

Pedagogical Manuscript for Landscape Ecology Course

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Development Project Report

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Abstract <p>The objective of this work was to construct a problem based, CMC landscape ecology course for higher education. This is an advanced course for ecology, environmental and forest science students. The purpose of this course is to provide students with an introduction to the discipline of landscape ecology that could be defined best by its focus on the interplay between spatial pattern and process - specifically, how to characterize spatial pattern, where it comes from, why it matters, and how it changes through time. The course is a student-centred instructional strategy in which students collaboratively solve problems and reflect on their experiences. In the PBL environment, students are responsible for solving a particular problem. In the beginning of each phase a discipline map is developed in order to outline principles and concepts students are expected to learn. The PBL process is such that students must identify, acquire, and synthesize relevant data, and then test hypotheses with the collection of new data in a cycle of analysis-research-report. In the science curriculum the pedagogical perspective has been and still is that the students require a sound body of knowledge and sufficient detailed skills before they are knowledgeable enough to engage with problem-based learning.</p>		
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1 Background of the project

The nature of the different fields of biological sciences demands plenty of mechanical learning i.e. memorisation. This forms a basis for learning complex concepts and phenomenon. (Eloranta & Jeronen 2000). In the teaching of the main learning approaches represent behaviouristic and cognitive theories. During the first few years of higher education the behaviouristic approach is dominating and as the studies proceed the focus devolves more to cognitive approach. At the higher level, where it is possible to arrange study trips, field and laboratory courses etc. also the contextual approach increases in importance. For several years, it has been recognised that science education should be more than just teaching about the ‘things’ that scientists know and have found out. It should enable pupils to ‘think like scientists’ and understand the ‘nature of science’ (Roberts 2001). A well-known alternative for the traditional disciplinary based education is a Problem-Based Learning (PBL) that is a total approach of education and involves a constructivist method to learning (Harper-Marinick, 2001). The emphasis of PBL is that students learn through the process of solving so called ‘real-world’ problems. The features of PBL regarded as essential for enhancing student learning are learning in context, elaboration of knowledge through social interaction, emphasis on meta-cognitive reasoning and self-directed learning (Boud & Grahame 1991). Using PBL, students acquire life-long learning skills which include the ability to find and make use of the appropriate learning resources. PBL is also a curriculum development and instructional system that simultaneously develops both problem solving strategies and learning by placing students in the active role of problem solvers confronted with practical problems in the workplace (Poon, Tang & Reed 1997).

The development of landscape ecology and its many applications in land use management has created a need for courses that address both the conceptual and practical sides of the discipline. Because landscape ecology involves the study of spatially explicit ecological patterns and processes along with much larger regions than ecologists have typically studied, landscape ecologists often employ a variety of new quantitative analysis techniques in their work. In addition to metrics used to quantify spatial pattern, modelling also plays an important role in landscape ecology,

because it is logistically and economically impossible to conduct truly replicated experiments across entire landscapes (Pearson, Turner & Urban 1999).

2 Introduction and objectives

The objective of this work was to construct a problem based CMC landscape ecology course for higher education. The course of *Landscape ecology* is an advanced course for ecology, environmental science and forestry students. The purpose of this course is to provide students with an introduction to the discipline of landscape ecology that could be defined best by its focus on the interplay between spatial pattern and process - specifically, how to characterize spatial pattern, where it comes from, why it matters, and how it changes through time. The course is a student-centered instructional strategy in which students collaboratively solve problems and reflect on their experiences.

- Learning is driven by challenging, open-ended problems.
- Students work in small collaborative groups.
- Teachers take on the role as "facilitators" of learning.

2.1 Pedagogical background

2.1.1 Constructivism

According to constructivism, knowledge does not exist external to the learner. Rather, individual learners construct their own meanings based on their prior experiences.

Learning is a result of construction, collaboration, reflection, and negotiation within a rich context in which learning is situated (Brown, Collins & Duguid, 1989). Jonassen, Davidson, Collins, Campbell & Haag (1995) argued that the four major features on which the designs of constructivist learning environments are based are context,

construction of knowledge, collaboration, and conversation. Driscoll (1994) states that new conflicting experiences will cause “perturbations in these structures”, where new knowledge structures arise making sense of the new information. Several different constructivist-learning theories exist. Common to each theory is that (a) learning is an active rather than passive process, and (b) we construct knowledge based on what we know (Kanuka & Anderson 1998). The constructivist environment is student centred, and encourages students to ask questions and make their own analogies and drawing their own conclusions. Knowledge building results when learners interact with their peers, collaborate, discuss their positions, form arguments, re-evaluate their initial positions, and negotiate meaning. The teacher has become more of a coach on the side rather than the main source for delivering information. Constructivism is not a theory about teaching; it is an epistemological position.

