

# Design and application of a proposal for cooperative learning for the contents in the field of ecology through case studies

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## Abstract

This article presents a web-based platform (<http://www.creaf.uab.es/AprenEcologia/>) containing 13 case studies with the goal of improving the learning of contents related to ecology in a variety of university degree programmes. The case studies can be chosen from the website based on their subject, although they are also categorised according to eight different educational criteria that can help each user choose the right case study depending on their goals, and allowing the professors who have used them to add their assessment. The case studies can be downloaded freely from the website by any user, and there is also the option of adding suggestions or assessments of how they work, as well as the ability to generate new case studies using a template. Most of these case studies have already been used in teaching Biology and Environmental Sciences at the UAB, and from the perspective of both faculty and students, they have been useful for learning the contents, both conceptual and methodological, of the different courses.

## General area of interest of this innovation

In addition to the different areas of study that involve issues related to ecology in the organisation and approach of the project, this innovation might be useful in general for many different university courses on the sciences, as well as for baccalaureate programmes.

## 1. Objectives

The general goals of the project were:

1. To design a series of case studies that would bolster the efficiency of the learning of the contents and skills related to ecology for university students at a variety of levels and from different degree programmes.
2. To present the case studies on a web-based platform that would enable users, mainly professors, to get all the material they needed, as well as an implementation guide for using the case study in their teaching.

The skills that are honed in the different case studies are not always the same, plus they can fluctuate in each case depending on how each teacher decides to use the case studies. For this reason, the information on each case study outlines the different skills that are meant to be practised in each specific case.

## 2. Description of the project

### 2.1. Background of the innovation

The need for this innovation emerged from the response by a group of professors in the Ecology Unit at the Universitat Autònoma de Barcelona to a series of shortcomings detected in our students' learning of the ecology contents in the Biology and Environmental Sciences programmes. We noticed how often the successive courses in this field of knowledge repeated the same syllabus with increasing degrees of complexity, but leading students to lose motivation when faced with concepts that they did not identify as new. The field of ecology is particularly sensitive to this due to its conceptual load. One alternative to this situation is the gradual acquisition of knowledge and skills using practical tools that are familiar to the students, taking advantage of some of the qualities of the young generations (Internet, visual communication, languages, etc.).

For years, the Ecology Unit in the Department of Animal Biology, Plant Biology and Ecology at the UAB has been conducting experiments with the goal of increasing students' active, practical learning. However, despite the positive results of many of these experiments, certain problems also came to light:

1. A great deal of time must be invested in acquiring the information.
2. It is difficult to share the professionals' vision.
3. Evaluation is difficult unless it is performed based on pre-established cases.
4. There is an overall lack of planning of the goals, methods and evaluation.

This series of problems could be improved via the proposal described herein, that is, by ensuring that part of the teaching practice of ecology revolves around case studies with different levels of specificity and methodologies. The case study methodology seemed appropriate because it is a practice that in many different settings has demonstrated its vast educational potential, especially because of its ability to foster reflective learning and to facilitate the understanding of complex issues. Case stud-

ies enable students to not just recall information and methods, rather it also helps them to know how to apply them within a specific context: «students have to know not just the “what” but also the “when”, “where” and “how”» (Dochy, Segers and Dierick, 2002). Its main characteristic as a teaching method does not lie in the fact that it uses cases, rather in how these cases are dealt with. The core of this methodology is discussion, the possibility of developing questions, comparing positions and putting into practice theoretical and practical concepts using dialogue. Therefore, as a method it does not work in itself, rather it depends on teachers who know how to use it in all its potential, professors who are capable of generating an interesting, reflexive educational atmosphere (Blythe, 1999).

