Changing environmental sciences education needs: how can we meet them?
Experiments with constructivist learning within environmental sciences curricula

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Introduction

An analysis of education in general and environmental science education in particular, reveals a number of trends. First of all a tendency exists to pay more attention to competence learning. Thus teaching is more focused on the enhancement of the ability of students to integrate knowledge, attitudes and skills in a right way at the right moment. Secondly, the importance of dual mode education, i.e. the combination of working and learning, is growing. Thirdly, it is generally accepted that learning doesn't stop when a university degree is obtained, life-long learning is becoming more and more crucial in anyone’s career. Fourthly, ongoing developments in information and communication technology give new opportunities to design student centred open learning environments. For environmental science education in particular international aspects (transnational/global problems, legislation, internationally operating companies) are (becoming) core issues. An international orientation will be important for future environmental scientists. Finally, the importance of an interdisciplinary approach of environmental issues is currently undergoing a revival.

This paper describes a potential way to anticipate these trends. Special attention is given to experiments with competence based, interdisciplinary, collaborative learning. An example of this is the project "Virtual Environmental Consultancy Agency" (VECA) which was carried out in 2000 by the Open University of the Netherlands in co-operation with the Maastricht University.

Analysing the curriculum

At the Open University of the Netherlands students can enrol for a 4-year academic study in environmental sciences. This curriculum is completely geared to distance learning. Face-to-face contacts between students and tutors have been minimised. By sending the students self-study materials and by supporting them through an electronic learning environment ('Studienet') the students are capable to study in their own place, time and pace.

When we analysed how our environmental sciences curriculum fared with respect to the trends in education described above, we detected a shortage of:
- relevant practical skills
- experiences with teamwork
- individualised learning paths
- active learner participation
- interaction between theory and practice

Others, both in the Netherlands and abroad have made similar observations when evaluating their curricula in environmental sciences. In their assessment report on environmental higher
education in Europe Jamison and Maarleveld (2001) state that 'while labour market ....... is increasingly interested in graduates with skills in communication and project organisation, it has been difficult to bring new methods and approaches into the curriculum'. A survey on environmental educational programmes in Belgium (Sys, 1999) showed that in these programmes 1) skill objectives are not emphasised sufficiently, 2) new teaching methods and active learning processes are mostly absent, and 3) co-operation between the higher education field and the environmental professionals is hardly established. Giacometti (1999) identified that in Italian environmental programmes theory generally prevails too much at the expense of practical training. In Ireland there seems to be a lack of emphasis on communication and teamwork skills in many environmental sciences programmes (Curtin, 1999). According to Bahadir (1999) employers in Germany ask for more practical competence of the environmental graduates which could be met by implementation of practical semesters with the industry into the curricula.

Bearing these observations in mind we decided to develop a module within our environmental curriculum that would address the demands for specific competencies from the professional field. An important limiting condition was that the module should be applicable in the context of distance learning. This led us to define a project called 'Virtual Environmental Consultancy Agency' (VECA) which was based on earlier experiences within the Open University of the Netherlands with the concept of a 'virtual company' (Westera & Sloep, 1998. Westera et al., 2000).

Characteristics of a Virtual Environmental Consultancy Agency

In the project Virtual Environmental Consultancy Agency we attempt to fully integrate learning and working in a distance education environment. This is unlike case-based and problem-based approaches, where the 'working' aspect generally is lacking. In the VECA we try to generate a networked learning environment that resembles an authentic professional situation. Students working in the VECA address real orders on behalf of real external customers, and deliver real products. Therefore the VECA is not an extended role-playing game, which usually represent self-contained business simulations.

