4

Developing the course "Ecology and Ecosystems Science in Relation to Environmental Economics"

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Introduction

This work reports group work by three colleagues involved in the establishment of a new MSc level course in natural resource ecology. The report therefore reflects our current effort to design and establish a new course and at the same time serves to meet the requirements for passing the course in university pedagogy.

Background

The MSc Programme in "Environmental and Natural Resource Economics" (ENRE) should make students capable of using a wide range of quantitative and qualitative methods for analysing economic effects of environmental and natural resource policies. Such economic analyses are important as support for policy and management decisions that concern the use and conservation of environmental and natural resources. According to the course description, students should become familiar with environmental and natural resource policy and project appraisal, including for example how to use economic instruments to efficiently control pollution problems and optimise the extraction of natural resources over time (Appendix A).

The MSc programme ENRE aims to develop four general attributes and professional competences (Appendix A). The course we wish to design should particularly support the students' ability to "understand basic information on environmental phenomena in natural science". Previously

no specific course within ENRE has directly focused on this competence. A thematic course in the first year has included a two to three week teaching module where teachers from environmental sciences taught cases from their own field of research, for example different environmental aspects of natural resource management such as sustainable bioenergy feedstock production and harvesting, management of carbon in forest ecosystems, groundwater as a natural drinking water resource, and issues related to groundwater pollution.

In 2012 it was decided that students of the ENRE MSc programme to a larger extent should acquire competence, understanding and insight in environmental and natural resource sciences, and that this should be done by including a 15 ECTS course to cover these issues. It was initially considered whether students could participate in an existing course for students in the MSc programme "Forest and Nature Management", "Ecology and Management of Forest and other semi-natural terrestrial ecosystems"[1], which is taught by Karsten Raulund-Rasmussen and J. Bo Larsen. However, the backgrounds and competence profiles of the two groups of students would be different. The existing course focuses on ecological understanding and management and planning in relation to forest and semi-natural terrestrial ecosystem. The ENRE students should also obtain understanding of natural resource ecology, but rather than management and planning, a crucial goal of the learning is, as expressed by one of the teachers in the programme, Frank Jensen, be able to read, understand and assess scientific literature on environmental and natural resource issues. Another shortcoming is that the existing course does not cover agricultural land uses, while several of the cases used later in the ENRE programme deals with agriculture. It was finally decided to establish a new specifically tailored course for the ENRE students.

The three authors of this report form a group of core teachers to cover the content of this new course in ecology and natural resources. As long-term colleagues we expect that our individual competences will be complementary in terms of research experiences. We are all working with sustainable management of ecosystems, but from slightly different points of view. Lars covers environmental impacts of land-use change and forest management and provisioning of ecosystem services related to carbon sequestration, water quality and water recharge. Morten covers environmental impacts related to Christmas tree production, ecology and growth of urban

[1] http://www.kursusinfo.life.ku.dk/Kurser/LNAK10064.aspx$

trees, biomass and bio-ash chemistry, soil amendment with bio-ash and forest fertilization generally. Inge is experienced in environmental impacts related to production of woody bioenergy feedstock within forests and short rotation systems, and also covers forest and biomass certification. Lars and Inge have a forestry and forest ecology background, whereas Morten has a background in chemical engineering.

During autumn 2012 we drafted the course description including the general intended learning objectives (ILO) of the new course with inspiration from the ILOs of the course "Ecology and Management of Forest and other semi-natural terrestrial ecosystems", together with inputs from other teachers of the ENRE MSc programme:

> "The aim is to give the student an in-depth understanding of the ecology of various land uses, e.g. forestry, agriculture, heathland, and dune ecosystems, and the interactions among them at the landscape level. The student should understand the reasoning behind the use of various management tools in different ecosystems according to specific management goals. Temperate ecosystems will be in focus, but the principles will be general and relevant for other biomes."

A number of more specific ILOs were formulated and structured as leading to knowledge, skills, and competences, respectively. The complexity of the ILOs increases from one level to the next, as required by the faculty template for course descriptions. This template is based on the "structure of observed learning outcome" (SOLO) taxonomy (Biggs & Tang 2007, p. 76) that describes how a learner's performance increases in complexity from lower to higher hierarchical levels.

The full course description was submitted to the Institute of Geosciences and Natural Resource Management on the second of November 2012 (Appendix B), under the title: "Ecology and Ecosystem Science in relation to Environmental Economics" and it was passed on to the Board of Studies on 16 November 2012. The approval is still pending.

Ideas about course design for effective teaching and learning

The ultimate aim of any professional education course is to improve the professional competences of the students (Biggs & Tang 2007, p. 50). This approach is confirmed by recommendations in a report by the Ministry of Science, Innovation and Education in Denmark, which states that teaching and assessment to a higher degree must be seen in relation to competences needed by graduates (FIVU 2006). This requires a well composed

study programme, and good and effective teaching in the courses of the programme.

Identification of the need for a new course in a study programme

The establishment of a new course must be justified by a gap in courses to cover the intended learning objectives (ILOs) of the study programme ILOs and it should contribute substantially to fulfill ILOs in the competence profile of the general part of the MSc Programme. Obviously, a MSc programme design with the same issues addressed at the same level in several courses would be redundant and most probably lead to student complaints (Biggs & Tang 2007).

The need for a course at MSc level should not only be justified in a gap in course curriculum since the necessary competences of students to some extent could have been obtained through their BSc programme. However, in international MSc programmes the background of students is often too heterogeneous to provide a well-defined common competence level, even if they must fulfill certain minimum requirements, often formulated as having a relevant BSc degree. To the extent possible, it is however, still useful to analyze information regarding student background, for example by use of experiences from teachers within the study programme.

Constructive alignment

According to the experiences of Biggs & Tang (2007) good and effective teaching may be achieved if courses are designed according to two principles (p. 50):

1. A constructivist learning theory
2. Alignment between ILOs, the teaching/learning activities (TLAs) and the assessment tasks (ATs)

The constructivist theory explains that learners should use their own activity to construct their knowledge or other learning outcomes (what the student does is more important for the learning than what the teacher does). The principle of alignment implies that TLAs should implement the verbs of the ILOs that are thus activated in the TLAs and ATs. Once the verbs of the ILOs have been specified, it should be clear what the TLAs are and what the student needs to perform in the ATs (p.52). Biggs & Tang (2007)

call the combination of these two principles constructive alignment, which is the fundamental principle they suggest for designing good and effective teaching. The use of this principle is also recommended for quality in university education by the Ministry of Science, Innovation and Higher Education (FIVU 2006).

Designing intended teaching and learning outcomes (ILOs)

From the principle of constructive alignment it is clear that the design of the ILOs is a crucial element in course design, as it influences all other elements of the course. The ILOs should clearly stipulate the kind of knowledge that should be learned, using a verb that clearly indicates also the level at which it should be learned, and performance should be displayed. Biggs & Tang (2007) suggest the following steps in formulation of course ILOs (p. 72):

1. Decide what kind of knowledge should be involved
2. Select which topics to teach
3. Decide the level of understanding desirable for the students to achieve

As for the kind of knowledge, Biggs & Tang (2007) distinguish declarative knowledge from functioning knowledge (p. 72). Declarative knowledge is knowledge about something or how to do something, while functioning knowledge is being able to do. Functioning knowledge is created through the student's own experiences, and puts the declarative knowledge to work.

The ultimate aim of the university education is that the students obtain functional knowledge, but there are still a number of reasons justifying that also declarative knowledge is being taught and learned. These include teaching and learning of contents that related to general cultural issues, the profession, or bears on functioning knowledge broadly and specially in relation to everyday decision making (Biggs & Tang 2007, p. 81).

The selection of topics and the context in which they should be presented is judged by the experts involved in designing the course, but especially in this context it is worth noting that when more teachers are involved, there is a tendency that courses get a broad coverage, at the expense of deeper understanding, and more likely lead to surface learning (Biggs & Tang 2007, p. 82), while effective teaching should rather eliminate those aspects which encourage surface approaches to learning, and instead set the stage for students to more readily use deep approaches to learning (p. 31). However, it is also mentioned that the range of topics that can be taught

without losing depth in understanding is larger if the teaching is effective and properly designed.

When deciding on the required level of understanding, it is important to know what are the reasons for teaching a particular topic; is it to give the students a broader picture, to inform them about the current state-of-the-art, to make them gain professional competences likely to be needed at some point in time, or to provide them with knowledge needed here and now in problem-based learning (Biggs & Tang 2007, p. 83)? The SOLO taxonomy (Structure of the Observed Learning Outcome) is a tool for defining the desirable level of understanding. Biggs and Tang (2007) distinguish between four different levels: unistructural, multistructural, relational, and extended abstract, and list a number of verbs that are suitable for each level (Biggs & Tang 2007, Table 5.1., p. 80).

Biggs and Tang (2007) recommend including no more than five to six course ILOs, as the alignment otherwise becomes too complicated.

Teaching and learning activities (TLAs)

According to the principle of alignment, the TLAs should implement the verbs of the ILOs, with the ILOs being activated through the TLAs and finally also the ATs. The most common TLA is to offer the students straight listening to lectures. However, such lectures do not activate the student. The term 'teaching session' may be used as an extended concept, with a teaching session being a teaching and learning situation that can involve a number of TLAs. These situations may take place in or outside the class room (Biggs & Tang 2007, p. 105).