## 2.2. Characteristics of the innovation

In this field, we consider that learning in ecology based on the globalising approach provided by the case study method allows for: cooperative work, active learning, realism, application of the knowledge in different contexts, transversality with other disciplines and the integration of knowledge and skills. Therefore, the content of this innovation involves the development of working techniques based on case studies in order to gradually organise the acquisition of knowledge and skills in the field of ecology within the Biology and Environmental Sciences degree programmes. Each case study has a description that includes its goals, a proposed guide for conducting the case study and all the materials (maps, databases, diverse documents) for conducting it in the classroom. The case studies can be chosen from the website based on their subject, although they are also categorised according to eight different educational criteria that can help each user choose the right case study depending on their goals. The case studies can be downloaded freely from the website by any user, and there is also the option of adding suggestions or assessments of how they work, as well as the ability to generate new case studies using a template.

## 3. Methodology

Thirteen case studies were designed focusing on the contents of ecology that were to be resolved by students in different degree programmes and at different university levels. The case studies are presented on a website: <http://www.creaf.uab.es/AprenEcologia/2008>.

Each case study has a guide sheet for conducting it that contains the following sections:

1. *Title of the case study*: This refers to its content.
2. *General introduction*: This tells for what type of students and class/group the case study was designed, and some defining element is highlighted.
3. *Description of the case study*: The case study is categorised according to eight strands or characteristics related to their contents or the skills they hone. Each character-

istic has a variety of alternatives, which are indicated for each case study and are not necessarily mutually exclusive, as shown in Table 1.

Table 1. Characteristics used to define each case study

Characteristic	Possibilities of each characteristics
Type of course	Compulsory – elective
Conceptual complexity	Abstract or concrete
Applicability of the concepts	Basic or applied
Information management	Acquisition, critical analysis or transmission of information
Type of skills	Transversal, scientific or specific to ecology
Professionalisation	From low to high
Analysis of dynamics	Pattern interpretation, process modelling, prediction
Degree of formalisation of problems	Qualitative, semi-quantitative or quantitative

4. *Goals*: The learning goals for the case study are explained.
5. *How to conduct the case study*: A proposal is offered for how to conduct the case studies indicating the different associated materials for examining it (these materials can be gotten by clicking on the name). In some cases, these materials are for the professors themselves, but the majority are there to help the students solve the case study.
6. *Evaluation*: Each case study proposes the evaluation system used in our classes as well as other possible systems. The goal was to offer different evaluation tools with special attention to formative evaluation, self-evaluation and peer evaluation as a sound complement to traditional evaluation systems (Brown and Glasner, 2003).
7. *Time*: This indicates the amount of time needed by both professors and students, specifying in-class work or individual independent study or group work.
8. *Notes*: This includes possible difficulties or factors to bear in mind, often based on the experience of having used the case studies in our classes.
9. *Supplementary activities*: Suggestions for supplementary activities or possible modifications in how the case study is conducted that might help to improve the learning of certain aspects dealt with in the case study.

The website is designed so that the professors can freely download each case study and apply them to the class without having to make virtually any changes. Table 2 lists the case studies, and Table 3 shows their categorisation according to Table 1.

Table 2. Titles of the 13 case studies generated

Case	Title
1	The ecological foundations of ecological agriculture
2	Atmospheric CO <sub>2</sub> , global warming and effects on the biosphere
3	Proposal for forest management
4	Effects of herbivore behaviour on plant species and communities
5	Population dynamics of the forests in Collserola
6	Proposal for a plan to biomonitor atmospheric pollution
7	Analysis of factors that influence infections on the leaves of holm oak trees
8	The plasticity of the leaves of holm oak trees
9	Hydraulic properties of the xylem of different woody Mediterranean species
10	Readings on conservation biology
11	Endocrine disruptors: «new» water pollutants
12	Proposal for post-fire forest management
13	The sludge from waste water treatment stations

Figure 1. General appearance of the <http://www.creaf.uab.es/AprenEcologia/> website showing the catalogue of titles of the different case studies on the left

**Casos d'estudi per aprendre Ecologia**

Les bases ecològiques de l'agricultura (ecològica)

**Descripció**

Aquest cas d'estudi té un caire aplicat, però també es busca que hi hagi possibilitat de formalització quantitativa dels problemes. El cas consta de tres sessions de dues hores cadascuna, i es desenvolupa a classe de teoria (60-70 alumnes). El treball es realitza en grups més reduïts, de a màxim 5 estudiants.

