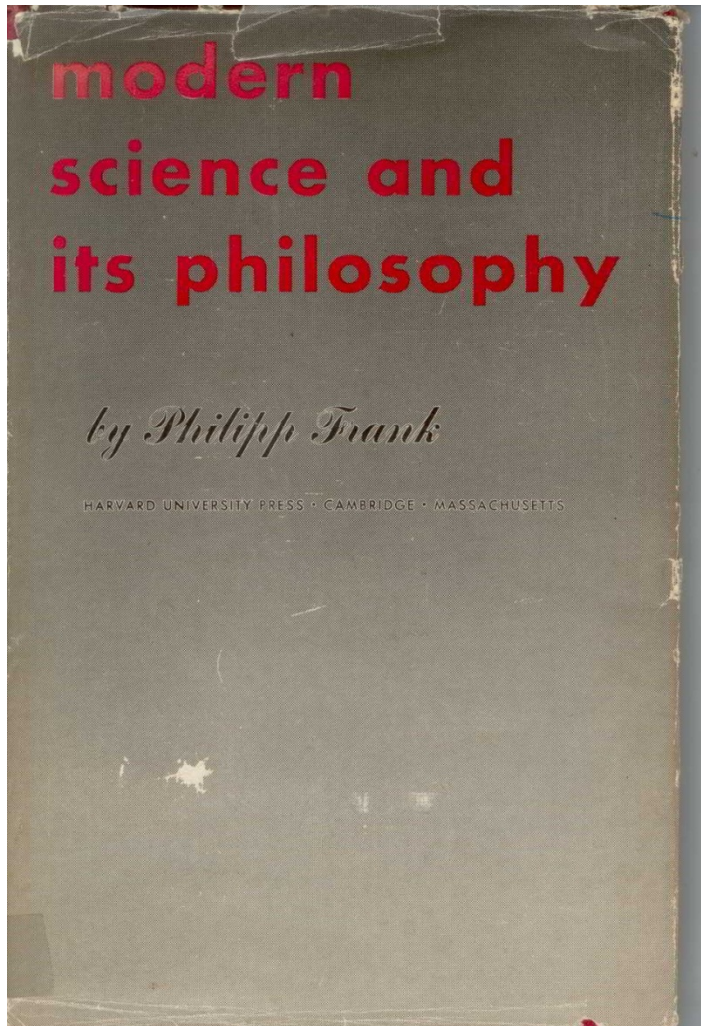
Science instruction in general education should be characterized mainly by broad integrative elements -

- # the comparison of scientific with other modes of thought,***
- # the comparison and contrast of the individual sciences with one another,***
- # the relations of science with its own past and with general human history,***
- # and of science with problems of human society.***



Philipp Frank

Harvard Philosopher & Physicist



Scanned at the American
Institute of Physics

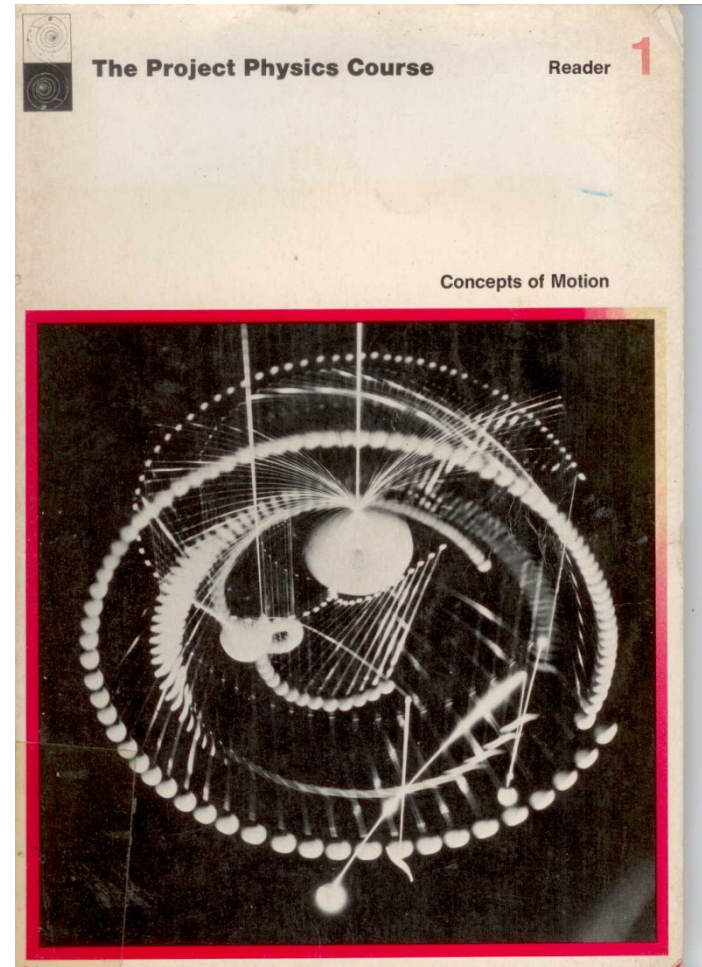
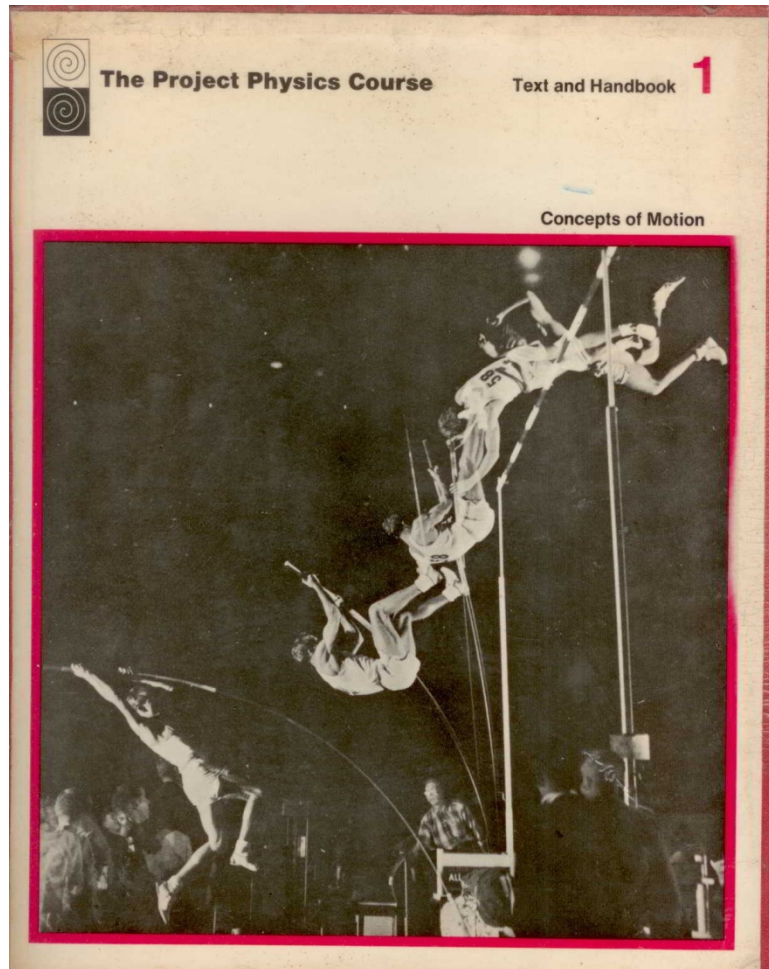
On Science Teaching (1949)

By its failure to give an adequate presentation of this historic dispute our traditional physics teaching misses an opportunity to foster in the student an understanding of the relations between science, religion and government which is so helpful for his adjustment in our modern social life.