TLAs for learning declarative knowledge should activate the student e.g. by making the student work with the knowledge in the exercises using student-student interaction with appropriate intervals (Biggs and Tang, 2007). Such activities are needed if students TLAs should support common ILOs that include the verb 'explain'. The students' understanding can be tested by letting them declare the take-home messages from the lecture, do multiple-choice tests or by reading back in their own words.

TLAs suitable for functioning knowledge should put the declarative knowledge to work. Most TLAs developed for functioning knowledge make use of the student-student interaction in the form of for example group work or role plays (Biggs & Tang 2007, p. 140). Group work will be most efficient if the student have sufficient background knowledge or an adequately broad range of relevant experiences to be able to contribute to

the build-up of knowledge within the group (Marzano 2004), even if more knowledge and experiences will also be built up while solving the task. The size of the group needed for optimal learning will depend on the nature of the task and the group dynamics. For example, it has been shown that in western cultures, larger groups lead to some persons leaving the work to others, while in the Chinese culture it was found to be opposite (Biggs & Tang 2007, p. 140). A number of group activities are mentioned and described by (Biggs & Tang 2007, pp. 141-143): buzz, syndicate, jigsaw, and problem-solving groups. Other types of student-student interaction may be generated in so-called learning cells or by reciprocal questioning. In group formation it is recommended by Yamane (2006, cf. Biggs and Tang, 2007, p. 141), that students are assigned to groups randomly. He found that groups formed by friends or voluntary membership tend to use more time on off-task activities.

Workplace activities through e.g. practicum or internships are other types of TLAs mentioned by (Biggs & Tang 2007, p. 143) as suitable for functioning knowledge. The TLAs for functioning knowledge involve activities that allow the students to get their own experiences. Such activities are usually associated with verbs like solving, designing, managing, planning, performing etc. (Biggs & Tang 2007, p. 72).

Assessment Tasks (ATs)

The ATs should, similarly to the TLAs, take a starting point in the verbs used in the ILOs and activate these, so that there is alignment from ILOs to TLAs and further on to ATs.

A distinction is made between formative and summative assessments, which have two different purposes. Formative feedback and assessment takes place during teaching and learning and serves to improve both learning and teaching, with the effectiveness of the teaching being directly depending on the its ability to provide formative feedback (Biggs & Tang 2007, p. 163). On the other hand, the summative assessment is used to grade the students at the end of the course, to see how well they learned what they were supposed to. Teaching and learning does not take advantage of the summative assessment.

In grading, a distinction is made between norm-referenced (NRA) and criterion-referenced assessment (CRA). When using the norm-referenced principle, the results of the assessment are expressed as comparisons between students after the teaching is over, where for the criterion-referenced

principle they express the performance (Biggs & Tang 2007, p. 179). In Denmark, criterion-based summative assessment has now replaced the norm-referenced assessment.

Alignment of individual course ILOs with teaching session ILOs

The ILOs of this course are connected to the different hierarchical structures of this course: ILOs on course description level, ILOs on module level within the course, and ILO´s on lecture level (Fig. 4.1). In the design of each lecture the lecture ILOs need to be aligned with the TLAs and ATs in the lecture

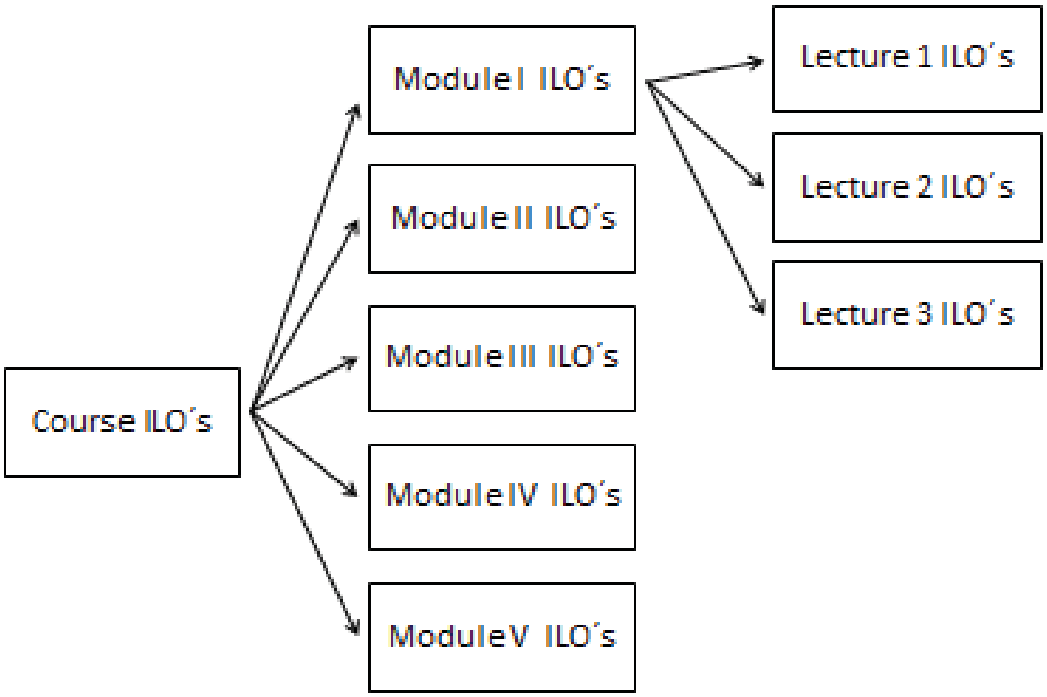

Fig. 4.1. Illustration of the alignment between the different hierarchical structures of the course.

Alignment at all levels

When course ILOs are designed, it is important to ensure that they are aligned with general graduate attributes set for the university, and the ILOs

of the programme. As such, alignment should take place at three levels (Biggs and Tang 2007, p. 85-87):

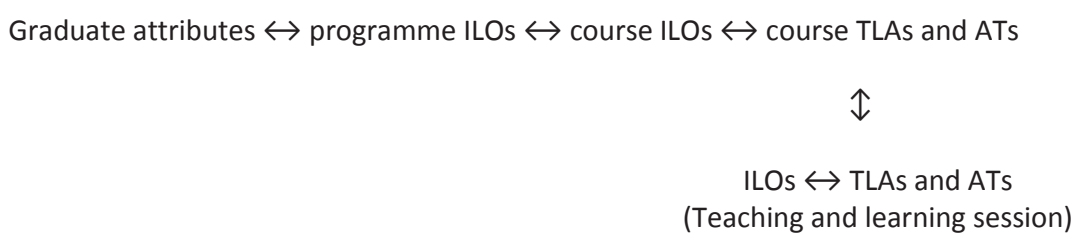

Fig. 4.2. Illustration of the alignment at all levels.

Student backgrounds

There is evidence that students learn more effectively when they already know something about a subject area and when concepts in that area mean something to them and to their particular background or culture (Marzano 2004). One of the reasons for this is that the student's interest and curiosity is activated when the teaching links the new information to the student's prior knowledge. With effectiveness of the teaching being increased when students' learning is based on their own experiences, it also seems obvious that teaching must take account of the students' previous experiences. This is in line with social constructivism which encourages the learner to arrive at his or her version of the truth, influenced by his or her background and culture (Wikipedia 2012).

A goal for the teaching should therefore be that students are able to connect new learning to their prior knowledge and experiences, and that teachers relate new learning to students' everyday lives and culture. This is especially a challenge for courses with students from different professional and national backgrounds, and when their backgrounds are different from that of the teachers.

Step by step model to course design

Based on the above, five stages of the course design were identified, using the principles of constructive alignment (modified from Biggs and Tang, 2007, p. 54):

1. Describe the ILOs in the form of a verb (learning activity), its object (the content) and specify the context and a standard that the students are to attain. Make sure that there is alignment with university graduate attributes and programme ILOs.
2. Create a learning environment using teaching/learning activities (TLAs) that address the verb and take account of the students' backgrounds, including knowledge learned at undergraduate level. Such learning environmental is more likely to bring about the intended outcome.
3. Use assessment tasks (AT) that also contain that verb, thus enabling you to judge with help of rubrics if and how well the students' performances meet the criteria.
4. Transform these judgements into grading criteria

When ILOs, TLAs and ATs should be implemented, a number of concrete additional challenges furthermore arise. These include for example:

1. Design of the individual lectures, which should also contain a set of aligned lower level ILOs, TLAs and ATs.
2. Identification of teaching materials
3. Identification of the teacher group and challenges when there is a group of teachers, compared to one or two teachers.

Theories related to these challenges have not been addressed by Biggs and Tang (2007) and will not be addressed here.

Objective

The objective of this project is to take first steps in the design the course "Ecology and Ecosystems Science in Relation to Environmental Economics (TEMP0404)" to be included in the mandatory course curriculum of the MSc Programme, "Environmental and Natural Resource Economic", at the Faculty of Science, University of Copenhagen. The principles of constructive alignment should, together with other up-to-date knowledge about effective teaching and learning, be used in the design of the course. The course has never been taught before, and will be launched in autumn 2013.