The VECA is not restricted to a fixed location on the premises of the educational institute, but is located in cyberspace, i.e. mediated via a computer network. It thus combines the flexibility that is so characteristic of distance learning -- students are at liberty to choose time, pace and place -- with the desired integration of learning and working. The VECA thus narrows the gap between theory and practice. Another rather unique feature is that the VECA is able to address individual needs, because it works with individualised learning contracts. Along the same lines, it fosters a relationship between tutors and students that differs significantly from the patterns common in education: not the educators are in control of the VECA, the students run the business. In the VECA students are stimulated to rely on themselves, to act autonomously and responsibly in their confrontation with the complexities of the real world. The educators mainly monitor and watch over the efficacy and quality of learning. Finally, like case-based and problem-based approaches the VECA supports active learner participation, takes on problem solving in complex environments, and promotes teamwork. The VECA has these features because it harbours a number of characteristic components and processes. Some of them are characteristic of the VECA qua learning environment, others qua business.

Within the VECA, all processes are dominated by the concept of competence learning: learn how to complete tasks by integrating complexes of knowledge, skills and attitudes.
So before any VECA can take off an exhaustive inventory has to be made of the competencies required. The resulting competence map is pivotal because it acts as a frame of reference for all processes involved: it limits the range of products and services rendered and defines what can be learned by the students.

Processes and components in the VECA

In running a VECA one can distinguish three main phases: the preparatory phase; the actual working period and finally the final assessment.

Preparation

During the preparation phase (figure 1) first potential orders are acquired from external clients. The clients are invited to put together various questions and problems on which they want to be advised. These orders are mapped into the competence map, first of all to decide whether they will be accepted or not. Only orders that for their completion require competencies present in the competence map, are admitted.

Furthermore, students have to be recruited. Competence counsellors, who are members of the educational staff, diagnose new students. In this intake procedure students reveal their learning needs, the competency counsellors map these into the competence map so as to arrive at student specific competence gaps. Collectively, the competence gaps constitute the student's career plan in the company. The career plan is subsequently used as the starting point for assigning sensible tasks to the students.

Tasks are derived from the orders obtained. Once accepted, an order is decomposed into a number of distinct tasks that can be distributed over individual students. As any order consists of numerous tasks; students work in project teams, headed by a project manager (also a student) who is responsible for the delivery of an advice that is both on time and up to the marks. Note that this task assignment strategy primarily aims to fill the competence gaps of workers. It thus is quite hazardous in terms of overall business success. While it prevents the employees from performing routine jobs, it principally advocates the idea of incompetence at work. This is the price to be paid if learning comes first and running a business only second. So from an educational point of view this is quite a healthy situation.

Before starting the real work students are recommended to carry out some settling-in tasks mainly with the aim to get familiar to the ICT-tools and the company's virtual environment.
The real work
The work starts with a plenary face-to-face introductory meeting. Thereafter project teams start carrying out their work. An extensive system is established that monitors and assesses students' (in)competencies (figure 2). It includes traditional teacher controlled evaluation (co-assessment) procedures as well as methods for self- and peer-assessment by the students themselves (Sluijsmans et al., 1998). The latter are used to assess the individual's informal knowledge and functioning.

The working period is concluded with a final face-to-face meeting where results are presented to the external clients and all members (students and teachers) of the VECA.

Final assessment
All documents produced in the course of a student's career - i.e. results of assessments along with reports and papers produced on behalf of customers, etc. - are collected in a personal portfolio that forms the basis of establishing and formalising performance levels. By asking the customers to assess the final report's merit in relation to the order originally submitted by them, an external assessment of the student's work is made. This too is incorporated in the portfolio. Collectively these assessments also reflect on the effectiveness and the quality of the teaching of the entire learning environment. Based on the portfolio the examiner establishes a final mark for each individual student (figure 3).

Figure 2: Main processes and components of phase II: work in VECA

Figure 3: Main processes and components in phase III: final assessment
The experiment in 2000

In the period October to December 2000 we carried out an experiment with the VECA. For this experiment about 30 orders where obtained from external clients. Typical examples of orders where:
- Risk assessment of soil pollution (client: TNO Environment, Energy and Process Innovation, TNO-MEP; knowledge-institute)
- Development of soil sanitation standards for phenols in Flemish Belgium (client: Flemish institute for technological research, VITO; knowledge-institute)
- Health risks of enlargement of Eindhoven Airport (client: Medical Service community of Eindhoven; governmental organisation).

