

Abstracts

History of Science in the Science Classroom

Fourth International Seminar for History of Science and Science Education

*The University of Manitoba
The University of Winnipeg
Canada*

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Welcoming remarks – Rod Bollman, Associate Dean of Science, The University of Winnipeg.

Keynote Monday, July 23, 0915 h

Scientific Myth-Conceptions

Douglas Allchin

Minnesota Center for the Philosophy of Science, USA

Using several familiar examples -- Gregor Mendel, William Harvey, H.B.D. Kettlewell (peppered moths), Ignaz Semmelweis (handwashing), and Alexander Fleming (penicillin) -- I will show how we currently portray the nature of science through the mythic structure of cultural stereotypes. These common stories are misleading about the nature of science. I will introduce the concept of pseudohistory and profile how it parallels the well-known dangers of pseudoscience. I will also focus on error in science as key to understanding both the authority of science and its limits. In this way we can balance the contrasting pressures of creationism and anti-science attitudes, as well as naive scientism and sociological criticisms of science in society. Ultimately, I profile what types of histories and narratives can convey the nature of science most effectively.

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Monday, July 23, 1115 h

Lessons from Smoke Rings

Michael Eckert

Deutsches Museum, Germany

In the middle of the nineteenth century, vortex rings--usually illustrated with smoke--became a vital field of research, after Helmholtz had discovered conservation

laws for vorticity in ideal fluids. Then, vortex rings were a theme of fundamental physics (Kelvin's vortex atoms, for example). In the twentieth century, vortices became of utmost interest in more applied areas, such as aerodynamics. In view of a rich history with fascinating examples from many areas, vortex rings may be used in science teaching as an example where real world physics contrasts with idealizations.

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Monday, July 23, 1330 h

Using experiments from the history of thermodynamics in teacher training

Peter Heering

University of Oldenburg

The use of historical experiments is one of the characteristics in the teacher training at the physics department of the Carl-von-Ossietzky-Universitaet Oldenburg. These experiments are used under very different circumstances of education; in my presentation I will limit myself to two examples from the field of thermodynamics that should demonstrate the scope: The first one being an experiment that has been described originally by Benjamin Thomson, Count Rumford in 1804. In his experiments Rumford described the thermoscope to examine the ability of different surfaces to emit radiant heat. This device is used in a compulsory lab course for teacher students. The second example will be based on the final thesis of a student who was supposed to analyze W. Herschel's experimental demonstration of the existence and distribution of radiant heat in the sun's spectrum. In discussing this thesis I will particularly focus on the physics that was involved in reconstructing the devices described by Herschel as well as making the experiments according to Herschel's description.

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Monday, July 23, 1415 h

Galileo's Experiments in Mexican Physics Textbooks

Josip Slisko

Benemérita Universidad Autónoma de Puebla, Puebla, México

The physics curriculum for secondary school in Mexico (VII to IX grades) advocates for the presentation of historical episodes, not in the form of anecdotes but in the form of the patterns of reasoning used by famous scientists. The experimental work of Galileo is explicitly required for presentation. How well do the authors of physics textbooks meet this curriculum requirement? To answer this question, we must first understand Galileo's work on free fall—his definition of acceleration, the thought experiment about the “logical incoherence” of Aristotle's view, the tower demonstration and the incline plane experiment. Each textbook's presentation of that content can be evaluated, to get a sense of the quality of pedagogical use of history of physics in teaching. The conclusion is rather disappointing, because the textbook treatments go

from superficial to incorrect ones. I will conclude with suggestions for a better pedagogical transformation of Galileo's experiments.

