Virtual learning environments for constructivist teaching in Biosciences to promote sustainable development in higher education

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Biodiversity education for sustainable development is crucial for the challenges of the 21st century and provides us with an excellent context for interdisciplinary study or issues based teaching. A pedagogical consideration of such courses is just as critical as the content i.e. the biodiversity ideas being communicated. Experiential learning and constructivist approaches to teaching and learning are important strategies to help students make value judgements and to reflect on their own behaviour. At the core of constructivism is a "view of human knowledge as a process of personal cognitive construction, or invention, undertaken by the individual who is trying, for whatever purpose, to make sense of her social or natural environment" (Taylor 1993). Thus when teaching students about the natural environment with a view to promoting sustainable practices, constructivist teaching makes good sense. The learning process is based in the personal experiences of the students and the acquisition of knowledge is the product of activities that take place in particular cultural contexts. Knowledge is constructed by the learners in the sense that they relate new elements of knowledge to already existing cognitive structures (Bruner 1993). Thus this approach to teaching can help overcome some of the challenges of teaching in higher education today, notably students with a wide variety of experiences, prior knowledge and goals. If we compare the traditional science curriculum with that of constructivist approaches the benefits are further outlined.

Traditional Science Curriculum	**Constructivist Science Curriculum**
scientific knowledge	knowledge about science
what we know	how and why we know
emphasise fully developed final form explanations	emphasise knowledge, growth and explanation development
breadth of knowledge	depth of knowledge
basic scientific knowledge	conceptualised science knowledge
curriculum units discrete	**curriculum connected**

Table 1. Comparison of traditional and constructivist curriculum (after Duschl and Gitomer 1991)

The justification and need for education on biodiversity in higher education comes from the Rio Earth Summit and the United Nations Environment Programme (UNEP) specifically The Convention on Biological Diversity. Specifically it states:

Na.92-7807 (5 JUNE 1992) Article 13. Public Education and Awareness The Contracting Parties (who include the UK and Poland) shall:

- Promote and encourage understanding of the importance of, and the measures required for, the conservation of biological diversity, as well as its propagation through media, and the inclusion of these topics in educational programmes; and
- Cooperate, as appropriate, with other States and international organizations in developing educational and public awareness programmes, with respect to conservation and sustainable use of biological diversity.

Whilst biodiversity education and sustainable development can be taught through specific higher education courses they can also be addressed by demonstrating good practice particularly through the pedagogy. For example, teaching materials for sustainable development need to be **produced** sustainably too. Guidelines set down by the UK government panel on sustainable development (DETR 1999) include the following ten principles:

- Principles of sustainable development;
- Integrity;
- Balance;
- Values and Attitudes;
- Knowledge and Skills;
- User-centred approach;
- Need;
- Development;
- Production; and
- Promotion and Distribution.

So how can we teach increasingly large numbers of students through a staged constructivist approach in a way, which sets good examples of sustainable development by promoting good practice?

In an undergraduate course that I teach I have tried to address all these issues. The course is a second year Ecology and Conservation option course within the Science faculty and students taking it are from a variety of departments, e.g. Mathematics, Computer Science, Biology, Chemistry, Physics, Statistics, Engineering. The challenges of teaching this option course are:

- diversity of prior experience and knowledge in the students;
- timetable issues;
- physical location within the university, i.e. distance from home department;
- physical room layout - large lecture theatre;
- large numbers of students (50-80); and

- resource availability for large numbers of students in a discipline which is rapidly changing and needs updating every year.

The students in the course are from a wide range of disciplines and thus have widely varying levels of scientific knowledge, IT skills and expertise yet the course objectives are to enhance all participants' understanding of the biodiversity and sustainable development. In traditional lecture courses the communication is presentational, the outcomes predetermined and the learner passive and over a number of years I became aware that the objectives were not always being achieved for all students. Nor was it very sustainable with: many students having to travel long distances at peak travel times; vast amounts of printed handouts; and many students using cars as they had little time to get to the next lecture.

