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Preparing Ph.D. students for the post-normal age

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International Network of Engineers and Scientists for global responsibility (INES) and Center for the Philosophy of Nature and Science Studies at the Faculty of Science, University of Copenhagen (CNPSS) organised in November 2006 a five-days Ph.D. course entitled "The Role of Young Researchers in the 21st Century: Problems and Possibilities." The purpose of the course was to prepare the participating Ph.D. students for the 'post-normal age.' This article presents and evaluates the course.

Ph.D. students can no longer expect a normal scientific university career with tenure after finishing their graduate studies, as they could in the 60s, 70s and 80s. Research funding is increasingly given to time-limited and inter-institutional projects, often co-sponsored externally. Local research quality criteria have emerged, as scientific projects are expected to be socially robust (read: useful to stakeholders). Today an array of actors invest cultural and financial capital in natural scientific research projects.

The societal and political context influences the questions taken up by scientists. Main-stream research projects used to be 'normal' – scientists were expected to produce clear-cut answers to the questions they investigated. 'Certainty expectations' defined, or at least heavily influenced, what kind of research questions that scientists scrutinised: Only questions that could be answered with certainty would be labelled scientific, and hence considered worthy of scientific investigation. Today stakeholders' utility expectations often outdo the conventional certainty expectation. Questions that stakeholders find important cannot (necessarily) be answered with clearcut certainty.

It is difficult for normal scientific projects to flourish in a context characterised by stakeholder involvement and uncertainty. Hence, the future career prospects for Ph.D.'s are today qualitatively different than those prevailing say 30 years ago, where a Ph.D. could expect to continue his/her academic university career. Today the scientific landscape is conflict-ridden, as tensions between different expectations easily collide in the realm of science (e.g. certainty versus utility). Mainstream science has become post-normal.

The course idea

Most Ph.D. students are not prepared for the post-normal age, where facts are uncertain and the stakes are high. Mainstream university science education can best be characterised by the term

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“normal science education” (NSE). NSE is a form of scientific training centred round practical standard puzzle-solving. As science students solve a vast number of canonized scientific puzzles they learn to recognise and identify new puzzles as well as to solve them using their discipline’s standard tools. After finishing the NSE training process a young scientist is a capable user of these standard tools on new scientific puzzles. Normal scientists are skilled to fulfill the certainty expectation. But they are not trained to relate to – honour or critically evaluate – stakeholders' utility expectations!

In collaboration with International Network of Engineers and Scientists for global responsibility, we – the authors – decided to set up a Ph.D. course entitled “The Role of Young Researchers in the 21st Century: Problems and Possibilities” at the Faculty of Science, University of Copenhagen, and hence create a space where course participants could reflect on their role as young researcher, and on the problems and possibilities they are likely to encounter. The course was open to all Ph.D. students – no specific disciplinary affiliation was preferred, and we expected participants from both the GRAINN (Genomics, Robotics, AI, Neuroscience, Nanotechnology) and the SHEE (Safety, Health, Environment and Ethics) sciences as well as from the conventional academic disciplines.

So what kind of skills are needed for a scientist working in a post-normal context? Clearly many more than one can expect to nourish in a five days course. We decided to build up the course around the competency: “The ability to identify and analyse concrete examples of scientific misconduct, social responsibility of scientists, or unforeseen consequences of techno-science”. Surely the post-normal scientist needs that ability, as many contemporary conflicts are related to these issues.

The content of the course

We wanted to activate the students early on. Hence, we asked them to identify a contemporary controversy within the sphere of science. To facilitate this identification process the participants were asked to address one of the following three tasks:

“Identify

- a researcher who has been accused or convicted of scientific dishonesty.
- a researcher you think have acted socially responsible.
- an example where scientific results and / or its applications have resulted in unforeseen consequences for the environment or local communities.”