**Caracterització del cas**

**Tipus d'assignatura:** Troncal  
**Complexitat conceptual:** Conceptes abstractes i concrets  
**Aplicabilitat dels continguts:** Conceptes bàsics  
**Gestió de la informació:** Adquisició, anàlisi crítica, transmissió  
**Competències:** Científiques i pròpies de l'Ecologia  
**Professionalització:** Baixa  
**Anàlisi de dinàmiques:** Interpretació de patrons  
**Formalització de problemes ecològics:** Tractament quantitatiu

**Fitxa del cas**

Els fongs del fong *Uromyces* i altres sobre la *Quercus ilex*  
 Proposta de gestió d'un bosc  
 Efectes de la herbivoria sobre les espècies i les comunitats de plantes  
 Dinàmica poblacional i les poblacions de Collserola  
 Proposta d'un pla de monitorització de la contaminació atmosfèrica  
 Anàlisi dels efectes que ocasiona el pas dels riu de les restes de la contaminació  
 La plasticitat de la fulla d'alzina *Quercus ilex*  
 Propietats hidràuliques del xilem de diverses espècies i les zones mediterrànies  
 Lectures sobre Biologia de la Conservació  
 Els disruptors endocrins: una nova contaminació de l'aigua  
 Proposta de Gestió forestal post-incendi  
 Els fongs del fong *Uromyces* i altres sobre la *Quercus ilex*

Table 3. Main characteristics of the 13 case studies designed according to the classification on Table 1 (case study number according to Table 2).

Case Course	Concepts	Application	Information	Competences	Prof.	Analysis	Formalisation
1	Compulsory Abstract and concrete	Applied and some basic	Analysis	Ecology	Average	Interpretation and modelling	Quantitative
2	Compulsory Abstract	Basic and some applied	Analysis	Ecology	Low	Interpretation, modelling and prediction	Quantitative
3	Compulsory Concrete	Applied	Analysis and transmission	Ecology and transversal	High	Interpretation and prediction	Quantitative and qualitative
4	Compulsory Abstract	Basic	Analysis and transmission	Ecology scientific and transversal	Average	Interpretation	Quantitative
5	Compulsory Abstract and concrete	Basic	Analysis and transmission	Ecology scientific and transversal	Average	Interpretation	Quantitative
6	Compulsory Concrete	Applied	Analysis and transmission	Ecology and transversal	High	Interpretation	Quantitative
7	Compulsory Abstract	Basic	Analysis and transmission	Ecology and transversal	Low	Interpretation	Quantitative

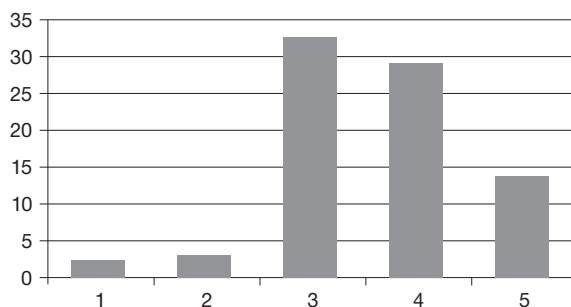
Cours	Concepts	Application	Information	Competences	Prof.	Analysis	Formalisation	
8	Compulsory	Abstract	Basic	Analysis and transmission	Ecology and transversal	Low	Interpretation	Quantitative
9	Compulsory	Abstract	Basic	Analysis and transmission	Ecology and transversal	Low	Interpretation and modelling	Quantitative
10	Elective	Concrete	Applied	Analysis	Ecology and scientific	High	Interpretation	Qualitative
11	Compulsory	Concrete	Applied	Analysis	Ecology and scientific	High	Interpretation	Qualitative
12	Compulsory	Concrete	Applied	Analysis and transmission	Ecology	High	Interpretation and prediction	Semi-quantitative and qualitative
13	Compulsory	Concrete	Applied	Analysis	Ecology and scientific	High	Interpretation	Qualitative

