

Application of the contemporary education strategies in teaching *Fundamentals of Computer Programming*

Yan Zheng

Beijing University of Posts and
Telecommunications
People's Republic of China

Abstract

Fundamentals of Computer Programming is an introductory and one of the compulsory courses for computer science undergraduates. It is the first programming course taken at Beijing University of Posts and Telecommunications. It targets students who have no previous knowledge of computers. It has been found in previous years that students have difficulties mastering the learning aims and teaching this course effectively is a challenge for new teachers. In this paper, several contemporary teaching strategies are first described and then incorporated into a practical teaching plan.

Introduction

In the 21st century student-centred teaching methods have become popular in the sciences, with the use of problem based learning, case based teaching and concept maps.

According to the syllabus of the Beijing University of Posts and Telecommunications (BUPT), *Fundamentals of Computer Programming* is an introductory and compulsory course for the entrants whose major is computer science and technology. It is a 5-credit point course, having 68 hours of lectures, 34 hours of experiments and one 5-week project. The assessment consists of a mid-term examination (written), a final examination (written), experiments and a report.

The main content of this course includes the following:

- basic concepts and computational theories;
- computer component and architecture;
- basic structure of the computer program;
- process-oriented programming method;
- object-oriented programming method;
- C/C++ programming language;
- programming skills; and
- introduction to Software Engineering.

The goal of this course is to understand the basic operation of computers, to establish an abstract model of the computer, to analyse and solve practical problems associated with computers, and to be familiar with the C/C++ programming language and master the skills of programming.

Fundamentals of Computer Programming is the first specialist course for undergraduate students some of whom may have no prior knowledge of computers, and some of whom come from hinterlands (rural areas) and may have never touched a computer before. For these students this course is difficult. At present, the teaching mode in BUPT is teacher-centred. The students are passive learners accepting the knowledge that the teachers have carefully prepared. The mission of the student is only to digest the knowledge. Perhaps it can be regarded as a 'spoon-fed' process. Though there are advantages, such as a well-grounded academic background with the potential for further study, the main disadvantages of this kind of teaching result in:

- less critical thinking;
- narrow knowledge vision;
- inactive learning attitude; and
- less creativity.

In order to overcome these disadvantages, teachers should refresh their conventional teaching mode by adopting more contemporary teaching strategies.

Detailed Applications

In the developed countries modern teaching approaches such as problem based learning (PBL), case studies, and concept mapping have been widely applied. Based on my own teaching experience, three aspects of the contemporary teaching approaches need to be seriously considered in our teaching activities. These are: students' learning style; teaching skills; and cooperation among faculty members.

Student's learning style

Chinese students are accustomed to being spoon-fed by teachers. It will be a shock to them if teachers now adopt a self-directed learning (student-centred) approach. Changing teaching approaches will need time for both students and staff to adopt. Using an e-learning platform might be a good way to solve some of the problems of change. With an e-learning platform teachers can prepare appropriate learning and referencing materials and put these on the Internet at the relevant time. In lectures teachers can then focus on the key concepts and students can access the rest of the materials to suit them, allowing for self-directed learning. Finally, using self-assessment tools available on the Internet, teachers can obtain feedback from students, help work through problems and help regulate the learning pace. These steps are continuous and recurring and the interaction between the teacher and students should appear seamless. In this process, the learning styles of the students have a very important influence on the teaching approaches. The modern learning methods such as self-directed learning, team learning and self-evaluated learning can be effectively adopted by students.

Teaching skills

Regardless of which teaching approaches are used, the final goal is to trigger the students' passion, and show the magic of the discipline to students. To achieve this goal, I will look at two teaching strategies, concept mapping and problem based learning.

Concept mapping

Concept mapping is a technique used for representing knowledge graphically. Knowledge graphs are networks of related concepts that are interconnected. Concept maps consist of *nodes* that represent related concepts within a topic, and *links* that represent the relationship between concepts.

Concept maps can be used to: generate ideas (brainstorming); explain complex structures; integrate the new with existing knowledge, evaluate the learning results; and diagnose misunderstandings and misconceptions. Concept maps can help teachers establish what the students' preconceptions are (right or wrong), and whether the students understand the concepts that link the various pieces of information together (linking concepts or ideas). Concept maps can also help to explain why teachers are focusing on a particular aspect of a topic so that students can see how particular pieces of information fit into the overall schema.