2.1.2 Problem-based learning

The process of PBL that requires the individual to seek information and knowledge to construct new understanding, meanings and concepts and the collaboration between peers towards the solution of authentic and real-world problems can be readily supported by current communication media based on the computer (McAlpine & Clements 2001). “PBL involves the use of complex, ‘real-world’ problems as the stimulus and framework for learning. It is based on the premise that students will be motivated to ‘want to know’ and solve the problem posed. As students engage in solving the problem, they develop critical thinking and problem solving skills while learning content and skills essential to the course.” (Harper-Marinick 2001).

Accordingly, students are encouraged to take responsibility for their group and organize and direct the learning process with support from a tutor or instructor (Hmelo-Silver & Barrows 2006). Advocates of PBL claim it can be used to enhance content knowledge and foster the development of communication, problem-solving, and self-directed learning skill. During the PBL process learners should discuss problems, define what they know, generate hypotheses, derive learning goals and organize further work. (http://en.wikipedia.org/wiki/Problem-based_learning).

The acquisition and structuring of knowledge in PBL is thought to work through the following cognitive effects:

- initial analysis of the problem and activation of prior knowledge through small-group discussion
- elaboration on prior knowledge and active processing of new information
- restructuring of knowledge, construction of a semantic network
- social knowledge construction
- learning in context
- stimulation of curiosity related to presentation of a relevant problem

Problem-based learning has long been proposed as a powerful and flexible form of learning for university settings. It offers the flexibility to cater for a variety of learning styles and the means to create meaningful and authentic settings in which to situate learning. It provides the opportunity to create engaging and stimulating student-centred learning activities. With appropriate design and implementation, problem-based learning can be seen as a very useful way to promote the development of key skills through its ability to encourage, enable and support tasks and behaviours of managerial skills (Bennett, Dunne & Carre 1999). The activities encourage the learners to interact with the course content, to read and explore beyond the immediate setting and to reflect on what is being read. Problem-based learning can offer students opportunities to learn how to learn, and to develop key skills, independence in enquiry and the ability to contest and debate. Barrows and Tamblyn (1980) claim that problem based learning is based on two assumptions. The first is that learning through problem situations is much more effective than memory-based learning for creating a usable body of knowledge. Through such an exploration students are expected to examine the gaps in their own knowledge and skills in order to decide what information they needed to acquire in order to resolve or manage the situation with which they were presented. "Learning should be seen as a cyclical process in which students make *transitions* through which they develop increasing (and also sometimes decreasing) understandings of themselves, their context, and the ways and situations in which they learn effectively" (Savin-Baden 2000). A number of articles at that time cited lists of advantages of problem-based learning over more traditional ways of learning (Neame

1982, Coles 1985) and others suggested that problem-based learning was found to be more enjoyable and stimulating by staff and students involved in such programmes.

2.1.3 Pedagogy of the web-based course

Web-based learning, allows participants to disintegrate time and space. Facilitators and students do course work on their own time and at their own place, thus freeing themselves of schedules imposed by others. For some, web-based pedagogy is also seen as a more egalitarian form of instruction insofar as it allows greater accessibility between the facilitator and the student and among students. There are some voices raising questions about the universality of web-based pedagogy. On the more cautious side, web-based learning is, for example, very time consuming. It takes tremendous time resources to build and sustain a web course. This is equally true for both facilitator and student. (Cole 2001). One of the biggest advantages of online courses is the fact that they allow for interaction in both synchronous and asynchronous ways. Because of its synchronous and asynchronous nature, computer-mediated communication (CMC) allows for self-paced learning and reflection. The real strength of CMC lies on the premises of constructivist theory. In a more decentralized environment such as facilitated with CMC, students take control of the learning environment, pose questions, moderate discussions, and summarize results.

The web-based learning environment requires a constructivist learning setting for a healthy learning environment to exist. Traditionally distance education courses of the 'industrial era' were based on an objectivist learning setting. In this setting teacher delivered content through satellite technologies to the passive student. Few opportunities for student-initiated questions, independent thought, or interaction between students occur in this environment. Still today this method of delivery is used and unfortunately has been transferred to some web-based courses. However, there is a shift away from this environment to a learner-centred collaborative environment utilizing constructivist learning theory.