## 4. Results

### 4.1. of case studies in the practices on General Ecology in the Biology and Environmental Sciences programmes

Case studies 4, 5, 7, 8 and 9 (Table 2) have been used in the practical classes of the General Ecology course in both Biology and Environmental Sciences programmes. However, in this case data that the students themselves gathered in the field were used instead of the databases presented on the website. In fact, this type of field trip in groups of 20-25 students and lasting an entire week has been part of this course for many years. The students' assessment of the usefulness of these practical experiences in learning ecology is quite positive (Figure 2).

Figure 2. Number of responses from students in the fourth year of the Environmental Sciences programme according to their degree of agreement (1 - not at all to 5- totally) with the statement «The second-year ecology practices were useful for my learning of ecology».



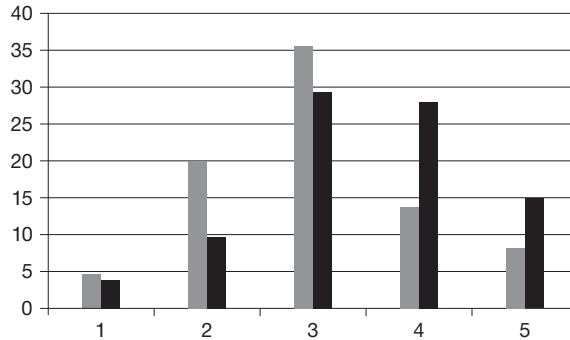
Likewise, the type of formative evaluation proposed in these case studies helps students to attain different competences related to ecology and scientific learning in general (Rodrigo and Ecology Unit, 2006).

### 4.2. Application of case studies in the theoretical classes on General Ecology in the Biology and Environmental Sciences programmes

Case studies 1 and 2 (Table 2) were used in academic year 2005-06 in the theoretical classes on General Ecology in the Environmental Sciences programme. These case studies are meant to be used in theoretical classes (60-70 students) with the primary goal of supporting the learning in the theoretical syllabus of the course. As shown in Figure 3, in this course, too, the students viewed these case studies as useful for helping them to understand the theoretical contents of the class, as well as to see the usefulness of the course and, therefore most likely to increase their motivation.



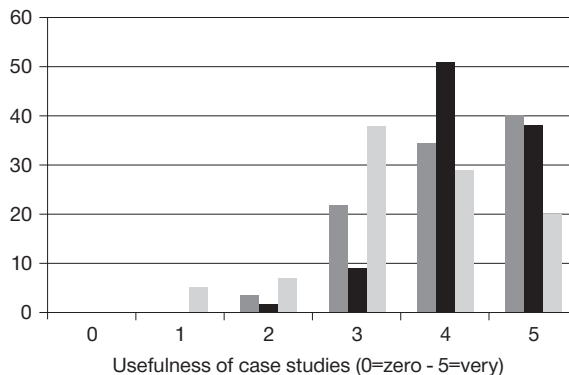
Figure 3. Number of responses from students in the second year of the Environmental Sciences programme in academic year 2005-06 according to their degree of agreement with the statement «The case studies have helped me to more clearly see the usefulness of the course» (black bars)



#### 4.3. Application of case studies in the theoretical classes on Applied Ecology in the Environmental Sciences programme

Case studies 3, 6 and 12 have been used since academic year 2005-06 in the theoretical classes of Applied Ecology in the Environmental Sciences programme. Their goal is to apply the contents and methodologies taught in a specific class, as well as to guide students in doing a project in the course that consists of resolving a similar case, but one that they have to pose and resolve independently. In order to analyse the result of this case study, we rated the students' perceptions. According to them, the three main