With a good understanding of the Copernican and similar conflicts, the student of science would have even an inside track in the understanding of social and political problems. He would be put at least on an equal level with the student of the humanities.

Harvard Project Physics (1974--)

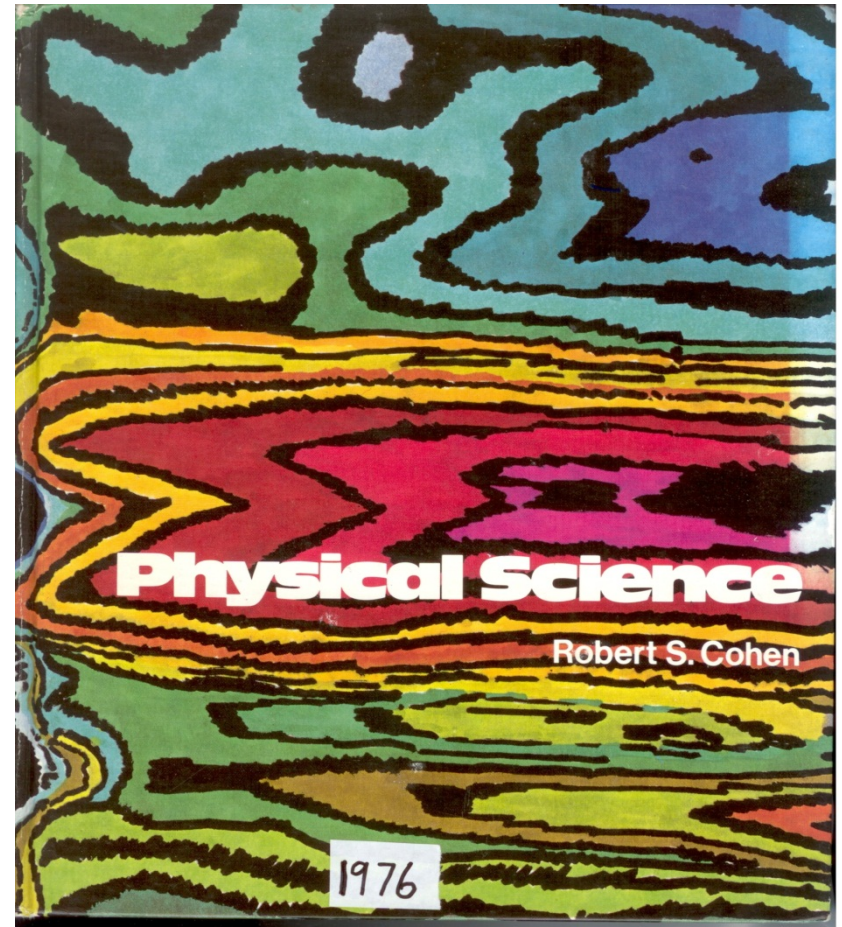
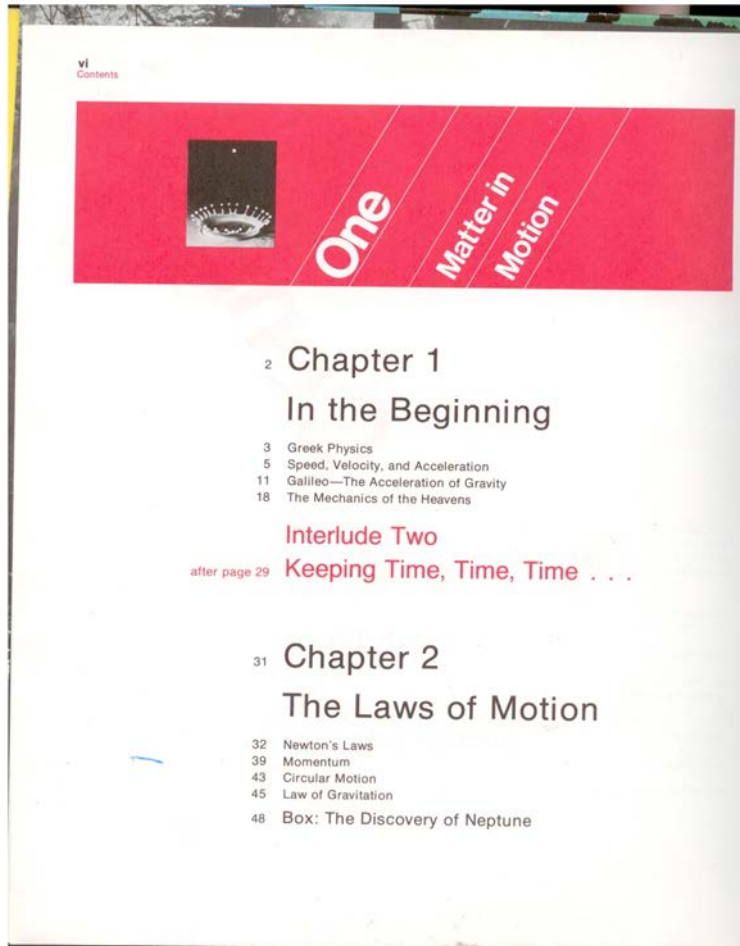
Gerald Holton, Harvard Physicist & Philosopher



Robert S. Cohen

(Boston University Physicist and Philosopher)

Physical Science (1976)

