Learning to cross boundaries between science, policy and society

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Abstract

What are the challenges involved for scientific experts in contributing to sustainable development? The complexity of sustainability issues and the changing process of knowledge production ask for engineers and environmental experts who are able to cross boundaries between science and policy and who are not afraid of leaving the classical roles and patterns in problem solving. They need a realistic view on the role of science in modern society. The purpose of this paper is to present and evaluate a Masters course developed to address these needs in the education of environmental experts. We discuss various dilemma's posed by the learning goals and specific setting of an academic course which had implications for the course design. Dilemma's include finding a balance between theory and practice and the question whether "boundary workers can be trained or that they are born". The distinguishing features of the course are (1) its focus on the changing patterns and roles in knowledge production and use, (2) its intention to provide handles for professional practice, and (3) its attention for the diversity of roles of experts and critical reflection on these roles. We conclude that the design proved successful to address the dilemmas, and that the course proved effective to meet the learning goals which focus on increasing insight of students in (1) the complexity and the institutional and societal aspects of knowledge production for sustainable development, (2) the skills required to work across boundaries between science, policy and society in order to deal with sustainability issues; and (3) the tools and roadmaps that can be used to support an integrative knowledge production process. The paper contributes to the discussion on how to prepare students for the complexity of sustainability issues, providing the example of a course which helps students rethinking themselves in their future career.

1 Introduction

What are the challenges involved for scientific experts in contributing to sustainable development? The complexity of sustainability issues and the changing process of knowledge production ask for engineers and environmental experts who are able to cross boundaries between science and policy and who are not afraid of leaving the classical roles and patterns in problem solving.

Sustainability problems can be characterized as wicked (Rittel & Webber, 1973) or unstructured problems (Hisschemöller & Hoppe, 1995). Such problems are hard to solve, because they extend over multiple scales and dimensions, the environmental dimension being tightly interwoven with the social and economic dimensions. As a consequence, they are surrounded by structural uncertainties and involve many interdependent stakeholders with often diverging or even conflicting interests and perspectives on what the problem actually is as well as on possible ways to solve it. To produce knowledge relevant to the management of such complex problems, approaches are needed that include

multiple types of expertise and multiple viewpoints. The classical model of scientists producing objective knowledge and decision-makers using this knowledge to solve societal problems is clearly inadequate in the case of complex sustainability problems and alternative, more interactive models of knowledge production and use have been developed (Gibbons, 1999; Pohl & Hirsch Hadorn, 2007). In these interactive models, the boundaries between science, policy and society have become more flexible and blurred. At the same time, the role of science as the sole provider of knowledge for problem-solving is being challenged by other actors that claim to have relevant knowledge as well. For scientific experts dealing with sustainability issues, this has consequences for their role and responsibility in the process of knowledge production and for the type of knowledge they will have to work with (De Kraker *et al*., 2007). They must acquire insight in the current, complex processes of knowledge production and use, and competences to work across the boundaries between science, policy and society. They also must develop skills to integrate diverse types of knowledge to address sustainability problems.

In this paper, we present and evaluate a Masters course developed to address these needs in the education of environmental experts. The distinguishing features of the course are (1) its focus on the changing patterns and roles in knowledge production and use, (2) its intention to provide handles for professional practice, and (3) its attention for the diversity of roles of experts and critical reflection on these roles. The course was developed for a Masters programme in Environmental Sciences, but its focus on the process of knowledge production for sustainable development ensures that its overall didactic approach and design is relevant to a wide range of academic disciplines.

2 Context, focus and learning goals

The course “Environmental problems: crossing boundaries between science, policy and society” is compulsory for all Master students enrolled in the Environmental Sciences programme of the Open Universiteit (OUNL), the distance teaching university of the Netherlands and Flanders. Important characteristics of this programme are that most students have a natural sciences orientation and usually combine working and studying. Only a small minority of the graduates pursue a career in academic research, most of them are employed as environmental expert in jobs varying from civil servants at the municipality or ministry and technical experts at consultancy firms to scientific officers in environmental NGO’s and applied researchers at knowledge institutes. They all need a realistic view on the role of science in modern society and handles to determine their own position and responsibilities. In this way the focus of the course differs from other courses that approach the interactions between science and society in a more analytical way and mainly target students with a future career in academic research.

