Using student-centred teaching strategies to carry out bilingual teaching in a *Data Structure* course

Lu Pengli
School of Computer
and Communication
Lanzhou University of Technology
Lanzhou 730050
People's Republic of China

lupl@lut.cn

Abstract

Chinese students' lack of motivation and innovation is the biggest concern in our universities. Traditional teacher-centred learning models are more likely to result in surface level learning. Based on the review of the current state of teaching in *Data Structure* in Lanzhou University of Technology, this paper discusses how to use the student-centred methods, such as concept mapping, case study, problem-based learning (PBL) and group projects to improve teaching quality. Also, the need of bilingual education in China is introduced. In addition, it explores assessment and problems that can be anticipated with these new teaching approaches.

Introduction

Learning is a complicated activity. Students aim to master knowledge and skills for their future career. Teachers aim to pass on knowledge and enhance students' learning ability. The most effective approach is to encourage students to become active participants in their own learning process and to take more responsibility for it.

In Western society, there are some new trends and changes in education including a movement from a 'teacher-centred approach' to a 'student-centred approach', and recognition that, wherever possible, students must be active participants in the learning process in order to promote deep level processing of knowledge.

Also, international cooperation and exchanges in education have increased year by year: many countries now proposing bilingual education.

In China traditional teaching approaches still dominate the campuses of universities. Teachers give formal lectures to transmit knowledge. Students receive it passively and are expected to reproduce it accurately in examinations. This kind of teaching approach mostly leads to a surface level learning and over-dependence on the lecturers.

The Ministry of Education has launched the *Higher Education Institution Teaching Quality and Higher Education Reform Project* aimed at upgrading the quality of higher education and using bilingual teaching in China. Through this project, some of the teachers in universities who teach science core curricula are sent to the developed countries such as Britain, the United States, Canada and Australia, to improve their English and teaching skills.

I was fortunate to be honoured with the chance to take part in the program *Teaching Science in English* at The University of Sydney. Here, I have learned some contemporary theories of teaching and learning.

Comparing with Australian education, I found some disadvantages in our traditional teaching. It is very important for students to have the ability to acquire information and learn by themselves at any time. When I return to China, I will introduce some new approaches into the course *Data Structure* at Lanzhou University of Technology including concept mapping, case study, PBL and group projects. Many of these are student-centred teaching and learning methods, employed in many large universities around the world and proved to be effective. These strategies can guide students to read widely, think deeply, analyse comprehensively, doubt boldly and improve their motivation and innovation.

Mentor
Bing Bing Zhou
School of Information
Technologies
Faculty of Science
The University of Sydney

Course description

In computer science, a data structure is a way of storing data in a computer so that it can be used efficiently. Often a carefully chosen data structure will allow a more efficient algorithm to be used. A well-designed data structure allows a variety of critical operations to be performed, using as few resources, both execution time and memory space, as possible. Different kinds of data structures are suited to different kinds of applications, and some are highly specialised for certain tasks. So, in the software construction, the choice of data structures is a primary design consideration.

Data Structure is a core course in computer science. It is available to second year undergraduate students in Lanzhou University of Technology. *Data Structure* is comprised of five parts: lectures (52 hours), practicals (8 hours), a group project (2 weeks with 3-4 students per group), a review paper (6 hours), and individual oral presentations (6 hours). The oral presentations are normally given as a review of the project.

Current teaching approaches

'Chalk and talk' is the predominant teaching style in the campuses of universities in China. Using these teacher-centred strategies, teachers give formal lectures to transmit knowledge and students receive it passively. Students are over-dependent on information selected and provided for them by their lecturers. However, many of us are becoming more aware that during lectures students are not actively engaged with the topic. They usually listen for long periods, and their retention of concepts is minimal. According to a survey, in a traditional course, students only listen, and they can only retain 26% of the knowledge the teacher presents (King 2006).

Generally speaking, teacher-centred approaches lead to surface learning. Teachers act as gatekeepers of knowledge, controlling students' access to information. Students have little motivation to learn.

Using student-centred teaching and learning strategies

'How can I get my students to think?' is a question asked by many faculties, regardless of their disciplines. Students are always the key players in learning activities. Teachers should act as facilitators to help students to access and process information.

Student-centred teaching and learning strategies focus not just on what is taught but also on how effective learning should be promoted. If motivated, students will spend more time and energy learning course material actively, instead of passively. It is not surprising that student-centred teaching and learning methods present good ways for students to learn, because of the following advantages:

- it can nourish and enhance curiosity and the natural desire to learn;
- it can help students achieve the results they appreciate and consider worthwhile, and which builds their self-esteem and confidence;
- it can uncover the excitement in intellectual and emotional discovery, which leads students to become lifelong learners; and
- it can improve the teachers' attitudes, which are very effective in facilitating learning.