Figure 4. Number of responses from students in the fourth year of the Environmental Sciences programme in academic year 2007-08 according to their degree of agreement with the statement «The case studies are useful for helping me understanding the conceptual contents of the course» (grey bars); the statement «Case studies are useful for tackling the project you have to do independently» (black bars); and the statement «The case studies might be useful for my future professional activity» (soft grey bars)



goals were fulfilled: the cases were useful for helping them to understand the concepts, for knowing how to use the process in another real case, and even, though to a lesser degree, for their future professional activity, an important goal for a course in the fourth year of the degree programme that aims to be applied (Figure 4).

A comparison among the courses in terms of numerical results of the final marks is quite difficult, especially in this course. For example, we could compare the marks earned for the independent project in the course in which the case study was not done in class and in those in which it was done in class, but the problem is that the project itself was altered. However, one figure that might be illustrative is the percentage of students who did not do the project, that is, those who received an incomplete in the class. Before doing the case study in class, the proportion was 17 % and 14 % in academic years 2003-04 and 2004-05, respectively, whilst after doing the case study in class there is a now solid trend in which practically all the students do the project, with incomplete rates of 9.8 %, 5 % and 5 % in academic years 2005-06, 2006-07 and 2007-08, respectively.

## 5. Conclusions

The main conclusion is that working based on resolving the case studies proposed improved attainment of both the specific Ecology skills and the general scientific and transversal skills. We can say that the exercise of applying the different knowledge and skills involved in resolving these case studies has enhanced the consolidation of these contents by students, while it has also improved their perception of their competence in Ecology.

Specifically, in the teaching of Ecology in the Biology and Environmental Sciences programmes at the UAB, we can claim that working with the case studies included in the project:

1. Has reinforced the students' knowledge about basic aspects of the syllabus.
2. Has consolidated more general scientific skills such as: resolving scientific questions based on rigorous discussions, which are in turn based on data, logical reasoning, formulating hypotheses and analysing statistical results.
3. Has been useful for working on transversal skills related especially to writing reports and doing oral presentations, as well as the skills involved in group work and taking joint decisions.
4. Has improved students' overall attitude towards the course.

From the teaching standpoint, the case studies designed are useful for the professors because:

1. They improve the monitoring of the learning process and students' understanding of the material.
2. They make it easier to implement different types of evaluation, including self-evaluation and peer evaluation. This way of evaluating enables teachers to detect gaps in students' knowledge or misunderstood ideas in order to correct them during the learning process itself.

3. They make it easier to including small-group tutorials; in the cases when these sessions have been added, they have proven to be a powerful learning tool for students. In terms of the case studies themselves, when applying them we have detected the following two needs:
- a) There need to be more case studies that involve modelling and predicting instead of just analysing the information. These would most likely be cases designed for small groups in elective courses.
  - b) There need to be more cases based on animal populations in aquatic and marine environments.

### References

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### Interesting links

- Innovation website: <http://www.creaf.uab.es/AprenEcologia/> [under construction]

### Keywords

Case studies, ecology, formative evaluation.

### Financing

This project was conducted with AGAUR financing for projects aimed at Improving the Quality of Teaching at Catalan Universities (MQD) for 2005 (ID number 2005 MQD 00170).

### Supplementary materials on the CD-ROM

Demonstration of the website *CASE STUDIES FOR LEARNING ECOLOGY*: virtual tour of materials for "Atmospheric CO<sub>2</sub>, global warming and effects on the biosphere".

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### **Presentation of the working group**

The working group is made up of professors from the Ecology Unit at the UAB and researchers from the Centre for Ecological Research and Forestry Applications (CREAF) with experience in teaching innovation and generating multimedia teaching resources, including websites.

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