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Monday, July 23, 1515 h

Lorand Eotvos and his research-related in-class experiments

Laszlo Kovacs

Berzsenyi Teachers' College, Hungary

[abstract misplaced by the editors, with apologies]

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Tuesday, July 24, 0900 h

A Short History of the Pendulum: From Aristotle to Chaos

Art Stinner and Peter Loly

University of Manitoba

...without the pendulum there would have been no Principia (Richard Westfall)

The inclined plane and the pendulum played a central role in the development of the kinematics and dynamics in the seventeenth century. Studying the pendulum, Galileo thought that an arch of a circle represented the "least time" path of an object in a vertical plane. Huygens showed that the cycloid was the path required for isochronous motion of a pendulum and not the arc of a circle. It was left to Johannes Bernoulli, Newton and Leibniz to invent a new branch of the calculus, in order to solve problems such as the brachistochrone, or "least time" of descent between two points in a vertical plane. We will demonstrate some of the well known properties of pendulum motion that can be used for novel demonstrations in a high school physics class. We will conclude with a discussion and demonstration of chaos theory using a pendulum.

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Tuesday, July 24, 1030 h

The History of Complex Numbers in Physics

Waldemar Feller

Kantonsschule Wohlen, Switzerland

In the fifteenth century Italian mathematicians introduced roots of negative numbers for the first time; in the sixteenth century it was the French mathematician and philosopher Descartes who called them "imaginary" numbers. The Swiss mathematician Euler was the first to call the imaginary unit just i . Finally, in the eighteenth century, the German mathematician Gauss spoke of complex numbers for the first time. Euler also introduced the very fundamental equation $e^{ij} = \cos(j) + i\sin(j)$ which has many applications in physics. It is often easier to describe two-dimensional problems by using complex numbers instead of vectors. For the well-known American physicist Richard Feynman, Euler's formula was even the most remarkable formula in mathematics.

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Tuesday, July 24, 1115 h

Integrating the History of Science in the Science Classroom – What Do the Students DO?

Donald J. Metz

Many authors (Matthews, 1994) have extended a rationale for the inclusion of the history and philosophy of science (HPS) in the science curriculum. Others, like Monk and Osborne (1997), have offered a model of a teaching process that can be used to integrate HPS in a science classroom. However, few proponents of HPS provide any details or sample strategies for the implementation of HPS at the classroom level which acknowledges the importance of students' prior knowledge and active engagement in their own learning. In other words, what do the students DO? Consequently, a gap between research in HPS and practice continues to exist. This article outlines the development of a course in the history and philosophy of science and science teaching for pre-service teachers intended to address the development of specific strategies to implement HPS. Additionally, a number of strategies for integrating several aspects of the history and philosophy of science in terms of student involvement and activity will be shared.

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Tuesday, July 24, 1330 h

The Story of X-ray Diffraction: From Bragg to Crick

Mark Larchez

University of Wisconsin-Stout, USA

Students are familiar with x-rays (xrays) for seeing broken arms or tooth cavities. But people have also used xrays to learn about things far different and maybe more amazing. Xrays have revealed some of the secrets about atoms, solid state crystals, and molecules like DNA. The combination of short wavelength and substantial energy

available in xrays allows us to see things that are invisible because they are too small to see. The tool of xray diffraction analysis has a story that can be told in terms of the people who worked on it and worked with it. The most famous are probably W.H. Bragg, W.L. Bragg, J.D. Watson, and F.H.C. Crick. Less famous men and women played important roles as well. Some of the most important (and most interesting) stories are told here. Study of science as a human activity can make the tricky scientific techniques easier for students to understand.

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Tuesday, July 24, 1415 h

**The Oil Drop Experiment:
How did Millikan Decide Which Was an Appropriate Drop?**

Mansoor Niaz

Universidad de Oriente, Venezuela

The oil drop experiment was not only difficult to perform but also generated considerable controversy between two well-known investigators, R.A. Millikan and F. Ehrenhaft. Given the importance of alternative interpretations of empirical data in scientific progress, it is important to contrast the views of physicists/philosophers of science with those of authors of physics and chemistry textbooks and laboratory manuals. Physicists and philosophers of science do understand that the experiment is difficult to perform even today, primarily due to the difficulty associated with the selection of appropriate drops, and that consensus was achieved in the scientific community after a bitter dispute. In contrast, authors of physics and chemistry textbooks and laboratory manuals ignore the controversy (especially with respect to the selection of the drops). As a consequence, textbooks present an inductivist interpretation in which empirical data was crucial in the quantization of the charge of the electron. Although the experiment is important epistemologically, its interpretation as a site of conflict and controversy is even more important.