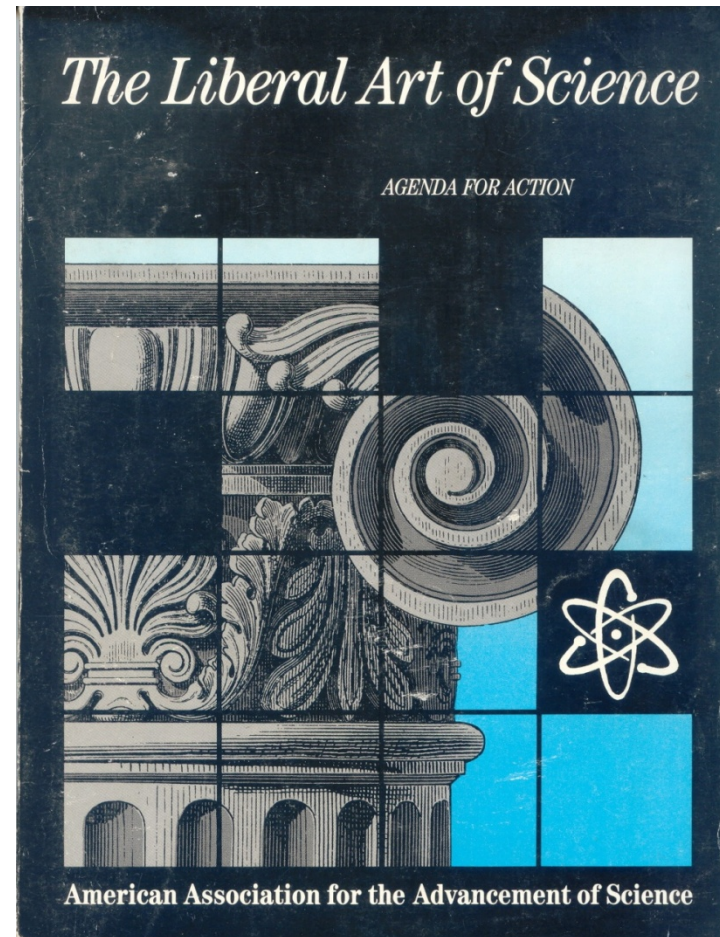


American Association for the Advancement of Science (1990)

The teaching of science must explore the interplay between science and the intellectual and cultural traditions in which it is firmly embedded.

Science has a history that can demonstrate the relationship between science and the wider world of ideas and can illuminate contemporary issues.

(AAAS 1990, p.xiv)

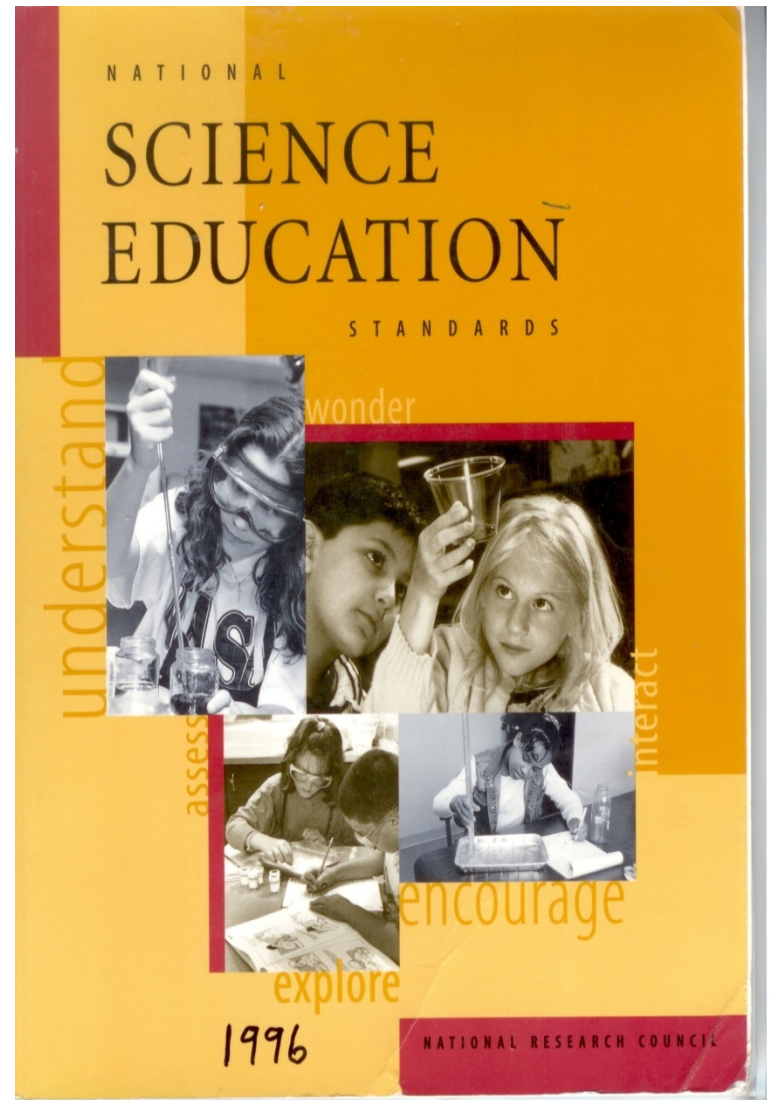


US National Science Standards

The standards for the history and nature of science recommend the use of history in school science programs to clarify different aspects of scientific inquiry, the human aspects of science, and the role that science has played in the development of various cultures.

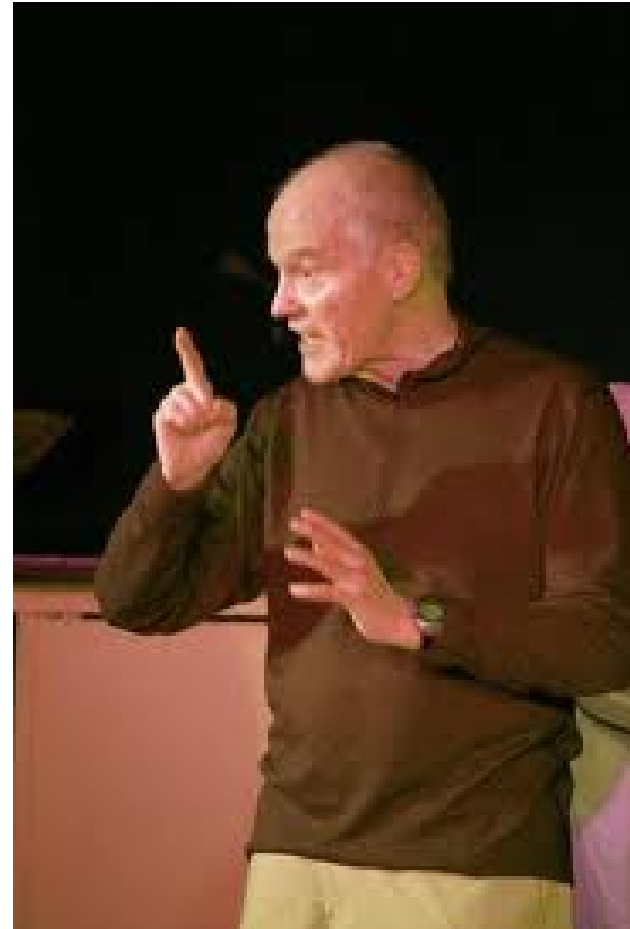
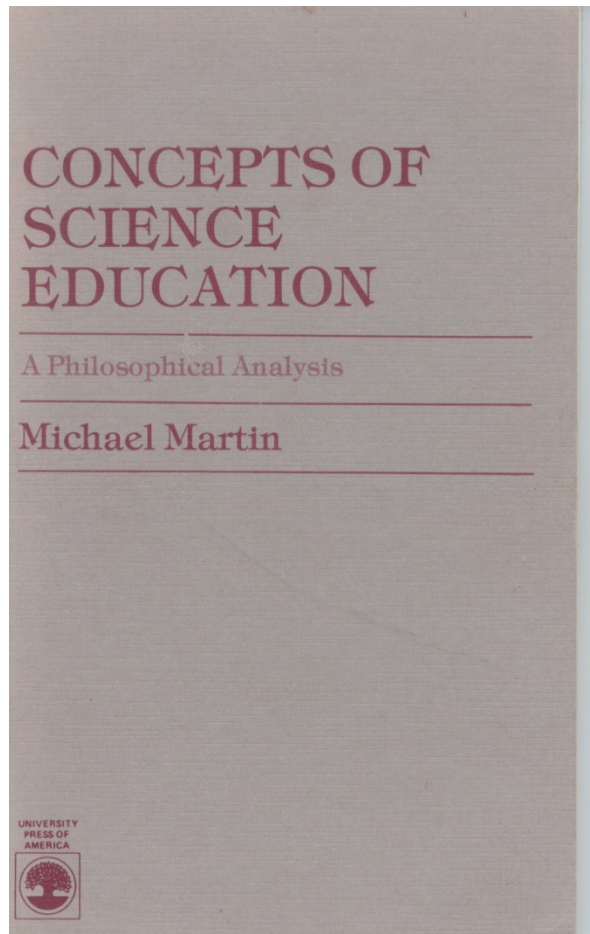
By tracing the history of science how difficult it was for scientific innovators to break through the accepted ideas of their time to reach conclusions that we currently take for granted.

