

Using appropriate strategies to improve teaching and learning in palaeontology at Chang'an University

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Abstract

This article discusses the use of contemporary teaching strategies to teach paleontology at Chang'an University. Student-centred approaches to teaching are generally accepted to be more effective than teacher-centred methods. This provides a rationale for modifying curricula and classroom practice with the aim of stimulating student interest in palaeontology and to motivate students to become responsible for their own learning. Information and communication technologies and multimedia technology instruments will be used to improve the delivery of content and concepts in lectures. Concept maps, research-projects and problem based learning will be added to the strategies currently employed in order to develop students' self-directed lifelong learning skills, communication skills, and to increase students' ability to engage with and solve real-world problems.

Introduction

Palaeontology is the study of the history of life on earth, and of the phylogenetic development of ancient plants and animals based on the fossil record. It relies on evidence of their existence that is preserved in rocks. This evidence includes impressions of skeletal remains and viscera (the so-called 'hard parts' and 'soft bodies'), tracks, burrows, cast off parts, fossilised faeces (coprolites), and chemical residues (Black 1998; Doyle 1997). Usually we teach an introductory course in palaeontology in the second semester to second year undergraduate students studying for a Geology degree at Chang'an University. Currently, this course consists of forty hours of face-to-face teaching which is divided into twenty-six hours of lectures and fourteen hours of practical classes. The course is assessed predominantly by examination—the final examination contributes eighty percent of a student's mark with the remaining twenty percent being comprised of a mark that measures a student's performance in practical class. The primary aim of this course is to familiarise students with the basic concepts of palaeontology and to introduce students to the basic morphology of the phylum or class of animals that are useful for stratigraphic determination of the age of sedimentary rocks. Typically this course will be given to a class of thirty to sixty students.

Until about five years ago we used a traditional, behaviourist style of teaching using the facilities available. Teaching was dominantly teacher-centred and relied on demonstrations using physical models, wall maps, and the presentation of important content by the so-called 'chalk and talk' method. In the class, we would call on individual students to answer questions and after lectures, we would hold a formal tutorial once a week but in general only a few students would attend these sessions—except, of course, before examinations, when many students would attend and ask questions aimed at passing the examination. The most common questions asked were always about content, for example 'What facts do we need to remember for the examination?' After the examination, it seems to those who taught the students that most of them quickly forgot the knowledge they had 'crammed'. This led to a common complaint that students do not study as hard as we expect. While some of us pondered the question 'What is wrong with our teaching?'

After attending the pedagogy and teaching strategy classes given during the *Teaching Sciences in English* course I found some answers to this central question. I realised that our current teaching practice provides typical examples of discipline-centred teaching and teacher-centred teaching. The course has a fixed structure. The course is driven by the need to deliver specific disciplinary content that is necessary for a practitioner to know in order to work in the discipline. The teachers select what is to be taught, studied and learned according to the discipline and students are the passive recipients of the information. This approach to

teaching commonly leads to surface learning in students. Students tend not to engage with the content and usually do not gain mastery of the knowledge. In my experience, most university teachers in China employ teacher-centred learning as a routine method to transmit knowledge to their students, consequently there is little deep-learning occurring except by those who were already genuinely interested in the material.

Contemporary teaching strategies

There are many teaching theories, for example behaviourism theory, developmentalism theory and constructivism theory. The first theory describes typical teacher-centred teaching and learning while the second two embody student-centred approaches to teaching and learning. *Student-centred teaching* focuses on the student and, in particular, on the cognitive development of the student. Rather than providing an environment where students passively receive information they should, instead, participate actively in the process of teaching and learning. In particular, they should participate in the process of thinking and processing concepts as part of the process of acquiring content. The teacher's goal is to help students grasp the development of knowledge. Content, teaching style, and methods are adapted to aid the cognitive and intellectual growth of students. (Committee on Undergraduate Science Education 1997). These teaching strategies not only tend to nourish and enhance curiosity and the natural desire to learn, but also help students achieve results they appreciate and consider worthwhile. More importantly, an effective teacher will help students discover the excitement and thrill that is an inherent component of intellectual inquiry.

There are many kinds of student-centred learning approaches that I will seek to use when I teach in the future. These include concept maps, problem based learning (PBL), case study, teamwork, workshop, etc.

Concept mapping

Concept mapping derives from constructivism theory. 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 (Lanzing 1997; Anderson-Inman and Zeitz 1994). 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 recognise for themselves what it is they have learned, the various relationships between content and concepts, as well as gain a sense of what it is they still do not understand.

Problem based learning (PBL)

PBL is a method of instruction that uses problems as a context for students to acquire problem solving skills and basic knowledge (Aspy, Aspy and Quimby 1993). PBL teaching method not only enhances students' knowledge of the basic principles, but also has the potential to develop students' self-directed lifelong learning and communication skills. It can also increase students' ability to solve real-world problems and motivation for learning (Nendaz and Tekian 1999). It has worked very well in several fields,

such as medicine (Noerman and Schmidt 1992) and engineering (Hessami and Gani 1993).