More specifically we aim at fulfilling the following criteria in our course design:

1. Course ILOs should be aligned with MSc programme ILOs (which should again be aligned with graduate attributes)

2. Course ILOs, TLAs and ATs should reflect the background of students to create motivation and thus ability to be successful.
3. Course ILOs, TLAs and ATs should be constructively aligned.

Methods

The course will be designed according to ideas and methods of Biggs and Tang (2007), chapter 5. These ILOs will then be analysed for alignment with graduate attributes and MSc programme ILOs using the method suggested by Biggs and Tang (2007), chapter 4. The course TLAs and ATs were designed using the principles outlined in Biggs and Tang (2007) chapters 6-11, to be in alignment with the course ILOs.

The outlined pathway appears to be linear, but we applied the principles in an iterative process where the different course components were revised if a need or a potential for improvements was identified. The already submitted course description, including the drafted ILOs, formed a starting point for a three-level analysis of the ILOs, and the further development and design of the course. Even if the already formulated ILOs were new, we decided to propose revised ILOs, before designing TLAs and ATs, if our analysis showed a need for further alignment with graduate attributes or Programme ILOs. We also propose changes to MSc programme ILOs if a need for this was identified in relation to the programme ILOs addressing topics to be taught and learned in the new course. The iterative approach was also used in the alignment process for course ILOs, TLAs and ATs, for example, if the time assigned to teach and learn a certain subject showed up to be insufficient for reaching the ILOs. Such discrepancies were removed by reorganising the time schedule and the TLAs or ILOs might be reprioritised. The iterative approach to the principles of constructive alignment was thus used at all levels.

The work on the course design was divided into the following parts:

- Course alignment
  - A two-level alignment of course ILOs with the MSc-programme ILOs and course ILOs for other courses in the programme.
  - An analysis of student backgrounds, including contents of relevant undergraduate courses.
  - Revised design of course ILOs (based on analyses in the above two bullets).

  - Design of course TLAs and ATs, and analysing their alignment with the course ILOs.
- Course implementation (implementation of ILOs, TLAs and ATs into an overall course plan)
  - Two level structure for all course elements, identifying a number modules to be taught , and suggesting a number of teaching sessions for each module, implemented into a calendar
  - Identification of the teacher group
  - Identification of teaching materials
- Development of an example lectures: alignment of lower level ILO, TLA and ATs (for an individual teaching session)
- Synthesis, conclusions and further work to be performed until August 2013.

Course alignment

Aligning course with MSc programme ILOs and ILOs of other programme courses

This analysis will be based on the ILOs of the MSc. Programme in Environmental and Natural Resource Economics (Appendix A), the initially suggested ILOs for the course we are designing (Appendix B), and course ILOs for other courses in the programme. A second part of the analysis will revise the course ILOs accordingly, and also includes thoughts from teachers within the study programme on the competences that students should obtain from following this course.

The analysis should reveal for example if there are gaps or disagreements in course curriculum compared to the MSc programme ILOs, if the course ILOs are supported by the other courses in the MSc programme and if they are in general agreement with other teachers' ideas about the competences that students should obtain.

The course ILOs describe the main contents of the course, but we will also formulate ILOs for the specific modules and teaching sessions of the course. The course ILOs will thus be specified in a three-level structure

Student backgrounds and undergraduate courses

The analysis of student backgrounds is based on available information on the students enrolled in the MSc Programme since 2003 (Appendix C), and

on feedback from last year’s students of the ENRE programme, when they were taught a module incorporating cases from environmental sciences in one of the economic courses (Appendix D).

Revision of course ILOs

Following the analysis of MSc programme ILOs, student background and information from economics teachers within the MSc programme we revisit drafted course ILOs for possible revision.

Design of TLAs and ATs aligned with course ILOs

We broadly discuss teaching and learning activities (TLAs) and assessment tasks (AT, formative and summative) required for constructive alignment of ILOs, TLAs and ATs. Alignment is finally demonstrated from ILOs over TLAs through ATs.

We will design the course using alignment in outcome-based teaching and learning activities (based on the results from the above listed activities).

Identification of the framework of the course, including a calendar showing the dates and times that the teaching will take place.

- Identifying the teachers and guest lecturers that need to be involved in the course
- Planning the teaching and learning activities (TLAs) in alignment with the ILOs. This will include formative assessments (ATs).
- Planning the summative assessments tasks (ATs) in alignment with the ILOs
- Planning reflective evaluation discussions at the end of each parts of the course

The TLAs will include teaching and tutorials in the classroom as well as smaller excursions in the region of Copenhagen and Zealand.

Implementation

Course structure

A first step in the implementation procedure was the development of an overall course structure, which included all ILOs, identified topics and contexts, and the associated TLAs and ATs. The overall structure was designed

to reflect the relative importance of the different ILOs. The ILOs and associated topics, TLAs and ATs were divided into modules that will be further developed into a number of teaching sessions. The balance between the different topics and the number and type of TLAs reflected the relative importance of the topic expressed in the individual ILO.

Teaching and learning materials

It was attempted to find a text book that could be used for the course, rather than relying on only selected individual studies or book chapters. If possible to find a suitable book, we reasoned that this would give the students a better overview of what should be learned.

We studied the text books used at BSc Level in the course Natural Resource Ecology which serves as the baseline ecology course for BSc Natural Resource candidates enrolled in the MSc programme. Text books used in the new course would need to be at a higher level, and possibly more targeted within the framework of ecosystem services and with link to societal needs in terms of natural resources. It was also sought to find textbooks that directly address the use of ecological knowledge in environmental economics.

Identifying the teacher group

The competences of the three core teaching were mapped in relation to course ILOs and gaps in their competences were identified. It was attempted to find ideal teachers for these topics, regardless if these were internal or external teachers, or if they employed within universities or professionals with public authorities or private companies.

A condition was that teachers from economic course in the programme should be responsible for teaching lessons that make the usefulness of ecological knowledge in environmental and natural resource economics clear to the students.

Designing a constructively aligned lecture

We constructed a sample lecture not included here) within ILOs A1-3 and B1-3, in the course structure placed within module 3, see chapter 5. The lecture falls within the subject of bioenergy and is titled 'Sustainable production of forest biomass for bioenergy'. A set of teaching session ILOs

was designed to be in alignment with first mentioned course ILOs. TLAs and ATs were designed to ensure that the specific teaching session ILOs were met, and thus contributing to learning of the associated course ILOs. Finally, the lecturing slides, and other teaching activities were elaborated.

Course and programme alignment

We carried out *curriculum mapping*, i.e. an analysis of alignment between programme ILOs and course ILOs in order to confirm the need for a course in ecology for students in the MSc. programme in Environmental and Natural Resource Economics, and to ensure that the drafted course ILOs of the new course were aligned with the programme ILOs.

As a supplement to answer these questions, we also examined the course curriculum for other optional courses in the MSc programme offering competences within basic ecology and environmental sciences and used feedback from the study director on the student profile and from core teachers regarding their previous experiences on the need that students possess knowledge with ecology, and environmental and natural resource sciences. This information was also used as a guideline for revising course contents.

The need for a new course

The course is expected to be placed in the first two blocks of the MSc programme to provide the necessary background knowledge for students to follow other courses. We examined the need for a new course by analyzing the general description of the MSc programme and course curriculum of the programme.

The overall objectives of the MSc programme (Appendix A) are:

1. "The objective of the programme is to offer students a coherent and profession-oriented education within the field of environmental and natural resource economics."
2. "Among other things, students will become familiar with environmental policy and project appraisal, and such policy issues as how to use economic instruments to control pollution problems and how to optimise the extraction of natural resources over time."

A set of programme ILOs exist to fulfill these objectives (Appendix A, see also Figure 4.5), and it was apparent that the new course could especially contribute to the general statement, that the study programme should enable students to "understand basic information on environmental phenomena in natural science". It is also stated in other places that the foundation within natural sciences is important: "Throughout, the programme maintains an emphasis on incorporating the biophysical aspects of environmental problems into the framework of environmental and resource economics analysis."

In the programme description is said that these aspects are being addressed in an introduction: "An introduction to applied ecology or environmental eco-technology keeps the focus on the physical and biological circumstances underlying environmental and natural resource policy problems."

However, these aspects would receive more attention through the inclusion of a new course specifically designed to provide common understanding of applied ecology. Due to the quite diverse backgrounds of the students, in some cases within politics, law and economy (Søren Boye Larsen, personal communication), it is especially important that a common knowledge basis is established.

We also examined the mandatory course curriculum of the MSc programme to check that no other courses address the same MSc programme ILOs as the new course. No other mandatory courses address ecology and environmental issues. However, a suggested optional core course "Environmental Management in Europe" (LNAK10043[2]) would be possible to follow in the second year of the MSc as a more specialized policy-related environmental management course with a specific European perspective, but we see no direct overlap with this course.

In a mandatory thematic course, "Applied Environmental and Natural Resource Economics" (block 3, LOJK10238[3]), a two week module entirely addressing environmental and natural resource issues has been taught. However, we expect that this module will be removed as the new course is introduced.