That progress in science and technology can be affected social issues and challenges.



Michael Martin

Boston University Philosopher



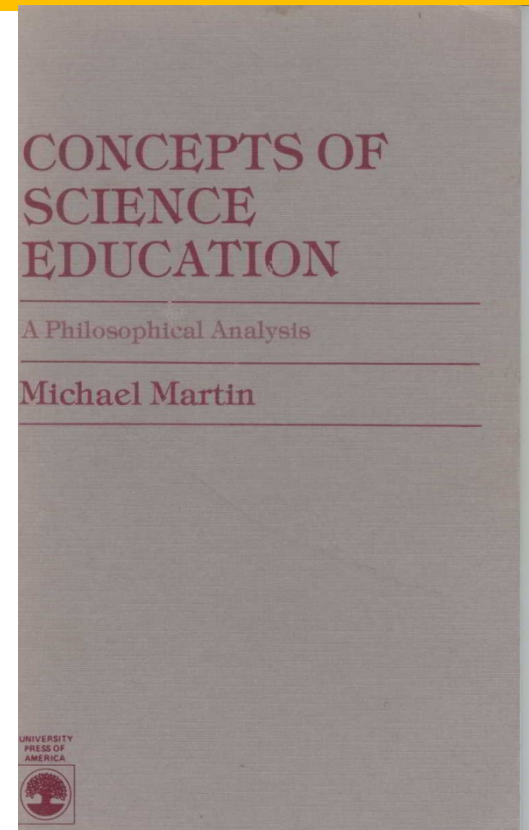
Michael Martin (1972)

Concepts of Science Education: A Philosophical Analysis

contents

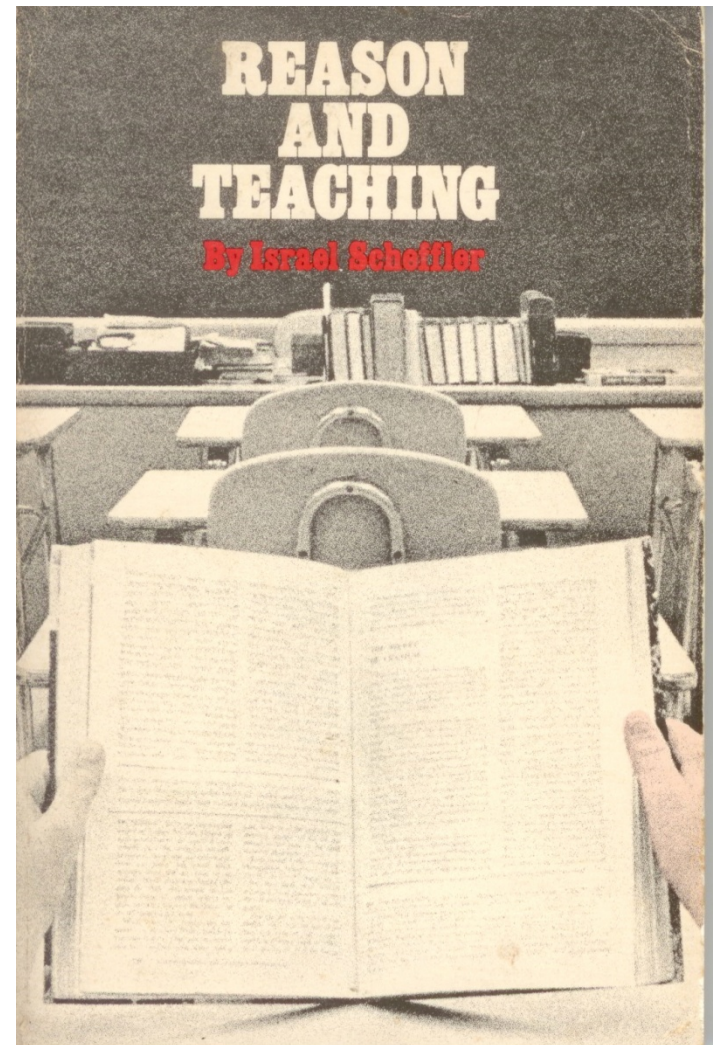
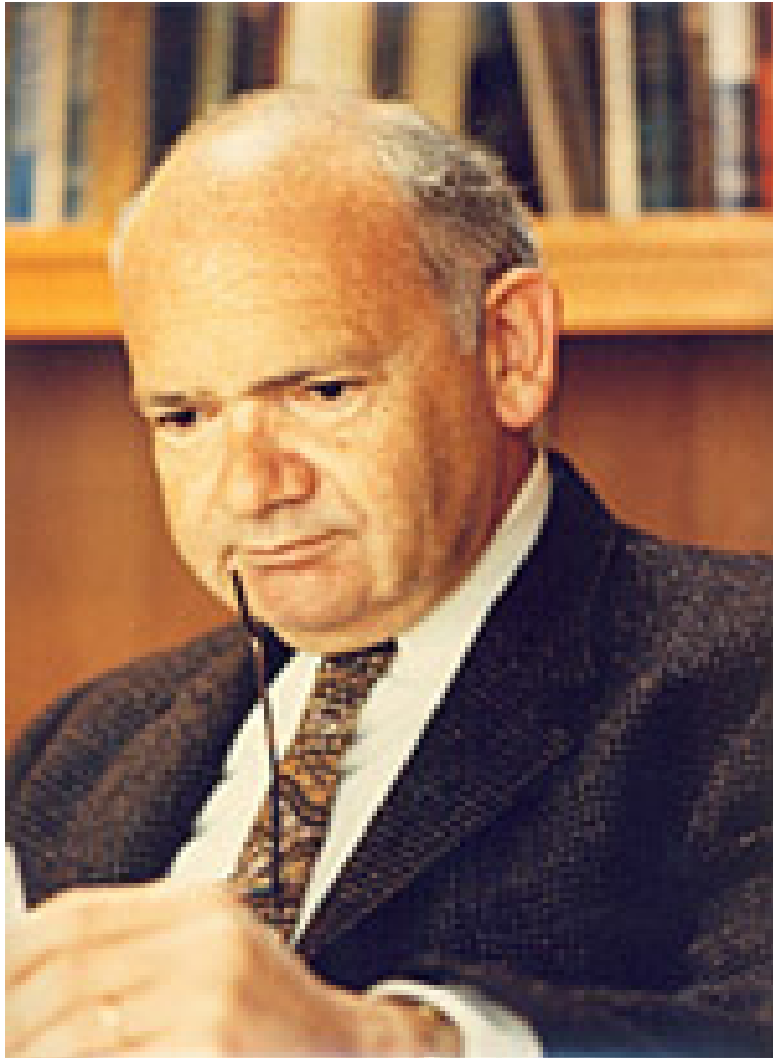
- **Chap. 1 Scientific Inquiry**
- **Chap. 2 Explanation**
- **Chap. 3 Definition**
- **Chap. 4 Observation**
- **Chap. 5 Goals of Science Education**