I thus decided to implement the use of a 'Virtual Learning Environment' and I replaced some of the traditional lectures with online conferences. This helped students to become 'active' learners (where learners have considerable autonomy and the mode of communication is a multi-faceted dialogue). The other benefits of the text-based computer conference are of the 'added value nature', for example:

1. It has 'real world' currency as a tool in use in commerce, industry and the professions.
2. An increasing number of documented case studies of its use in professional development is available (Birchall and Smith 1996; Salmon 2000).
3. It is an example of sustainable practice - it cuts down on traffic at peak times, it reduces the number of car movements during the day and handouts are printed only when needed by the student, all the lecture notes being available online.

The way in which students engage in the virtual learning environment (VLE) certainly has parallels with constructivist teaching approaches through a staged approach. The idea of a staged approach was formalised by Salmon following research and evaluation based on the Open University Business School's distance education programmes (Salmon 1998, 2000). Salmon has set out a five stage developmental model:

Stage one: access and motivation;
Stage two: online socialization;
Stage three: information exchange;
Stage four: knowledge construction; and
Stage five: development.

This very much parallels the process of constructivism as outlined earlier where students are motivated to contribute online, they are able to socialise, present their own ideas, read that of other students, staff and designated web sites. These steps allow them to develop their own understanding of the issues in question. There is no doubt that large lecture theatres are an impediment to constructivist teaching. The links between constructivist teaching and educational technology are documented with a consensus that individuals engaged in learning should have the opportunity to inquire and to develop understanding from their own and other perspectives when constructing knowledge and that educational technology can facilitate this (Adams 1989; Adams and Hamm 1988; Duffy and Jonassen 1992).

In my ecology and conservation course I used online conferencing to:

- reflect on lecture sessions by posing questions immediately after a lecture;
- substitute lectures with online lectures and web-based tasks; and
- support students, leading up to the examinations, with responses to individual queries for all to see etc.

Computer conferencing does not always engage the totality of any particular group but this is true also of traditional lectures and seminars. My analysis of student engagement with the VLE is that about one third of the students participate fully with participation as contributors or as spectators or listening in; about one third will engage to a degree, but usually as part-time spectators; and finally one third will have negligible involvement possibly never even logging on and using the VLE. Although this is rather disappointing when you put so much time and effort into planning the conferences it is probably no worse than engagement in seminars or even lectures. To encourage participation in computer conferences, online activity needs to be purposeful, authentic and embedded in the programme. Achieving this mix is not straightforward, as many commentators make clear (Birchall and Smith 1996; Salmon 2000; McConnell 2000; Stratfold 2000).

An important area where the conferencing needs to be embedded is assessment. Students who are ready and willing to participate in the VLE deserve, and may need, recognition; those who are less forthcoming may be influenced by a direct connection with assessment arrangements. Students are very much influenced by the tangible outcomes of courses and how it contributes to their final degree and often are not able to see the intangible benefits particularly an improved understanding or longer term benefits. The assessment in this case is purely by examination thus the immediate rewards to the student are not clear. Over a six-year period of using VLEs in this course, I have recorded performance in examinations and although the mean mark is only marginally better, performance has been enhanced by a wider range of examples being used in answers. The longer term benefits in terms of student attitudes to biodiversity and sustainable development I suspect will be much higher although this has not as yet been analysed. Course evaluations have been much more positive with students welcoming the availability of lecture notes, and more flexibility in terms of when they can do their learning. Students indicated that they do not like 9am lectures and preferred an online task to these early starts. However most students indicated that they would not like to see the entire course delivered through the VLE. They do like face-to-face contact with a tutor and their peers, and enjoy the performance of a lecture. Very few recognised the tremendous additional environmental benefits that using VLEs offer.

The only problems I came across were in the early days of using VLEs (i.e. six years ago in 1997) when some students did not have sufficient IT skills to get the most out of the facility. This has steadily improved over the years and in 2002 all students are completely comfortable with the IT demands of the VLE. Indeed many students find this a motivating factor. The main problem now is the infrastructure within the university and the provision and access to computers.

In conclusion the use of VLEs particularly through a text-based computer conference and online resources can significantly improve the quality of teaching on interdisciplinary bioscience courses **and** promote sustainable development through examples of good practice.

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