The Ph.D. students were also asked to do a litteratur search on the chosen case, and were expected to continue to work on their case during and after the course. The last day of the course was allocated to students' case presentations, and half a day during the course was set a side as 'preparation time' for the case presentations. To gain full credit for the course (7,5 ECTS) the course participants were required to hand in a report where (s)he presented an analysis of the chosen case. Ph.D. students could also participate in the course without handing in a report, but would then only earn 2,5 ECTS

To build a bridge from (what we expected to be) the course participants' paradigmatic conceptual frameworks we begun with a presentation of the canon of History and Philosophy of Science (HPS): Positivism, Popper, Kuhn and Social Constructivism. In the remaining course time four issues were addressed moving away from the HPS canon:

- Scientific Dishonesty. This theme was initiated by a presentation of Merton's 'Ethos of (academic) science', which then was linked to institutions of (academic) science: the peer review system, definitions of scientific misconduct and good scientific conduct. Examples of specific scientific institutions were given. Then followed a presentation of different understandings of the role of experiments in science: verification of theories, falsification of hypotheses, and construction of phenomena. These 'normal scientific' / conventional perspectives on science were put into perspective by addressing outlayer data, changing values of fundamental physical constants, experimenter's regress and the theory-ladenness of observations. These phenomena were linked to participants' own experiences.

- Instrumentalisation of Science. In this course theme three approaches to 'the new sciences' were presented: Post-academic science, Modus2-research, and Post-normal science. The idea was to present for the students three analytical theories that they could use in their case analyses.
- Social Responsibility of Scientists. During this theme arguments pro and contra the idea that scientists have a social / ethical responsibility were presented . Then a classification of different kinds of social responsible behaviour of scientists were outlined: A scientist can be said to act socially responsible if (s)he i/ only does what (s)he is told, ii/ refuses to work on certain projects or use certain methods (conscientious objection), iii/ works for structural / political change iv/ is willing to become a whistleblower and reveal classified information that he or she considers important for preserving public health, protecting the environment, or maintaining world peace, or v/ get involved in civil disobedient activities. Also the ethics of Hans Jonas (the imperative of responsibility) were presented during this theme.
- Risk & Uncertainty. This topic addressed post-normal science (again) and the precautional principle. A case study of 'chemical boomerangs' and 'chemical sputniks' were given: These two concepts refer to two categories of chemical pollutants. International law (the Stockholm convention and REACH) was mentioned.

These themes were addressed in lectures partly given by the course responsible and partly by invited key-note speakers. Analytical tools, that the Ph.D. students could use in their case analyses, were presented in the lectures. Course participants were themselves invited to identify additional analytical tools that were not presented during the course. Valery Petrosyan and Claus Montonen appeared as INES keynote speakers. Tom Børsen Hansen attended the team of course responsible / permanent teachers as the INES representative.

More information on the course (course description, programme, content of course compendium etc.) is available at the course websites http://www.inespe.org/phd2006 and http://www.nbi.dk/natphil/kur/phd/.

The participants

The course "The Role of Young Researchers in the 21st Century: Problems and Possibilities" was offered in November 6 to 10, 2006. Twenty-four Ph.D. students signed up for the course. One student did not show up. Nine women and 14 men attended the course. A crude analysis shows that nine Ph.D. students were working on a GRAINN-oriented research project (Genomics, Robotics, AI, Neuroscience, Nanotechnology), nine did a project related to SHEE (Safety, Health, Environment and Ethics), one Ph.D. student was working with an academic natural scientific research project. Four course participants were working within the social or human sciences. All course participants had affiliation to a Danish University, and 19 with the University of Copenhagen. All, but three, spoke fluently Danish.

Elleven course participants handed in a report with a case analysis, and the remaining 12 did not. To have the report approved a student were required to describe the chosen case, outline an analytical tool, and use this tool in the analysis of the case. Four of the reports were not approved in first instance. Three reports did not adequately present and use an analytical tool. The fourth report was purely theoretical and lacked a case-study. The authors of these four reports received thorough feedback on their work, and were given a chance to repair the submission. In second instance the four reports were re-submitted and approved.

In table 1 a list of the case studies and the analytical tools, covered in the reports authored by the course participants, is shown.