The course approaches the knowledge production process targeted at solving environmental problems in the context of sustainable development as a process of interaction between science, policy and society. It aims to offer students insights into the different roles that science, policy and society play in dealing with complex sustainability issues and how the different roles are coordinated. The course takes a practical perspective: How to contribute effectively as an environmental expert to problem solving in complex issues? Students are introduced to topics such as dealing with uncertainties, conflicting knowledge claims and the integration of different types of knowledge. Also, they are offered concepts to reflect on their own role and responsibilities as an expert and dilemma’s such as keeping their credibility as a scientist while engaging in controversial issues.

The learning goals of the course are to increase insight of students in (1) the complexity and the institutional and societal aspects of knowledge production for sustainable development, (2) the skills

required to work across boundaries between science, policy and society in order to deal with sustainability issues; and (3) the tools and roadmaps that can be used to support an integrative knowledge production process.

3 Course design

Following from the learning goals the challenge for the course designers was to deal with a set of dilemmas having implications for the course design. 1) It should be a course which on the one hand should have its roots in the philosophy and sociology of science but on the other hand should be starting from practice. It should not be too theoretical and abstract, still it should remain an academic course and not just a training module for science-policy interaction. Also it should appeal both to the more natural science oriented students and to the more social science oriented students. 2) Another dilemma was the insight that on the one hand you would like to educate students to be "boundary workers", experts who can work on the boundary between science, policy and society. Important skills here are communication, creating connections, process and management skills etc. On the other hand these might be skills which are difficult to train. Put in a different way: are boundary workers born or can they be trained? 3) Finally, the course should be operated at the Open University in a distance learning setting and already in an early stage the decision was taken that no group work would be involved. Students would be studying the course on their own, in their own pace and there would be no direct interaction with other students. Yet, the course designers wanted to make use of the fact that OUNL students are in many cases already working in practice as experts and could learn a lot from each other's' experiences and perspectives.

We dealt with these challenges and dilemmas in the following ways: First, we decided to split up the course in six different tasks, which both would include theoretical reading material and practical examples. Rather than a reader, the backbone of the course is a web-based workbook with assignments which guides the students through the material (course book, scientific papers in a reader and multi-media materials offered via the internet). Students finalize each task with an assignment, the results of which they post on a central discussion board (forum) in the electronic learning environment. Figure 1 shows the didactical design of the course, split up in six different tasks.

The course starts from a practical perspective in Task 1, *The complexity of environmental problems*. Students watch a video on a controversial issue, in this case controversies around decision making about gas drilling and cockle fisheries in the Dutch Wadden Sea. Students analyze the roles and perspectives of stakeholders and experts featuring in the video and get acquainted with issues as uncertainties, different stakes and conflicting knowledge claims. This sets the stage for the central themes in the course: dealing with different perspectives (plurality), dealing with uncertainties and integration of knowledge.

Task 2, *Science and society*, forms the theoretical basis of the course. In this task the concept of the "linear model" of the relation between science and decision making is presented as well as the problems associated with this model. It proceeds by introducing the concept of boundary work (Gieryn, 1983) and alternative, more dynamic and inclusive models of knowledge production. Questions and small assignments guide the students through the theory, challenging them to connect with the issues raised in Task 1.

