The application of contemporary teaching strategies in plant biology

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Abstract

This paper reviews the reform of plant biology in China, and gives an analysis of current approaches to teaching and learning of plant biology. Based on the drawbacks of conventional teaching methods and the advantages of contemporary education strategies, three possible approaches: case study; concept mapping; and PBL (problem-based learning), are proposed. Also discussed are possible problems concerning their combination with traditional teaching methods. We believe that as long as these modifications are implemented appropriately, the best possible teaching/learning results can then be achieved.

Introduction

In contemporary society, it's very obvious that as a result of the rapid explosion of knowledge in biology, due to the achievements of molecular biology and biotechnology, many new content areas and technologies are involved in the teaching of biology. This means that our graduates are part of a society in which knowledge will be rapidly changing as we go through the 21st century, and they will need to be able to cope with these changes. It is also the case that they will certainly have to be prepared to change their professional focus during their working life (Boardman 2001). In order to be successful, they must have the ability to access and generate new knowledge in a purposeful fashion, and to move beyond simple content knowledge to critical analysis and an understanding of emerging trends and issues. They should be able to solve real life problems, to communicate with one another, to see relationships within what they have learned, to perceive their field of study in the broad perspective and to develop flexibility and adaptability to continue learning in their disciplines throughout life, including practical skills and personal skills. That is common to all the major universities around the world. The implementation of contemporary education theories and strategies in the teaching process will facilitate students developing the above generic skills.

Based on the reform and analysis of plant biology teaching in our university (Yao, Shi and Zhao 2001), this paper will investigate how to apply contemporary teaching/learning strategies to teach plant biology, using three possible ways: case study; concept mapping; and PBL. The ways in which these may enhance teaching are discussed and the problems that may arise by making these changes are considered.

Course description

Background of reform of plant biology in China

Three years ago the plant biology course in most of the universities in China was usually divided into two or three courses, including botany, plant physiology and plant systems and evolution. With the explosion of knowledge in biology, particularly achievements in molecular biology and biotechnology, much new content and many new courses should be included in the discipline of biology, However, because of limited study hours, we must combine some related courses and compress some concepts. More importantly, designing the curriculum should depend on the system of the course, i.e. the structure and physiology are adaptive in plants, so it's unreasonable to separate them into different courses. The recent research indicates that the trend in the development of the discipline in plants is integrative. Another reason is that we expect to construct a whole concept of plant biology for first year students. Based on this background, under the program of reform of biology courses which was supported by MOE (Ministry of Education) of China, we have redesigned a new course in plant biology and following two main strands: individual plant development and plant systems and evolution, we have developed a new course syllabus.

Plant biology is intended to introduce some of the broad and fundamental issues in plants, and is designed to be an integrated course, including morphology and the anatomy of plants, and metabolism and bioenergetics in plants, with the emphasis being on the relationships and adaptability between the structures and functions in plant. Plant systems and diversity is one of the main content areas relating to angiosperm classification. We also introduce the basic characteristics of algae, liverworts, ferns and seed plants so as to be able to identify them and explain the difference between these groups. The tight relationship between plants and their environment and the way in which they influence one another are important contents of this course, as is the protection and utilizing of plant resources involved in plant biology.

This course is designed for first year students, and is given in four sections: lectures (50 hours), practical work (60 hours), field trip (10 days) and project of teaching/learning (1 week).

We expect our students to: be able to gain an insight and understanding of structure and function, growth and development of individual plants, understand the origin of life and the principle of evolution of plants. In addition they need to be able to develop the generic skills employed by scientists in biology, have a basic understanding of the relationship between plants and their environment, and be properly equipped to participate in more advanced units of study involving plant biology.

Current approaches to teaching and learning

Plant biology is usually taught as a two semester compulsory course. At present, the teaching method I use is conventional lectures which are given by multimedia. We made the courseware for the plant biology lectures. Sometimes, I organize discussion classes, giving students some topic for reflection, and in the next lecture students are required to answer it in about 10 minutes of lectures. Unfortunately, the response of students is not as active as I expected. In laboratory classes, there are individual and teamwork tasks. Before the examination, there are consultations and tutorials, but few people meet with us, the majority of students not asking academics issues in plant biology. Instead, they are focusing on how to pass the examination. The question they frequently ask is 'What is the main content we should remember for the examination?'. Although students who have got good 'A-level' grades can remember the definitions of terms, they do not adequately understand the concepts involved and commonly they forget the knowledge soon after the examination.

