

# Improving Teaching and Learning in University Education

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## Abstract

Research into student learning at university has guided changes that have led to improvements in teaching and learning in tertiary education. Understanding the approaches students take to learning and why they take these approaches may help change teachers' approaches to teaching. How to improve student learning outcomes is becoming an urgent task for every university teacher. The advent of student-centred learning experiences has been shown to be an important factor in stimulating students to achieve their desired learning outcomes. This paper will first focus on a description of deep and surface approaches to learning and how student-centred learning can be encouraged and nurtured. This will be followed with a discussion of how microbiology could be taught in a student-centred mode at Zhejiang University.

## Introduction

Depending on the learning situation and student perceptions of what is expected of them, students will adopt either a surface or a deep approach to learning during their studies. Surface learning occurs when students focus on reproducing content for the examinations. This focus does not allow for the development of the interconnections between elements, or the meanings and implications of what is being learned. This focus is just on specific details, neglecting a holistic approach to the information. Students use strategies to remember the content of lectures. They just study the pieces of information without making links between the information and seeing the structure of what they have studied. In this mode students are likely to have a negative attitude towards learning, or at least, a very surface level approach to learning.

When students have an intrinsic motivation or curiosity towards a subject, they will tend to acquire an understanding of what they are learning. Deep learning focuses on the meaning of the new knowledge, searching for relationships between new ideas and prior knowledge, summing up what is learned, and deriving extensions and exceptions. With a deep learning approach, students try to understand a topic, or a subject and they do this by reading widely, relating the new knowledge to the prior knowledge and reflecting on the relationships within the topic, or subject, and between subjects.

## Encouraging a deep approach to learning

Most university teachers prefer their students to take a deep approach. However, students often take surface approaches. Students' learning approach will strongly influence the quality of their learning outcomes (Chin and Brown 2000). As surface approaches generally lead to low retention of the knowledge and an inability to use the information in new contexts, students easily forget the knowledge shortly after the examination (Gibbs 1992). While the deep approach leads to a better understanding of the knowledge and application of it in practice, good teaching should encourage the development of a deep approach which in turn will lead to good learning outcomes.

Student approaches to learning are not fixed characteristics. Research shows that students' approaches can vary according to students' learning environment (Trigwell, Prosser and Lyons 1999). A student who takes a deep approach in one subject or part of a subject, may take a surface approach in other subjects. We can activate students' learning motivation and influence their approaches by the way we design our subjects and courses, particularly the assessment. We can provide a student-centred learning environment and use some effective teaching techniques to encourage students to take a deep-learning approach.

The development of deep approaches to learning can be encouraged by:

- activating students' learning motivation by providing distinct course objectives, and clearly explaining the structure of the subject/course in an explicit manner;
- encouraging a student-centred approach that emphasises students' understanding and the development of awareness of the relationships between prior knowledge and new knowledge;
- encouraging active engagement in the learning tasks, such as inquiring into relative issues, analyzing complex problems or case histories, and attending practice laboratory;
- organising small group discussions, group presentations (e.g. posters), holding debates; allowing students to compare their understandings with each other and the tutors; and
- designing assessment to encourage students to understand and make their own connections with the content (this requires giving students qualitative feedback).

### ***Encouraging a student-centred learning approach***

After graduating from university, students will engage in their professional jobs. They will need to continually upgrade or improve their knowledge and skills in order to make a contribution to their profession or job. For this to happen, during the formal years of education, students need to learn how to be self-motivated and how to continue to learn when there are no teachers to tell them what to do.

Student-centred learning helps develop the generic skills of students. We should develop students' knowledge skills, thinking skills, personal skills, personal attributes and practical skills. When they graduate from the university, students should have a command of the basic knowledge and be able to apply theory to practice in particular situations; they should be able to think independently, and have the ability to make informed decisions and solve problems; they should be able to plan and achieve goals in their personal and professional field and have the ability to work with others; they should be able to use information technology for professional and personal development, have the ability to observe, analyse and test the experiment results. These generic skills are essential for their lifelong professional life.

Student-centred approaches can be encouraged by:

- *offering a safe student-centred environment for them to talk about the discipline, to explore ideas without receiving too much negative criticism*
- *using active classroom styles, e.g. small group activities so that students can share information and help to teach one another* Students listening to other students sometimes is more effective than students listening to the teacher.
- *encouraging students to give presentations or posters on a subject* Before the individual student gives a presentation, he/she has to confront the issues of 'Do I understand it myself?'. Most research indicates that students really understand something when they need to teach the knowledge to someone else (Tao 1999). This

will encourage students to find the related information and improve their self-study skills.

