Using student-centred teaching approaches in the course of *Analog Electronic Circuit*

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Abstract

This paper introduces the current teaching and learning strategies in *Analog Electronic Circuit* in Fudan University, compares the different teaching practices at Fudan University and The University of Sydney, and analyses the problems experienced in the delivery of the course. Strategies for student-centred teaching are reviewed and recommendations are made to improve the quality of teaching and learning.

Current teaching and learning situation in the course

Analog Electronic Circuit is a compulsory course and fundamental for all engineering students. The purpose of this course is to teach students analysis and design techniques for electronic systems such as signal, differential and power amplifiers. Completion of this course will allow progression to advanced studies or to employment in electronics and telecommunication engineering.

The course consists of 72 hours of lectures, 18 hours of laboratory sessions and 36 hours of question and answer sessions. Assessment includes: laboratory work worth 25%; and an end-of-semester examination worth 75%. Each year there are three classes, each of 100-150 students and three teachers. Also each class has 2-3 postgraduate students who tutor the students, assist in lectures and correct student homework. In recent years, we have tried many new teaching approaches in order to improve the quality of teaching within this course. Some of innovations that I have employed in the course are outlined.

Multimedia and use of the Web within lectures
Data projectors and computers with Internet access have been installed in about 90% of classrooms in Fudan University. Most of the teaching and laboratory materials are made available from the web site. The electronic engineering department has a FTP server available to the students and teachers and each student has an email account.

Preparing lecture slides in English
Within Fudan University's Library and in some technical bookstores in China, there are many English-language reference books that are used in Massachusetts Institute of Technology and Harvard University.

Student consultations
Outside of lectures, I make two hours per week available for student consultations. Also there are two assistant teachers assigned to correct students' homework and answer student's questions.

New software
ORCAD software is used in the laboratory to help student analyse and design electronic circuit. (A special hardware experimental course is conducted in the following semester.)

Peer assessment
Two retired academics attend my lectures at random to assess teaching quality. There is also an online curriculum evaluation system within Fudan University.

What we have achieved is enhanced student motivation and provided some opportunities for students to solve problems themselves and to allow them to develop better communication skills. But any improvement in the effectiveness of this delivery is not obvious. Some students still feel the course is difficult and boring and they are not interested in it. Each year about 10% of students fail this course. So what can be done to change this situation in the future?

I have been very fortunate to have had the opportunity to attend the professional development program, *Teaching Science in English* at The University of Sydney and observe lectures, laboratory classes, tutorials in my discipline. During the course, I have learnt a great deal about contemporary education theories. I have come to realise that I have adopted a teacher-centred approach, with the intention of transmitting content to the students. In Fudan University, most of the students have four hours of lectures each day. They have little time available for thinking about the content or discussing it with their fellow students. Strategies adopted by The University of Sydney are more student-focused. Most of the courses involve lecture time that is only half of what is common at Fudan University, and the lectures are supported with tutorials. *Electronic Devices and Basic Circuits* is a core unit in second year electrical engineering at The University of Sydney. To use it as an example, the course consists of 36 hours of lectures, 18 hours of laboratories and 18 hours of tutorials. Assessment includes: laboratory work – 15%, online exercises – 5%, mid-semester quiz – 10%, end of semester examination – 70%.

Even when we provide students with an opportunity to ask questions and discuss problems, very few students participate. So what are the advantages of student-centred strategies?

The next section covers a brief review of contemporary education theories and the approaches which I plan to introduce into my course.

A review of contemporary education theories

During the course *Teaching Science in English, w*e have been introduced to contemporary issues and research into the areas of teaching and learning in science. These include: constructivist learning theory; problem based learning; case study and contextualised learning; student-centred and collaborative learning practices; and the use of online learning strategies in science teaching. Based on this experience, I believe the most appropriate combination of contemporary education theories is student-centred and collaborative learning practices. In traditional teacher-centred approach, students attend lectures, copy from the blackboard, take notes from the lecture material: some of them study the material and attempt to solve the textbook questions after the lectures while others might face the material for the first time just before the final examination. This approach focuses on transmitting information to the students. The prior knowledge of students is not considered to be important and it is assumed that students do not need to be active in the teaching-learning process. (Trigwell and Prosser, 1996). Alternatively, a student-centred approach is one in which teachers adopt a student-centred strategy to help their students change and reconstruct their views or concepts of the phenomena they are studying, and so the teacher has to focus on what the students are doing in the teaching-learning situation. The teacher must realise that he/she cannot simply transmit the new knowledge or concepts to the students, (Trigwell and Prosser, 1996).

Trigwell and Prosser (1999) reported the results of a quantitative study aimed at investigating the relationship between a teacher's approach to teaching and their student's approach to learning. They concluded that teachers who themselves report adopting a more information transmission/teacher-focused approach to teaching have students who themselves report adopting a more surface approach to learning.

So research has suggested ways to improve student learning. How can we apply those ways in our class?