1972



Israel Scheffler

Harvard University, Philosophy & Education



Scheffler on Science Teaching (1970)

The teacher of science ... needs to have a conception of the field of science as a whole, of its aims, methods, and standards; he needs to have principles for selecting materials and experiences suitable for inducting novices into the field, and he needs to be able to communicate both with novices and with scientific sophisticates ...

But the scope of this requirement is, I suggest, virtually indistinguishable from that of the philosophy of science.

Scheffler's Claims for History and Philosophy of Disciplines in Education

four main ways in which philosophies-of disciplines contribute to education:

- (1)** the analytic description of forms of thought represented by teaching subjects;
- (2)** the evaluation and criticism of such forms of thought;
- (3)** the analysis of specific materials so as to systematize and exhibit them as exemplifications of forms of thought;
- (4)** the interpretation of particular exemplifications in terms accessible to the novice.

The Present

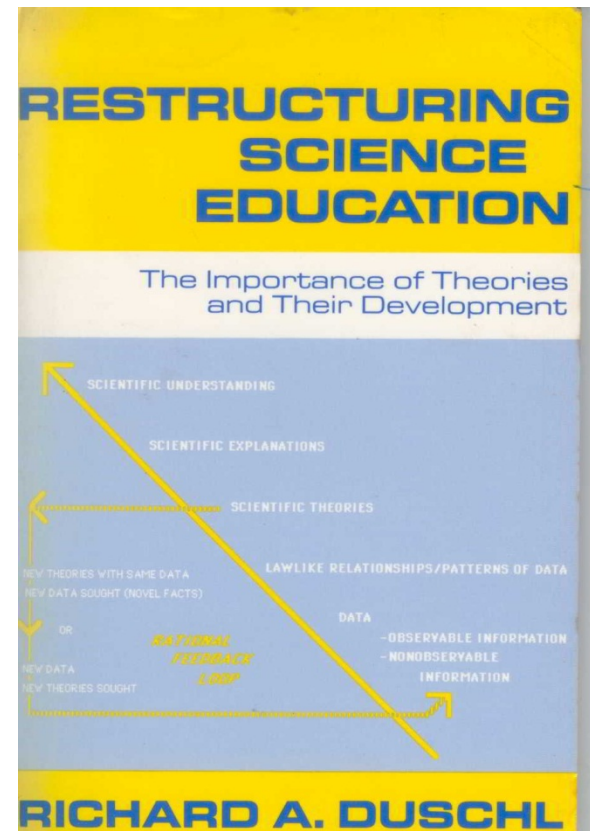
Books

Richard Duschl (1990), *Restructuring Science Education: The Importance of Theories and Their Development*

Chapters

- Bases of Science Education
- Retrospective of Sc. Educ.
- Rethinking Our View of Sc.Ed.
- Status of Theory in Sc.Ed.
- Restructuring of Scientific Theories
- Learning as a Restructuring Process
- Applying the Growth of Knowledge Frameworks (Chem. & Physics)
- Applying the Growth of Knowledge Frameworks (Biol. & Geology)

1990

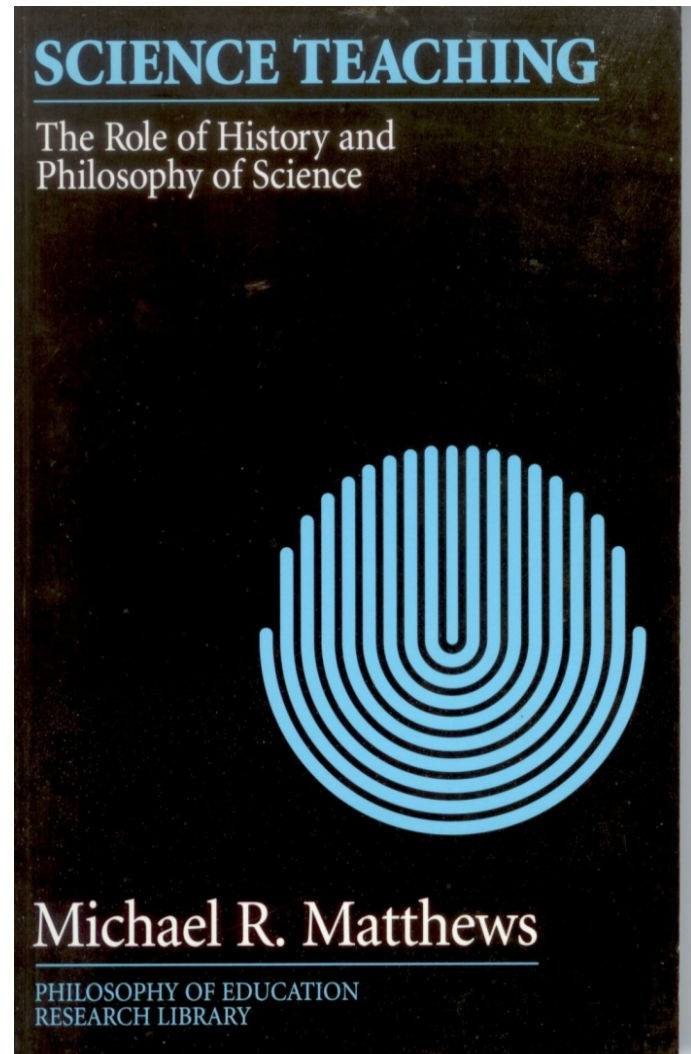


HPS&ST Book (1994)