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Tuesday, July 24, 1515 h

Huygens' Clocks in the Classroom

Helga Klebermass

Germany

In order to build his pendulum clocks Christiaan Huygens conducted a lot of mechanical experiments. In my presentation I will deal with possibilities to include his results concerning gravitation and circular movements into the teaching of physics. Of course, his studies of the degree of longitude will also be an important part.

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Wednesday, July 25, 0900 h

Of Rice and Men

Douglas Allchin

Minnesota Center for the Philosophy of Science, USA

I will engage participants in the case of Christiaan Eijkman and the cause of beriberi. Eijkman's massive controlled study earned him the Nobel Prize, but also reflected a prominent error: he rejected the very notion for which the Nobel was awarded(!). Using this case, I hope to demonstrate strategies for using case studies to develop thinking skills and convey nature of science. First, such case studies provide the context of a real problem or question that can motivate students intellectually. Second, they allow students to practice important reasoning skills: generating plausible hypotheses; designing experimental investigations; interpreting data; assessing alternative hypotheses; posing new problems; etc. At the same time, casework deepens an appreciation of the structure of scientific concepts. Fourth, specific historical cases offer occasions to understand various social dimensions of science: for example, the politics of funding; the ethics of research; the role of scientific communication; or the challenge of persuading peers in a scientific community.

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Wednesday, July 25, 1030 h

The Presuppositional Structure of Scientific Revolutions, with Examples from Biology, Economics, Logic and Physics

Ian Winchester

University of Calgary, Canada

In this presentation I shall discuss the underlying presuppositional structure to the revolutions in biology, economics, logic and physics associated with Darwin, Keynes, Russell, and Einstein. My analysis will draw on both Collingwood and Wittgenstein in trying to recharacterize a striking transformation change in scientific practice and theory. In particular, I will discuss the deep presuppositional structure in these disciplines and the ways in which they can undergo strain, ascend to consciousness and be subject to both conscious and unconscious revision. In the process I shall reconsider Kuhn's picture of scientific revolutions, which still tends to dominate the picture of scientific revolutions outside of philosophy circles. My analysis will not offer much succor either to the followers of Kuhn or of Popper, his main critic.

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Wednesday, July 25, 1115 h

Assessment in School Science: Is There a Role for History?

Barbara McMillan

Faculty of Education, University of Manitoba, Canada

Educators writing on assessment in school science advocate direct as opposed to indirect methods, or what is currently labeled performance-based and traditional, respectively. Whether the assessment is for diagnostic, formative, or summative purposes, the goal is authenticity: obtaining the best possible picture of what children know and understand and how they think in areas they are being taught. Wandersee has argued that the history of science has a role to play in diagnostic assessment, if only to make teachers aware of children's alternative beliefs. Using examples from biology and physical science, it is suggested that the history of science, utilized in pictorial forms of assessment and reflective questioning, can offer insight into children's conceptual understanding that is not often attained by other formative and summative methods.

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Thursday, July 26, 0900 h

Tests of Observation and Logic

Wesley Stevens

University of Winnipeg, Canada

During the thirteenth and fourteenth centuries, all students began their studies at the University of Paris with computus and astronomy. Then came lectures on the ten categories of Aristotle, the Isagoge of Porphyry, and the higher logic of Aristotle's Posterior Analytics. Finally, certain questions were posed for debate in public. If the masters were satisfied, a student could be recognized as a bachelor. Thereafter, it was possible for him to pursue particular subjects such as law, medicine, natural philosophy, or theology.

