Enhancing *Transducers Technology* teaching with contemporary pedagogy

Chen Zhihong
Faculty of Physics and Electronics
The Central University for Nationalities
Beijing 100081
People's Republic of China

Chen_zhihong@21cn.com

Abstract

This paper considers teaching *Transducers Technology* to third year electronics engineering students. An undergraduate course in transducers technology is regarded as an essential component of any degree program in electronics or electrical engineering. I will discuss how the teaching outcomes of such a course might be improved by introducing contemporary teaching strategies such as problem based learning (PBL), case studies, concept mapping, and peer review.

Introduction

Transducers Technology was previously included in the courses *Instrumentation and Measurement* or *Control Systems*, but has now evolved into a separate subject. *Transducers Technology* deals with acquiring information. With the development of communication technology and computer technology, information transferring and control/manipulation technology are developing very rapidly, and this has led to a demand for a more efficient approach to acquiring information. As *Transducers Technology* has become somewhat of a bottleneck for technological development, many universities have introduced transducer technology into the curriculum.

I have been teaching this subject to electronics students for four years, with around 120 students taking the course each year. This subject is focused on the principles and applications of varieties of transducers. At our university, *Transducer Technology* is divided into 2 parts: 27 hours lectures and 18 hours of laboratory work. With the support of the faculty, I have tried introducing some strategies to improve the teaching/learning outcomes of the course. These include using multimedia technology to deliver lectures, using the Internet to communicate with students, and modifying the assessment. However these reforms have not proved to be as effective as I anticipated. The students are still not actively involved in class. The results of the examination show that some students still have not grasped the basic knowledge. Some students came to me for help subsequently when they had to deal with transducers in their further study and professional career. They regretted for not paying more attention to the subject when they were studying it.

In the past four months I have learned a lot from the courses of Mike King and Mary Peat and the seminars from the faculties at The University of Sydney.

I have come to realise that:

- not all students learn the same thing at the same time during lectures, it is necessary to use different 'hooks' to 'catch' different students; and
- motivation can have a greater effect on the success or failure of a teaching/learning situation than other factors (Wlodkowski, 1999)

When I return to China, I will try to modify my teaching of *Transducer Technology*, based on these two realisations. My modification will focus on the aspects described below, and I have given some examples to explain the proposed changes.

Proposed teaching design modifications

Updating the course content
Transducers Technology is a very broad subject and is interdisciplinary in content. It is based on a knowledge of physics, chemistry, biological processes, signal conditioning and processing and even manufacturing technology. So what should

be taught? How should the content be organised? (Fox, 1996)

The traditional content of this course is listed in Table 1 and these are the basics that students should master. Some of concepts have been discussed in previous courses such as *Universe Physics* and *Basic Circuit's Theory*, and some students might find that the content is not very challenging, and they are more interested in the transducers introduced to industry in more recent years. Therefore in my lectures I would like concentrate on those new categories of transducers that are widely used in industry. Some of these are easy to understand (e.g. resistive transducer, capacitive transducer and inductive transducer) so I will discuss them briefly and leave the students to study them independently.

Most of the textbooks published in this field in China organise the content according to the characteristics of the transducers, while textbook published in other countries organise the content based on the application of the transducer (as shown the right hand column in Table 1). In my opinion, the traditional arrangement of content is more suitable to be used in the preparation and deliver of lectures. The latter or western arrangement will be more helpful when designing or selecting a device for a specific application, and it is good for developing the students' problem solving skills. This arrangement will be recommended to students for reference.

Table 1

Traditional contents	The content I will choose
Resistive transducer	Transducer for length
Capacitive transducer	Transducer for force
Inductive transducer	Pressure Transducer
Piezoelectric transducer	Transducer for temperature
Thermal transducers	Flow Transducer
Photoelectric transducer	Acceleration Transducer
Radioactive transducer	Transducer for light
Chemical transducer	Chemical transducer
Bio-transducer	Bio-transducer
Signal conditioning and process	Signal conditioning and process

Interactive lectures

As a teacher of engineering, I had taken it for granted that the students should be motivated and have an interest in engineering subjects because the knowledge is so useful. On the contrary, some students feel that engineering is boring. I prepare my lectures very carefully so that students find them interesting and easy to follow, but still the outcome is not what I expect. Some of the students just sit in the classroom copying the notes with confused expressions. They will forget most of what I tell them in lectures except the jokes. I now realise that the students are not properly motivated, there is little interaction in the classroom.

Interaction in the lecture is very important. An easy interaction in class is through demonstration but sometimes it is not very effective. Another method to encourage interaction is posing questions. When the lecturer asks a question in the class, some students may not want to answer the question because they are shy while others are worried that if they make an incorrect answer they might appear not as clever as some other students. Personal Response System (PRS) is an effective and powerful interactive classroom communication system which allows instant feedback in large lecture classes (Sharma, Khachan, Chan, Stewart, Hogg and O'Byrne, 2002). With PRS, each student can answer the question by pressing a number on a keypad. However the system is expensive and it may not be available if we cannot get financial support. I will try these simple approaches to stimulate interaction in class: I would like to ask the students to 'check with your neighbour'; argue with each other; or present your answer to me by displaying it on a paper board (suitable for multiple-choice questions).

