

UNIVERSITY COLLEGE CORK AS A LEARNING ORGANISATION



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CHAPTER 6

USE OF LEARNING OUTCOMES IN THE TEACHING OF ECOTOXICOLOGY: A PERSONAL REFLECTION

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Background

One of the major threats to animals, plants and humans is pollution. Pollution occurs at local, regional, national and global scales and affects organisms in a number of ways. In some cases, organisms are able to respond and adapt to a polluted environment (e.g. through natural selection) in other cases they get eliminated and become extinct. This leads to a decline in biodiversity at the relevant scale, with potential effects on ecosystem functioning. In order to understand these processes we must be able to understand the causes and consequences of pollution and examine approaches to monitoring and remediation. The study of ecotoxicology (Figure 1) goes some way towards trying to understand these processes and looks at the impact of pollution at several levels of biological organization from cell to tissue, to physiology, to organ, to individual, to community, to population.

When I was appointed to UCC in 1989, it appeared to me that a course should be developed to provide a deeper understanding of pollution and ecology, or to put it another way, a deeper understanding of Ecology and toxicology or Ecotoxicology. The process began in 1991 and continues to this today.

Ecotoxicology is taught as two modules (AE3010 and AE4010) to third and fourth year science students at UCC. It is an integrated course and the motivations for adopting the learning outcome model(s) was the same for both modules and is set out below. Before considering the details of one of the courses it is worth defining learning outcomes. I will then proceed to consider my third year module by way of illustration.

What are learning outcomes?

The idea of learning outcomes is not new and has been used in a number of courses in science, for example in Physics, (Castelli, 2003), electrical engineering, (Houghton, 2002), commerce (Medlin et al. 2003) and other areas of higher education (Lizzio et al 2002). The idea is that when designing course content, instead of grouping a series of academic topics together, we focus instead on what we want our students to know at the end of the course. The learning outcome approach is about rethinking the curriculum, the mode of instruction and assessment (Centre for Curriculum, Transfer and Technology 2003). The learning outcomes are designed to make explicit the implicit expertise of experienced practitioners. The approach is to identify the essential integrated abilities associated with a professional area and then work backwards. The learning outcomes then are matched to the type and mode of assessments to ensure that these have been achieved during the course.

Why did I adopt this approach?

My ecotoxicology course was originally designed as AE353 an Introduction to Pathology and Ecotoxicology (UCC Calendar p394-395 in 1991/1992). The format of the course was mostly lectures with some practical and fieldwork. Student feedback highlighted a number of strengths and weaknesses in the course. The use of videos, field trip and practicals was broadly welcomed, but students felt that the timing (sequential) and the duration of time available in the class was not enough. This caused frustration in that there was a gap in time between the subjects covered in lectures and insufficient time to complete the practicals. Some of the topics and issues considered were too advanced for 3rd year students (or not communicated by me in a way to help them learn). Coupled with this, I had not fully defined and communicated my expectations as to what I wanted the students to know (i.e. learning outcomes). Although I had precise ideas in my head as to what I wanted the students to know, I never told them! The result was a good course, but one that I felt could be improved. Accordingly, I undertook a complete review of the modules in 1998 and completed the new course structure about a year later. The course objectives, course materials, lectures, practicals were all evaluated and a new course developed into a new exciting opportunity for learning.

Defining learning outcomes in ecotoxicology

The learning outcomes I defined for third year ecotoxicology are directly linked to the objectives, modes of teaching and the assessment types of the module. The broad objectives of my 3rd year ecotoxicology course are

- 1 to introduce an understanding of the ecology of pollutants and their effects on organisms
- 2 to investigate the effects of pollutants at different levels of organization (i.e. from cell to ecosystem)
- 3 to consider some examples of aquatic pollution and to present some solutions