New teaching approaches of my course

As lecturing is one of the most important teaching strategies, I will concentrate on what constitute a good lecture. 'Good lectures' can be described in terms of seven characteristics: level; pace; structure; clarity; explanation; enthusiasm; and empathy. Of these, it is the *three Es* – explanation, enthusiasm, and empathy that are supportive of a deep approach to learning (Hodgson, 1997; Ramsden, 1997; Marsh, 1987). So what can we do to incorporate *three Es* into our lecturing? One method is Interactive Lecture Demonstrations (ILDs), a methodology which originated at Tufts University, Boston and one which I plan to introduce into my teaching. Thornton and Sokoloff (1996) indicated from their research data that students' understanding of dynamics concepts is significantly improved when ILDs are substituted for traditional lecture at both Oregon and Tufts. However, further research (Johnston and Millar, 2000) indicated that this new method of teaching, while effective in itself, may not yield the very impressive results experienced in the previous study. I believe ILDs can stimulate student's interest and motivate learning because they are more student-centred encouraging students to actively participate in the lecture, and I will try to use them in my teaching. To stimulate the interactive discussion, I will use computer aided instruction in the form of electronic circuit simulation software to perform a number of experiments. Prior to the electronic circuit simulation and experiment, students will be required to write down their predictions and discuss them within the group, then I will perform the demonstrations and discuss the explanations.

Secondly I will introduce problem based learning in my course. Problem based learning supports a contemporary constructivist view of education by using realworld cases or problems as vehicles for students to develop critical thinking and problem solving skills. Problem based learning allows students to develop better communication, team work and problem solving techniques. It is essential that the problems are properly chosen and adequately defined before being presented to students (Cawley, 1991; Prosser, 1985). The problem should be an open-ended mini-project which has the potential for self-directed study (Barrows, 1986) and research. There are many realworld cases and problems appropriate to *Analog Electronic Circuit*. I will select some cases or problems suitable for problem based learning.

For example, when teaching Integrated Operational Amplifier, I will develop a mini-project: *Electrocardiogram measure, amplify and display* for the students. This project covers many concepts related to electronic circuit and operational amplifier, concepts such as input impedance, differential signal, common mode rejection ratio, signal filter, etc. Students will be able to use sensors, operational amplifiers, resistances, capacitors, and batteries to design a circuit to measure and amplify electrocardiogram signal. They will work in small groups. In order to introduce the topic, I will cover some of the important concepts and methods in 6 lectures before introducing the students to the problem to be solved. Students will be required to design the circuit using electronic circuit simulation software since the appropriate hardware is not available for this course. As it is difficult for students to design hardware circuits if they are unable to use the necessary equipment, a special practical course related to the analog electronic circuit and involving hardware is conducted in the following semester. After the students have completed their design, they will be required to give presentations during lectures.

The third technique I will introduce is tutorials and experiments. Tutorials and experiments provide opportunities for the students to do be involved with group work. Group work is an important method for many students to develop their conceptual framework and to improve their problem solving skill. Although there are two assistant teachers to correct students' homework and answer questions for the students, there are no formal tutorials in my course. While some students do their homework themselves, others ask teacher questions about the homework, some seldom do their homework and some copy solutions from other students. At The University of Sydney, most courses have tutorials, and marks are awarded for attendance. As tutorials are more student-centred with students able to discuss and solve the problems within their small groups, I will introduce tutorials in my course.

Another important strategy to promote groupwork is experiments. At The University of Sydney most of the experiments are done as groupwork, while in our university most of the experiments are completed by each student working independently. It may be good to analyse and solve problem independently, however students do not benefit from working within a group. In my opinion it is important to have both independent work and groupwork for students to develop deep learning. My students will be required to complete two experiments working as a member of a small group, and seven simpler experiments working independently.

Finally, I will address assessment. In order to improve the teaching approaches, I will modify the assessment tasks. As well as determining to what extent students have mastered the course content by the end of the semester, assessment is also useful to guide and motivate students to become actively involved in their own learning. To support the new teaching and learning approaches discussed, assessment be varied to include: laboratory work – 20%, tutorials and quizzes – 5%, mid-semester examination – 5%, PBL project – 5%, and end of semester examination – 65%.

Summary

Student-centred teaching provides students with the opportunities to develop their lifelong learning skills. We are at a time when skills and knowledge are becoming obsolete very quickly, so in order to keep pace with developments in science, technology, globalization, and population ageing, we must continue our education and training throughout our working life. Although the effectiveness of student-centred teaching approaches has been proved in the western world, it still needs to be assessed in the performance of my teaching in the future. By comparing and analysing feedback from the students and the results of final examinations, it may be possible to see some benefit in the different teaching approaches. Maybe I will experience some problems in my future teaching, such as a lack of experience in student-centred teaching, time-consuming practices, but I will constantly analyse the situation and try to solve the problems in order to improve the quality of my teaching.

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