Case studies

Case studies are stories with an educational purpose. The formal use of case studies in the science classroom is a recent initiative. A good case tells a short story that focuses on interest-arousing issues set in the past five years. A good case is relevant to the reader, creating empathy with the central character/s. A case study is a meaningful way to teach science with classroom discussions and small group learning.

An example

In a university's computer access centre, an ultraviolet light was set up in order to clean the air. On the wall there is a sign from the administrative staff. It reads: 'Before you enter, please switch off the ultraviolet ray light!' On one occasion, students forgot to turn the ultraviolet ray light off and they suffered damage to their eyes. Design a simple system that will automatically control the ultraviolet light.

To prepare the students, I will give lectures on photoelectric transducer.

Problem based learning (PBL)

PBL is a learning environment that embodies most of the principles that we know improve learning outcomes: active learning; cooperative learning; prompt feedback; and tailoring to students' learning preference. PBL forces the students to learn the fundamental principles of the subject in the context of needing it to solve a problem. PBL offers an opportunity to practice, use (and even develop) such processing skills as problem solving, interpersonal and teamwork skills. PBL begins with tackling a relevant problem that usually covers most of the course knowledge (Woods, 1994). As educators, we need to be careful when preparing problems suitable for PBL, because real problems are usually very complicated and may be confusing to students.

An example

In a spaceship there are many parts which should be in a controlled temperature. Size, lifetime, stability and energy consumption are key specifications for such equipment. A research group from NASA (National Aeronautics and Space Administration) is advertising for an auto-regulated temperature control system, which will be used to control the temperature of a very small metal cylinder (no more than 2 cm high and 1 cm diameter) and stabilise its temperature to an exact temperature of 120°C (however it *should be adjustable to 120 ±0.001°C). If you are successful in designing such a system, you will be rewarded with the opportunity to work for NASA.*

Concept mapping

Concept mapping has been proved to be a very useful skill for students and teachers. Using concept mapping, students can deconstruct and reconstruct relevant mental models. Concept mapping is a very important component of modern teaching strategies. If it is applied in association with modern teaching strategies (e.g., PBL and case studies), then we can avoid some of the shortcomings of the other modern teaching strategies. When compared with traditional teaching methodologies, the knowledge that students achieve from PBL and case studies is somewhat less systematic. According to developmentalism, we all have different schema and they are of varying degrees of sophistication because each of us has a different experience of the world. We should teach by trying to understand our student's schemas, by challenging them and forcing them to assimilate and accommodate new aspects of the schema. Learners learn by modifying these schemas through the processes of 'assimilation and accommodation'. If students can accommodate new information in a meaningful way into their existing schema, it means students learn in a deeper way. (Jiang, 2004)

In the past, it has been my experience in the first lecture on transducer technology, to give the students an opportunity (5-10 minutes) to think about anything which is related to sensors, and I would repeat it at the end of the semester. Now I can see that it is similar to the process of concept mapping. I intend to enhance this in my future teaching by asking the students to draw a concept map and give a short presentation.

Laboratory work

In recent times there has been a move towards design oriented laboratory work in our teaching and I will attempt to alter my experiments to follow that trend.

'Push the student to think like an engineer/scientist', was stated in many of the seminars during *Teaching Science in English*. Most of the contemporary teaching strategies such as PBL and case studies are helpful. However I realise that it is also very important to pay attention to the laboratory record book (logbook). I used to think that it was very important for an engineer to be scientifically rigorous. In order to develop in my students, the habit of being precise, I required that the students' experimental reports were very neat. In reality, the engineering process requires accurate and usable records of the work that has been done and the logbook is both a scientific record and legal document. In real engineering project, properly recorded and authorised logbook plays a very important role in protecting your patent rights. So I would like to ensure that the logbook be properly recorded in the future. For example, the records must be done by pen, not pencil, correction fluids must not be used to hide preexisting results. Pages must not be removed etc. I think it will not only force the students to prepare carefully before they come to my laboratory session, but will also help them to develop good habits.

Peer review

Peer review is based on social constructivism. Through peer review, the teacher can form an authentic learning environment similar to an academic society in which a researcher submits a paper to a journal and receives reviews from society members before publication. Students using this learning strategy are expected to develop higher level thinking skills. Peer review is an effective strategy that promotes learning motivation. (Liu, Lin, Chui and Yuan, 2001)

In recent years, I have tried to reform the assessment procedures. It has been traditionally an examination in an assigned time, say 2 hours. Last year, I introduced presentations as part of the examination process. The students were asked to do an investigation and give a 15 minute presentation on one of sensors that had not been discussed in lectures. Because it is a very large class, the examination required a great deal of time. Although the students were not required to attend all of the presentations, most of the students did and found them very interesting. They perceived it as being very helpful. It may be better to change the individual presentation to a group presentation requiring teamwork.

Conclusion

We are in a time of knowledge explosion, and as science teachers we are facing great challenges. I would like to try to improving my teaching with contemporary strategies, such as PBL, case studies, peer review, concept mapping. When using these strategies, I will concentrate on teamwork and professional practice because employers are looking for cooperative spirit and skills in undergraduates.

My change in teaching is based on the contemporary education theory and other research, and while it seems feasible, whether it is suitable for my students is yet to be seen? In order to find out if these changes in teaching are realistic, effective and manageable, I will need to analyse the result of the paper examination and to survey the students. I will modify it frequently.

In conclusion, I will try my best to apply the contemporary pedagogy in my teaching, but I expect the change to be an evolution, not revolution.

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