There are many kinds of student-centred learning approaches, such as concept mapping, case study, PBL, group project, etc. When I return to China, I would like to integrate some of the student-centred learning approaches I have learned from the project into the course *Data Structure*.

Concept mapping

Concept maps offer a method of representing information visually. The primary function of the brain is to interpret incoming information in order to make meaning of it. It is easier for the brain to interpret it when the information is presented in visual formats: this is why a picture is worth a thousand words.

Concept maps are networks of related concepts that are interconnected. Usually, the maps consist of nodes and links. Nodes represent related concepts within a topic; links represent the relationship between concepts (Lanzing 1997). Concept maps can be used at the start of a topic, which can help students establish the main relationships between different concepts (Novak 2006). Then the teacher can focus on one or two important aspects, and let students study other concepts by self-directed learning.

Many of the concepts in the course *Data Structure* are extremely abstract. Constructing a concept map is a good way to help students build a knowledge framework and a mental connection between the main concepts and their relationships and master the knowledge system. Figure 1 is a concept map for *Data Structure*, which involves two of the most basic concepts: data structure and algorithm. In the first class, I will give students the concept map. Then after one chapter, students can draw their own concept map of that chapter. These concept maps could help students to test their understanding and force them to actively and critically think about what they have learned and what the relationships between all those relevant concepts are. This will aid students' learning by explicitly integrating new and old knowledge and assimilating new concepts into existing cognitive structures.

Problem-based learning

PBL is a curriculum design and a teaching/learning strategy which simultaneously develops higher order thinking by placing students in the active role of practitioners (or problem-solvers) (Cruickshank 2002).

The problem selection is the most challenging and important component in PBL. The problems should be open-ended enough to require collaborative and creative problem solving but not too ill-structured to cause students to wander too far from the intended learning outcome.

