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## Theories and Methods of Research (Philosophy of Science for Life Science and Engineering Students)

Lecture Course, Winter Semester 2016/2017

Mon. 12:00-14:00 h (c.t.), start: Mon. 24 October 2016

Rooms B 410, Im Moore 21 (Bldg. 1146), rear entrance (inner courtyard), fourth floor &  
A 004, Im Moore 21 (Bldg. 1146), front entrance, ground floor

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### *Course concept and aims*

Among the central aims of research in the philosophy of science are to understand how science works, and how scientific research is able to produce reliable knowledge about the world that can be used for all kinds of practical and technological purposes. While one could think these questions are mainly of interest to people who study science from the outside (such as philosophers, historians, and sociologists), a basic understanding of these issues is also important for practicing scientists and engineers. After all, in order to assess whether they are doing their job well scientists and engineers should be able to reflect on the reasoning methods they use, on the adequacy of these methods in relation to the general aims of science and engineering, and on what these aims are (and could be) in the first place.

This course offers a practice-oriented introduction to the philosophy of science for science and engineering students. The course is designed for the M.Sc. programs (second year) *International Horticulture* and *Water Resources and Environmental Management*, but is open to interested students from all areas. Topics include the question whether there is a general reasoning method in science (deduction, induction, falsification), progress in science (revolutions, research programs), the question how scientific explanations work and the role of laws of nature in them, the aims of science (and the question how we determine these), and the basic elements of good scientific practice.

The general **aim** of the course is to provide students with tools from the philosophy of science that enable them to reflect on the reasoning methods they use, on how they do their work, and on their views of the general aims of science and engineering. As **learning objectives** upon completion of the course students should be able to

- explain in their own words the various topics, issues, ideas etc. that were discussed in the course;
- develop their own position regarding the question whether there is such a thing as *the* scientific method (and if there is, what it consists in);
- develop their own position regarding the question how science progresses and what progress in science consists in;
- develop their own position regarding the question what it means to scientifically explain a particular phenomenon;
- develop their own position regarding the question what the aims of science and engineering are – or rather, what these aims *should* be and how we can go about determining them;
- place their own research projects and research interests in the context of the various issues discussed in the course.

With respect to **general competences** after completion of the course students should be able to

- read and understand complicated argumentative texts;
  - to identify the principal ideas, arguments, etc. in such texts and to separate them from side issues;
  - to present their own work (orally and/or in writing) in a clear and concise way.
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### *Organizational and formal issues*

The course is an integral part of the M.Sc. programs *International Horticulture* and *Water Resources and Environmental Management*. In addition, the course is intended for students in the M.A. program *Philosophy of Science*, as well as in the major or minor Philosophy in the dual-subject Bachelor and M.Ed. programs. Students can take the course as part of the following modules:

- M.Sc. *International Horticulture*: compulsory module A01 “Theories and Methods of Research”;
- M.Sc. *Water Resources and Environmental Management*: basic module “Theories and Methods of Research”;
- M.A. *Philosophy of Science* (Masterstudiengang Wissenschaftsphilosophie): modules “Aufbauvorlesungen” (AV) & “Vertiefung Theoretische Philosophie” (VT);
- Dual-subject Bachelor (*Fächerübergreifender Bachelorstudiengang*), Philosophy: “Forschungsmodul” (FM);
- M.Ed. teacher training Master (*Masterstudiengang Lehramt an Gymnasien*), Philosophy: “Vertiefungsmodul zu einem systematischen Schwerpunkt” (VMs);
- Teacher training certificate program, third subject (*Zertifikatsprogramm Drittes Fach für das Lehramt an Gymnasien*), Philosophy: “Vertiefungsmodul zu einem systematischen Schwerpunkt” (VMs).

In addition to the abovementioned programs, the course is open to interested students from all other areas, as well as guests and auditors. No specific prior knowledge is required to be able to participate in the course, and the course will be accessible to novices to the fields of philosophy / philosophy of science. In case of a shortage of places in the course, students from the M.Sc. programs *International Horticulture* and *Water Resources and Environmental Management* will enjoy priority admittance, followed by students from the other programs listed above. Participants from programs not listed above should contact the student advisor of their own program to discuss whether they can obtain credits for participation.

The course will be supported by a website in the university’s online learning environment, Stud.IP (<https://elearning.uni-hannover.de/index.php>). On this website you will find information about the course, as well as notifications of changes in the program, or time or location of individual sessions. All participants **must register** for the course on the course website. All course readings (listed below in the course plan under “required reading” and “optional background reading”) will be made available to registered participants as downloadable PDFs on the course website. The **course readings** will be drawn from these texts:

- James Ladyman (2002): *Understanding Philosophy of Science*, London & New York: Routledge. **[principal textbook]**
- Peter Godfrey-Smith (2003): *Theory and reality: An Introduction to the Philosophy of Science*, Chicago & London: University of Chicago Press. **[background textbook]**
- Francis Bacon (2000): *The New Organon* (Ed. Lisa Jardine & Michael Silverthorne), Cambridge: Cambridge University Press. **[selections]**
- Karl R. Popper (2002): *The Logic of Scientific Discovery*, London & New York: Routledge. **[selections]**
- Gillian Barker & Philip Kitcher (2014): *Philosophy of Science: A New Introduction*, New York: Oxford University Press. **[selections]**
- ESF/ALLEA (2011): *The European Code of Conduct for Research Integrity*, Strasbourg: ESF / Amsterdam: ALLEA. **[selections]**
- Philip Kitcher (2004): ‘Responsible biology’, *BioScience* 54: 331-336. **[full text]**

All participants are expected to **actively participate** in the sessions, for example by asking questions during the lectures or engaging in discussions with the audience on lecture topics. The lecture sessions will contain **dedicated question/discussion sections** focused on questions from course participants about the required readings or related issues. Accordingly, participants are expected to have read the required readings for each session, and to **have formulated questions about the text(s)**, e.g., about things they have not understood, with which they disagree, or that for any other reason they find important to discuss with the group. Participants are **expected to attend all sessions**.

Depending on the program within which the course is taken **3 to 6 ECTS credit points** can be obtained. Students in the M.Sc. programs *International Horticulture* and *Water Resources and Environmental Management* can obtain 3 credit points and have to fulfill the following **course requirements**:

1. **Preparation:** Thoroughly read and prepare the required readings – this includes detailed reading of all texts and **writing down a few questions and/or topics for discussion** that you would like to raise after the lecture.
2. **Questions:** Get together with 1 or 2 study partners and discuss the questions / topics that you have written down while preparing the readings. For every class session every group of 2-3 participants must **hand in a set of questions / topics for discussion** on a single sheet of A4 paper on the day of the session.
3. **Participation:** Everyone is required to **participate actively** in class.
4. **Oral or written presentation:** Students in the M.Sc. programs *International Horticulture* have to give **one oral presentation** about their research in connection to the course topics; students in the M.Sc. programs *Water Resources and Environmental Management* have to hand in **one written discussion** of their research in connection to the course topics.
5. **Exam:** You have to pass a **written exam** at the end of the course.

Students in the M.A. program *Philosophy of Science* or the M.Ed. and certificate programs *Lehramt an Gymnasien* can obtain 5 credit points and have to fulfill the following **course requirements**:

1. **Preparation:** Thoroughly read and prepare the required readings – this includes detailed reading of all texts and **writing down a few questions and/or topics for discussion** that you would like to raise after the lecture.
2. **Questions:** Get together with 1 or 2 study partners and discuss the questions / topics that you have written down while preparing the readings. For every class session every group of 2-3 participants must **hand in a set of questions / topics for discussion** on a single sheet of A4 paper on the day of the session.
3. **Participation:** Everyone is required to **participate actively** in class.
4. **Essay:** You have to submit **an essay of 2000-4000 words** about one of the course topics after the course.
5. **Exam:** You have to pass a **written exam** at the end of the course.

Students in the dual-subject Bachelor program can obtain 6 credit points in the context of the “Forschungsmodul” and have to fulfill the following **course requirements**:

1. **Preparation:** Thoroughly read and prepare the required readings – this includes detailed reading of all texts and **writing down a few questions and/or topics for discussion** that you would like to raise after the lecture.
2. **Questions:** Get together with 1 or 2 study partners and discuss the questions / topics that you have written down while preparing the readings. For every class session every group of 2-3 participants must **hand in a set of questions / topics for discussion** on a single sheet of A4 paper on the day of the session.
3. **Participation:** Everyone is required to **participate actively** in class.
4. **Essay:** You have to submit **an essay of 4000-6000 words** about one of the course topics, using additional literature selected on the basis of independent research.

5. **Exam:** You have to pass a **written exam** at the end of the course.

Students who want to be examined in the context of finalizing a module in one of the philosophy programs (“Modulprüfung”) should make separate arrangements with the instructor.

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### Contact details

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### Course plan

– (17.10.16) *no class – intro week for new students*

1. (24.10.16) Introduction – What is philosophy of science?

**Required reading:**

Ladyman, *Understanding Philosophy of Science*, Introduction (pp. 1-8).

2. (31.10.16 – **10:15-11:45h, room A 004**) The origins of modern science, inductivism as a research method

**Required reading:**

Bacon, *The New Organon*, Preface to ‘The Great Renewal’, The Plan of the Work, Preface to the ‘New Organon’ & Aphorisms XXXVIII-XLIV (pp. 6-24, 27-31 & 40-42).

**Optional background reading:**

Godfrey-Smith, *Theory and Reality*, Chapter 3 (pp. 39-56).

3. (31.10.16) Inductivism as the scientific method (1)

**Required reading:**

Ladyman, *Understanding Philosophy of Science*, Chapter 1 (pp. 11-30).

**Optional background reading:**

Godfrey-Smith, *Theory and Reality*, Chapter 3 (pp. 39-56).

4. (07.11.16 – **10:15-11:45h, room A 004**) Inductivism as the scientific method (2)

**Required reading:**

Ladyman, *Understanding Philosophy of Science*, Chapter 2 (pp. 31-61).