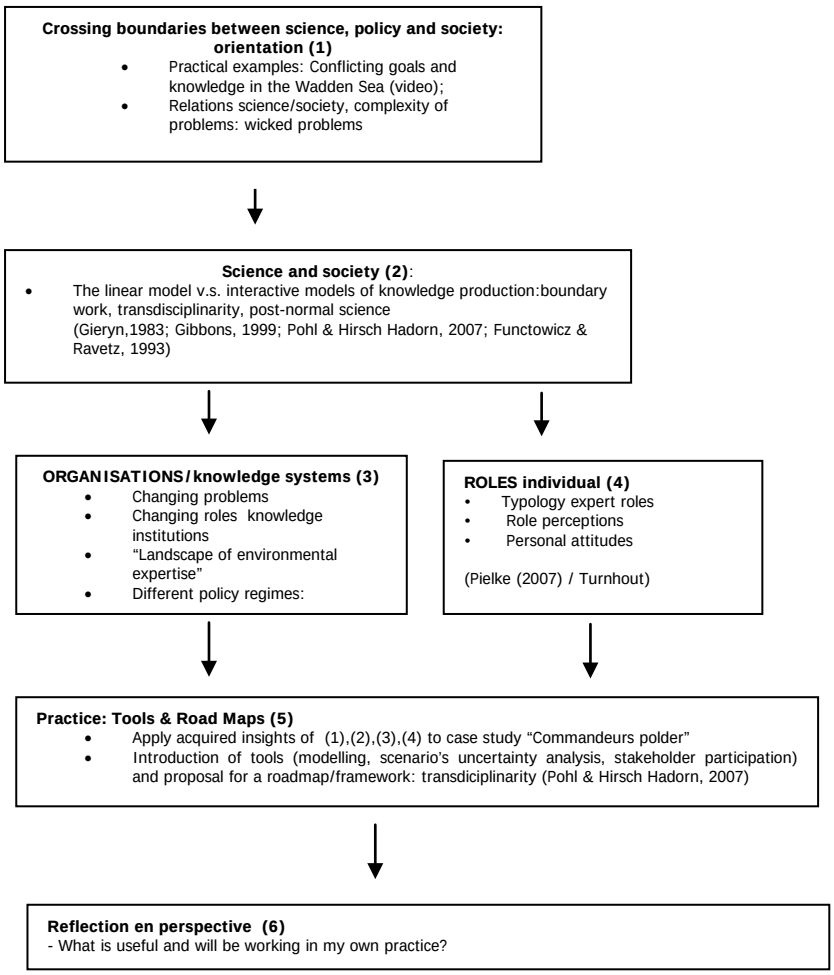

Figure 1: Course design in six tasks. Task 1 familiarizes students with the complexity of issues related to sustainability. They proceed with task 2 which provides a theoretical basis to understand science-society relationships. Tasks 3 and 4 zoom in on the roles and room for manoeuvre of organisations and individual experts respectively. Task 5 has a practical orientation, wraps up and introduces tools for knowledge production. Task 6 asks students to reflect on what they learned and how they can apply this in their own context

The combination of tasks 1 and 2 presents a strategy in the course design to deal with the dilemma of setting a practical stage and rooting in fundamental academic theories.

The challenge of combining theory and practice is taken up further in the design of task 3 and 4 in which the focus is on *The landscape of environmental expertise (roles of organisations)* and *Roles of environmental experts in practice* respectively. Students are offered analytical concepts (e.g. policy cycle, policy regimes, role typologies) which help them to position cases, organisations and individual stories and experiences of experts and to understand the conditions under which expert and organizations have to operate and the room for manoeuvre they have.

Task 5 zooms in on practice by presenting different *tools and "road maps"* to support integrative knowledge production processes and to deal with key issues addressed in the previous tasks. In particular, it focuses on the principles of transdisciplinary research (Pohl & Hirsch Hadorn, 2007). Special attention is given to tools for dealing with uncertainty, plurality of perspective, conflicting knowledge claims and integration of knowledge. This task also intends to be integrative, so throughout this task student integrate insights gained in the previous and current tasks by addressing one case

study: the Commandeurspolder case, in which in a medieval polder in the Maasland region the Water Board and municipal authorities launched a project to develop an improvement plan for the embankments. This case study runs through the task as an assignment.

In task 6 the students are given the opportunity to reflect on the presented concepts and tools in terms of their applicability in their own current or future professional context. They are also asked to react on posts of fellow students on the discussion board and discuss differences in perspectives.

4 Effectiveness of the course design in practice

Currently, the course has been offered for over a year, and a first evaluation of the effectiveness of the course design is possible. Does the course design indeed live up to our ambitions? Does it contribute to insight of students in (1) the complexity and the institutional and societal aspects of knowledge production for sustainable development, (2) the skills required to work across boundaries between science, policy and society in order to deal with sustainability issues; and (3) the tools and roadmaps that can be used to support an integrative knowledge production process?

Our evaluation is based on three sources. The first source is the feedback from students who test-studied a pilot version as part of the development phase of the course. The second source are the reflections of the students, written as part of the reflection task in the course (Task 6 discussed above). Our third source are the assessments of the students' Final Exam Paper. In total, we base our evaluation on information collected from 17 students in a time-frame of about 1.5 year.