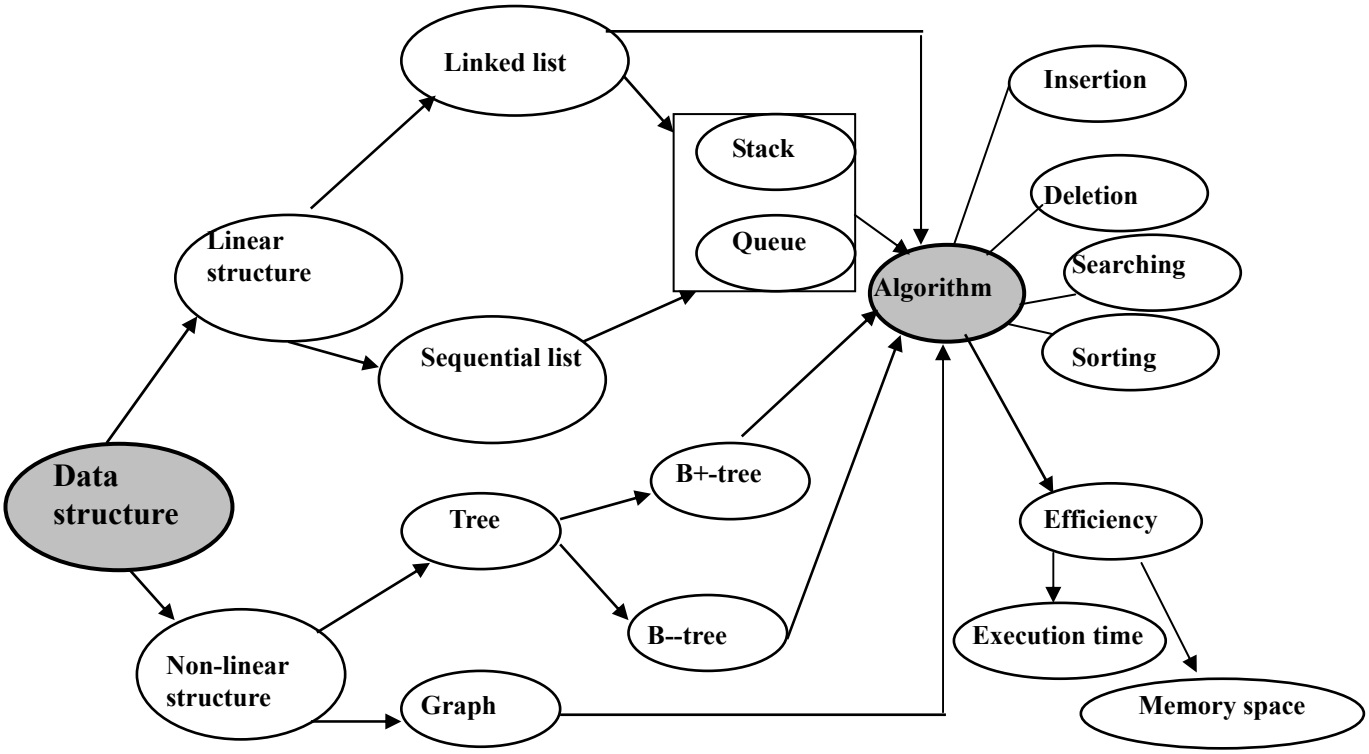

Figure 1. Concept map of *Data Structure*

Good PBL problems are meant to encourage a dialogue within a group about what knowledge or insights each student brings to the situation, what information is still lacking, and where to find that information. Students can make a valuable contribution to the efforts of the group. Some students may have more 'content' knowledge than others, and will be able to test just how deep that knowledge is, by trying to explain an idea to someone else. Others can often help their group see a situation from different perspectives and, through their questions, make certain that all in the group finish with a true understanding the material.

An important result of PBL is that while problems are used to identify what to learn, the process of learning 'how to learn' is also developed. This method can help students develop important skills for success both in their undergraduate education and in their professional life following graduation.

Case study

Case studies are different from PBL. They give real and complete stories with messages and questions, and teach through those stories. The case usually has both academic significance and social application (King 2006). A good case study should be interesting, relevant, motivating, integrating many disciplines and related to the real world.

Case studies enable students to understand the application of data structure to real-world problems. In a case study, the teacher guides students through the maze of the case discussion by questioning, demonstrating, and highlighting the main points or issues. The students will be given background material related to the case, to read, think about, and discuss. After that, students can understand the generation of the problem, and determine the methods to solve the case. At the same time, there is an opportunity for teachers to ask students some relevant questions to stimulate their thinking and to enable them to discover the route to a possible solution or resolution. It is a very useful way to train their academic and critical thinking abilities (King 2006).

Group project

Some of the projects in *Data Structure* such as complex expression evaluation using stack; creating binary tree and getting binary code, can not be done by one student. Students will be divided into small groups, each group with 3-4 people. Attending a group project is a cooperative learning experience for students because of the following features:

- face-to-face meetings;
- leadership skills;
- self-esteem gains;
- conflict resolution skills; and
- role-taking abilities.

Though many approaches mentioned above for teaching/learning exist, they should not be divided sharply or be used in isolation. The best result will be obtained by integrating several approaches in any individual course.

Using bilingual teaching

International cooperation and exchanges in education have increased year by year. Adapting to these changes, many countries have used bilingual teaching and new strategies in their universities where core subjects are taught in both the mother language and a second language (usually English). In Japan, there are many scholars who advocate teaching students subjects such as mathematics using English, while

other subjects such as history is taught solely in Japanese. In parts of Southeast Asia, such as Thailand and Malaysia, since the mid-1990s bilingual teaching to higher education has become more and more prevalent. Bilingual education that emphasise a gradual transition to English academic material reading and understanding, provides continuity in student's cognitive growth and lay a foundation for academic cooperation and success in the future.

In China, students learn English from primary school. Yet a great proportion of the postgraduates can not read academic papers in English due to the lack of the knowledge of terminologies. In order to provide the undergraduates with skills for conduct research internationally in their future study, some of the universities choose one or two core curricula and adopt bilingual approaches in mathematics, biology, physics, or information technology courses.

To carry out bilingual teaching, first of all, I should choose a good English textbook for students and prepare English slides for lectures; I should provide English information about *Data Structure* for students to read. As many of the concepts in the course *Data Structure* are extremely abstract I should pay attention to the proportion of English interpretation and some lectures should be given in Chinese.

Assessment

In a group project, student experience collaborative work and develop project management skills. How can we assess the work of students working as a member of a team?

Peer assessment in group projects

Peer assessment is assessment of students by other students. Table 1 and Table 2 provides examples of peer assessment (Kennedy 2006) where:

- n is the number of members in the group;
- each member allocates scores to other members (n-1), marks totalling 100*(n-1); and
- final 'contribution' for each group member is an average of the n-1 scores allocated to them by other members of team.

Table 1. Example of assessment of peers

Team 1: Peer assessment by Wang (8)		
ID	**Name**	**Score**
1	Zhao	115
2	Qian	100
3	Sun	100
4	Li	100
5	Zhou	95
6	Wu	95
7	Zheng	90
8	Wang	-
9	Lu	105

Peer assessment has some advantages as follows:

- helps students to become more autonomous, responsible and involved;
- encourages students to critically analyse work done by others, rather than simply seeing a mark;
- practises the transferable skills needed for lifelong learning, especially evaluation skills;
- gives students a wider range of feedback; and
- reduces the marking load on the lecturer.