**Optional background reading:**

Godfrey-Smith, *Theory and Reality*, Chapter 3 (pp. 39-56).

5. (07.11.16) Falsificationism as the scientific method (1)

**Required reading:**

Popper, *The Logic of Scientific Discovery*, Chapter 1, Sections 3-6 (pp. 9-20).

Ladyman, *Understanding Philosophy of Science*, Chapter 3, Sections 3.1 & 3.2 (pp. 62-74).

**Optional background reading:**

Godfrey-Smith, *Theory and Reality*, Chapter 4 (pp. 57-74).

6. (14.11.16 – 10:15-11:45h, room A 004) Falsificationism as the scientific method (2)

**Required reading:**

Ladyman, *Understanding Philosophy of Science*, Chapter 3, Sections 3.3 - 3.6 (pp. 74-92).

**Optional background reading:**

Godfrey-Smith, *Theory and Reality*, Chapter 4 (pp. 57-74).

7. (14.11.16) Revolutions and research programs

**Required reading:**

Ladyman, *Understanding Philosophy of Science*, Chapter 4, Sections 4.1 - 4.5 (pp. 93-115).

**Optional background reading:**

Godfrey-Smith, *Theory and Reality*, Chapters 5 – 7 (Sec. 7.1 & 7.2) (pp. 75-108).

– (21.11.16) no class

– (28.11.16) no class

8. (05.12.16) Explanations and laws of nature

**Required reading:**

Ladyman, *Understanding Philosophy of Science*, Chapter 7, Sections 7.1 & 7.2 (read until the beginning of subsection 7.2.1) (pp. 196-210).

**Optional background reading:**

Godfrey-Smith, *Theory and Reality*, Chapter 13 (pp. 190-200).

9. (12.12.17) Values, aims and good science (1)

**Required reading:**

Barker & Kitcher, *Philosophy of Science*, Chapter 6, first part (pp. 136-150).

ESF/ALLEA, *The European Code of Conduct for Research Integrity*, Chapter 1 & Chapter 2, Sections 2.1 - 2.3 (pp. 5-15).

**Optional background reading:**

Godfrey-Smith, *Theory and Reality*, Chapter 11 (pp. 163-172).

– (19.12.16) no class

– (26.12.15) no class – Christmas break

– (02.01.16) no class – Christmas break

10. (09.01.17) Values, aims and good science (2)

**Required reading:**

Barker & Kitcher, *Philosophy of Science*, Chapter 6, second part (pp. 150-163).

Kitcher, 'Responsible biology', article in *BioScience*.

**Optional background reading:**

Godfrey-Smith, *Theory and Reality*, Chapter 11 (pp. 163-172).

11. (16.01.17) Student presentations by IntHort-students (1)

No readings. **Written assignments due for WatEnv-Students!**

12. (23.01.17) Student presentations by IntHort-students (2)

No readings.

13. (30.01.17) Written exam

**Suggested further reading (small selection)**

- Allhoff, F. (Ed.) (2010): *Philosophies of the Sciences: A Guide*, Chichester: Wiley-Blackwell.
- Bird, A. (1998): *Philosophy of Science*: London: UCL Press.
- Bortolotti, L. (2008): *An Introduction to the Philosophy of Science*, Malden (MA): Polity Press.
- Chalmers, A.F. (1978): *What Is This Thing Called Science? (Third Edition)*, Maidenhead: Open University Press.
- Curd, M., Cover, J.A. & Pincock, C. (Eds) (2012): *Philosophy of Science: The Central Issues*, New York: W.W. Norton & Company.
- French, S. & Saatsi, J. (Eds) (2011): *The Continuum Companion to the Philosophy of Science*, London: Continuum.
- Hacking, I. (1983): *Representing and Intervening Introductory Topics in the Philosophy of Natural Science*, Cambridge: Cambridge University Press.
- Harré, R. (1972): *The Philosophies of Science*, Oxford: Oxford University Press.
- Hempel, C.G. (1966): *Philosophy of Natural Science*, Englewood Cliffs: Prentice-Hall.
- Losee, J. (2001): *A Historical Introduction to the Philosophy of Science (Fourth Edition)*, Oxford: Oxford University Press.
- Machamer, P. & Silberstein, M. (Eds) (2002): *The Blackwell Guide to the Philosophy of Science*, Oxford: Blackwell.
- O'Hear, A. (1989): *An Introduction to the Philosophy of Science*, Oxford: Clarendon Press.
- Okasha, S. (2002): *Philosophy of Science: A Very Short Introduction*, Oxford: Oxford University Press.
- Psillos, S. & Curd, M. (2008): *The Routledge Companion to Philosophy of Science*, London & New York: Routledge.
- Rosenberg, A. (2012): *Philosophy of Science: A Contemporary Introduction (Third Edition)*, London & New York: Routledge.
- Staley, K.W. (2014): *An Introduction to the Philosophy of Science*, Cambridge: Cambridge University Press.

Useful internet resources:

- Internet Encyclopedia of Philosophy* (<http://www.iep.utm.edu/>).
- Stanford Encyclopedia of Philosophy* (<http://plato.stanford.edu/>).