Table 1: Casestudies and analytical tools presented in the Ph.D. student's reports

Case study	*Analytical tool*
Ignacio Chapella	Post-academic science
Climate Change	Post-normal science
Climate Change	Post-normal science
Fighting malaria with DDT	Post-normal science
Sir Joseph Rotblat	Social responsibility
Woo Suk Hwang	Scientific Dishonesty
The Bogdanov Affair	Scientific Dishonesty
The Sokal Affair	Deconstruction
Doping	Risk Society
Thalidomide Scandal	Risk Society
Thalidomide Scandal	Modus 2 research

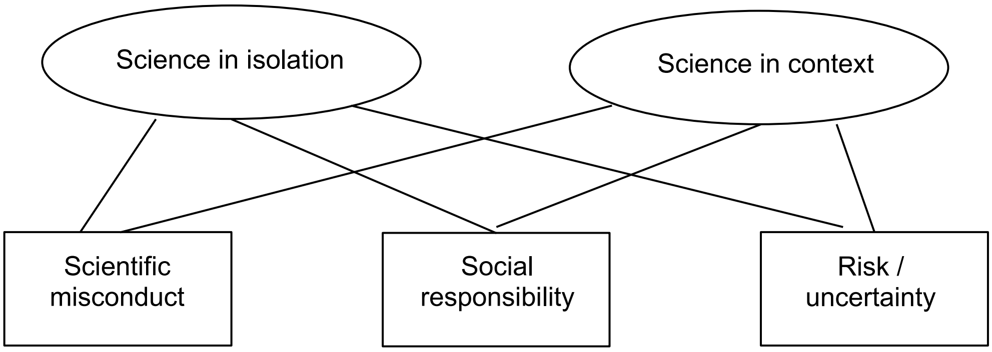
Prior to the course we had made arrangements with the editors of "The ISYP Journal on Science and World Affairs": We would submit the best course reports / papers to the journal, and – if passing the peer review – they would be published. Two articles from the course will (properly) be published in "ISYP Journal on Science and World Affairs": The paper on Ignacio Chapela, and a joint paper by the two Ph.D. students who analysed climate change from a post-normal science perspective.

Lessons learned

Four lessons can be learned from our experience with setting up and teaching this course. The first lesson learned regards the main thread of the course, which could be more clear. In the course it was not sufficiently underlined that two basic understandings of the relations between science and society were addressed in the course: One that sees science as ideally isolated from its social context and one that analyses science as being co-formed by social conditions. How one perceives scientific misconduct, the social responsibility of scientists or risk / uncertainty differ according to whether one approaches science as ideally isolated, or as an activity formed by its context.

Next time we offer this course we should first line up the conventional view on science (the canon of HSP), and contrast it with the the emerging contextual perspectives on science (post-academic, modus 2, post-normal). Then we should address scientific misconduct, social responsibility and risk / uncertainty from an isolationalist respectively contextual point of view. Such a main thread would be in better agreement with the tasks given to the course participants.

Figure 1: Revised main thread of the course



The second lesson to be learnt from our experiences in organising and teaching the course regards the analytical tools introduced. It became clear that the majority of the attending Ph.D. students did not know basic ethical theories, like utilitarianism, deontology and virtue ethics. A presentation of this ensemble of standard ethical theories would properly have made it more easy for the course participants to grasp Hans Jonas' imperative of responsibility, as it would have made the categories of social responsibility more applicable to concrete situations (it is only when scientists' ethical orientation system is violated, that s(he) becomes a whistleblower or conscientious objector). Two students identified themselves Ulrich Beck's concept of the risk society as an analytical tool. Both analyses were done well, and we could easily in future courses include risk society in the selection of analytical tool presented for analyzing cases on risk and uncertainty. Beck himself is aware of the dichotomy between the two perspectives on science (isolation versus context), and hence the theory of risk society fits well into the the general framework of the course (i.e. the figure above).

Thirdly we should do something about the form by which the analytical tools are presented. At the course in November 2006 the tools were presented in lectures. If the lectures are supplemented with discussion exercises and group work they would properly be easier and better understood by course participants. Additionally we might include lectures where good examples of case analysis are presented (so-called exemplars). The two papers that will be submitted to the “ISYP Journal on Science and World Affairs” can fulfill this function, and the authors of (one of) these papers could be invited to lecture next time the course is offered. We might also consider including post-course supervision sessions that students can sign up for when writing their report.

A final lesson concerns the composition of participants. The participants were this time all affiliated to a Danish University. This is not an ideal composition, as science is becoming increasingly global. The collaboration with INES did unfortunately not result in attendance by an international group of Ph.D. students. We must improve our ability to circulate course information, extend the number of partners, and maybe try to raise funding to reimburse participants' travel expenses.