The overall conclusion is that a new course would bridge identified gaps in programme ILOs and course curriculum, thereby strengthening the MSc programme.

[2] http://www.kursusinfo.life.ku.dk/Kurser/LNAK10043.aspx

[3] http://www.kursusinfo.life.ku.dk/Kurser/LOJK10238.aspx

Alignment of course and programme ILOs

As mentioned above, we identified one crucial ILOs of the MSc. programme that directly relies on supporting knowledge ILOs in the new ecology course: “Show acquaintance with relevant environmental phenomena within natural science”. This is a very broad and vague knowledge-related ILO that will now be matched and detailed by many ILOs of the new course, including also more complex skill- and competence-related ILOs (Appendix B).

Two skill- and competence-related ILOs of the MSc programme are of more generic nature, i.e. the skill to “communicate solutions to the management- and climate change-related problems in reports and oral presentations” and the competence to “work effectively in teams or on an individual basis in multi-disciplinary settings...”. These MSc programme ILOs are also well aligned with specific course ILOs.

Several ILOs of the MSc programme furthermore indirectly rely on competences regarding understanding of ecosystems, their ecology and functioning, when the students should apply the tools and perform analyses on environmental and natural resource issues. Understanding of ecosystem processes and patterns within relevant forest, agriculture or nature ecosystems is thus required. An example is the ILO ”Identify relevant policy instruments to manage environmental problems and the utilization/extraction of natural resources”, where knowledge of environment, natural resources and ecosystems forms the framework for identification of economic incentives to promote a certain management. Moreover, graduates from the programme “will later be charged with solving broad-spectrum problems where economic disciplines, natural science and law are combined”.

It is concluded that the programme and course ILOs are well aligned, and that there is sufficient degrees of freedom within the most relevant programme ILOs to design specific course ILOs in a manner that makes them complementary to other course ILOs and well linked to other courses.

Complementarity and linkage between ILOs of the new course and existing courses

As the new course should provide a common basis for learning in other courses, it should be properly linked to other courses and be complementary to these.

One of the courses that most obviously link with the new course is the course previously including the two week module on natural science

Type of ILO	Study programme ILO	Matching course ILO
Knowledge	Define the welfare economic foundation of environmental and natural resource economics	
	Display an overview of environmental and natural resource economic disciplines and the analytical methodologies applied within these disciplines	
	Refer to other economic disciplines relevant to the analysis of environmental and natural resource problem	
	Show acquaintance with relevant environmental phenomena within natural science	• Describe fundamental structures, functions and processes of systems ecology, for example biogeochemistry, soil processes, hydrology, succession, biodiversity, disturbance), including interactions between ecosystems. • Explain how ecosystem structures, functions and processes can be influenced by management and climate change. •
	Refer to major environmental policy issues and discussions	Describe the most common certification and labelling systems relevant to sustainable and responsible management in forestry and agriculture
	Identify relevant policy instruments to manage environmental problems and the utilization/extraction of natural resources	
	Reflect about the value concepts underlying environmental and natural resource economics as well as alternative ethical positions	
Skills	Carry out quantitative as well as qualitative analyses of environmental and natural resource policy problems based on appropriate theories and methods	• Explain key theories and methodologies for ecosystem management, including principles of sustainable management, restoration, and protection of environmental values. • Adapt principles and methods for management of ecosystems to achieve identified ecosystem services and goals.
	Use state-of-the-art statistical and analytical techniques used in environmental policy and project appraisals such as economic valuation methods and cost-benefit analysis	
	Discuss alternative economic theories and recommendations regarding environmental and natural resource issues	
	Critically assess the validity and limitations of economic theories, models and methodologies when dealing with different scientific problems	
	Plan and coordinate projects	
	Communicate issues regarding environmental and natural resource economics effectively to specialist and non-specialist audiences, at a variety of levels, using modern information and communication tools	Communicate solutions to the management- and climate change-related problems in reports and oral presentations
Competences	Assess environmental and natural resource policy and economic problems and propose solutions based on a solid theoretical foundation in complex economic, political, social and ethical contexts	
	Adapt different analytical approaches to unforeseen problems	
	Show awareness of and enter into scientific discussions and political disputes within areas of interest to environmental and natural resource economics.	Evaluate methods and plans for ecosystem management, e.g. by identifying strengths and weaknesses of various solutions in relation to specific sets of environmental challenges.
	Integrate new scientific findings in professional or research activities at a high academic level	
	Work effectively in teams or on an individual basis in multi-disciplinary settings, exercising initiative, personal and management responsibilities as required	Cooperate effectively in multidisciplinary and multicultural groups within a group project.
	Value lifelong learning as a principle and demonstrate the independent learning ability to structure ongoing learning processes effectively	

Fig. 4.3. Examples of course ILOs that would contribute directly to ILOs of study programme (Appendix A).

issues, "Applied Environmental and Natural Resource Economics" (block 3, LOJK10238[4]). Among the knowledge-related ILOs of this the thematic course is "Give an overview of a topic from the point of view of natural science". A skill-related ILO is to "Integrate natural science and economics", while a competence-related ILO is to "Identify the border lines between economics and natural science". Thus, a good foundation in natural resource and environmental science is a requirement for this course, and the new course will strengthen the basis compared to the previous two week module addressing natural science issues.

Feedback from teachers and students are however worth noticing when revising course ILOs of the new course. The teacher of the thematic course in block 3, "Applied Environmental and Natural Resource Economics" (LOJK10238) has mentioned the importance of students obtaining sufficient knowledge within environmental and natural resource sciences for them to be able to read, understand and utilise scientific literature and findings within these subjects" (F. Jensen, personal communication). Feedback from students, after the two-week natural science module taught in 2012, showed that also students also saw a need for better integration of economics with environmental science issues (Appendix D). They specifically asked for use of literature that would help bridge this gap.

It is as such important that the new course will enable more time on how to approach the application of studies on environmental services in applied studies within environmental economics.

Student background

Analyses of student profiles and behavior 2003-2011 revealed that the typical student is increasingly a foreigner (53% in 2010 and 71% in 2011), mainly from other EU countries, but not Nordic countries (Appendix C). In 2011, the few students from the University of Copenhagen (UoC) have a BSc in Natural Resources or Agricultural Economics. Thus, the MSc programme cannot rely on competences acquired in BSc programmes of the UoC.

There are no statistics on the BSc background of the large group of non-UoC students. A background in natural sciences is among the general criteria for enrolment in the MSc programme, but the study director has informed us that there may be several students allowed with no previous

[4] http://www.kursusinfo.life.ku.dk/Kurser/LOJK10238.aspx

background in natural sciences. Student feedback (Appendix D) also indicated that some students found it difficult to read scientific literature within natural sciences and that there is a need for specifically training of this skill. It will be a challenge to gauge the need for competence building of all students as we expect that the level of competences in environmental science from BSc level is quite heterogeneous within the student group.

Conclusion

We conclude that there is a clear gap in the course curriculum of the MSc programme. This is based on 1) lack of mandatory natural science-devoted courses in spite of the clear application of economic theories on issues related to environment and ecology, 2) information from economics teachers that the natural science basis appears too weak in students, 3) the student background analysis indicates that the MSc programme cannot rely on competences expected to be acquired in BSc programmes of KU, and 4) some students have no natural sciences background at all. ILOs of the MSc programme and content of later courses do not provide any specific guidance regarding focus on certain environmental issues of most relevance for students. This leaves the options for the specific design of the course quite open. The course in ecosystems ecology would therefore be a key course for establishing the foundation of the MSc programme within natural sciences to enable integration of natural science and economics.

Alignment of course ILO, TLA and ATs

Apart from the revision of the course ILOs as recommended above, this section takes the development of the course one step further by designing at set of TLAs and ATs suitable for the individual ILOs.

Revision of preliminary course ILOs

We revisited the preliminary ILOs based on information collated and analyses of MSc programme ILOs. Since the drafting of the ILOs that were submitted to the board of studies we had more time to consider the information about the specific competence needs of students and additional information about the background of students, as well as additional information from a teacher in economic courses.

Since the study director of ENRE specifically mentioned a paper by Bateman et al. (2011) as a good example for understanding the role of the course in the MSc programme course curriculum, we wanted to further *emphasize the concept of ecosystem services*. MSc progamme teachers and the study director emphasized that there should be an early linkage between knowledge about natural resource science and its application in economics, and we also wanted to support *the ability of students to critically read scientific literature within natural sciences for integration with economic methodologies and analyses*. This is specifically what distinguishes the candidates within the ENRE MSc programme from “conventional” candidates in economics.

We therefore revised some of the ILOs to meet the needs for students to:

1. Better understand the concept of ecosystem services
2. Critically read and understand scientific literature and be able to extract qualitative as well as quantitative information on impacts of natural resource management
3. Be able to use a common framework for integration of natural resource management/environmental sciences and economics, i.e. the concept of ecosystem services *sensu* the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment 2005).