Learning outcomes for 3rd year ecotoxicology

At the end of this module, students should be able to

1. **identify** the major types of aquatic pollutants;
2. **explain** how pollutants get into and move around ecosystems;
3. **understand** the effects of pollutants at different levels of organization;
4. **design** an experiment to test the effects of aquatic pollutants;
5. **conduct** a pollution based experiment to assess toxicity;
6. **write** a scientific paper on a pollution topic;
7. **maintain** a good scientific record in a practical notebook;
8. **distinguish** between pollutants that are toxic and those that change the physical environment;
9. **list** the treatment options for organic waste;
10. **identify** the major causes and consequence of aquatic pollution in Ireland;
11. **critically** evaluate the causes and consequence of pollution;
12. **interpret** water quality standards;
13. **use** data to understand EC50 in toxicity assessment;
14. **communicate** in written form and orally;

Delivering on the learning outcomes

In order to deliver on the learning outcomes the course materials, the modes and diversity of teaching methods and assessment had to be completely reviewed in order that student learning was harmonized with learning outcomes and these are described below.

Revision of course materials

I undertook a complete review of the module(s) to ensure that all the topics I wish students to understand and learn about were contained in the curriculum and matched my expectations regarding learning outcomes. I provided a tentative lecture list, cross-referencing the lectures to the relevant chapter(s) of my recommended textbook. I clearly outlined the modes of delivery of course material, assessment and its value. All lectures were presented in Power Point Presentations and the students were given a copy of the presentations. New practicals were designed which focused on the non-formative elements of assessment and these were matched with learning outcomes. A practical schedule was also provided and each practical session was detailed in a handout. One change to the practicals was the introduction of study questions. The study questions were short questions to enable students to focus on a deeper understanding and application of the practical materials. Feedback suggested that the students found this approach very valuable. Reading lists were also provided with details of ecotoxicology related books and available scientific papers.

Teaching methods and approaches

I adapted my teaching methods to empower students and help them to achieve the module learning outcomes (e.g. increased dialogue in class to achieve learning outcome 14). Teaching methods were developed and adapted as follows:

- ◆ My lectures became interactive (I learned the student names from photos and I engaged with them fully in class). The approach I used was to enter into 'contract' with the students, whereby I agreed to provide the Power Point lectures, if they agreed to full participation in class;
- ◆ I converted all my lectures to Power Point Presentations and I used colour and good field examples to display pollution/ecotoxicological impacts;
- ◆ I used videos to demonstrate water treatment and water quality assessment;
- ◆ I developed practical classes to hone laboratory skills to advance their understanding of the scientific method;
- ◆ I required students to keep a laboratory notebook that is their record (or portfolio) of the laboratory exercises;
- ◆ I used a guide to scientific writing as a guide in the preparation and drafting of a scientific paper;
- ◆ I provided the opportunity for individual discussion with students after class;
- ◆ In all cases I linked my research to the classes through the use of data and examples from our own cutting-edge research.

Assessment: modes and diversity

Assessment (method, type and frequency) 'close the circle' on learning outcomes and student learning. Because of the diversity of modes of teaching I used, I was able to assess the modules in

a number of ways. At the beginning of the module I clearly outlined the assessment regime: the elements involved and the time deadlines. The methods of assessment were carefully matched to the learning outcomes. For example, in order to achieve competency in learning outcome (7) –to maintain a good scientific record in a practical notebook, I collected student notebooks twice during the module. After the first collection, I gave the students feedback (without grading). The second collection was used for assessment and to see whether they had achieved competency in the learning outcome. Other assessment types used were a laboratory report, practical write-up, scientific paper drafts, oral presentation and end of year summer exam

Has the learning outcome model worked?

In order for me to assess whether the learning outcome model has worked, I have adopted a model used in ecotoxicology. This model is used to analyze environmental impacts by the EPA and by the European Commission for measuring sustainability: it is called the DPSIR model (European Environment Agency 2000). An example of this Model in pollution assessment is set out in Figure 2.

It should be stated at the outset that this model has not been used in this context before, but it provided a very useful framework for me to reflect on my teaching and on the use of learning outcomes. I have used this model to help me to measure the effects, if any, of introduction of the learning outcomes approach and to provide an opportunity to assess my teaching. The idea here is that any system, which requires improvement or monitoring should measure the Drivers, Pressures, the State, Impacts and Responses or corrective actions in order to meet or reduce the drivers. The key point here is that we can measure the various compartments and conceptualize the teaching and scholarly pursuit.

