

# Active teaching and learning in *Principles of Communication Systems*

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## Abstract

*Principles of Communication Systems* is a fundamental course for telecommunication engineering and electronic engineering students. In this paper, I discuss the traditional teaching strategies, describe the contemporary education theories, and analyse the relations between teachers' teaching and students' learning. I describe new teaching strategies and ways to change teacher-centred teaching approaches into students-centred approaches. Finally, I discuss the challenges and barriers I may face when adopting the new teaching approaches.

## Introduction

At Beijing University of Posts and Telecommunications, *Principles of Communication Systems* is an introductory course for third year students who major in telecommunication engineering and electronic engineering. It is also a fundamental course for students to learn more advanced communication theory. In this course, I teach students the basic concepts and theories of analogue and digital communication theory. There are 68 lecture hours, 34 laboratory hours, and weekly homework assignments. Each year around 750 students take this course, and there are six lecturers. Figure 1 shows the structure of the course. The content can be divided into three parts. In the first part, knowledge of prerequisite courses is reviewed (e.g., definite signal analysis, signals and systems, and random signal analysis). In the second part, analogue communication theory, i.e. linear modulation theory (such as, amplitude modulation, double-sideband suppressed carrier modulation, single sideband modulation and vestigial-sideband modulation) and nonlinear modulation theory (frequency modulation and phase modulation) is covered. This is followed, in the third part by digital communication theory, which includes baseband transmission theory, digital transmission theory and optimum receiver theory.

The traditional teaching approaches we use are teacher-centred. I usually use blackboard and chalk, and seldom use an overhead projector (OHP) or *PowerPoint*. Because there are many mathematical details, I spend a great deal of time deriving equations, and showing some properties of communication signals. In the classroom, I try my best to make the materials I present logical, interesting and easy to follow. The students are passive. They just listen and write down what I say and copy what I write on the blackboard.

In recent years, we have become aware that there are some problems with the traditional teaching strategy. Due to the amount of mathematical content in this course, the students often feel it is boring and they lose interest: each year more than 10% of students fail this course. We have tried to reform the traditional teaching methods. We have updated our teaching materials, introduced new materials from classic international textbooks. We built a web site to assist students to learn by themselves. In the classroom, we tried to improve the interactivity between teachers and students by asking questions and using new presentation facilities, such as animation, OHP and *PowerPoint*. However, we did not try to change the teachers' roles. We are usually orators and information transmitters, paying more attention to presenting skills, rather than considering how much information is retained in the students' minds.

I am glad to have had the opportunity to attend the training program on *Teaching Sciences in English* at The University of Sydney. In the past four months, I learnt a great deal about contemporary education theories. In this paper, I will discuss how to use these theories in my future teaching, to help students learn better. In following sections, I will briefly review the contemporary education theories, and then I will describe the new teaching strategies that I am going to use and the

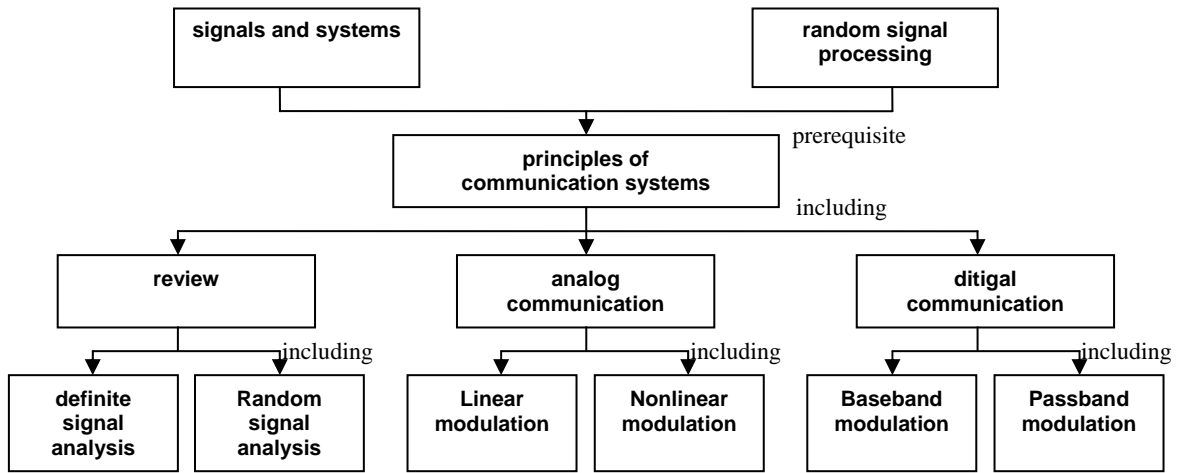


Figure 1. Course structure

challenges and barriers I may face. Finally, I will give the conclusions and acknowledgements.