Routledge Philosophy of Education Library

[invited by Israel Scheffler]

- **CHAP. TWO** Historical Debates About the Science Curriculum
- **CHAP. THREE** Contemporary Curricular Developments
- **CHAP. FOUR** History of Science in the Curriculum
- **CHAP. FIVE** Philosophy in the Curriculum

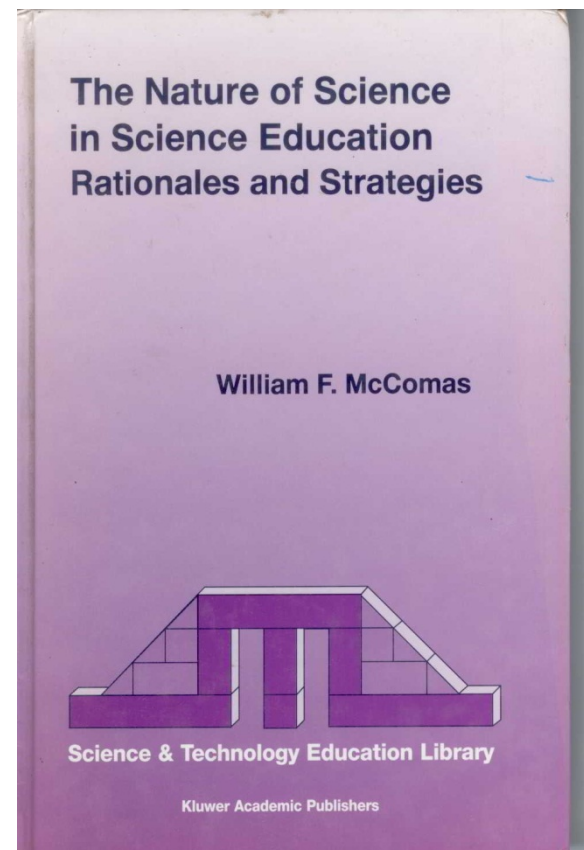


McComas, W.F. (ed.) (1998), *The Nature of Science in Science Education: Rationales and Strategies*

Sections

- **Rationales for NOS in Science Education**
- **Communicating NOS: Plans, Approaches & Strategies**
- **Communicating NOS: Courses and Course Elements**
- **Assessing NOS Understanding**

1998

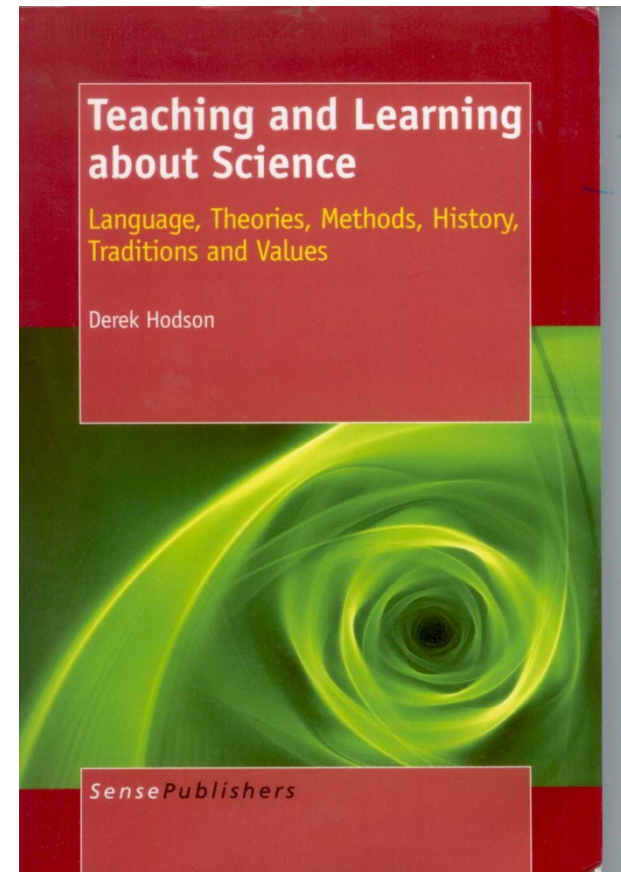


Derek Hodson (2009), *Teaching and Learning about Science: Language, Theories, Methods, History, Traditions and Values*

Chapters

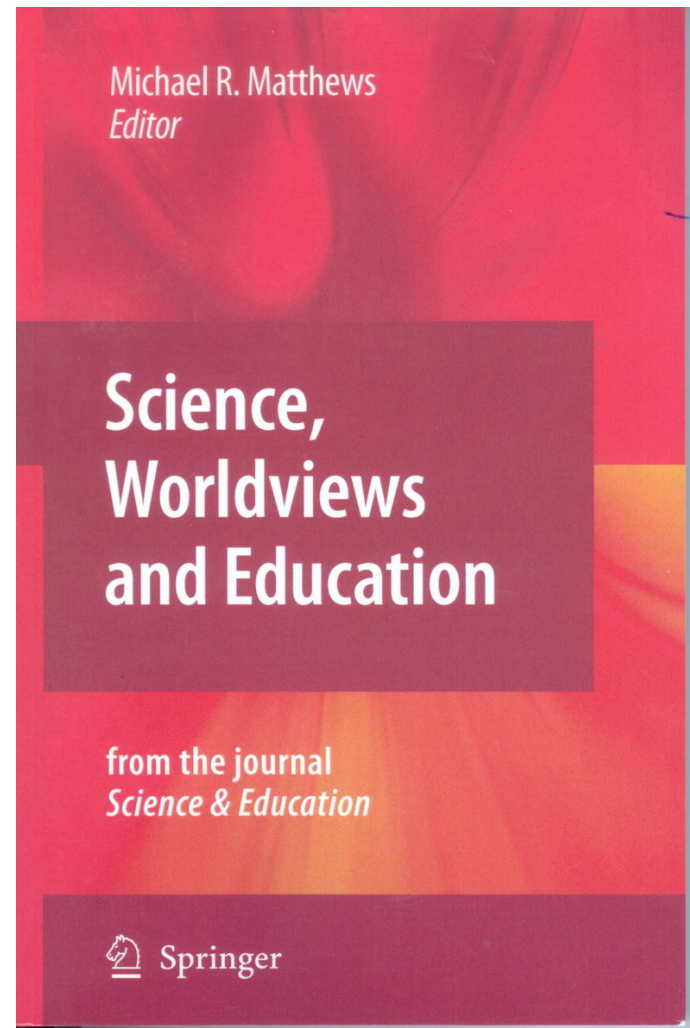
- **Scientific Literacy & HPS**
- **Students' Views of NOS**
- **Teachers' Views of NOS**
- **Making NOS Teaching Explicit and Reflective**
- **Thoughts on Demarcation**
- **Substantive Structure of Science**
- **Syntactical Structure of Science**
- **Reading, Writing and Talking for Learning**
- **History, Traditions and Values of Science**