2.1.4 Problem based learning and CMC

The emergence of Information and Communication Technology has led to a tremendous interest to incorporate the constructivist PBL approach into the Web-based environment (Oliver, Omari & Stoney 1999, Varanelli, Baugher & Hall 2001). Related to web-based learning are two widely accepted epistemological positions: cognitive or critical constructivism and social constructivism. Cognitive constructivism assumes that knowledge is constructed through internal contradictions resulting from environmental interactions (Driscoll 1994). Piaget's development theory describes the cognitive development of humans, and explains it as the construction of knowledge through experience. These experiences create schemas, or mental models. These schemas are altered, enlarged, and made more sophisticated through two processes: assimilation and accommodation. Assimilation refers to the way humans transform new information so that it makes sense within their existing knowledge structure. Accommodation refers to the change in cognitive structure in the attempt to understand new information. (Kearsley 2000). The use of electronic networks and the Internet in education shape in new ways how we interact, share information, and communicate with each other (Vrasidas & McIsaac 1999). Apart from the role of CMC in supporting the process of conventional face-to-face PBL, the web-based PBL involves a creation of instructional materials that facilitate problem presentation; the required self-investigations and analysis can be conducted through the online resources and the social interaction for peer-peer collaboration and student-teacher facilitation can likewise be easily performed through asynchronous forum boards or synchronous chats.

3 Practical implementation of the project

3.1 Course format and structure of the course

In the PBL environment, students are responsible for solving a particular problem. The problem is presented before any relevant information is delivered on lectures. In the beginning of each phase a discipline map is developed in order to outline

principles and concepts students are expected to learn. The PBL process is such that students must identify, acquire, and synthesize relevant data, and then test hypotheses with the collection of new data in a cycle of analysis-research-report. Traditionally, students work in small, self-directed groups. It has been noted that problems that are complex, open-ended, and do not have one correct solution are the problems that have been shown to engage students most successfully in the learning process. However, the landscape ecology problems usually have one solution.

The used learning environment is web-based. This provides a channel for students to collaborate on set problems, to share resources, to post solutions and to compare and review answers from other groups.

- ④ Each week a problem is presented to students, the purpose of which is to contextualise and authenticate the weekly content of the course.
- ④ Students are required to work within groups of 3 or 4 to explore the topic, locate relevant information and resources, consider the various options and outcomes and to create a response which is informed and well argued.
- ④ The group post this solution to the system bulletin board, an action which then reveals to them the solutions of the other groups in their cohort. Each group is asked to review the solutions of the others and through their feedback, the solutions are given a peer-assessed grade. Each tutor also reads the solutions and gives a mark which is added to the peer-assessed grade to give an overall mark for the solution.
- ④ Students are able to view the marks achieved each week in a number of ways and this mark accumulates throughout the semester as each new problem is solved. (Oliver & McLoughlin)

The course is divided into lectures, face-to-face sessions, independent web-based learning and computer sessions to begin some of the tasks. The course will last for five weeks and there will be 4 45 minute lectures covering the material in the assigned readings, including a review and discussion of the most relevant material. The purpose of the GIS-lab section is to provide students with hands-on experience analyzing real data sets using state-of-the-art landscape analysis software.

Rough structure of the course

- ⊙ **Landscape ecological theories**
 - **LE theories in general**
 - **Detecting and characterising landscape pattern**
 - Finding the characteristic scale of spatial pattern
 - Defining the elements of pattern:
 - Connectedness
 - Fractal geometry
 - Percolating networks
 - **Landscape dynamics**
 - Physical template of environmental constraints
 - Biotic processes
 - Disturbance regimes
- ⊙ **Methods**
 - Techniques detecting and analysing landscape change
 - Remote sensing and image interpretation
 - Quantifying landscape pattern
 - Spatial statistics
 - Spatially explicit models
- ⊙ **Spatial models**
- ⊙ **Landscape management studies on the long-term change**
 - **Management of complex landscape**

Prerequisites for the course

- Statistics in advanced level
- Geographic information systems

The structure of the course in more detail

STRUCTURE OF COURSE		Type
Pre-course work	Pre-course task	Web-based
1. Meeting	<ul style="list-style-type: none"> • Introduction to the course • Review of the pre-course work and discussion 45 min. • Lectures 4 x 45 min covering the topics of: <ul style="list-style-type: none"> ○ LE theories in general ○ Detecting and characterising landscape pattern • Giving 1st assignments 	Face-to-face