Furthermore, the wording of certain ILOs was revised for simplification and to link up with the ecosystem service concept, and the number of ILOs was reduced to get closer to the maximum of 5-6 course ILOs recommended by Biggs and Tang (2007). We also organized ILOs at the three levels of understanding according to the concept that functioning knowledge ILOs should put declarative knowledge to work, cf. Biggs and Tangs (2007). Therefore, each of the two knowledge ILOs are connected with an ILO at the skill and competence levels. The revised course ILOs are presented in Figure 4.4, in which they are compared to the preliminary initial course ILOs. The ILOs numbered with the same letter are linked so that the knowledge ILO is put to work by the corresponding skill and competence ILOs.

Level of under-standing	Initial ILOs	Revised ILOs
Knowledge (uni- and multi-structural)	Describe fundamental structures, functions and processes of systems ecology, for example biogeochemistry, soil processes, hydrology, succession, biodiversity, disturbance), including interactions between ecosystems.	A1. Describe fundamental structures, functions and processes of ecosystems, for example biogeochemistry, soil processes, hydrology, succession, biodiversity, disturbance), including interactions between ecosystems and the concept of ecosystem services.
	Explain how ecosystem structures, functions and processes can be influenced by management and climate change.	-
	Explain key theories and methodologies for ecosystem management, including principles of sustainable management, restoration, and protection of environmental values.	***B1. Explain key theories and methodologies for ecosystem management, including principles of sustainable management, restoration, and protection of environmental values and natural resources.***
	Describe the most common certification and labeling systems relevant to sustainable and responsible management in forestry and agriculture.	**-**
		C1. Explain the process of creating scientific knowledge.
Skills (multi-structural, relational and extended abstract)	*Make plans for application of methods for ecosystem management.*	***A2. Compare impacts of climate change and various ecosystem management methods on structures, functions and processes of ecosystems and thus the provisioning of ecosystem services.***
	Develop long-term strategies, operational targets and specific operational plans for sustainable use and protection of various ecosystems, and evaluate agreement with standards of selected certification or labelling systems.	***B2. Apply strategies and operational targets in the planning of sustainable management and protection of various ecosystems, and evaluate the agreement of such plans with recognized standards for sustainable management or provisioning of ecosystem services.***
	Assess implications of management and climate change for ecosystem structures, functioning, and processes.	-
		C2. Critically read and understand scientific literature on quantitative and qualitative impacts of ecosystem management and climate change
	Communicate solutions to the management- and climate change-related problems in reports and oral presentations.	D2. Communicate solutions to the management- and climate change-related problems in reports and oral presentations.
Competences (Extended abstract)	*Identify environmental possibilities/limitations in relation to management of ecosystems and mitigation and adaptation to climate change, including tradeoffs between reduction of greenhouse gas emissions and other environmental services.*	***A3. Reflect on environmental possibilities/limitations in relation to management of ecosystems and mitigation and adaptation to climate change, including tradeoffs between various ecosystem services***
	Adapt principles and methods for management of ecosystems to achieve identified ecosystem services and goals.	***B3. Adapt principles and methods for management of ecosystems to achieve identified potentials for provision of ecosystem services.***
	Evaluate methods and plans for ecosystem management, e.g. by identifying strengths and weaknesses of various solutions in relation to specific sets of environmental challenges.	***C3. Use scientific literature for analyses of environmental impact as a basis for economic analyses, development of policies advice and governance measures related to environmental services (e.g. as in the Millennium Ecosystem Assessment (MEA, 2005))***
	Cooperate effectively in multidisciplinary and multicultural groups within a group project.	D3. Cooperate effectively in multidisciplinary and multicultural groups within a group project.

Fig. 4.4. Initial and revised ILOs for the course. Revised or added ILOs in bold italics. The level of understanding to be achieved, using SOLO taxonomy, is indicated in brackets.

Learning environment and selection of suitable TLAs and ATs

We browsed the revised course ILOs in order to identify relevant TLAs and ATs to establish the best possible learning environment and to enable constructive alignment of the course according to Biggs and Tang (2007).

The course will form a major part of the teaching in the first block of the MSc programme, and based on information on student background it can be expected that very few students know each other from BSc level and most of them have just arrived in Denmark. We therefore see it as an important task for the course to establish a good learning environment by a group activities during the first week, e.g. an excursion that will serve partly as an introduction to the course content and partly as a social event, e.g. by concluding the day with a few social get-together activities and a common dinner at the Danish Forestry College in Nødebo.

It will also be emphasized in this first part of the course why students should be motivated to learn about environmental and natural resource sciences, particularly in case they have a more economic background. This will be done by an early lecture on cases exemplifying situations where professional environmental economists are needed for integration of natural sciences and economic analyses. The lecture should include a sound example of such work as well as an example of wrong conclusions from economic analyses in case the underlying assumptions from natural sciences are false.

Furthermore, we will strive to create a good learning environment by use of teaching/learning activities (TLAs) that address the verbs of the ILOs and take account of the students' backgrounds, including possible knowledge learned at undergraduate level. Such a teaching and learning environment is more likely to result in the intended outcome being achieved.

Teaching and learning activities (TLAs)

The selected constructively aligned ILOs, TLAs and ATs are given in Figure 4.5, with the reasoning behind the selection further explained in this chapter.

The knowledge-related ILOs about basic ecology and ecosystem science most concern learning of declarative knowledge and will be conveyed through teaching sessions that contain the following types of TLAs:

1. *Lectures*, that are as much as possible based on a dialogue between students and the teacher s using problem-based learning approach. The

relatively small expected class size (25-30 students, Appendix C) enables a high degree of student-teacher interaction during lectures, and we will therefore aim at establishing an informal environment.
2. *Exercises* to be discussed in groups or with neighboring fellow students will be an integrated part of the lectures that also ensures change in activities. Formative assessment of these exercises will be carried out within groups or in plenary, e.g. at the blackboard, check-out-points in PowerPoint slides or multiple choice in Absalon guided by clickers as formative evaluation of own understanding of main take-home messages
3. *Excursions* that will illustrate ecosystem structures, functions and processes, and environmental services. The excursion will set the context of the descriptive knowledge to be learned.
4. *A group project* which gives the student the possibility to explain the knowledge to be learned in their own words.

Dialogue, small exercises and the project will serve to engage and activate the students, so that they will themselves gain experience in describing or explaining the knowledge to be learned, in a manner which points beyond the knowledge-based ILOs.

The skill- and competence-related ILOs mostly concern functional knowledge, and also here, we will also actively engage students as much as possible by conveying teaching sessions that contain the following types of TLAs:

1. *Cases, exercises, and specific assigned group projects* for comparing climate change and management impacts and for applying strategies and operational targets in management planning. From our own research we possess several good cases regarding changes in ecosystem services that may be used and we will as far as possible use a problem-based approach to teaching, e.g. in order to balance the provisioning of more than one ecosystem service (e.g. climate change mitigation and recreation and water recharge). Cases or exercises will primarily be applied during afternoon sessions but also as "breaks" during lectures as relevant in the given context of learning.
2. *Excursions* will be arranged using external guides or we might guide the excursion ourselves and integrate with exercises. The excursion should also serve as an important inspiration for projects as well as source of knowledge. Questions for external guides will be prepared in advance and the minutes from excursions will serve as teaching and