2009



M.R. Matthews (ed.) *Science, Worldviews and Education* (2009)

- **What are worldviews?**
- **Is science committed to a worldview?**
- **Is naturalism a methodological commitment or ontological commitment?**
- **What response should be made when there is a clash between students' worldview and that required by science?**

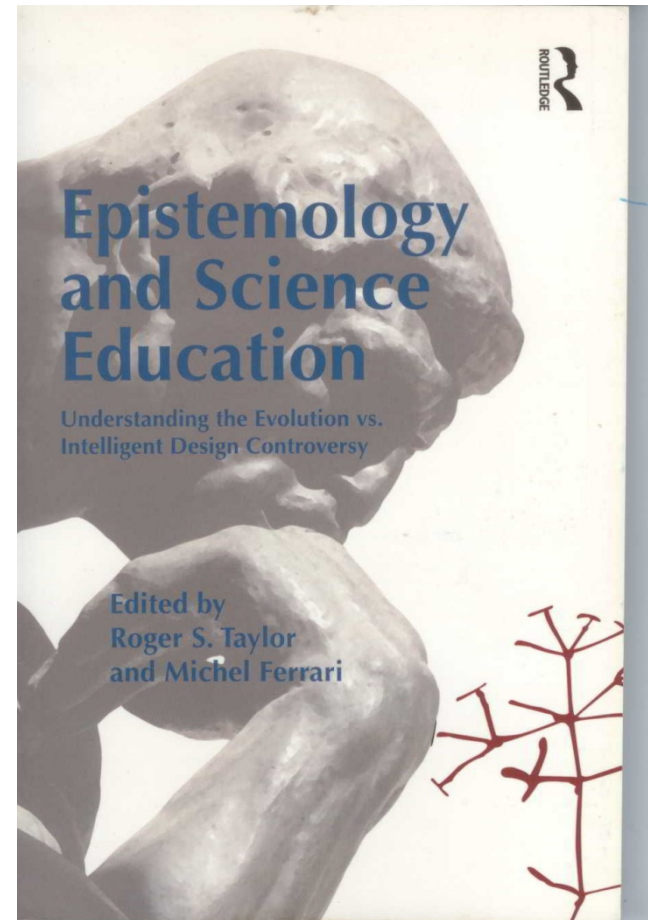


Taylor, R.S. & Ferrari, M. (eds): 2011, *Epistemology and Science Education: Understanding the Evolution vs. Intelligent Design Controversy*

Parts

- **Epistemology**
- **Intelligent Design & Evolution**
'Ontologically Different Epistemologies' (Sinatra & Nadelson)
- **Teaching Science**
- **Conclusion:**
Teach the Demarcation

2011

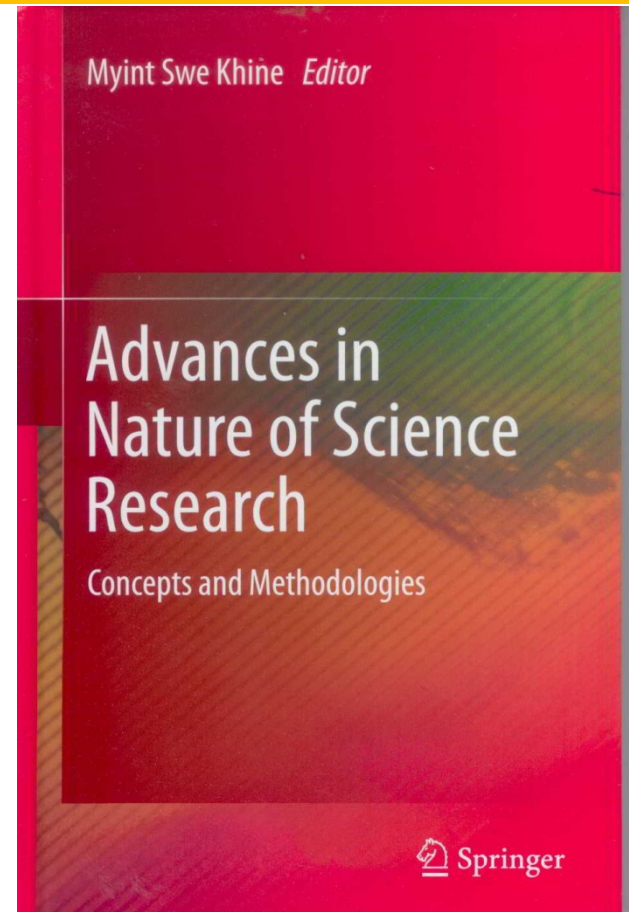


Myint Swe Khine (ed.): 2012, *Advances in Nature of Science Research: Concepts and Methodologies*

Contents

- **Pt.1**
Conceptual Issues in NOS Research
M.R. Matthews, 'From NOS to FOS'
S.A. Southerland et al 'The Bounded NOS'
- **Pt.II**
Methodological Advances in NOS Research

2012

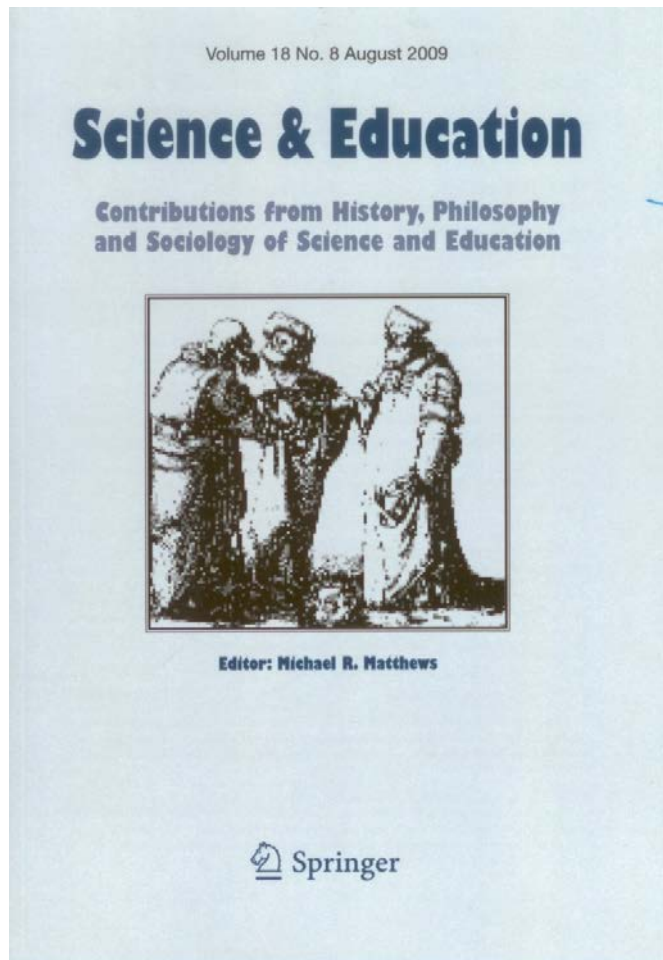


IHST

International History, Philosophy, and Science Teaching Group

- 1989, Tallahassee, Florida
- 1992, Kingston, Ontario
- 1995, Minneapolis, Minnesota
- 1997, Calgary, Canada
- 1999, Pavia, Italy
- 2001, Denver, Colorado
- 2003, Winnipeg, Manitoba
- 2005, Leeds, England
- 2007, Calgary
- 2009, Notre Dame University
- 2011, Athens
- **2010, 2012 Latin American meetings**
- **2012 Asian meeting**
- **2013, Pittsburgh (June 19-23)**

