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RESEÑAS

# Review of Matthews, M.R. (2015). Science Teaching: The Contribution of History and Philosophy of Science (20th Anniversary Revised and Expanded Edition). New York: Routledge☆,☆☆

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## Introduction

According to latest Google Scholar Citation figures, the first (1994) edition of this book has over 1,500 citations, more than double of its closest rival. For science education research these are fairly high figures.

The revised edition has the following 12 chapters: 1) The reapproachment between history, philosophy and science education; 2) The enlightenment tradition in science education; 3) Historical and current developments in science curricula; 4) History of science in the curriculum and in classrooms; 5) Philosophy in science and in science classrooms; 6) History and philosophy in the classroom: Pendulum motion; 7) History and philosophy in the classroom: Joseph Priestley and the discovery of photosynthesis; 8) Constructivism and science education; 9) A central issue in philosophy of science and science education: Realism and anti-realism; 10) Science, worldviews and education; 11) The nature of science and science teaching; and 12) Philosophy of teacher education. Although the titles of some of the chapters are the same as in the first edition, the content has been thoroughly revised and enlarged. Besides revising the chapters the author has taken care to include the current debates in the science education community. The details provided in each chapter are so diverse that one could write a review for every chapter. Consequently, this reviewer has decided to write with respect to only some of the chapters.

## Enlightenment philosophy

Chapter 2 is devoted to the Enlightenment philosophers (Locke, Voltaire, Hume, Kant, among others) that represented the age of reason in the 18th century. Although the views of these philosophers varied they shared some core commitments, such as: free speech, separation of church and state, blasphemy should not be a crime, the church should not monopolize or control schooling, and state service should be open to the followers of all religions (p. 24). The period before the 18th century was characterized by torture, burning and hanging of heretics by both the catholic and protestant churches (p. 25). Matthews provides a dramatic turn by stating: "The Salem witch trials took place in Massachusetts in 1692, 5 years after publication of Newton's *Principia*" (p. 25). In order to provide a balanced picture, Matthews also presents a critique of the

*E-mail address:* niazma@gmail.com (M. Niaz).

☆ Solicitada por el Director de la revista, dada la importancia que tuvo y tendrá el libro de Michael Matthews en el terreno de la enseñanza de la ciencia.

☆☆ A preliminary version of this review was presented at *The 2nd International History, Philosophy and Science Teaching Asian Regional Conference,* 4-7 December, 2014, Taipei, Taiwan.

enlightenment by feminists, constructivists, postmodernists and multiculturalists. With this background, Matthews suggests that perhaps the enlightenment thinking facilitated the introduction of a secular education and understanding of nature of science (NOS) free from different dogmas. If one could extend this line of reasoning it is no wonder that in most parts of the developing world even in the 21st century secular and universal education is still a chimera. Actually, Matthews goes into considerable detail to illustrate the case of India (pp. 49-51). Soon after independence in 1947, India's first Prime Minister J. Nehru (1889-1964) introduced educational reforms in the national constitution that included concepts such as: "scientific outlook", "scientific habit of mind", and "scientific temper". According to Matthews most recent reform documents in different parts of the world (e.g., Project 2061, American Association for the Advancement of Science) could not even dream of including such illuminating concepts. However, despite all the good intentions most of these dreams did not come to fruition due to criticisms of the postmodernists and the conservative elements in the Indian society. This led Matthews to conclude that India's case is similar to other places where educational reform has to steer through philosophical ideas, politics, economics and religion (for details see Nanda, 2003).

Another subject in Chapter 2 deals with a reappraisal of the myth and reality of positivism in the science education literature (pp. 43-44). Matthews draws attention to the need to re-conceptualize our understanding of positivism, especially with respect to two positivist philosophers (Frank and Feigl) and following are some of the salient aspects of these philosophers' thinking: *a)* Both recognize the theoretical dependence of observation; *b)* Do not promote unquestioning textbook learning (that is rules and algorithms); *c)* Do not approve of behaviorist psychology; and *d)* Do recognize the importance of history, especially for science education.