Level of under-standing	Intended learning objectives	Teaching & learning activities (TLAs)	Assessment tasks (ATs) – formative (f) or summative (s)
Knowledge	A1. Describe fundamental structures, functions and processes of ecosystems, for example biogeochemistry, soil processes, hydrology, succession, biodiversity, disturbance), including interactions between ecosystems and the concept of ecosystem services.	*Lectures (including exercises)* - module 1 (fundamental ecology, ecosystem concepts) and 2 (environmental services and assessments). *Excursion* – excursion 1 (ecosystems and environmental services)	*Multiple choice or "check-out questions"* in end of lecture (f) *Exercise approved* (s) *Final exam* (s) - criteria-based grading
	B1. Explain key theories and methodologies for ecosystem management, including principles of sustainable management, restoration, and protection of environmental values and natural resources.	*Lectures* - module 3 (forests), 4 (agriculture), 5 (nature). *Project group* work - Project 2 (forestry), 3 (agriculture)	*Multiple choice or "check-out questions"* in end of lecture (f) *Project feedback* by peers and teachers (f) and passed (s) *Final exam* (s) - criteria-based grading
	C1. Explain the process of creating scientific knowledge.	*Lecture, (including exercises)* – module 1-2 *Excursion* – excursion 1 (ecosystems and environmental services)	*Multiple choice or "check-out questions"* in end of lecture (f) *Exercise approved* (s) *Final exam* (s) - criteria-based grading
Skills	A2. Compare impacts of climate change and various ecosystem management methods on structures, functions and processes of ecosystems and thus the provisioning of ecosystem services.	*Lectures, (including exercises) and cases* - modules 3-5 *Projects* – project 2-3 *Excursions* – Excursions 2 (forest management and ecosystem services) and 3 (agricultural management and ecosystem services)	*Multiple choice or "check-out questions"* in end of lecture (f) *Exercises approved* (s) *Project feedback* by peers and teachers (f) and passed (s) *Final exam* (s) - criteria-based grading
	B2. Apply strategies and operational targets in the planning of sustainable management and protection of various ecosystems, and evaluate the agreement of such plans with recognized standards for sustainable management or provisioning of ecosystem services.	*Lectures (including exercises) and cases* - modules 3-5 and 6 (land use change and interactions) *Project group work* - Project 4 (land use change and interactions) *Excursion* – Excursion 4 (land use change and interactions)	*Project and case feedback* by peers and teachers (f) and passed (s) *Final exam* (s) - criteria-based grading
	C2. Critically read and understand scientific literature on quantitative and qualitative impacts of ecosystem management and climate change	*Lecture (including exercises)* – module 1-2	*Exercise approved* (s) *Final exam* (s) - criteria-based grading
	D2. Communicate solutions to the management- and climate change-related problems in reports and oral presentations.	Exercises using journal papers on ecosystem service provisioning, e.g. from land-use change.	*Oral and written feedback* - evaluation of communication skills (f) *Final exam* (s) - criteria-based grading
Competences	A3. Reflect on environmental possibilities/limitations in relation to management of ecosystems and mitigation and adaptation to climate change, including tradeoffs between various ecosystem services	*Case* on ecosystem services *Project group work* – Project 2-4	*Oral and written feedback* on project reports and cases by peers and teachers (f) and passed (s) *Final exam* (s) - criteria-based grading
	B3. Adapt principles and methods for management of ecosystems to achieve identified potentials for provision of ecosystem services.	*Lectures* (including exercises) about specific ecosystems – module 3-5 *Project group work* - Projects 2-4	*Multiple choice or "check-out questions"* in end of lecture (f) Project report (f, s) *Final exam* (s) criteria-based grading
	C3. Use scientific literature for analyses of environmental impact as a basis for economic analyses, development of policies advice and governance measures related to environmental services, e.g. as in the Millennium Ecosystem Assessment (MEA 2005)	*Exercises* using journal papers on ecosystem service provisioning, e.g. from land-use change *Project group work* – Project 2-4	Evaluation of exercises (f), projects passed (s) *Oral and written feedback* on project reports by peers and teachers (f) and passed (s) *Final exam* (s) - criteria-based grading
	D3. Cooperate effectively in multidisciplinary and multicultural groups within a group project.	*Group work* during exercises, cases and projects 1-4 *Group formation activities* (Perhaps a short intro lecture on group work dynamics)	*Oral feedback* (f) – especially in case of problems and challenges in relation to group work

Fig. 4.5. Constructive alignment at course level. Visit Figure 4.6 to see the course structure referred to in this table (the course has been structured into seven modules addressing different course ILOs and topics, with four group projects being included).

learning materials. ILOs such as the skill-related "Apply strategies and operational targets in the planning of sustainable management" and competence-based "Adapt principles and methods for management of ecosystems to achieve identified potentials" must be supported by excursions to relevant ecosystems.

3. *Case-based exercises* will be used to focus on ILOs regarding the skills to understand environmental science literature and to interpret journal article results for use in economic evaluations. To this end, teachers in economics specifically requested students are competent in understanding, extracting and distilling the relevant quantitative measures of ecosystem services in order to enable economic evaluations.
4. *Lectures* will be used to shortly introduce cases, exercises, projects and excursions.
5. *Group work* will support generic competences such as "cooperate effectively in multidisciplinary and multicultural groups within a group project". The teachers will guide the formation of different groups for some or all four projects. It is our experience that some teacher-guidance is needed to support the group formation process, but we might also let the students form groups themselves in the two last projects. The guided group formation can be done directly based on information on nationality, BSc. background, age and gender to achieve working environments where the students may complement each other. It can also be done more indirectly by supporting group formation based on common interests, i.e. by a poster session where students can shop around between different issues.
6. *Written reports and oral presentations* will support the other generic skill-related ILOs "communicate solutions to the management- and climate change-related problems in reports and oral presentations". These activities will especially take place in relation to presentations of projects, but may also be used for case-based exercises. Written reports may be in a form such as poster or information briefs in order to train various forms of communication that will be relevant for candidates.

Assessment tasks

Formative assessment of ILOs will be included as part of lectures as mentioned above, i.e. as "check-out questions" at the end of lectures for students to self-evaluate their understanding. ILOs associated with exercises

will be assessed formatively during oral presentations through use of peer opponents and feedback from teachers.

After the formative feedback give at oral presentations, the project reports will be finalized and submitted for summative assessment (pass or not pass). Selected exercises may also be summatively assessed after formative feedback and submission (pass or not pass).

The final exam would need to evaluate not only knowledge-related ILOs but also skill and competence ILOs supported by the project work. Therefore, the final exam should assess declarative knowledge as well as functioning knowledge related to projects. A minimum of three projects and 75% of the selected exercises must be passed for the student to attend the final examination.

Generic competences regarding communication of solutions may be assessed by presentation of certain projects as a part of the exam. The final exam could be structured in two sections, 1) an oral presentation of one report from another group and 2) one exam question reflecting ILOs of the course.

Implementation

In the previous sections it was decided which topics should be taught and learned, to which extent the learned knowledge should be declarative or functional knowledge should be involved, and at which level the student understanding and competences should be, i.e. the formulation of ILOs. Suitable TLAs and ATs were identified for each ILO in the previous chapter, in an iterative process with the identification of topics, elaboration of a course structure and other implementation aspects presented in this chapter.

In this chapter we describe the implementation aspects, including those already referred to in the previous chapter. This included the elaboration of a course plan which structures the identified ILOs, TLAs and ATs into modules that are further structured in time (Figure 4.6). We also elaborated more details with regard to the topics to be taught and learned, including issues related to selection of learning materials and identification of the teacher group.

Course plan

The developed general course structure is presented in Figure 4.6. The priorities made concerning time distributed to different topics reflect the im-

portance of a certain topic/ILO, even if it is not necessarily so, that the importance is proportional to the time needs (Biggs and Tang, 2007).

The course includes a lump of declarative important knowledge to be learned. It was considered if such knowledge should be taught and learned in connection with the functional ILOs, that put this knowledge to work, or if it should all rather be taught and learned in the beginning of the course. We chose to include it in the beginning of the course, as it would be difficult to separate it as topics associated with individual functional ILOs. The only exception is ILO B1, which will be addressed in projects later the course.

Two initial modules were made for teaching and learning of declarative knowledge. Ecosystem structures, functioning and processes in module 1, and concepts of ecosystem services and environmental impact assessments in module 2.

A module on management impacts in land uses forestry, agriculture, and other nature and urban areas, respectively, addressed skill and knowledge ILOs by putting the declarative knowledge to work, as is already indicated by the structure of the ILOs.

Mod.	Weeks	Topic	TLA				AT
			Lectures	Exercise/Cases	Excursions	Projects	Assessment
1	Week 36-39	Ecology and ecosystems science	Yes	E/C 1-3	Excursion 1	Project 1	Formative
2	Week 40	Environmental services and assessments	Yes	E/C 4			Formative
3	Week 40-41	Forests management impacts	Yes	E/C 5-6	Excursion 2	Project 2	Formative
-	Week 42	*Holidays*	-	-	-	-	-
3	Week 43-44	Forests management impacts	Yes	E/C 7			Formative
4	Week 44-46	Agriculture	Yes	E/C 8-10	Excursion 3	Project 3	Formative
5	Week 47-48	Heathland and other nature areas	Yes	E/C 11-12			Formativer
6	Week 49-51	Land-use changes and alternatives	Yes	E/C 13-14	Excursion 4	Project 4	Formative
-	Week 52-1	*Holidays*	-	-	-	-	-
7	Week 2	Project finalisation and review	-	-	-	-	-
-	Week 3-4	Assessments	-	-	-	-	Summative

Fig. 4.6. Overall structure of the course, with ILOs, TLAs and ATs from Figure 4.5 included. Note that lectures may include smaller exercises to discussed and solved in plenum or in groups.

Literature

At BSc level the text books in the basic ecology course (Natural Resource Ecology) are

1. Smith and Smith: Elements of ecology (main textbook) http://www.pearsonhighered.com/educator/product/Elements-of-Ecology-8E/9780321736079.page
2. Botkin and Keller: Environmental science (secondary text book) http://eu.wiley.com/WileyCDA/WileyTitle/productCd-EHEP001554.html?filter=TEXTBOOK

Based on studies of these text books we have preliminarily considered using a more targeted text book on ecosystms ecology, e.g. Jørgensen, S.E., Ecosystem Ecology. http://books.google.dk/books/about/Ecosystem_Ecology.html?id=a-LjEvwWmOEC&redir_esc=y

Screening of various books and final selection of literature will be carried out at a later stage.

Identification of the teacher group

The core group of teachers consists of the three persons behind this project. The clear aim to integrate natural resource science and economics made it clear that involvement of teachers from environmental economy courses within the MSc programme would be necessary to ensure the right context for the course, i.e. to establish exercises in which students are faced with the task of extracting quantitative information on environmental impacts for use in economic analyses. The inclusion of economy teachers will also ensure good internal communication and targeted learning for use in economics courses.

We also realize that some of the modules, i.e. on agricultural management and heathlands, will require some input from guest teachers. Some guest teachers will be colleagues within our institute whereas experts on agricultural management will need to come from another institute within the faculty. In the detailed planning of establishment of the teacher group we will, however, consider the added value of including external teachers against possible tradeoffs, e.g. that the course will be more difficult to manage and that it may be more complicated to ensure constructive alignment throughout the course.