Science & Education: ***Contributions from History & Philosophy*** ***of Science and Education***



- **1992, four numbers**
1997, six numbers,
2003, eight numbers,
2007, ten numbers.
- **1992-2012 approx. 800**
articles published
- **2011, 108,650 article-**
downloads

Asia (32%), Europe (31%)
Nth. America (27%)

Thematic Journal Issues

- 1994, '**Science and Culture**', 3(1).
- 1995, '**Hermeneutics and Science Education**', 4(2).
- 1996, '**Religion and Science Education**', 5(2).
- 1997, '**Philosophy and Constructivism in Science Education**', 6(1-2).
- 1997 '**The Nature of Science and Science Education**', 6(4).
- 1999, '**Values in Science and in Science Education**', 8(1).
- 1999, '**Galileo and Science Education**', 8(2).
- 1999, '**What is This Thing Called Science?**', 8(4)
- 1999, '**Children's Theories and Scientific Theories**', 8(5).

Thematic Journal Issues

- 2000, '**Thomas Kuhn and Science Education**' 9(1-2).
- 2000, '**Constructivism and Science Education**' 9(6).
- 2003, '**History, Philosophy and the Teaching of Quantum Theory**', 12(2-3)
- 2004, '**Science Education and Positivism: A Reevaluation**', 13(1-2)
- 2004, '**Pendulum Motion: Historical, Methodological and Pedagogical Aspects**', 13(1-2, 7-8)
- 2006, '**Textbooks in the Scientific Periphery**', 15(7-8)
- 2005, '**Science Education in Early Modern Europe**', 14(3-4)
- 2007, '**Models in Science and in Science Education**', 16(7-8)

Thematic Journal Issues

- 2008, '**Teaching and Assessing the Nature of Science**', 17(2-4)
- 2008, '**Social and Ethical Issues in Science Education**', 17(8-9)
- 2008, '**Studies in Historical Replication in Psychology**', 17(5)
- 2008, '**Feminism and Science Education**', 17(10)
- 2009, '**Politics and Philosophy of Science**', 18(2)
- 2009, '**Science, Worldviews and Education**', 18(6-7)
- 2010, '**Darwinism and Education**' 19(4-5, 6-8)
- 2011, '**Science and Pseudoscience in Society and Classrooms**' 20(5-6)

Thematic Journal Issues

- 2012, '**History of Experimental Science Teaching**' 21(2)
- 2012, '**Popular Science Between News and Education: A European Perspective**' 21(3)
- 2012, '**Popularizing and Policing "Darwinism" 1859-1900**', 21(7)
- 2012, '**Mario Bunge's Systematic Philosophy**', 21(10)

Thematic Journal Issues (coming)

- **Philosophy and Chemistry Teaching**
- **Philosophy and Biology Teaching**
- **Genetics and Society: Educating Scientifically Literate Citizens**
- **Philosophy of Commercialized / Commodified Science**
- **Science & Literature**
- **Museum Education: The Place of HPS**
- **Mendel and Mendelism**

The Future

***International Handbook of
Research in History, Philosophy
and Science Teaching***

**Michael R. Matthews (ed.)
Springer 2013**

Purpose

The Springer Handbook is to provide a structured, documented and critical guide to extant HPS&ST research.

It can be used by the profession as an important marker of progress, and platform for informed and coherent future contributions.

The handbook as a whole, and each chapter within, is meant to straddle both the fields of HPS scholarship *and* educational research.

Section Structure

- ***PART I: PEDAGOGICAL STUDIES***
- ***PART II: THEORETICAL STUDIES***
- ***PART 111: REGIONAL STUDIES,***
- ***PART 1V: BIOGRAPHICAL STUDIES***

PART I: PEDAGOGICAL STUDIES

- **Physics:**

- mechanics
- optics,
- electricity,
- relativity,
- quantum theory,
- Energy

PART I: PEDAGOGICAL STUDIES

- **Chemistry:**
- **history of chemistry and classroom teaching and learning**
- **philosophy of chemistry and classroom teaching and learn**
- **historical teaching of atomic and molecular structure**

PART I: PEDAGOGICAL STUDIES

- **Biology:**

- evolution,
- genetics I,
- genetics II
- ecology

PART I: PEDAGOGICAL STUDIES

- **Earth sciences,**
- **Astronomy,**
- **Cosmology**

PART II: THEORETICAL STUDIES

- (a) **Features of Science:** Their Educational Importance
- (b) **The Teaching, Learning and Understanding Science:** Historical and Philosophical Considerations
- (c) **Science, Culture and Society:** Philosophical Issues for Education
- (d) **The Role of Science Education within Education:** Historical and Philosophical Considerations

(a) Features of Science: Their Educational Importance

- **History of Nature of Science studies & NOS measurement scales**
- **Philosophical appraisal of NOS studies**
- **Women and science education: What has feminist philosophy contributed?**
- **Constructivism: lessons from the history of its impact in science education**
- **Constructivism: philosophical issues in its utilisation in science & mathematics education**

(a) Features of Science: Their Educational Importance

- **Experimentation in science and school laboratory activities**
- **Postmodernism and science education**
- **Philosophical comment on cultural studies in science and science education**
- **Hermeneutics in Science and in science teaching and learning**

PART 111: REGIONAL STUDIES,

- **USA**
- **Canada**
- **Brazil**
- **Argentina**
- **Mexico**
- **England**
- **China**
- **Korea**
- **Japan**
- **Europe**
- **Bosnia and Herzegovina**

PART 1V: BIOGRAPHICAL STUDIES

- **Fredrick W. Westaway**
- **Eric J. Holmyard**
- **Joseph Schwab**
- **John Dewey**
- **Ernst Mach,**
- **Martin Wagenschein**

How to Improve Preparation for HPS&ST Research?

- **Include history and philosophy courses in Education PhD programmes**
- **Have historians and philosophers on PhD committees**
- **Encourage joint appointments between History or Philosophy and Education Departments**
- **Ease publication pressures on new staff so they can study the history and philosophy of science and/or other foundational disciplines**

INTERNATIONAL HISTORY, PHILOSOPHY & SCIENCE TEACHING GROUP



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