Title:
"Learning Research - History and Philosophy of Science for the Engineering Sciences.”

Author:
Mieke Boon, Department of Philosophy, University of Twente, The Netherlands.
http://www.utwente.nl/gw/wijsb/organization/boon/

Abstract:
This contribution will describe a history and philosophy of science course for graduate students in the engineering sciences. The approach and content of this course has resulted from a research-project Philosophy for the engineering sciences funded by a grant from the Dutch National Science Foundation, and a close collaboration with research groups in the MESA+ Institute for Nanotechnology.

The general context is scientific research in the context of technological applications. Its general aim is developing in-depth understanding of scientific knowledge and scientific research. Our two-tiered approach, on the one hand illustrates by means of appealing and challenging historical examples ‘how scientific theories were produced,’ and on the other hand clarifies by means of a body of helpful philosophical ideas ‘how scientific knowledge is made’.

General issues that justify the relevance of aiming at in-depth understanding of scientific knowledge and scientific research relate to ‘becoming a better scientist’, such as, adequate uses of scientific knowledge; adequate reading of the scientific literature; translating technological problems to scientific research; and working inter- or multi-disciplinary.

In the research-project Philosophy of the Engineering Sciences, several of the ‘common’ notions discussed in the philosophy of science and commonly used in the language of scientific practices, have been reconsidered from the perspective of the engineering sciences. These notions are, for instance, phenomena, laws of nature, truth, observation, proof, explanation, scientific concepts, scientific discovery, fundamental theories, scientific models, instruments and experiments, and fundamental versus applied science. This approach has resulted in a preliminary conceptual framework that is more productive in understanding the engineering sciences as a scientific research practice. In this course, students learn to use this new conceptual framework.

Importantly different from traditional approaches in the philosophy of science is the focus on ‘how scientific knowledge is constructed’ (traditionally called the context of discovery), which I propose to call the context of construction. Similarly, one of our didactical aims is that students learn ‘to think as a scientist.’ Moreover, they learn that even our most fundamental theories have been constructed by studying historical texts of the great scientists (e.g., Newton, Faraday, Maxwell, Carnot and Prandtl). In brief, by learning to apply the new conceptual framework, students develop an understanding of how these scientists constructed their theories.

Based on the new conceptual framework, also a concrete conceptual tool is proposed for analyzing current scientific research. Based on analyses of many different scientific articles, it is
suggested that most of the construction of knowledge concerns scientific modeling of phenomena, such as phenomena that are held responsible for the (dis-)functioning of technological materials, processes and devices. The conceptual tool enables analyzing these articles as models of phenomena – in turn, these models are considered as epistemic tools that enable e.g., reasoning about (e.g., intervening with) the phenomenon. It appears that these kinds of analyses enable better understanding of scientific articles, even in fields that are unfamiliar. Also, they facilitate structuring and explaining research-projects, and assists in inter- and multi-disciplinary communication.