In total 18 students participated in the experiment. Twelve students were from the Open University of the Netherlands: the Environmental Science Program (9 students), the Food and Toxicology Program (2 students) and the Social Science Program (1 student). Six students were from the University of Maastricht: Environmental Health Program. Nine students worked full-time in the VECA, while the other nine students worked half time. Total study load was about 240 hours for the full-timers and about 120 hours for the half-timers.

Preliminary evaluation of the experiment reveals the following major points:
- the final judgement of all (!) students was positive
- the participants came up with a lot of recommendations for future improvements
- due to the short working period it appeared to be difficult both to deliver a high-quality report to the external clients and to enhance one's individual competencies
- the portfolio concept requires more guidance for the student-employees
- it was still difficult for student-employees to obtain an active learning attitude; they still tended to 'wait and see'
- the demarcation of roles within VECA, e.g. between general management (educational staff) and project leaders (student-employees), was not always clear.

Future developments

In the short-term we intend to carry out a follow-up of the experiment in 2000 (probably in the period September - December 2001). In this follow-up the working period of the student-employees will be somewhat longer: 18 weeks (study load 9 weeks). We plan to implement several recommendations from the experiment in 2000, with special attention to improvements concerning the portfolio concept, the demarcation of roles and the self-responsibility of the students (active learning attitude). Besides the University of Maastricht we look for further co-operation with other universities for implementing this model in curricula.
In the longer-term we intend to position the VECA as the final part of our Bachelors program in Environmental Sciences. By then the VECA should correspond to a total study load of about 21 weeks.
In further runs we will explore the possibilities to make the work in the VECA more multidisciplinary.
Because the major part of this educational model is situated within an electronic learning environment it could offer an interesting platform for international co-operation of students in Environmental Sciences. In the year 2000 run of the VECA we already had external clients and student employees both from Belgium and the Netherlands.
Conclusion

As argued before, the key achievement of the VECA is that working and learning are seamlessly integrated into one activity that at the same time addresses the traditional want for knowledge collection and the recently identified need to acquire competencies. The VECA does this by offering a mixture of collaborative learning, competence based learning, learning by doing, all in an open and authentic learning environment. Although no VECA is necessarily restricted to this mode of delivery, the VECA of the OUNL operated entirely within the distance learning paradigm, offering student maximal freedom of place, time and pace. Even though evaluations revealed that fine-tuning of the concept is needed, the overall conclusion was that students judged the VECA to be a stimulating, productive learning environment. On the basis of these experiences, particularly with distance learning, we feel confident that the concept of a VECA offers ample opportunities to design new transnational environmental education programmes that address various problems that current environmental science programmes in Europe experience.

In this paper we focussed on the model of a Virtual Environmental Consultancy Agency. There exist several other models/concepts that offer good opportunities to address specific educational needs in Environmental Sciences. For example to give students a more international orientation one can organise a virtual seminar. Such a seminar has been run already for some years by several universities worldwide in the project "Global Seminar on the Environment and Sustainable Food Systems"(www.cals.cornell.edu/global).

To address the need for interdisciplinary approaches of environmental issues several Dutch educational institutes work together in experiments on 'Interdisciplinary study modules on sustainability". In these modules students from different disciplines and different educational institutes work in project groups on sustainability matters. Because students are present on different locations spread over the Netherlands, the collaboration in these projects is facilitated by groupware.

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References

Bahadir, M. 1999. Higher education environmental programs and the environmental labour market in Germany. Institut für oekologische chemie und abfallanalytik; Institute of ecological chemistry and waste analysis, Braunschweig, Germany.


Giacometti, A. 1999. Excellence in Environmental Science Education; A survey on the influence of internal and external factors on high education environmental programmes. The labour market
for professionals in the EU countries: opportunities and time trends in Italy. University of Venice, Italy.


Sys, M. 1999, Higher environmental education and the (environmental) labour market in Belgium, Institute for environmental sciences, University of Antwerp, Belgium.
