Applying student-centred strategies in the course of *Environmental Biology*

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Abstract

This paper gives a general view of how to shift from teacher-centred teaching to student-centred learning in the course *Environmental Biology*, offered at the University of Science and Technology of China. The author will modify this course by applying the use of concept maps, problem based learning, case studies and online learning to improve teaching and learning quality. Different teaching strategies will be used appropriate to the content of the course.

Introduction

Educational curricula and teaching methods are changing in China. One component of the current redevelopment of all subject area curricula is the change in focus of instruction from a transmission curriculum to a transactional curriculum. In a traditional curriculum, a teacher transmits information to students who passively listen and acquire facts leaving little room for student-initiated questions, independent thought or interaction between students This approach to teaching is teacher-centred. Students attend classes to listen and take notes. Good memory can help them to gain a high mark. The traditional classroom can sometimes resemble a one-person show with a captive but largely uninvolved audience. Classes are usually dominated by lecture or direct instruction. The idea is that there is a fixed body of knowledge that the student must come to know. Students are expected to blindly accept the information they are given without questioning the instructor (Stofflett 1998). This teacher-centred method of teaching also assumes that all students have the same level of background knowledge in the subject matter and are able to absorb the material at the same pace (Lord 1999). This teaching method hinders the development of individual student's activity and creative ability (Zoller 2000). Moreover, students in introductory science courses find the subject boring, difficult and generally unnecessary for non-science-oriented careers.

In a transactional curriculum, students are actively involved in their learning. Students play an active role in reaching their own conclusions. Teachers assist the students in developing new insights and connecting them with previous knowledge, but leave the discovery and discussion to the student groups. Questions are posed to the class, and student teams work together to discuss and reach agreement on their answers, which are then shared with the entire class. Students are able to develop their own understanding of the subject matter based on previous knowledge, and can correct any misconceptions they have.

In order to improve the quality of student learning we must clearly modify the way we teach, to develop students who are enthused about science and who really understand the material (Lord 1998). Teaching methods must shift from teacher-centred to student-centred learning.

Description of course

Environmental Biology is an interdisciplinary science. It mainly introduces the interaction of organisms with the environment, and how to use organisms to inspect, bioremediate and clear polluted environments. The course involves 36 hours of lectures and 18 hours of experiments. Teacher-centred teaching methods are currently used. Students are given a closed-book examination at the end of the semester.

Objectives of the course

Our goal is:

- to prepare students with the knowledge and skills to identify, analyse and resolve environmental issues from an inter-disciplinary perspective;
- to understand what the environment is and how it works, in terms of basic principles of biology, chemistry and physics;
- to understand the relationships between organism and environment;
- to understand the advantages and disadvantages of possible solutions to environmental problems; and
- to develop the students' generic skills and abilities.

If traditional teaching methods are used, it is impossible to reach these aims.

Modification of the course

The aim of our modification is to apply student-centred teaching strategies, giving students an active learning environment and training students in lifelong learning skills. We will attempt to apply the following teaching strategies in the course *Environmental Biology.*

Using concept mapping

Concept mapping is a technique for representing knowledge in graphical form. It can help students generate ideas (for example, brain storming), design a complex structure (long texts, hypermedia, large web sites), communicate complex ideas, integrate new and old knowledge, and assess understanding or diagnose misunderstanding. Use of concept mapping is potentially a very effective way for students to develop understanding of *Environmental Biology*. Indeed, concept Mapping may also help students to solve complex environmental problems.

For example, in the first class students can construct their own concept of environmental biology (Figure 1) on the basis of their individual knowledge of the discipline. The concept map helps students visualise their understanding. Moreover, constructing the map makes students use an active process. The first draft is a simple map. At the end of the semester students can complete a more comprehensive map of environmental biology using their new knowledge.