4.1 Student feedback on pilot version

An important part of the course design and development process at OUNL is the evaluation of course effectiveness in a pilot version run. This pilot version is tested with a small group of students who are asked to comment on draft versions of course material with regard to various criteria: technical quality, clarity, comprehensiveness, up-to-datedness, course content, usefulness of the exercises, effectiveness in reaching learning goals, and study load. In this case a pilot version of the current course was run with 8 students in the period of April-September 2011. An evaluation report was drafted by an educational expert in cooperation with the course authors (Verstappen & Tuinstra, 2012). The course design of the pilot was the same as the one presented here. There was no reason to change the design. Students were overall enthusiastic about the course in general and about the balance between theory and practice. Based on student feedback the amount of theoretical papers was diminished and some websites of expert organisations to be viewed added. Furthermore, in task 3 the analytical models offered were framed in a less abstract way and more in the context of other concepts.

4.2 Student reflections

We pooled the reflections in task 6 of both the pilot group and the students who enrolled and finalised the course between February 2012 and April 2013 to get determine how the students felt the course had contributed to their insights. This resulted in 17 reflections: five students identified themselves as being more natural science oriented, five as being more social science oriented, seven as a mixture of the two. The reflections taught us that all of the students valued the overview of concepts, the systematic approach and in particular the application of the concepts in the integrative case study in task 5.

This task really helped them to integrate all lessons learned and to appreciate the different analytical concepts and practical tools presented in the course.

"This was definitely the most useful task of all. I was really nice to apply the theory on a real case. Before starting this course, I thought science should be strictly separated from the rest of the world. But cases like this prove my thoughts where wrong. I was happily surprised to see the 'power' of lay-knowledge. Although there might also be a down side on this since it can severely slow down processes."

" Task 5: By applying what I have learned to the Commandeurspolder, it became clear to me how I have interpreted all the different notions and concepts I have learned in this course."

Quotes from Student reflections, task 6, 2012-2013, Electronic discussion board Course site "Crossing Boundaries"

The more natural science oriented students valued in particular the discussion of the linear model and alternatives (task 2) and the different role typologies of experts (task 4) as eye-openers. The possible differentiation of roles and the complexity of the relation between science and society were new insights to them.

"…It again was an eye-opener to read about the different roles of experts. Maybe I was a bit stuck on the vision of the pure scientist so I forgot that there are also other forms of scientists.. "

"..The introduction part highlighted to me that there are also other aspects involved in 'science'. I consider myself to be a 'pure scientist' who's working in his 'black box' following the linear model. By introduction the IPCC cases, it became clear to me that a scientist must have different roles. The complexity at stake was surprising for me..."

"…the linear model also triggered my interest. I recognized myself in this model. You get a problem and you work towards a solution. I like the idea of strict separation between science and all other actors. So the problems related to this linear model and the need to do boundary work was a new insight…"

Quotes from Student reflections, task 6, 2012-2013, Electronic discussion board Course site "Crossing Boundaries"

Students who saw themselves being "in between" and with a clear focus on process appreciated the typologies and the possibility to better grasp the dynamics in the complexity of daily practice.

"….A good connection has been made to see how boundary work actually functions in practise (…)I find it interesting to see all the attempts that are made to demarcate the roles that experts can possibly play, are expected to play or prefer to play. And indeed it shows me just how complicated the domain of science in environmental issues is. There is no real definite answer to the demarcation, as the roles of experts can shift, change, expand, scale down. I would say it has far more to do with someone's intentions and aims towards its action. And here, the typologies and categorisations become helpful to map out each actor's interest and expected method of work. "

"… For instance that you have to deal with uncertainties, plurality of perspectives and integration of different kinds of knowledge. When you are working for a small political institution like a province (like I did) you run into these things all the time. (…) Also the clean development of thought gives one the impression that these are really the main, if not the only, things to take care of. In other words: if I had known this back then in such precise form it would have helped enormously to get a grip on the situation and feel confident about it.

Quotes from Student reflections, task 6, 2012-2013, Electronic discussion board Course site "Crossing Boundaries"

We also asked the students explicitly to reflect on the fact that engaging in boundary work and transdisciplinary science is typically a subject for learning by doing, while this course is given in a distance learning context. The general response was that the backgrounds and examples given in the course were an important first step to start "learning by doing":

".. this course gives a good background before starting with learning by doing. In this course pointing to real examples and be able to visualize the problems using films was very useful…

"I would have been very happy in the period that I was the project manager of ….to do a theoretical course like this and apply it in my work. Learning to apply this correctly and fully will probably take years. Having these tools and roadmaps is a much better situation to start off with than just swimming around until some important actor becomes very unhappy and starts making problems."