Along the way, the old question might be posed: Does the Sun move around the Earth, or the Earth around the Sun? This presentation will consider how old that question was, and whether it could be usefully discussed in the absence of telescopes. The diversity of the discussion will be represented by the great natural philosophers, Jean Buridan (1290-1360) and Nicole Oresme (1320-1382).

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Thursday, July 26, 1030 h

Lutheran Educational Reform and Kepler's New Astronomy

Rhonda Martens

University of Manitoba, Canada

The great Renaissance astronomer Johannes Kepler (1571-1630) was educated in theology at the University of Tübingen. Tübingen was a Lutheran institution and its curriculum was heavily influenced by Lutheran reformer Philip Melanchthon (1497-1561). The purpose of this paper is to trace some of the roots of Kepler's radical innovations in astronomy to Melanchthon's thought, focusing in particular on the implications of their shared view that one can commune with God through the study of astronomy.

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Thursday, July 26, 1115 h

Public Outreach in the Hamburg and Marseille Observatories

Gudrun Wolfschmidt and James Caplan

University of Hamburg, Germany and Marseille Observatory, France

The first Hamburg observatory was founded in 1802, and the Marseille observatory is 100 years older. Both institutions are now university centres of astronomical research. Visitors come principally to see the 'normal' astronomical exhibits. We try to convey to the public the importance of protecting the historical heritage represented by the older buildings and instruments. In this talk, which will include a virtual visit, we shall try to explain how heritage instruments can enable both children and adults think about science as an activity and not just as a set of answers and astounding facts. At the same time, current technology can bring interdisciplinary topics like "Colors" into the school program.

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Thursday, July 26, 1330 h

From the Earth's Shape to the Sun's Distance: Ionian Physics as the Basis of a Course in Astronomy

Dolf K. Machold

University of Education of Weingarten, Germany

The object of the paper is developing an introductory course in astronomy on the basis of Ionian physics. A method is pointed out - already well-known for 2000 years - which allows us to determine the shape of the earth and the size of the radius of the earth. On the basis of this knowledge the other unknown quantities can be determined step by step combining the experimental results of observing phenomena in astronomy with methods of geometry. Discussing the solutions of the problems involved, students can become aware of essential characteristics of research methods in science and they have the chance to learn that there is an interdependence between scientific experience and theories in physics. Furthermore, the high level of science and mathematics in antiquity is demonstrated. With respect to teaching physics the concepts of Ionian scientists are elements on the basis of which we can develop a curriculum in astronomy.

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Thursday, July 26, 1415 h

The History of the Geosciences in the Classroom

Wladyslaw Altermann & Renate Sievers-Altermann

University of Munich & FWU Institut für Film und Bild, Germany

The structure of the school system in Germany is introduced and a short overview of the development of the curriculum in geography is presented. "Geography" in German schools covers the entire spectrum of geosciences. An exemplary syllabus of the subject geography in schools is shown and the role of the subject at different levels is explained. The FWU - Institut für Film und Bild, is the media institute of all German States and the leading producer of educational media at all schools levels. It provides teaching materials and media for geography next to all other school subjects. Examples of media productions for geography are presented.

At the university level geosciences are compartmentalized into various institutes of specific specializations. Teaching up to the "Diplom" degree (equivalent of 4 or 5 years MSc) is thus distinctive for Geography, Geology/Paleontology, Geophysics, Crystallography, Mineralogy and other subjects, with only limited overlap or interchangeable courses. Doctoral degrees are granted in general natural sciences "rerum naturum". The "Diplom" is the lowest degree available at present in Germany. However, the fiscal restraint and cuts in funding for education forces restrictions as to the duration of studies, which are free of tuition fees. New educational models are therefore discussed and implemented. On one hand a radical reorganization of teaching and institute funding is taking place, based on the teaching and research output of the institutes. Many institutes are presently being closed down and the Geoscience Faculties experience reorganization into "Earth Science Departments" that incorporate all the individual institutes. On the other hand a strong tendency to adapt the Anglo-American system can be seen in all German universities where bachelor (BSc) and master (MSc) courses in geosciences are introduced and the German "Diplom" is being abolished. Positive and

negative results of this new development are discussed using geology as the major example.