‘The drivers’ for me in this context are:

- ◆ My desire for excellence in teaching and learning;
- ◆ Demand by Government and Society for quality teaching and learning;
- ◆ My wish to advance in scholarship;
- ◆ To meet the demand by students for excellence in teaching and learning;;
- ◆ To help students to learn not just take notes but to engage in the full scholarship of learning;

The pressures for me in this context are:

This process forced me to think more broadly about what I wanted to achieve, as a teacher, how I would do it and how I might engage students in the scholarship of teaching and learning.

‘The state’ of my modules

My teaching schedules, lectures and materials for classes were better than before the introduction of learning outcomes. I discovered I was more focused and better prepared for classes and willing to explore scholarship of learning more fully in class.

The impacts

The positive impacts of introducing learning outcomes have been dramatic for myself and my students. The learning outcome approach has helped me to be more considered in my curriculum

development, more explicit about my expectations regarding what I want the students to know and how I intend to assess them (by linking the assessments to the learning outcomes). The students have responded well and attained competency in the expected outcomes.

The responses

The responses are a measure of the corrective steps taken to reduce the drivers. The responses (in this case the introduction of the learning outcomes), which have impacted most notably on the students, are a reduction in formative assessment, an increase in feedback on learning, the development of identifiable skills and expertise. The responses for me have been the introduction of the learning outcomes and the development of a framework for me to reflect more fully on my teaching.

Conclusion

In conclusion, I feel that the introduction of the learning outcome approach has increased my effectiveness in delivering on my teaching objectives. It has also helped me to focus on the key skills that I want my students to acquire. When I first started to engage with practitioners about the learning outcome approach, I was concerned that defining learning outcomes was too limiting and may inhibit students from excelling. I was mistaken. In fact, I have discovered that the development of learning outcomes has not only helped me to be more explicit about my expectations of students, but also has enabled my students to understand and learn more deeply, than they might otherwise do. It also provides an opportunity for innovation, creativity in teaching and learning. In the same way, the DPSIR framework has enabled me to monitor my teaching and learning in a way that will permit me to review my learning outcomes in my objective to achieve excellence in teaching and learning.

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Figure 1 The ecotoxicology triangle provides a useful framework to link different elements of study in environmental science

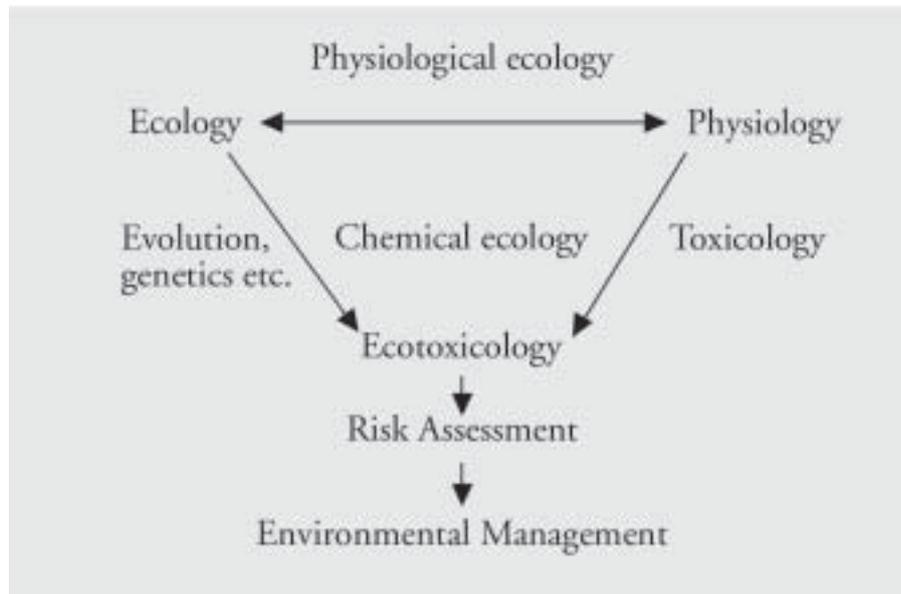


Figure 2 An example of the DPSIR Framework for the impact of aquatic pollution: eutrophication. {The idea is that the pollution is driven by something, creates pressure, effects the state of the environment has an impact and requires some response or remediation}