### Contemporary education theories

In the past four months, we learnt a great deal about new education theories, such as constructivism, concept map, problem-based learning, case studies, lifelong learning, tackling large classes, etc. (King 2004). All these theories led me to rethink the relationships between teachers' teaching and students' learning. Figure 2 shows the links between teachers' conception of teaching and learning and students' learning outcomes (Trigwell, Prosser and Waterhouse 2000). The teacher's teaching approach depends on the teacher's conception of teaching and learning as well as the teacher's perceptions of the teaching environment. Traditionally, teachers conceive of learning as information accumulation and teaching as transmitting information to students, and adopt teacher-centred strategies. However, students' learning outcomes depend on their own learning approaches (surface or deep learning). Deeper approaches to learning are related to higher quality learning outcomes (Van Rossum and Schenk 1984). Students' learning approaches depend on students' conceptions of learning and their perceptions of the learning environment. Related studies show that a deep approach is associated with perceptions of high-quality

teaching, some independence in choosing what is to be learned, and a clear awareness of the goals and standards required in the subject (Trigwell and Prosser 1991). Now, the question is, what kind of teaching strategy can make students adopt deep approaches to learning? Or, how can we link the teachers' approaches to teaching with students' approaches to learning? Preliminary studies show that student-centred strategies can make students tend to adopt deep approaches to learning (Trigwell, Prosser and Waterhouse 2000).

Other studies show that learning strategies are varied substantially for different students (Committee on Undergraduate Science Education 1997). Some students prefer to learn through lectures, while others may learn best through hands-on or personal experiences. Learning is enhanced when teachers create a classroom environment that provides students with opportunities to learn in several ways. Teachers can employ a range of active learning approaches (talking and listening, writing, reading, reflecting) and varied teaching techniques and strategies (such as lectures, videos, demonstrations, discovery labs, collaborative groups, independent projects). Thus, teachers can help students make sense of the world in different ways and increase the likelihood that they will develop conceptual understanding.

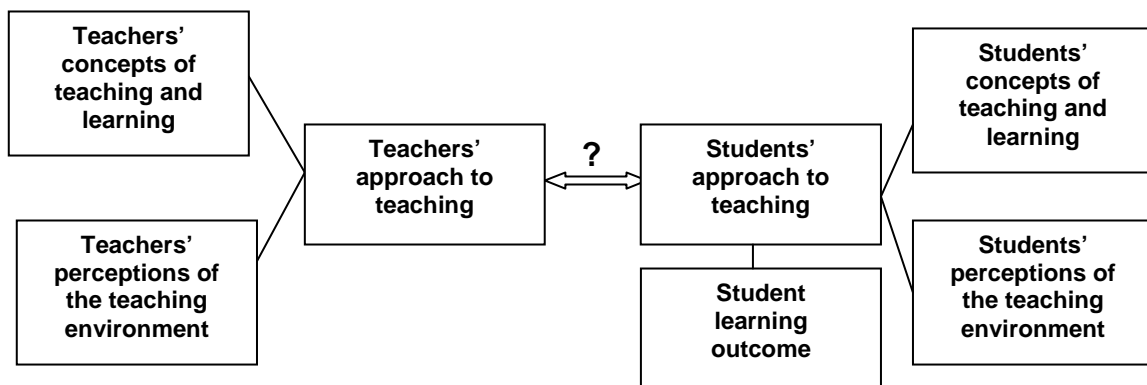


Figure 2. Links between teachers' conceptions of teaching and learning and students' learning outcomes