The project of teaching/learning is a good way to train students in practical skills, and the topics we offer cover the main contents and experiment skills of the course. Students make plans to complete these tasks by themselves, the teacher supervising if needed.

In terms of assessment, apart from reports of experiments mid-semester and the final closed-book examination, the practical test is a necessity for all students. If someone can't pass it, he/she will not be permitted to participate in the final examination, meaning that they will have to study this course again.

All the recent research in science education in universities suggests that we would like 'teaching intent' and 'learning outcomes' to be consistent (Print 1991). When we design plant biology courses, the teaching intent is to get students to grasp the theories and skills of plant biology, to establish good knowledge backgrounds for higher level courses, to develop the ability to solve real problems using the theories and skills learned in classes, to understand the concept that plants are forever evolving and have done so since the origin of life, and to develop an inquiring and open approach to the study of plant biology. Through the examination, practical tests, field trip reports and questionnaires, these surveys showed that students understand the basic theories of plant biology, including the structure and function, growth and development in plant; learn the basic skills, including observation of microstructure, collecting and identifying species; and improve their technique in producing biology slides. Ninety percent of students can pass the examination, but after the examination the knowledge they learned is quickly forgotten; and after two semesters 70-80% students can't do the field trip work. Empirical research has shown that our students are not necessarily learning what it is we think we are teaching and our results supported the view. In other words, we do not attain the purpose as well as we expected, and many of us realise that students learn too little of what we teach. Though the design and the aims of course are good for students, and we intend to develop students' various skills, the quality of teaching is not as we expected. What's wrong?

Reconsideration about current teaching styles

Faced with these conditions, we have to reflect on our current teaching strategies. The characters in current teaching are discipline-centred, teacher-centred teaching, and the student learning is passive surface learning. A wealth of evidence has been reported to support the concept that under the discipline-centred teaching, the needs, concerns, and requirements of teacher and student are not considered because the course is driven by, and depends mainly on, the disciplinary content that must be presented. The teacher transmits information. In the teacher-centred style, the teacher is regarded as the authoritative expert, the main source of knowledge, and the focal point of all activity. The student is the passive recipient of the information already acquired by the teacher. The teacher selects from the discipline the information to be taught, studied, and learned. In this environment, surface approaches to learning are very common, the students reduce what is to be learnt to the status of unconnected facts to be memorized. The learning task is to reproduce the subject matter at a later date (Chin and Brown 2000). In our course reform, we focus on what and how to teach, pay more attention to the transmission of knowledge of plant biology, address a lack of consideration of how students learn, and acknowledge a failure to develop the skills including lifelong learning, problem solving and teamwork skills.

In fact teaching and learning should be inseparable, in that learning is a criterion and product of effective teaching. In essence, learning is the goal of teaching. Science teaching requires attention to both the content of the course and the process of moving students from their initial state of knowledge and understanding to the desired level. In fact, teaching is part of a whole that comprises the teacher, the learner, the disciplinary content, the teaching/learning process, and the evaluation of both the teacher and the learner (Järvelä and Niemivirta 1999).

So, I should consider how I impart the content knowledge and provide the opportunities to facilitate learning amongst my students. This means most importantly that our education concepts must change. The contemporary major theoretical development is the move towards the constructivist perspective and view of how people learn science. The major practical development is the move towards student-centred approaches and student active science as an appropriate teaching technology, which is seen as compatible with the constructivist view of learning. Student-centred teaching focuses on the student and, in particular, on the cognitive development of the student. The teacher's goal is to help students grasp the development of knowledge as a process rather than a product. The focus of classroom activities and assignments is on the student-centred process of inquiry itself, not on the products of inquiry. Students create their own conceptual or cognitive models. Content, teaching style, and methods are adapted to aid the cognitive and intellectual growth of students. Student-centred teaching combines an understanding of the way that humans process information with other factors that affect learning such as attitudes, values, beliefs, and motivation (Trigwell, Prosser and Lyons 1999). If we adopt student-centred teaching, we would therefore expect that the learning style of students will convert to active, deep and lifelong learning.