How do I want to teach in the future?

'Teaching and learning should be inseparable, in that learning is a criterion and product of effective teaching. Learning is the goal of teaching. Students learn best if they are engaged in active learning' (Committee on Undergraduate Science Education 1997). So, I will try to use student-centred strategies to teach palaeontology in my university. The first step is to choose interesting topics. The second step is to provide more effective lectures, by using appropriate teaching approaches, such as concept mapping, problem based learning and case studies that require students to engage with and process the content I want them to become familiar with.

Teaching topics in palaeontology

On the basis of contemporary teaching strategies, I think we should first modify and update the course content in Palaeontology. Organising courses around themes, issues, or projects not only can broaden student thinking and problem solving abilities, but also can enrich the students' view of science as a multi-faceted enterprise. Consequently, I have chosen the following topics or themes to order the content and concepts I wish to cover in the course:

1. what is Palaeontology and what is a fossils;
2. fossils and evolution;
3. the main fossil groups;
4. fossils as indicators of age, environment, and ecology (i.e., stratigraphy palaeobiology, palaeoenvironmental analysis and stratigraphy; and
5. extinctions and climate.

By ordering the content through these topics it is possible to introduce a strong element of inquiry into the course—an element of 'WHY?' rather than the present focus on facts and knowing 'THESE THINGS ARE SO!'. Students can learn why they study palaeontology, what a fossil is and what it tells us about how things were when it was alive. They will know that fossils provide us with the basic information that demonstrates evolution, and enables palaeobiologic, palaeoenvironmental and stratigraphic analysis. Meanwhile, students can understand the importance of environmental change, especially climate change in the study of extinction, particularly mass extinction. This will inspire their passion to protect our environment and encourage them to become lifelong learners.

Teaching methods in lectures

The use of information technology, computers and multimedia for teaching has become very popular in China in recent times. So it is possible for us to do multimedia teaching. The use of multimedia technologies, models, diagrams, figures and illustrations can combine audio and visual explanation together, helps students learn and remember. (Ardac and Akaygun 2004). The present study makes use of the capabilities of computerised environments to enable simultaneous display of structure of fossils corresponding to related phylum or class. So, I am going to

consider using slides, videos, films, CD-ROMs, and computer simulations to enhance my lectures.

Using concept maps

There are many academic and technical terms in palaeontology, and there are some concepts that can be confusing and are commonly difficult for students to understand, such as fossils, evolution, extinction, punctuated equilibrium, etc. So concept mapping is a powerful tool to help the understanding of some these confusing and difficult concepts.

For example, the following concept map shows how this tool can also be used to help students to organise information and concepts so that they can understand what a mass extinction is, the related phenomena, the number of mass extinctions recognised, what organisms have become extinct at that particular time and what events caused these extinctions; as well as the implications of present-day ecological and environmental change.

Concept maps can be used to help students recognise what it is that they have learned and what it is they still do not understand and retain a mind-map of the information they are studying. Students can also be asked to draw the concept maps before and after teaching a new topic in paleontology, such as fossils, evolution, radiation, etc. in order to can find out what the students' preconceptions are and what might be their misunderstandings and weaknesses. This can assist in developing the best way to teach that topic, and thus to modify the content and teaching methods correspondingly.

Student research project and oral presentations

An effective way of encouraging students to take responsibility for their own learning is a research project that is well-integrated with the concepts and content of the course. I observed this style of teaching in Professor Peter Davies' course on Fossils and Time. Students will be divided into small groups comprised of four or five people. Each group will work on a single topic. Firstly, they will gather relevant information from textbooks, the library, the Internet, journals and perhaps interview their teachers. During the last few weeks, each group will be asked to give a one-hour formal presentation using *PowerPoint* to the whole class, with each person required to present for about 15 minutes. At the end of their presentation, the presenting students will also answer the questions from the audience. Then, the other students will give a mark to assess their work which accounts for 40% of their grades, and the teacher gives a comment for the group and each person and give a mark which accounts for 60%. This kind of research can not only develop student's ability of doing scientific research, broad their knowledge, but also can develop their oral abilities and teamwork abilities.

Example of suitable topics is listed below:

1. The origin of life;
2. Evolution;
3. Gradualism and Punctuated Equilibrium;
4. Gaps in fossil records;
5. Mass Extinction;
6. Cambrian explosion; and many more.