## New teaching strategies

With the above education theories in mind, I will consider how to improve my teaching approach to help students learn more effectively. Figure 3 shows my new teaching approach, which includes four sessions: lectures, assignments, tutorials and laboratory work. The tutorial is a new session. In these four sessions, I will introduce several new teaching strategies, they are: problem based learning (PBL), case study, group work, and computer simulation. PBL and case study can enhance students' interest. Here, I want to emphasise the importance of group work and computer simulation. Group work used to be neglected in China's education system. From primary school to the university, Chinese teachers pay more attention to students' competitive ability rather than their cooperative ability. We always tell students to do their homework individually, not to copy others' homework. According to contemporary education theory, group work is very important for students. Group discussion is an effective way for many students to develop their conceptual frameworks and to learn problem-solving skills as they try out their own ideas on other students and the instructor. The give and take of technical discussion also sharpens critical and quantitative thinking skills. Classes in which students must participate in discussion, force them to go beyond merely plugging numbers into formulas or memorising terms (Committee on Undergraduate Science Education 1997). Another reason for me to emphasise the group work ability is that most of our students will become telecommunication engineers or researchers when they graduate from the university. They will design and evaluate new telecommunication systems. Most of the current telecommunication systems are so complicated that we can't use analytical method to evaluate their performances.

Computer simulation is a powerful tool for telecommunication engineers and researchers. We have computer simulation courses for postgraduate students. Now I intend to introduce it to undergraduate students and integrate it into my teaching. In my opinion, the main advantages of computer simulation for undergraduate students are as follows:

1. Simulation can model real communication systems, and enhance student interest. Students can act as real telecommunication engineers to design and simulate simple communication systems. Readers can refer to the

literature (Proakis and Bauch 2004) for more detail about computer simulation of communication systems.

2. Simulation gives more opportunities for students to participate in self-study on communication system. Students can easily change the parameters and components of a communication system in a simulation, and then evaluate the performance of the new system.

## Challenges and barriers

The challenges and barriers for me to adopt new teaching strategies can be categorised into the following four aspects.

1. The challenges for managers and colleagues. *Principles of Communication Systems* is a large course. Each year around 750 students take this course. The students are divided into six classes, each with a different teacher. It is important for all the teachers use similar teaching strategies, because we usually have the same assessment task. I will need to convince the leader to approve my teaching strategies.
2. The challenges for students. The students are accustomed to traditional teaching strategies. They love to be taught and are accustomed to being passive. If I change the traditional teaching style, the students may feel uncomfortable, and it will take a long time for students to accept the new teaching style.
3. The challenges for myself. If I adopt new teaching strategies, I will spend a great deal of time rewriting my lecture notes, developing cases and teaching problems, and designing new assessment strategies.
4. The barriers from the 'hardware' environment. Our classrooms are not suitable for student-centred teaching and learning. They are designed for lecturing and are not for discussion and group work.

## Conclusions

*Principles of Communication Systems* is a core course for telecommunication engineering and electronic engineering undergraduate students. Traditional teaching strategies pay more attention to teachers' teaching rather than students' learning and are teacher-centred. Contemporary education theories suggest that teachers adopting student-centred strategies can help students learn better. If new teaching strategies are introduced into my teaching, there are many challenges and barriers to face and much arduous work to be done.

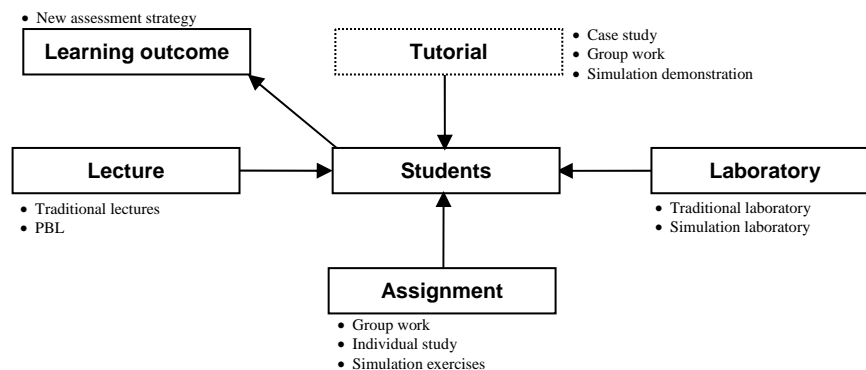


Figure 3. New teaching strategies

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