According to the result of peer assessment, students will consciously or unconsciously assess themselves. Also, self assessment is a lifelong learning skill.

Assessment by lecturer or tutor

Individual oral presentations require too much time by lecturers and tutors, so each group should select one person to give the presentation. Teachers give a group mark according to the presentation and outcomes of the project. A mark will also be given based on whether students write reports correctly and seriously.

Individual marks are given by peer assessment, group mark and individual report marks. Table 3 shows group mark and individual marks.

Table 2: Peer assessment matrix: Team 1

Team 1											
Student Id	1	2	3	4	5	6	7	8	9	Total	StDev
1		97	97	97	97	97	97	97	121	800	8.5
2	110		100	100	90	100	90	100	110	800	7.6
3	110	100		100	100	90	80	100	120	800	12.0
4	112	100	100		95	95	90	100	108	800	7.2
5	100	100	100	100		100	100	100	100	800	0.0
6	120	95	95	100	100		95	95	100	800	8.5
7	100	100	100	100	100	100		100	100	800	0.0
8	115	100	100	100	95	95	90		105	800	7.6
9	125.6	96.5	96.5	96.5	91.5	96.5	100.5	96.5		800	10.6
Total	892.6	788.5	788.5	793.5	768.5	773.5	742.5	788.5	864	7200	
Average	111.6	98.6	98.6	99.2	96.1	96.7	92.8	98.6	108.0		
Stdev	8.9	2.1	2.1	1.5	3.9	3.5	6.8	2.1	8.6		

Table 3. Group mark and individual marks

Totals	Column totals	Column averages	Group Mark(%)	Individual Marks	Report marks	Individual Marks(final)
1	892.6	111.6	70	78.12	15	93.12
2	788.5	98.6	70	69.02	15	84.02
3	788.5	98.6	70	69.02	15	84.02
4	793.5	99.2	70	69.44	15	84.44
5	768.5	96.1	70	67.27	15	82.27
6	773.5	96.7	70	67.69	15	82.69
7	742.5	92.8	70	64.96	15	79.96
8	788.5	98.6	70	69.02	15	84.02
9	864.0	108.0	70	75.6	15	90.6

Possible implementation problems

Language barrier

Both teachers and students are not native English speakers. Although I have been learning English at The University of Sydney for about four months, it will be not easy for me to deliver lectures in English. For Chinese students, it is also not easy to understand both a foreign language and technical content.

Therefore, it is very important to carefully design all aspects of teaching and learning in order to improve the quality of *Data Structure* learning.

Teacher's change from the role of disseminator to facilitator

The role of teachers in traditional teaching methods is as knowledge disseminator. But in student-centred teaching/learning methods, teachers act as facilitator, helping students access and process information. This may mean 'less' work in class (as students are directed to solve carefully constructed tasks by themselves and in collaboration with their peers, under the teacher's supervision), but more work outside the class to prepare for the class and evaluate students' work. In this case teachers need to spend more time and energy on preparing and organising the class.

Acknowledgements

I would like to express my thanks here to The University of Sydney and the Chinese Scholarship Council for their support. Grateful thanks to Associate Professor Mike King, Associate Professor Mary Peat and Dr Tom Hubble for their wonderful introduction of contemporary education approaches. I would also like to give thanks to my mentor, Dr Bing Bing Zhou in the School of Information Technologies who gave me valuable guidance and help. I also want to give my thanks to all other people who have given me their help. Finally I want to express my sincere thanks to all of my classmates for the wonderful time together.

References

Cruickshank, B.J. and Olander, J. (2002) Can problem based instruction stimulate higher order thinking? *Journal of College Science Teaching*, **31**(6), 374–378.

Kennedy, G. (2006) Seminar Notes: Peer-assessment in group projects: Is it worth it? School of Information Technologies, The University if Sydney.

King, M. (2006) Lecture Notes: Teaching Science in English, The University of Sydney.

Lanzing, J.W.A. (1997) *The concept mapping homepage*. http://users.edte.utwente.nl/lanzing/cm_home.htm.

Liu, C. (2003) The use of student-centred learning strategies in the course of Data Structures and Algorithms, *The China Papers* (July), 90–94.

Novak, J.D. (2006) *The Theory Underlying Concept Maps and How To Construct Them*, Cornell University [Online] Available: http://cmap.ihmc.us/Publications/ResearchPapers/TheoryCmaps/TheoryUnderlyingConceptMaps.htm.

San Diego State University (1996) The Barriers to PBL. [Online] http://edweb.sdsu.edu/clrit/learningtree/PBL/PBLBarriers.html.

San Diego State University (1996) *What Is PBL*? [Online] http://edweb.sdsu.edu/clrit/learningtree/PBL/WhatisPBL.html.