## Constructivism

Chapter 8 deals with constructivism a topic of considerable interest to science educators. While reading this chapter I was reminded of the 1990 Annual Conference of the National Association for Research Science Teaching (NARST), Atlanta, GA. Rosalind Driver was the Plenary Speaker and she started her talk by the following words: "Now that we are all constructivists…". She could not finish her sentence as a young tall man stood up and said: "Just leave me out…". Driver at that time was at the peak of her popularity and continues to be a much respected figure. The young man was Michael Matthews, unknown to most of the conference participants. This episode illustrates Michael's strong, honest and forthright views on controversial topics. In this chapter (p. 303) Matthews explains that constructivism is presented both as theory of learning (psychological theory) and a theory of knowledge (philosophical and epistemological theory). After presenting a detailed critique of radical and social constructivism, Matthews rightly refers to "An evidential dilemma." The dilemma lies in the fact that many constructivists deny that reality can be known or is forever inaccessible. Despite this constructivists (especially radical and social), advocate empirical research in order to support their theories. If the reality is forever elusive, it is not clear how the evidence can facilitate a better understanding and hence the dilemma. In order to highlight the contradiction in constructivist thinking, Matthews goes beyond and asserts: "Here, it is being said that the Earth does not have a structure until geophysicists impose it; there is not an evolutionary structure in the animal world until biologists impose such structure; atoms have no structure until such is imposed by physicists; and so on. One might ask: if gravity waves are our creation, why spend so much time and money looking for them?" (p. 312). These are important questions for science educators. It is one thing to say that atoms have no structure of their own and the scientists impose such a structure. In contrast, one could reason that atoms do have a structure and scientists are developing the experimental methods required for understanding that reality, hence the multiplicity of atomic models in the history of science: Dalton, Thomson, Rutherord, Bohr, Bohr-Sommerfeld and wave mechanical models of the atom. Furthermore, this facilitates the construction of atomic models that progressively increase in their explanatory power and thus illustrate the tentative nature of scientific progress. In a similar vein, Niaz (2011) has established an analogy between the progressive nature of atomic models and the changing nature of various forms of constructivism, such as: Trivial constructivism in 1960 (Piaget), human constructivism in 1970 (Ausubel and Novak), radical constructivism in 1980 (Von Glasersfeld), social constructivism in 1990 (Vygotsky) and pragmatic constructivism in 1999 (Perkins). Perkins (2006) has called for a more pragmatic approach to constructivism, more like a Swiss army knife with various blades for various needs.

## Nature of science

In his book *The Unnatural Nature of Science,* Lewis Wolpert, a developmental biologist, states cogently:

> *"… both the ideas that science generates and the way in which science is carried out are entirely counter intuitive and against common sense — by which I mean that scientific ideas cannot be acquired by simple inspection of phenomena and that they are often outside everyday experience. Science does not fit with our natural expectations" (Lewis Wolpert, 1993, p. 1, italics added).*

With this background it is understandable why nature of science (NOS) is a controversial topic in science education, as most science curricula and textbooks emphasize simple inspection of phenomena, assuming that nature's secret can be easily perceived.

Matthews reviews the different approaches to understanding NOS in science education, among others the consensus view (Lederman, Abd-El-Khalick) and the family resemblance view (Irzik, Nola). Matthews is particularly critical of the consensus view: "The assumption that NOS learning can be judged and assessed by students' capacity to identify some numbers of declarative statements about NOS" (p. 389). Despite this, he recognizes that such an approach to NOS is positive as it "puts NOS into the classrooms" (p. 393) and at the same time negative as it constitutes "a catechism". Understanding this difference is critical for introducing NOS in the classroom. If a teacher wants to evaluate students' understanding of NOS prior to teaching about NOS then the instruments developed by the Lederman group are quite appropriate. However, if the teacher wants to go beyond and teach about NOS in the context of a particular topic of the science curriculum then it is essential to "immerse" in the history of science.

Matthews draws attention to the fact that the importance of history of science for education was recognized by Whewell (1855), English scientist, philosopher and historian more than one hundred years before Popper, Kuhn and Lakatos: "Whewell's point is worth drawing attention to, as so much NOS discussion in science education goes in direct violation of it. NOS is frequently taught without reference to history and is not informed by history" (p. 390). For anyone who has followed the development and progress of the journal *Science & Education,* over the last 23 years this should not be a surprise. Recent publication of the *International Handbook of Research in History, Philosophy and Science Teaching* (Matthews, 2014) is a further vindication of the historical approach to teaching NOS and science. Nevertheless, two distinguished science educators have argued that current philosophy of science has gone beyond the historical turn (Kuhn, Lakatos, Laudan) and now espouses a naturalist philosophy of science, and suggested that the views of those who emphasize history of science are "Grounded in dated (logical positivism and historical turn) views that depict NOS through heuristics that focus on individual scientists justification of knowledge" (Duschl & Grandy, 2013). This may not only surprise science educators but may even be disconcerting to those who are beginning their careers in science education. Interestingly, Matthews cites these authors in the references but do not comment on these views in the text of the chapter. Matthews however does make an important contribution by suggesting that the various aspects of NOS be considered as Features of Science (FOS) that are more relaxed, contextual and heterogeneous. This will facilitate the inclusion of numerous other features, such as epistemological, historical, psychological, social, and technological.

Finally, the new edition of the book by Matthews is a rich source of historical, epistemological and philosophical ideas that can be of immense help to the graduate students, teachers and researchers.

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