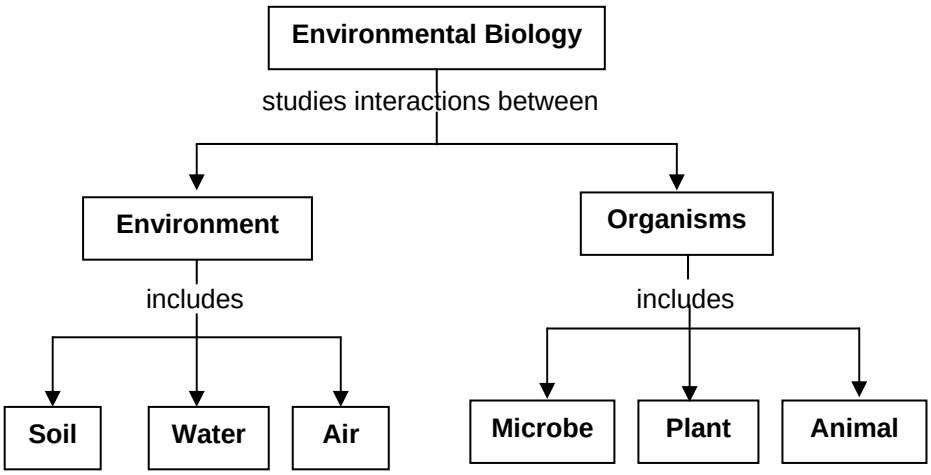

Figure 1. The concept of *Environmental Biology*

Using problem based learning for developing generic skills

Problem based learning (PBL) is an exciting way to learn *Environmental Biology*. PBL engages students in solving authentic environmental problems, stimulating discussion among students and reinforcing learning. Most environmental issues call for students with an interdisciplinary training that combines expertise from a variety of interrelated sciences.

Traditional environmental biology courses tend to concentrate on explaining the principles and methods, but students seldom get to learn how to use these together. By contrast, in the problem based approach used in the new course, the students will first review a particular problem, find out what specialised skills are needed, then learn in context. In this way, the students concentrate on the objective of solving the problem, rather than rote learning the principle and skills.

There are a lot of problems that need to be solved. If teachers select suitable problems for the students, the problems should be discipline related, and need to cause significant interest and stimulate active learning among the students. For example:

In Middletown, Iowa, the lagoon basins and underlying groundwater have been contaminated with 2,4,6-trinitrotoluene (TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) as well as many other compounds and heavy metals. The action levels were driven by explosives contamination. Soil action levels were set at 47 mg/kg for TNT and 1.3 mg/kg for RDX. Action levels for aqueous concentrations were set at existing EPA health advisory lifetime levels: 2 mg/L for both TNT and RDX.

The teaching and learning process will be based on 'how to resolve the pollution problem'. Solving such a problem requires broad background knowledge. First let students brainstorm ideas. To help students solve the problem, step-by-step, some relevant questions may be provided to guide

the problem solving process, and to enable deeper thinking. For this example, five questions might be asked of students:

1. How many kinds of pollutants are included in the lagoon basins and underlying groundwater?
2. What are the possible proposals for solving the problems?
3. What are the mechanisms of the treatment technologies?
4. If bioremediation is used, what conditions should be considered ?
5. What is the advantage of bioremediation, compared with other methods?

The function of the first question is to let student determine the kinds of pollutants found in this type of situation. This is basic knowledge. The aim of the second question is to make students generate and search for possible solutions. They have to think independently and creatively. They have to research some materials and processes, and discuss these with classmates and teachers. In this process they gain new knowledge and improve generic abilities. They also develop a real experience of finding solutions. By asking the last question students are encouraged to pay more attention to bioremediation. They must understand the definition of bioremediation and conditions of bioremediation treatment technologies.

After 4 weeks, students have a group discussion and finish preparing their report, including an oral presentation, some practical work and a written paper.

Cost of problem based learning

Such a problem based course is more expensive to run than a conventional course. It will take a great deal of time to design and set up, and uses a large design studio. It is hard to assess the learning outcome, and financial support and training for tutors may be needed.

Case studies and group discussion in the course

Case study is a strategy used for motivating learning interest in specific courses or sessions by using a real world story, which relates to the content of that learning. Case study can succeed, and additionally induce students to give more consideration to real problems.

For example, in The Lorax, Dr. Seuss introduces the 'Once-ler' who cuts down the beautiful Truffula trees so that he can use their wonderful silk tufts to knit 'thneeds'. Thneed sales are so successful that the Once-ler builds a factory and invents the Super Axe Hacker who cuts down four trees at a time. The Lorax speaks up in defense of the trees, animals, air and water that the Once-ler is destroying in pursuit of bigger and bigger profits. Finally, when the last Truffula tree is cut down, production of the Thneeds ends. Closed factories, polluted air, polluted water and an uninhabitable wasteland are all that remain on the once beautiful site. The Lorax can no longer live here, but he leaves behind a small pile of rocks on which the word UNLESS is inscribed.