- *letting students assess one another's work* The skills of peer assessment and self-assessment are not easy but for lifelong learning students need to be able to self-assess.

### ***What type of teaching encourages effective learning?***

Teaching is a complicated business. A commonly held view about teaching is that teachers transmit information to students. Good teachers, according to the traditional view, are those who understand their topics well and are able to present information in a clear, interesting and enthusiastic fashion. A more contemporary view would add that good teachers not only have to transmit knowledge clearly, but also need to develop the generic skills of students so that when they graduate they are well rehearsed to join the workforce in an effective way. Employers now demand that graduates are able to deal with the issues of the 21<sup>st</sup> century including the ability to work effectively in groups, to be able to search (the Web, databases, libraries, etc.) for information and to be able to process and use the information in a productive way.

### ***What are 'good' teachers?***

Good teachers not only instruct students, they also plan suitable and relevant learning activities for their students. They are able to devise learning tasks that capture student interest and engage students in solving problems and in analysing new information. Good teachers are concerned with helping students to learn how to study and they are continuously improving their teaching strategies to help students grasp the demanding ideas and the complex theories of the ever-increasing science disciplines. Good teachers encourage students to take a deep approach to learning.

Good teachers pay attention to their students' progress. They care about monitoring students' learning and helping students overcome any misunderstandings they have developed. Good teachers are continually challenging students, while at the same time supporting them during their learning. Good teachers are frequently asking their students questions and carefully considering what their answers reveal about their learning. Good teachers encourage deep learning approaches and provide student-centred learning environments. Good teachers develop students' generic skills.

### **The introduction of student-centred learning in the teaching of Microbiology**

The knowledge base in all scientific disciplines is getting larger every year, and this is especially so in the field of modern molecular biology. It is important then that the scientists of tomorrow have the skills to cope with this expanding base and to develop processes to work with the inevitable inventions and developments of the future. Developing self-motivation and reliance in students is an important attribute and the use of student-centred learning in science teaching is a mechanism to help enhance the abilities and attributes of our future leaders of science.

### **Context of the discipline and its teaching**

Microbes (microorganisms) are essential to life. Among their roles, they are necessary for geochemical cycling and soil fertility. They are used to produce foods (e.g. bread, wine, soy sauce) as well as pharmaceutical products (e.g. antibiotics) and industrial compounds (e.g. acetone, acetic acid). In addition microbes are used extensively in research laboratories to investigate cellular processes because they are easy to grow and manipulate. On the negative side, they are the cause of many diseases of plants and animals and are responsible for the spoilage of food.

We require our students to grasp the basic theory and experimental skills of Microbiology. They need to understand the activities of microbes and how to control them. They must not only develop an understanding of how and when microbes are detrimental to humans, but also appreciate how to enhance and manage the beneficial effects of microbes.

Microbiology is a required course for a third year Biology major student at Zhejiang University. There are about 30 students in each small class. The course is taught in a traditional manner with formal lectures (using *PowerPoint*) and practical classes and with a teacher-centred teaching approach. The students just follow the lectures, take notes or copy notes after class. There are 3 hours of lectures and 3 hours of practical class each week. Practical classes are an important part of the learning experience as there is a need for students to grasp the basic experimental skills of microbiology, which include: microscope techniques; microbial staining techniques; inoculation technique; microbial purification; culture media manufacture; and some basic biochemical tests.

Microbiology is a subject that has very significant links to real world situations and many of the problems of the future may be associated with microbes and their effect on environments. To be better equipped to deal with real-life problems in the future students should be encouraged to adopt deep learning approaches when studying at university so that they develop the skills of analysis, problem solving, and critical thinking.

Students currently appear to be taking a surface approach to learning. They appear to focus on the content of the course and pay attention to the results of the examination. Introducing them to a safe student-centred learning environment may encourage them to take a deeper approach to learning. Some of the strategies that could be introduced are discussed below.

### **Small group discussion**

Small group discussions give students the opportunity to have time to think about an issue, search for appropriate and relevant information, and improve their self-study skills. Small groups are considered to be more appropriate than large groups and it is suggested that student are provided with the topic in advance, together with some information resource (suggest use of the Web, journals, etc.). Topics suitable for small group discussion include the function modes of antibiotics, nutrition requirement of microbes, and factors affecting microbial growth.