Contemporary teaching strategies to modify the teaching/learning in plant biology

If students are to become independent, lifelong and active learners, our program of teaching strategies needs to include methods and tasks which are interesting, motivating and require our students to be involved in both team and individual learning tasks (King 1997). Then what should I do? I am going to introduce some new teaching strategies, such as case study, concept mapping and problem-based learning into my future teaching in China.

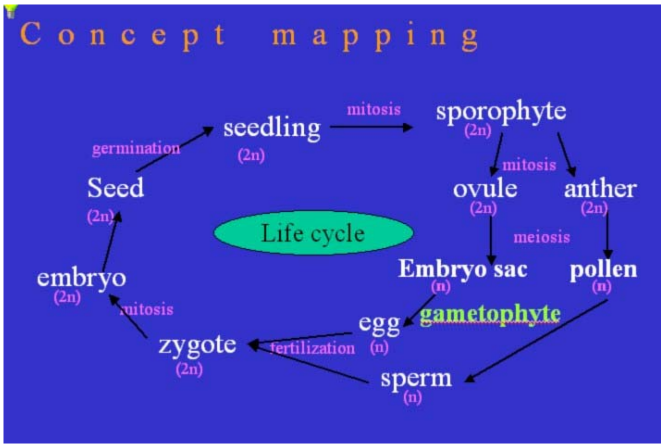
Case study

Many of us struggle while teaching science. Students sit in class with glazed expressions and forget everything you've worked so hard to teach them the moment they walk out of the classroom. Using case study strategies may perhaps change this situation. What is the case study? The case selected by the lecturer is a real and complete story, has academic and professional significance, is usually interdisciplinary and is always set in a real world context and always has social implications (Wilson 1996). I think they are short, and easy to understand, yet will completely change my approach to teaching. For example, in plant biology, the secondary growth and structure of stems is a difficult concept to understand and remember for students. I have therefore designed a case study for students to work with.

The case is that there is an old oak in our campus, it is hollow, but it still burgeons and flowers year after year. The aim is to make students understand secondary growth and the structure of the stem. Discussion and small groups are a good style I want to employ, in order to ensure that my discussion class is not a free-for-all or futile exercise as I will try to get students to say something intelligent. For preparation, students must read a case study ahead of time. In the discussion class, it will be important to ask some questions to guide and warm-up their discussion in the correct way. Such as: 'What's the stem structure of perennial oak?'; 'Where is the conducting tissue of this oak?'; and 'Why does this oak normally grow with a hollow in the centre of its stem?' I believe it's very helpful to study this topic for students. They would think these contents are very interesting rather than boring learning of facts which they don't understand.

Concept mapping

There are many academic and technical terms in plant biology, and especially, there are some concepts that are very difficulty and confusing for students to understand. Concept mapping is a very useful tool for solving these problems. A concept map is a diagram in which various forms or lists of information are classified and their linkages are shown (Novak 1991; Lawson 1994).



Concept maps can give a schema of the main concepts. I am going to use a concept map when I introducing the life cycle in plants. There are many notes and linkages in the life cycle, and they can be used to help me to establish whether or not the students understand the concepts that link various pieces of information together. They can be used to explain why I am focusing on the sporophyte and the gametophyte generations, meiosis and fertilization as parts of the life cycle. In this way students can see how particular pieces of information fit into the overall schema. The completed concept map; can be used to help students know what it is they have learned and what it is they still do not understand, and can be used as an assessment tool. The linking concepts such as mitosis and meiosis can tend to relate to the content I teach in my lectures. So concept mapping is a powerful tool to help the understanding of some confusing and difficult concepts in the course. I think concept mapping is really suitable for plant biology. I'd like to use it more.