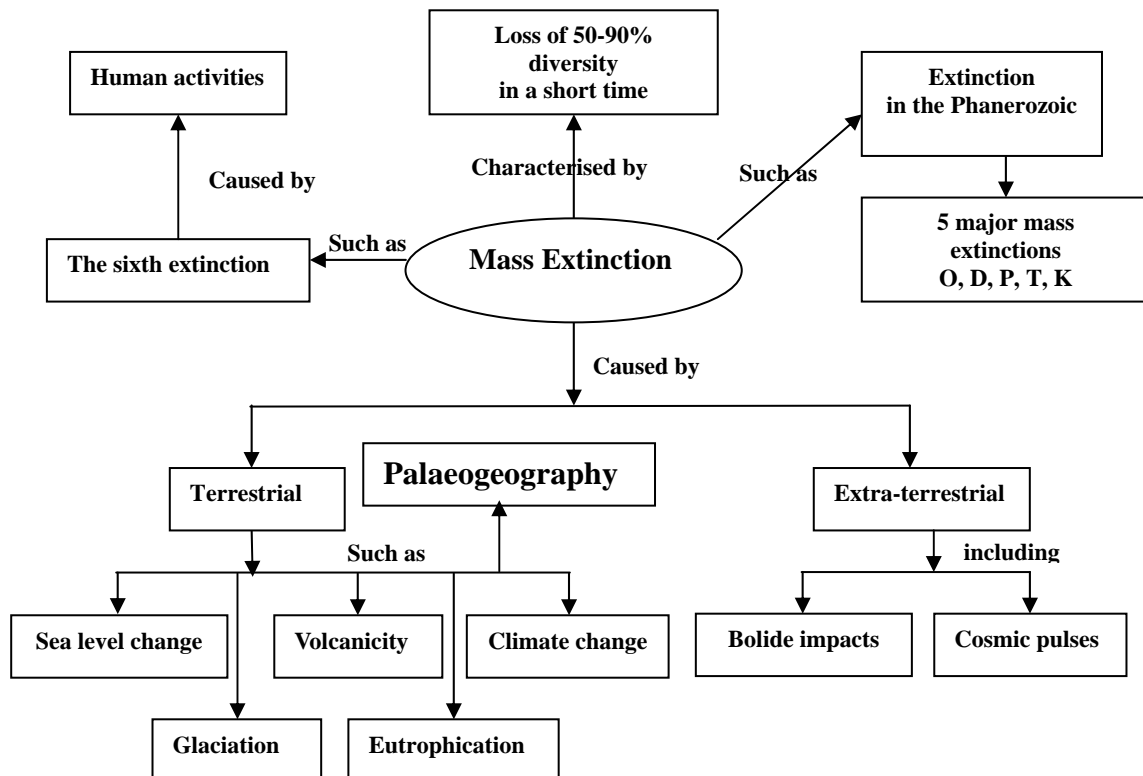


Figure 1. An example of a concept map for mass extinction

Problem based learning

During recent decades, problem based learning has become very common in teaching science in western countries. There are many problems that need to be solved in palaeontology, such as classification and correlation of strata, identifying fossils, and so on. For instance, the age of a section in some area is not clear, we can give the original data including description of strata and fossils to students let them solve this problem. Students should use the knowledge and skills they have learned to successfully integrate interdisciplinary knowledge. This kind of learning could promote self-directed and lifelong learning skills, problem solving, analytical and critical thinking skills, and integration of interdisciplinary knowledge, teamwork and interpersonal skills.

Assessment

'Assessment is an important aspect of both the student learning experience and the practicalities of providing fair and thorough feedback and, of course, assessment is the most powerful lever that teachers have to influence the way students respond to courses and behave as learners' (Gibbs 1999). If we introduce the teaching strategies described above into our course then we should also change our assessment system to reflect these changes. The follow assessment strategy is an outline of appropriate changes to assessment that could be introduced.

Lecture Attendance: I think it is important for students to attend lectures as this is where the necessary content and concepts are outlined. I prefer the time students attend lectures and associated activities account for 10%.

Practical reports and examination: students will be asked to write a report in each practical class and will take part in the practical examination at the end, which will account for 20% of their final grade.

Quizzes: every three or four weeks students will be given a five minute quiz which together will account for 10% of the final mark. This can help me check what the students have learned, but will also encourage them to attend lectures and be active in the class.

Oral presentations: students do research and give a formal oral presentation, which will account for 20% of their final grade.

Final closed-book examination: students should take closed book final examinations to assess whether they have mastered the basic knowledge, which will account for 40% of their grade.

Discussion

Contemporary teaching strategies such as concept maps, PBL and student research projects could be very useful in improving the teaching of our course in paleontology. I will make a detail plan to introduce the new teaching methods to my course by picking out some key ideas to encourage students to adopt a deeper approach to learning.

But there is a problem that we will have to overcome, our students are accustomed to conventional behaviourist

teaching methods. They are in a tidy comfort zone where they expect to be told what to do, and to have all the answers given to them at some stage. They may not be enthusiastic about being required to take responsibility for their own learning and will complain about the extra effort needed. Therefore it is very important to make the transition smooth for students (Bridges 1992). So, at the beginning of a course, I will discuss with students several strategies for effectively engaging in and learning from my classes.

Similarly, it may not be that easy to convince my colleagues to agree with, and use these new teaching strategies in Palaeontology, It needs time to communicate with one another and discuss these new ideas. So to begin with I will seek their support by giving a seminar about contemporary education theory and teaching strategies and discussing the success these approaches have had elsewhere.

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