### **Student presentations**

Various types of presentations can be used in class, including the use of a debate (simulating a real debate) and the production of a poster (mirroring what happens at a scientific conference). Examples for a debate include 'antibiotics have done more harm than good' and 'microorganisms are beneficial to human beings' and for a poster include 'bacteria in the environment', 'antibiotics and its function', and 'industrial microbes'. These activities will help students develop their oral and written communication skills and will be seen as relevant to real-world issues both in the content of the activities and the ways they are carried out.

### **Use problem based learning (PBL) in Microbiology teaching**

Problem based learning (PBL) is a powerful learning and teaching approach (Woods 1994). Students learn by themselves or in groups and learn how to solve the problems. The essence of problem based learning is to use a real-life problem that is not too easy or too difficult for the students and one that may have several 'solutions' (as real life often does).

### **Example of a real-world problem**

The following is an example that could be used anywhere in the world.

*During the September 11 terrorist attack in 2001, it was reported that the office of the US Senate majority leader, Tom Daschle, received a letter that contained anthrax powder in it. The official speaker said there maybe some possible link with the terrorist attack.*

*The official said the powder had been sent to the Centers for Disease Control and Prevention for additional testing. In the following days, several cases of anthrax are reported including the death of one man in Florida. The official wanted the public not to open suspicious letters but to send them to the police.*

*Inhaling anthrax causes the most lethal form of anthrax. It resembles a viral respiratory illness and initial symptoms include sore throat, mild fever, muscle aches and malaise. A person who is exposed to anthrax but is given appropriate antibiotics usually avoids developing the disease.*

This news made many Americans very anxious about the disease. It was reported that many Americans spent many hours searching for information about anthrax; they reported suspicious letters to the authorities; and even bought antibiotics if they were available.

*What is anthrax? Why did this event cause public panic?*

### **Techniques to use in a PBL situation**

- **Brainstorming for students** – is a useful technique for students to start working on a problem. In a small group they can develop a pre-concept map about the problem and this can then help the teacher to appreciate the current level of student understanding and to make suitable suggestions about resources that could be followed up by the students.

- **Identify/discuss/assign mode for teachers** – is a good set of instructions to follow. The teacher provides students with 1) textbooks, 2) web sites, and 3) some scientific journals. The teacher's role is supportive, assuming the role of a tutor or coach, not directive.
- **Individual reading/research/preparation** – Students will be expected to spend time on individual study outside the small group to search for and study the new information and concepts. Students should be allowed to build up their own schema. Let students do experiments in the open laboratory and write laboratory reports.
- **Return to group for discussion and reporting** – As they return to their small group, students will bring their new knowledge and information to the group. The teacher should give frequent feedback to students about their understanding of the process and the content, but avoid giving the 'answer(s)'. If necessary, the teacher may need to give mini-lectures on small aspects of the problem along the way.

### **Topics that could be used for PBL style teaching**

- **Basic topics:**
  1. Bacterial structure and function – including bacterial cell structure, bacteria cell wall, nutrient transport across the cell membrane;
  2. Microbiology nutrition and growth – covering nutrients of microbes, culture media, methods for cultivating microbes, factors affecting microbial growth;
  3. Bacteria and their environment – environmental issues, bacterial disease, human host defense mechanism, control of bacterial infection; and
  4. Antibiotics and their function.
- **More advanced topics:**
  1. Microbiology metabolism – including heterotrophic pathways, electron transport and oxidative phosphorylation, autotrophic metabolism, biosynthetic pathways; and
  2. Bacterial genetics – mutations, mutagenesis, recombination and transposition, DNA repair mechanisms, plasmids.

## **Educational implications**

To improve teaching and learning in university education, we should encourage students to develop deep learning approaches to their studies. Providing a student-centred learning environment for the students enables them to work comfortably within the discipline. This may be enhanced by the use of group activities with students sharing their ideas and helping one another. In this way they will also develop the generic skills needed for their professional careers.

The provision of independent students who take responsibility for their learning, and who have the capacity to continue to learn after graduating, will enhance the scientific community of tomorrow. These scientists will have the ability to work cooperatively on serious world issues associated with all aspects of microbiology whilst continuing to improve and upgrade their skills.

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