Other possible ways to use it might be that students are asked to draw the concept maps before and after teaching a new topic in plant biology. In this way the lecturer can find out what the students' preconceptions are and what might be their misunderstandings and weaknesses. This can lead the instructor to work out the best way to teach that topic, and thus to modify his/her lecturing content and teaching methods correspondingly.

Problem-based learning

During recent decades, problem-based learning has become very common in teaching science in western countries. PBL is a curriculum design and teaching/learning strategy that simultaneously develops higher order thinking and disciplinary knowledge bases and skills by placing students in the active role of problem solvers confronted with a situation that reflects the real world. So PBL is a very effective method to develop learner critical thinking, self-directed and lifelong learning, problem solving and teamwork skills (Woods 1994). It is well documented in the literature that PBL is a very good teaching strategy. It has worked very well in several fields, for example medicine (Norman and Schmidt 1992) and engineering (Hessami and Gani 1993).

There are many real life problems that need to be solved in the plant biology field and we met such a problem in our university three years ago. A farmer came from the Jinshan county of Hubei province, asking for help, because he did not harvest any plums last year. This is a real story which I can develop for students to use with PBL. Solving the farmer's problem is a challenge to students. I will give this problem to them after my lecture. Students will be divided into groups, each group having 5-7 people. Firstly, they should gather the relevant information from textbooks, the library, Internet, journals and staff of the department. It may be necessary to have an interview with the farmer. There are many factors which influence fruiting including harsh climates, the development of flower organ abnormality, diseases and insect pests and the nutrition of the soil. So students should investigate using the knowledge and skills they have learned to successfully integrate interdisciplinary knowledge. They must analyze and figure out the main reason behind the plum trees not fruiting, and finally they should make a plan to help the farmer so that next year he can get plums.

It's very obvious that PBL facilitates self-directed and lifelong learning skills, problem solving, analytical and critical thinking skills, integration of interdisciplinary knowledge, teamwork and interpersonal skills.

Unfortunately, some problems also exist with this approach. Typically, it is time consuming, and it is difficult to create suitable problems for first year students. It requires the students having integrated knowledge and teamwork skills, but these are exactly what first year students lack.

Possible implementation problems

In the practice of my future teaching in China it will be hard to achieve this in a short period of time and these changes will be a big challenge for all of us. Our students are accustomed to the conventional teaching methods, where they are used to getting knowledge just by memory. They are not used to taking as much responsibility for their own learning and will complain about the extra efforts needed and be reluctant to use these learning approaches. Therefore it's very important to make the transition smooth for students (Bridges 1992). Limitation of hours is a common problem, but a good way to solve this problem may be by using *WebCT*. However this may elicit the next problem, that is financial and facilities problem. Setting up *WebCT* involves systems engineering, and will need cooperation between the academic staff and computer engineers. Besides, possibly, it will not be easy to convince my colleagues to agree with, and use, these new teaching strategies in plant biology, It needs time to communicate with one another and discuss these new ideas.

There may also be some handicaps from the level of the whole university. Currently our present system of university administration is not flexible enough to accommodate such change, and it is not easy to make a special policy for modifications of plant biology. So I will need to be passionate about these modifications in order to convince my colleagues and governors. I'll seek for their support as much as possible and will try to inform them about these changes by giving a seminar about contemporary education theory and teaching strategies. Most importantly, I will also make a detail plan to introduce the new teaching methods to my course in which I will pick out some key ideas to get students to adopt a deeper approach to learning. It's a hard task, but I have been chosen to be involved in it and that is why I have been an enthusiastic participant in the program at the University of Sydney.

We are lucky, because as part of its Education Invigoration Action Plan 2003-2007, the Ministry of Education has launched the 'Higher Education Institution Teaching Quality and Higher Education Reform Project' aimed at upgrading the quality of higher education in China. That is a big challenge and chance for us! We believe that so long as we have good ideas to improve the quality of teaching and learning, we should try to make them work!

Summary

To summarise the main issues of this paper, using case studies will foster students' critical thinking and active learning. Problem-based learning will develop students' problem solving, deep and lifelong learning, and use of teamwork skills. Finally concept mapping will promote the quality of teaching and learning.

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