1. distant learning period	1 st assignments Discussion in web-discussion forum	Web-based
2. Meeting	<ul style="list-style-type: none"> • Review of the 1st assignment and discussion 45 min. • Lectures 4 x 45 min covering the topics of: <ul style="list-style-type: none"> ○ LE dynamics • Giving 2nd assignments 	Face-to-face
2. distant learning period	2 nd assignments Discussion in web-discussion forum	Web-based
3. Meeting	<ul style="list-style-type: none"> • Review of the 2nd assignment and discussion 45 min. • Lectures 4 x 45 min covering the topics of: <ul style="list-style-type: none"> ○ Methods 	Face-to-face
3. distant learning period	Giving 3 rd assignments 3 rd assignments Discussion in web-discussion forum	Web-based
4. Meeting	<ul style="list-style-type: none"> • Review of the 3rd assignment and discussion 45 min. • Lectures 4 x 45 min covering the topics of: <ul style="list-style-type: none"> ○ Quantifying landscape pattern • GIS-lab-work 4 hours • Giving 4th assignments 	Face-to-face and GIS-lab-work
4. distant learning period	4 th assignments Discussion in web-discussion forum	Web-based
5. Meeting	<ul style="list-style-type: none"> • Review of the 4th assignment and discussion 45 min. • Lectures 4 x 45 min covering the topics of: <ul style="list-style-type: none"> ○ Landscape management • Giving 5th assignment, final report 	
Final report		Web-based, Seminar

3.2 Assignments

Learner activities

The problem-based learning involves a number of activities and tasks that appear to provide strong support for the development of a number of key skills. The activities, in general level which the students are required to undertake each week include:

Information Seeking. The tasks require students to seek information from appropriate sources to create an answer that reflects current thinking and knowledge. The students are able to use the WWW, especially google scholar webb-sites as an information source but have to isolate from among the numerous of resources available, those that are relevant and helpful.

Critical Thinking. Having obtained relevant information, the students are required to apply this to the immediate setting to explore the options and possibilities available in developing a solution. The students have to examine the information, consider the scope of their inquiry and decide the parameters in which they are going to work.

Collaboration. Each group has a number of members. The problem solving task requires members to organise themselves into productive teams who share the workload, undertaking separate tasks and maintaining tight deadlines and schedules from one week to the next. Such activities demand that students consider the requirements of others, be adaptive, be responsible and flexible.

Problem Solving. Each task is different and needs to be tackled in varying ways. Students need to use their initiative and intellects to consider the form the solution will take and to consider ways in which the solution can be expressed concisely and succinctly. The nature of the learning involves high degrees of self-regulation on the part of the students. (Oliver & McLoughlin)

Assignments are included in the pedagogical manuscript and more detailed instructions are included there. For the final report students can choose one of the topics or develop their own, if suitable material is available:

Project 1.–Neutral landscape analysis. In this assignment, groups will learn to use the program RULE to generate and analyze neutral landscapes.

Project 2.–Quantifying landscape pattern. In this assignment, groups will learn to use the program FRAGSTATS to quantify the structure of several local landscapes.

Project 3.–Landscape Dynamics. In this assignment, groups will use the software RMLANDS to investigate the dynamics of a landscape under various disturbance regimes.

Project 4. –Habitat modelling for chosen mammal species. In this assignment, groups will develop habitat models for species of their own choice.

3.3 Instruction

The course objectives listed above largely dictate the teaching and learning method used in this course. This course is strongly focused on problem-based, student-directed learning. The individual web-tasks constitute the major emphasis for the course. Lectures are designed to support these tasks, not vice versa. The instructor is available to help students in all aspects of the course. The guiding will take place in web-based discussion forum as well as on the face-to face meetings and lectures. Sulaiman et al. (2004) has found out that the student-facilitator and student-peer collaboration in the constructivist PBL approach in the Web-based learning environment resulted in many positive aspects of the educational outcomes. The synchronous student-facilitator collaboration was perceived to be the effective pedagogy that could result in the enhancement of the learning quality through the engagement of group tasks and the scaffolding provided by the facilitator. The student-peer collaboration enabled the students to link up different ideas and to share knowledge and it induced motivation that contributed to positive learning outcomes. Students also regarded the learning processes to be effective, motivating and

satisfying and all these results reflect the inherent capability of the constructivist PBL approach in the Web-based environment in yielding positive educational outcomes.