"Being aware of the possibilities and having real existing examples therefore, does give you a good inside about the boundary work and transdisciplinary science. This course contributes to improvement of your knowledge about boundary work and moreover in case of bringing it into practice you already are more aware of important steps and pitfalls."

"it is like learning to drive a car: the real skills and competences you only learn in practice without a teacher in the seat next to you. In that sense distance learning doesn't difference that much from driving lessons: really driving a car you learn only after the exam. The course offers more than enough assignments practice to applying theoretical knowledge."

Quotes from Student reflections, task 6, 2012-2013, Electronic discussion board Course site "Crossing Boundaries"

4.3 Performance in the final exam paper

Finally, from the way students perform in the Final Exam we were able to assess the extent to which students were effective in applying theories and concepts from the course. Students finalise the course by writing an Final Exam Paper which is graded. This exam paper is based on the analysis of a case, comparable to what they have done in task 5. In this analysis the students are asked to apply the theory and tools of analysis offered in the course. In general what we see is that students demonstrate a quite fundamental understanding of the concepts and that they are able to apply theory with a clear focus. In two cases, the students at first seemed to think it would suffice to include "buzzwords" of the course randomly within the text and make general statements about the importance of it all. However, after targeted feedback, in a second round they too showed the ability to use theory effectively.

5 Conclusions and Discussion

We conclude that the design of the OUNL course "Environmental problems: crossing boundaries between science, policy and society" proved successful to address the dilemmas sketched in this paper. 1) Theory and practice were well balanced and appreciated by both the more natural science oriented students and the more social science and process oriented students. Especially effective in this respect proved the combination of scientific papers, multimedia presentation of cases, practical assignments and an integrating concluding task to apply again the different concepts. 2) With regard to the question whether boundary workers can be trained or are born, we started from the assumption that even if personality and interest play an important role, the course aim should be to create awareness of the various roles of scientists, interrelationships and dynamics and offer concepts and tools and analytical handles to position oneself and various processes. Even students not intending to play a "boundary role" indicated that this awareness in itself was enlightening and important. 3) The dilemma of the distance and individual learning setting was dealt with by offering the possibility to look at and compare the interpretations of fellow students of the assignments in each study task on the electronic discussion board. Also, students were asked to react to each other's perspectives in the reflection. In this way there could be a learning effect from an increasing awareness of perspectives in each other's working situations.

The course design proved effective to meet the learning goals. The evaluation and student performance so far shows that the course indeed contributes to appreciation of students of the complexity of knowledge production for sustainable development and enlightens them about their own role and room for manoeuvre and that of others. They are more aware of the skills required to work across boundaries between science, policy and society in order to deal with sustainability issues and have the possibility to train the analytical part of this in the course. Students are able to indicate which tools and roadmaps could be useful in what kind of situations.

Most useful in the course proved the practical start of the course by showing the complexity of real-life cases and connect this directly to theory and analytical concepts. E.g., for some students the articulation of the linear model and alternatives was new and insightful and helped to assess the importance of attention for process-related issues, perspectives of others and the usefulness of tools. For others, the complexity of problems and the importance of process-related issues were already clear from their own working experience, while the analytical tools helped them to understand what was going on and the practical tools offered handles to work in a more systematic way. The typology of

role perceptions and the concept and steps of transdisciplinary research seemed to be the most appreciated

In this case an asynchronic, individually studied course setting was a given. We expect that it would be more effective for getting experience and practice with different perspectives and handling different types of knowledge if the course design would include group work in which students would apply the theory to a case and to experience tensions and experiment with possible solution pathways. In our case students already practice with these kind of settings in other courses in the curriculum. In a standalone course we would advise to include group work. Not only to be able to experiment but also to fully make use of the experience in practice of the different students and increase the possibility to learn from each other.

It is our hope that by providing the example of a course which helps students rethinking themselves in their future career we contribute to the discussion on how to prepare students for dealing with the complexity of sustainability issues.

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