Synthesis, conclusions and further work

Summary conclusions

We have established a first framework for a new mandatory 15 ECTS course "Ecology and Ecosystems Science in Relation to Environmental Economics" to be taught for students during blocks 1 and 2 in the first year of the MSc programme "Environmental and Natural Resource Economics" (ENRE). The course aims to strengthen the natural resource and environmental science aspects of the MSc programme to better support the integration of "biophysical aspects of environmental problems into the framework of environmental and resource economics analysis" as stated in the MSc programme description. The course design was based on state-of-the-art ideas and recommendations regarding constructive alignment of the teaching for improved and effective learning.

The inclusion of a mandatory ecology course was justified by analysis of MSc programme ILOs, the course curriculum information from teachers, feedback from students, and information on the diverse BSc background of the mainly foreign students accepted for the programme. It was explicitly stated that environmental and natural science aspects needed strengthening, in a manner that also ensures integration of environmental sciences and economics. It was also clearly stated that students should be more competent in understanding scientific literature and in their ability to extract qualitative as well as quantitative information on impacts of natural resource management for use in economic evaluations.

For the revision of the preliminary course ILOs, we decided to introduce a common framework for integration of natural resource management/environmental sciences and economics, i.e. the concept of ecosystem services *sensu* the Millennium Ecosystem Assessment (2005). Based on the revised ILOs, we planned the framework for TLAs and ATs using the concept of constructive alignment, i.e. alignment of ILOs, TLAs and ATs. Planned TLAs include lectures with student interaction tasks, case-based exercises, excursions and project work in groups. Formative assessment tasks will be linked with lectures, exercises and projects, and these will be used as a basis for the final summative assessment (oral exam).

The preliminary course plan is structured in six modules with two initial basic "tool-like" modules (general ecology and ecosystem services, respectively) followed by three land use-specific modules (forest, agriculture, nature areas), a module that addresses land-use change influences and interaction between adjacent land-uses as well as synergies and tradeoffs between

different environmental services. Finally a project presentation and examination module consists of summative assessment of projects and individual learning of the students.

We present a sample lecture within the course module “forest management impact” to illustrate planned alignment of course ILOs, module ILOs, and lecture ILOs with lecture TLAs and ATs.

This project work has set the framework for the new course, but many details remain to be settled. The current report forms our basis for further work on those details.

Status of the work

1. The framework for the new course has been established.
2. Analyses of course justification within MSc programme and the overall content is finalized
3. Course ILO are finalized; perhaps with some minor adjustments still being needed
4. TLAs are preliminarily drafted but should be specified in more detail, e.g. the use of different forms of student-student and student-teacher interaction during lectures (buzz groups, jigsaw groups etc.) as well as e-tools for deeper learning.
5. ATs are preliminarily drafted but should be specified in more detail, e.g. formative assessment using multiple choice tools in Absalon, clickers, Socrative etc.
6. The course plan is finalized in “low temporary resolution” and needs to be specified on a course day basis
7. Text book search has been initiated but book selection is pending, and other supplementary teaching materials need to be identified.
8. The need for inclusion of 2-3 guest lecturers has been identified but lecturers should be selected and contacted, as is the case for guest lecturers from economic courses.
9. Communication with study director and teachers in economy in MSc programme has been initiated but meetings should be set up for further coordination and fine-tuning of course content.

Plan for the further work

January

1. First framework for course contents, structure, implementation and evaluation
2. Identify potential guest lecturers
3. Identify potential text books
4. Arranging meeting in February with MSc programme study director and teachers of ENRE
5. Request to colleagues teaching another course on ecology and natural resource management, if they can review the course design and implementation plan in February

February

1. Meeting with MSc programme study director and teachers for revision of the course according to their feedback (including suggested guest external and programme teachers and text books)
2. Revised course description reviewed by colleagues teaching another course on ecology and natural resource management
3. Contact guest potential lecturers
4. Guest lecturers from economic courses have been identified and confirmed

March

1. Text book selected
2. Follow up on status of guest lecturers
3. Identification of potential excursion destinations and related project topics and concepts, and contact potential excursion hosts
4. Initial planning of course "kick-off"

April

1. Initial planning of tutorials and case materials, especially those involving teachers from economic courses or needing material from these teachers
2. Final distribution of teaching obligations to different core and guest teachers
3. Initial plan for management of the teacher group

May

1. Final excursion destinations and project topics decided.
2. Final detailed course plan available

3. Start detailed planning of lectures including additional learning materials
4. Final plan for management of the teacher group

June

1. Continuing detailed planning of lectures
2. Planning of tutorials and cases finalized
3. Final planning of course “kick-off”

July - holiday
August

1. Organisation of the course in Absalon, including implementation of planned electronic formative assessments as multiple choice systems
2. Final matters of any kind

What have we learned in this project?

We have particularly gained a better understanding of:

1. course justification and alignment within a MSc programme.
2. course design using the principle of constructive alignment for alignment of study programme ILOs over course ILOs to TLAs and to ATs at course level.
3. the alignment of higher level course ILOs with ILOs at lower hierarchical levels, i.e. teaching modules and individual teaching sessions.
4. alignment of ILOs, TLAs and ATs within the individual teaching session.
5. how declarative knowledge from knowledge ILOs can be put to work as a basis for gaining functioning knowledge in skill and competence-related ILOs.

We have touched upon a number of other topics such as:

1. composing a teacher group for a course
2. selecting text books and course materials
3. the use of formative and summative assessment.

A MSc Programme in Environmental and Natural Resource Economics

The entire MSc programme description can be found at: http://www.science.ku.dk/studerende/studieordninger/kandidat/enre/Sto_Environmental_and_natural_resource_Economics.pdf/

Here we only present the most relevant parts of the programme.

The programme's objective

The objective of the programme is to offer students a coherent and profession-oriented education within the field of environmental and natural resource economics. On completion of the programme, participants will have acquired the skills required to conduct a broad spectrum of environmental and natural resource economic analyses. Among other things, students will become familiar with environmental policy and project appraisal, and such policy issues as how to use economic instruments to control pollution problems and how to optimise the extraction of natural resources over time.

Competence profile

During the master's programme in Environmental and Natural Resource Economics students must obtain the knowledge, skills and competences described below. These qualifications are obtained partly through participation in core modules partly through the participation in elective courses and the preparation of a master's thesis.

Knowledge

1. Define the welfare economic foundation of environmental and natural resource economics.
2. Display an overview of environmental and natural resource economic disciplines and the analytical methodologies applied within these disciplines
3. Refer to other economic disciplines relevant to the analysis of environmental and natural resource problems
4. Show acquaintance with relevant environmental phenomena within natural science

5. Refer to major environmental policy issues and discussions
6. Identify relevant policy instruments to manage environmental problems and the utilization/extraction of natural resources
7. Reflect about the value concepts underlying environmental and natural resource economics as well as alternative ethical positions

Skills

1. Carry out quantitative as well as qualitative analyses of environmental and natural resource policy problems based on appropriate theories and methods
2. Use state-of-the-art statistical and analytical techniques used in environmental policy and project appraisals such as economic valuation methods and cost-benefit analysis
3. Discuss alternative economic theories and recommendations regarding environmental and natural resource issues
4. Critically assess the validity and limitations of economic theories, models and methodologies when dealing with different scientific problems
5. Plan and coordinate projects
6. Communicate issues regarding environmental and natural resource economics effectively to specialist and non-specialist audiences, at a variety of levels, using modern information and communication tools

Competences

1. Assess environmental and natural resource policy and economic problems and propose solutions based on a solid theoretical foundation in complex economic, political, social and ethical contexts
2. Adapt different analytical approaches to unforeseen problems
3. Show awareness of and enter into scientific discussions and political disputes within areas of interest to environmental and natural resource economics.
4. Integrate new scientific findings in professional or research activities at a high academic level
5. Work effectively in teams or on an individual basis in multi-disciplinary settings, exercising initiative, personal and management responsibilities as required
6. Value lifelong learning as a principle and demonstrate the independent learning ability to structure ongoing learning processes effectively

B Course description with preliminary ILOs

Only the most relevant parts of the course description are presented here. The entire course description can be found at: http://kurser.ku.dk/course/nigk13008u/2013-2014

Content

Basic knowledge about systems ecology is essential for evaluations and analyses within the field of environmental and natural resource economics. Through lessons and case studies of various ecosystems (forest, agriculture, heathland, dunes etc.) you will be introduced to various aspects of ecosystem structure, functioning and processes that are of special importance to the practical application of economic theories, methods and instruments taught in subsequent economics courses in the M.Sc. in Environmental and Natural Resource Economics. Systems ecology: the ecosystem concept, succession and disturbances, biochemical cycling of nutrients, soil processes, hydrological cycles, carbon sequestration and turnover of organic material, other greenhouse gases than carbon dioxide, biodiversity and wild life ecology. Management and human impacts on ecosystems and their services: management and land-use change effects on ecosystem services such as nutrients and soil fertility, water quantity and quality, habitats and organisms, climate change mitigation (C sequestration). The specific management related topics are for example, pesticide and fertilizer use in agriculture (loss of nitrogen and phosphorus, impact on water quality of lakes, streams, ground water, riparian zones), bioenergy feedstock production, waste recycling (sludge, waste water, bioashes from combustion), land use and land-use change (afforestation, conversion to perennial crops in agriculture, impacts on e.g. water quality and quantity and greenhouse gas balances), general soil conservation, habitat protection, game management, grazing ecosystem restoration, and climate change adaptation.