The participation of the instructors in online discussions moderated by students adds more credibility to the discussion. Therefore, instructors can participate in the weekly discussions, comment on the student's contributions, and add comments and references that relate to the weekly topic. The instructor should not be seen as an authoritarian figure, but rather as a coach and a facilitator and refrain from imposing her views on the discussion but carefully guide the students in exploring an issue through multiple perspectives. While participating in the discussions, the instructor has the opportunity to model expert behaviour and appropriate etiquette. The first discussions should be moderated by the instructor so that students can have concrete examples of how to go about structuring and moderating their own discussions. (<http://seamonkey.ed.asu.edu/~mcisaac/ICEM99/pedagogymss.html>).

3.4 Grading System

In judging the responses, such aspects as: quality of the arguments presented, level of research evident, quality of the language and information presented and strength of arguments and reasoning is applied. (Oliver & McLoughlin). Consequently, grading is based largely on student participation and performance in student-directed projects. Grading will be based on several items; each item is described in detail below.

	Percentage of course grade
Assignment 1.	15 %
Assignment 2.	15 %
Assignment 3.	15 %
Assignment 4.	15 %
Final report	40 %

3.5 Technical part

Testing

The web-based course will be tested in three different sections:

1. The pedagogical solutions and functionality of the web-based part will be tested, in order to see if it works as planned
2. The functionality of the content will be examined
3. Technical testing will make sure that the course will function as planned

Assessment of the technical part of the course

In the assessment of the course following issues will be considered:

- Achieving the set objectives
- Appropriateness of the content
- Usefulness assignments
- Timetable
- Functionality of the web-learning environment
- Quality of learning
- Chart the problems aroused

3.6 Special features of the students

Like in all distance education courses, online courses require self-motivated students in order to be successful (McIsaac & Gunawardena 1996). In addition, structure is even more important in online courses to promote interaction and create a successful learning environment (Vrasidas & McIsaac 1999). Master's students at the advanced level are usually already very independent learners with high motivation. They have already learned to study and gained knowledge of the tasks they will need in their future profession. Therefore these students are optimal learners and ideal to teach.

4 Discussion

The objectives of this web-based course were to provide support for students learning, but not to organise materials for them; encourage independent thought process, build critical thinking skills and scientific way of thinking as well as to motivate students for explorative research. In the science curriculum the pedagogical perspective has been and still is that the students require a sound body of knowledge and sufficient skills before they are knowledgeable enough to engage with problem-based learning. Similar pedagogical though structure has been found in engineering, Therefore problem-bases learning is more likely taking place in the latter part of studies. (Savin-Baden 2000).

Similar to PBL, are case study teaching method that value the “real world” cases used in the classroom. Different from PBL, one of the primary strengths of case-based learning is its ability to compare and contrast ideas through the study of a sequence of cases (problems). Conversely, problem-based learning typically focuses on the analysis-research-report cycle with one problem. Also closely related to PBL-method applied in the designed course is traditional field work that has been a very essential form of ecology education through centuries. Rickson et al. 2004 have found on their research on outdoor learning, that: "Fieldwork can have a positive impact on long-term memory due to the memorable nature of the fieldwork setting. Effective fieldwork and residential experience in particular, can lead to individual growth and improvements in social skills. More importantly, there can be reinforcement between the affective and the cognitive domain, with each influencing the other and providing a bridge to higher order learning." One of the major benefits cited is the opportunity for lecturers to interact with the students in a less formal setting than is possible at university. This enhances the educational experience and has long term benefits for the students in terms of increased motivation and improved academic performance (Boyle et al. 2003). Furthermore, freedom to learn by discovery, without a strict course of action, increases the projects' educational worth. Carefully planned and supported by educators, PBL projects have the capacity to change not only the way students learn, but also the long-term desire and motivation to do so. (Ehlert 2005).

Challenges

Because the success of the PBL-course is strongly depending on the response of students, i.e. in a way it is unpredictable, the developed LE-course should be tested and further develop with students. PBL sets demands for the motivation of students and their eagerness to learn and work rather independently with each other. The primary limitations of PBL rest with the approach and strategy that educators adopt in order to present problems to students. Problem-based learning can become mechanical in practice, simply encouraging students to obtain only the minimal information and knowledge needed to solve a problem. Consequently, problem-solving becomes a prescribed process and little room is left for the development of interpersonal and communication skills. If the PBL process is to genuinely stimulate student learning and develop critical problem solving skills, unlike traditional subject-based teaching methods, educators must take responsibility in designing and establishing an appropriate learning environment.

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Appendixes

Appendix 1. Landscape ecology – manuscript