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Thursday, July 26, 1515 h

A Historical Eclipse

Ian Cameron

University of Manitoba, Canada

The problem of eclipse prediction reveals especially the mutual astronomical and historical significance of eclipses. Although the geometric conditions for eclipses are generally well known the process of their prediction is perhaps less well known. The selection of a few historical eclipses allows a brief history of eclipse prediction from the ancient to modern world to be outlined.

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Friday, July 27, 0900 h

Interrelations Between Science and Technology

Jürgen Teichmann

Deutsches Museum, Germany

Science (natural philosophy) and technology seem to be two very distinct activities of human culture until about the nineteenth century. To what extent is this wrong - starting with the Greeks, looking at the Middle Ages, the Renaissance and then starting Scientific and "Industrial" Revolutions? I think more and more "intermediate" activities grew up since the nineteenth century that do not belong to pure science and do not belong to hard technology either. Also "hybrid" careers have emerged, between scientist and engineer, standing on their own. What – in respect to science or technology – is the role of rational knowledge and tacit knowledge in those developments? What is the role of looking for basic philosophical insights (in German: Erkenntnis) and searching for practical uses for humankind? There is no simple answer – at least not yet.

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Friday, July 27, 1030 h

The Role of Context in Science and Technology Learning

J. Stephen Klassen

The University of Winnipeg, Canada

The contextual approach to teaching has been advocated and practiced as a reasonable and desirable strategy to enhance student learning. However, there is not a strong linkage of contextual methods in science education with learning theory. Various cognitive, brain, and learning theories suggest that there are at least five contexts that are important in engaging learners: the theoretical, practical, social, historical, and affective contexts. This five-fold model naturally suggests the use of the large context approach in teaching. In this model both storyline and story are essential to providing a full complement of contexts. An application of this approach in the large context of the Atlantic cable story is discussed along with observations.

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Friday, July 27, 1115 h

History of Electricity as Used in Electrical Engineering Technology Courses

Jana Jilek

Red River College, Canada

We encounter electricity in various forms countless times every day. Electricity runs the clock radio that wakes us up. It supplies electric lights, toasters, electric trains, televisions, computers, and numerous other devices we use. In its untamed form, electricity crackles in the fur of a cat when we pet it. It is the awesome power in lightning, and provides the power of the northern lights. In the electrical courses we teach the "workings" of electricity. We teach how to predict behavior of electric devices and how to improve their performance. But do we really understand electricity? This presentation is the introductory lesson in a course on electric circuits. It intends to give students a background on how our present theories developed and a reason for some of the inconsistencies in the theories.

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Friday, July 27, 1330 h

Scientists as Role Models: Making Good Examples from History's exemplars

Ralph Mason

University of Manitoba, Canada

A historical approach to high school curriculum has been suggested for appealing to those students who are more attracted to meaningful stories about

interesting people than to scientific and mathematical ideas. The mathematics and science of Archimedes provide significant opportunities for engaging students in scientific and mathematical inquiry. Unfortunately, the historical record of the life and personal character of Archimedes proves to be a good source only of anecdotes of superficial interest. More is needed if the history of science is to be presented as a field of inquiry full of rich and interesting persons as well as rich and interesting ideas. How can a scientist and mathematician serve as a positive role model, when little detail is available about his/her personal life? Alternatives will be suggested for inviting students to make personal connections through the history of science and mathematics.

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Friday, July 27, 1415 h

The Radiometer – An Explanation by a Historical Approach

Stefan L. Wolff

University of Munich, Germany

Today the radiometer is a well-known toy sometimes still mentioned in physics textbooks. A first glance at the phenomenon suggests that radiation pressure will be the reason for its motion, but more sophisticated investigations reveal that the temperature gradient is decisive. The study of the historical development, including the incorrect ideas of the nineteenth century, provides not only a deeper understanding of the physics but imparts also some more general insights of physics research at that time.

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