Learning Outcome

The aim is to give the student an in-depth understanding of the ecology of various land uses, e.g. forestry, agriculture, heathland, and dune ecosystems, and the interactions among them at the landscape level. The student should understand the reasoning behind the use of various management

tools in different ecosystems according to specific management goals. Temperate ecosystems will be in focus, but the principles will be general and relevant for other biomes.

Knowledge

1. Describe fundamental structures, functions and processes of systems ecology, for example biogeochemistry, soil processes, hydrology, succession, biodiversity, disturbance), including interactions between ecosystems.
2. Explain how ecosystem structures, functions and processes can be influenced by management and climate change.
3. Explain key theories and methodologies for ecosystem management, including principles of sustainable management, restoration, and protection of environmental values.
4. Describe the most common certification and labelling systems relevant to sustainable and responsible management in forestry and agriculture.

Skills

1. Analyse structures, functions and processes of specific ecosystems.
2. Make plans for application of methods for ecosystem management.
3. Develop long-term strategies, operational targets and specific operational plans for sustainable use and protection of various ecosystems, and evaluate agreement with standards of selected certification or labelling systems.
4. Assess implications of management and climate change for ecosystem structures, functioning, and processes.
5. Communicate solutions to the management- and climate change-related problems in reports and oral presentations.

Competences

1. Identify environmental possibilities/limitations in relation to management of ecosystems and mitigation and adaptation to climate change, including tradeoffs between reduction of greenhouse gas emissions and other environmental services.
2. Adapt principles and methods for management of ecosystems to achieve identified ecosystem services and goals.

3. Evaluate methods and plans for ecosystem management, e.g. by identifying strengths and weaknesses of various solutions in relation to specific sets of environmental challenges.
4. Cooperate effectively in multidisciplinary and multicultural groups within a group project.

C Kandidatuddannelsen i Environmental and Natural Resource Economics

Årgangsanalyse, opgjort oktober 2011
Årgangene 2003 – 2010 (2011 hvor relevant)

Generelle oplysninger

I tabel 1 vises aktuel status for alle der er optaget fra 2003 til 2010. Status kan være ”afbrudt”, ”afsluttet” eller ”aktiv”.

Tabel 1 Oversigtsbillede årgang 2003 til 2010:

	2003	2004	2005	2006	2007	2008	2009	2010
Afbrudt	4	2	6	1		1		1
Afsluttet	18	14	11	3	9	6	4	
Aktive					2	8	5	14
I alt (optagelsestal)	22	16	17	4	11	15	9	15

Optagelsestallet har svinget noget igennem årene med et dyk i 2006.

Tabel 2 Optagne pr. årgang fordelt på køn:

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Mænd	11	12	12	3	6	9	7	11	14
Kvinder	11	4	5	1	5	6	2	4	14
I alt	22	16	17	4	11	15	9	15	28

Af tabel 2 fremgår, at uddannelsen primært tiltrækker herrer – 62% på de 9 årgange.

Tabel 3 Alder ved optagelse, årgang 2003 til 2011:

	2003	2004	2005	2006	2007	2008	2009	2010	2011	I alt
21 – 24 år	2	3	4	1	2	7	4	12	12	47
25 år	3	5	3		2	2		2	4	21
26 - 30 år	15	7	8	2	4	5	4		11	56
31 -35 år	2	1	2	1	1	1				8
35 +					2		1	1	1	5
I alt	22	16	17	4	11	15	9	15	28	137
Yngst	23	24	22	24	23	21	21	21	23	-
Ældst	31	31	34	33	48	34	30	37	39	-
Gns. alder	26,6	26,5	26,4	27,9	29,3	25,9	28,5	24,5	26,0	26,5

Gennemsnitsalderen ved optagelse er på de 8 varierer en hel del.

Tabel 4 Optagne pr. årgang fordelt på udenlandsk nationalitet (i parentes er angivet procent af optagne):

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Skandinavien	1					1		1	
Øvrig Europa			1	1	3	2	2	6	17
Afrika		1				3	4	1	1
Asien		1	3						2
I alt	1	2	4	1	3	6	6	8	20
I alt i %	5%	13 %	24%	25%	27%	40%	67%	53%	71%

Der er en markant stigning i andelen af udenlandske studerende.

Tabel 5 Optagne pr. årgang, adgangsgivende eksamen:

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Ikke LIFE-baggrund	4	5	9	4	8	11	9	10	26
LIFE-baggrund:									
Agronom	3		2						
Skovbrug	13	10	5		3	2			
Landskabsarkitektur	1								
Jordbrugsøkonomi	1	1	1			2		1	
Naturressourcer								4	2
Optagne i alt	22	16	17	4	11	15	9	15	28

Det fremgår, at tendensen er, at der i højere grad rekrutteres fra eksterne institutioner (og fra udlandet jf. tabel 4)

Frafald

13 af de i alt 109 optagne har afbrudt uddannelsen. Kun 1 er optaget på en anden kandidatuddannelse på Life (kandidatuddannelsen i skovbrug). 9 af de frafaldne er danskere (derudover en fra Norge, en fra Ghana og to fra Parkistan).

Gennemførelsestider

Gennemførelsestiderne er beregnet på baggrund af det antal studerende pr. årgang, der har afsluttet uddannelsen på opgørelsestidspunktet. Af de 22 optagne i 2003, har 15 gennemført uddannelsen, hvilket svarer til en aktuel gennemførelsesprocent på 68.

Tabel 6 Gennemførselstider:

	2003	2004	2005	2006	2007	2008	2009	2010
Afsluttede	18	14	11	3	9	6	4	-
I pct. af optagne	82 %	88 %	65 %	75 %	82 %	40 %	44 %	-
= 24 mdr.	5	1	1		1	4	4	-
]24 – 27 mdr.]	2	2	2	1				-
]27 – 30 mdr.]	3	1		1	1			-
]30 - 36 mdr.]	5	3	3		3	2		-
]36 -	3	7	5	1	4			-

Det ses, at over halvdelen af dimittenderne overskrider normeringen med mere end 3 måneder.

Tabel 7 Antal STÅ ved dimission:

	2003	2004	2005	2006	2007	2008	2009	2010
Afsluttede	18	14	11	3	9	6	4	-
2.0	3	1	1	3	6	5	4	
]2.0 – 2.25]	9	13	10		3	1		
]2.25 – 2.50]	5							
]2.5 – 3.0]	1							
Gns.	2,19	2,08	2,07	2,00	2,02	2,00	2,00	

Det fremgår, at kandidaterne for årgang 2003 i gennemsnit dimitterer med en pointsum, der overstiger normeringen en del.

Tabel 8 STÅ optjent ved merit fra andre institutioner:

	2003	2004	2005	2006	2007	2008	2009	2010
Antal dimittender	18	14	11	3	9	6	4	-
Antal dimittender med merit	11	9	9	2	3	4	1	-
Antal STÅ	5,32	3,34	2,65	0,63	1,22	1,46	0,5	-

Af tabel 7 ses, at 60 % af dimittenderne har fået meritoverført pointgivende studieenheder fra andre institutioner.

D Student evaluation

Following teaching cases of environmental science in the course “Applied Environmental and Natural Resource Economics”

Summarized evaluation by the students of previous teaching of natural sciences (bioenergy and bio fuel from forests) in Applied Environmental Natural Resource Economics in spring 2012 by Inge Stupak and Morten Ingerslev. This summary was based on both class room evaluation (documented by pictures of the blackboard by the end of the last lecture on bioenergy) and on questionnaires that the students filled in at the end of the last lecture on bioenergy.

Major points for general improvement:

1. Closer integration between natural science and economics (a general comment from all students)
2. Find and use literature (papers) that link natural sciences and economics
3. The subject of bioenergy should be included in the teaching of economics
4. Too much chemistry
5. Send out the ILO (intended learning objectives in advance before the lectures
6. The literature for lecture 1 was tough to some of the students (scientific literature on forest ecosystems, element budgets, biomass harvesting and wood chip ash fertilization). Others found it more easy to follow
7. The ILO was most often met

Major points for improvement of the excursion to Amagerværket

1. It is a good idea to spend some time for preparing various questions to the guide at Amagerværket, however it should not be mandatory to ask all of them, and it should be legal to ask other questions as well.

2. It would be nice to talk to an economist at Amagerværket also (besides the environmental chemist)
3. All students were satisfied with the excursion and found that it was inspiring and fruitful for their learning

Major points for the daily assesments

1. They clearly contributed to the learning and was closely linked to the lectures

All contributions to this volume can be found at:

http://www.ind.ku.dk/publikationer/up_projekter/2013-6/

The bibliography can be found at:

http://www.ind.ku.dk/publikationer/up_projekter/

kapitler/2013_vol6_bibliography.pdf/