Objective of the example

1. Students will read or listen to an environmental fable, *The Lorax*, and understand the concept of an ecosystem through the example of the Truffala Village. Students will draw conclusions and make predictions about the environmental impact and wise use of resources.
2. Students will make connections between the hazards and issues facing our own environment and those of the Truffala Village, and draw parallel solutions for problems facing our own environment today.
3. Students will brainstorm possible solutions to rebuild the Truffala Village ecosystem and discuss the knowledge or skills needed to create viable solutions for current environmental problems.
4. Students' critical thinking skills will be improved.
5. Students' situation analysis skills and integrating skills and creative ability will be trained.

The teacher encourages the students to speculate on:

1. Why did the *Once-ler* ignore the Lorax's warnings?
2. What is the meaning of the Lorax's message 'UNLESS'?
3. How does the fate of the Truffala Village relate to current predictions for our own environment?
4. What do we need to learn to help prevent our own environment from becoming like the Truffala Village?

In a case study, students spend some time learning independently. Students will be required to work in groups of four to brainstorm the case and build up a mind map. After a week they will express their view by oral presentation and then discuss and exchange ideas in a small group. Self-assessment and peer assessment will be used.

Improving learning resources

Available learning resources are not enough for using contemporary education strategies. To improve learning resources, I will:

- set up a web site and use the web site for online teaching and learning;
- use the web site to communicate with students; and
- develop multimedia resources such as video and audio.

Comprehensive assessment system

Whatever strategy is used, students will be influenced by the assessment system they are working within. The design of assignments and, in particular, the criteria used in allocating marks have a dramatic effect on carrying out new teaching strategies. More effective teaching may also result from a change in the way teachers gather information about what students are learning. Traditionally, I have evaluated my students' knowledge by giving examinations and papers, often only at the middle and end of each semester. As a result, a teacher might not recognize until the final exams are finished, that students had trouble explaining or using a concept covered in the second week of class, or that some students consistently confuse related ideas. Therefore, student-centred strategies in environmental biology require the use of new assessment systems.

The Assessment system

Opening a dialogue with students.

Dialogue helps improve the quality of the course. When a teacher asks 'how much of what I'm teaching are students learning?' and gets specific kinds of feedback to answer this question, the teacher can better focus teaching effort. In effect, I can then begin to determine what is and isn't working in the classroom.

Using classroom assessment techniques, for example, one-minute papers:

A teacher ends class a few minutes early and asks one or two questions which students answer, on an index card or half sheet of paper, and hand in. Questions often asked are 'What were the main points of today's class?' or 'What was the muddiest point in today's lecture?' This is an example of assessing teaching effectiveness.

Comprehensive assessment for students' knowledge and skills

- Written Exams (50%)
- Tutor assessment (5%)
- Reports (20%)
- Self and peer assessment (10%)
- Oral presentation (15%)

In short, good assessment techniques help students learn more effectively and efficiently. When students are encouraged to take the time to gauge what they know and how well developed their learning and academic skills are, they then begin to recognize their capacity to become active learners; they begin to see the importance of learning how to learn as well as the importance of course content.

Possible challenges and problems

Applying student-centred strategies in environmental biology might be a challenge for teachers and students because they have been accustomed to the traditional way of teaching. Many teachers are hesitant to try different strategies, because they require additional planning and a relaxation of the traditional rules of the classroom. Teachers may feel as though they aren't doing their job if the students are working together and actively discussing the material instead of busily taking notes. So at first teachers must change their old conceptions and understand that their responsibility is not only to provide content and outline of the course as the distributor of knowledge, but also to motivate students to be more creative, self-directed, cooperative and inductive in their thinking.

Chinese students do not express themselves. They do not ask questions and give answers during lectures because in the teacher-centred class, they don't have the opportunity to practice these abilities. When these new teaching strategies are used in the class, the students will need time to adapt.

Conclusions

Student learning will improve by the application of student-centred strategies (such as problem based learning). These strategies enable students to develop their ability to solve problems, think critically, self-direct their learning, work in teams, and acquire lifelong learning skills. Change should be attempted step-by-step. At the beginning, the best approach may be to integrate student-based learning methods with traditional teaching methods.

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