In the course of *Fundamentals of Computer Programming*, we could use concept maps to explain the basic computer

components. The concept map of the computer components is shown in Figure 1.

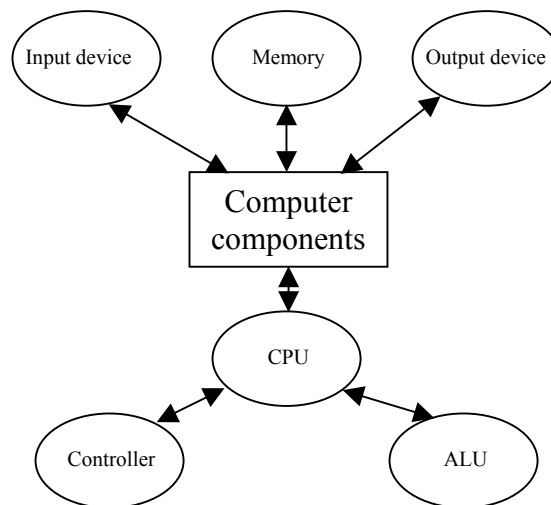


Figure 1. A concept map of computer components

As shown in Figure 1, the computer consists of five components: input device; output device; memory; controller and ALU (Arithmetic/Logic Unit). Usually the controller and ALU are called the CPU (Central Processing Unit).

Problem based learning (PBL)

PBL is a specific strategy for engaging students in collaborative learning. The PBL cycle is shown in Figure 2. In PBL teachers encourage students to work together to find potential solutions to the problem by pooling their resources. For PBL to work properly the problem posed must be complex enough so that there is no one 'right answer', but rather a group of potential answers so that interdependence and communication are enhanced.

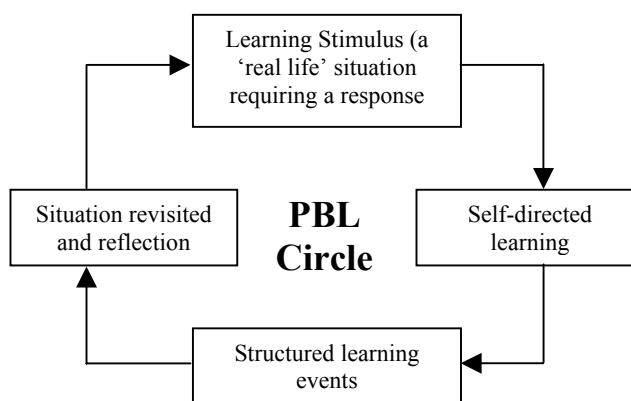


Figure 2. The PBL cycle

In the course of *Fundamentals of Computer Programming*, for example we could use PBL in a 5-week project in which students are required to finish a program of a lift simulation using object oriented programming and C/C++ programming language. The details are shown in Figure 3.

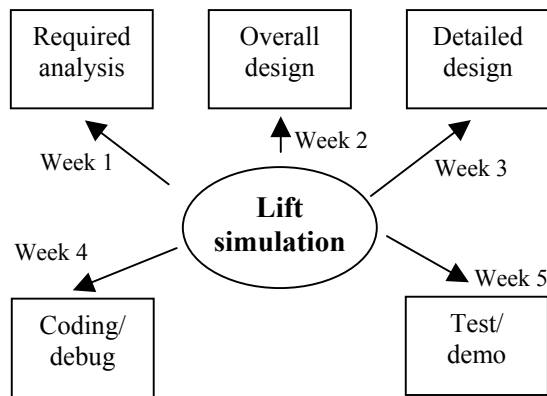


Figure 3. A 5-week project based on PBL

In this project, the solution to the problem is not unique. There is a lot of space for students to explore and ponder. In order to help students to finish the task successfully, the schedule, as shown in Table 1, could be adopted.

Table 1. The schedule of the project based on PBL

	Tasks	Descriptions
Week 1	Discussion and report	
Week 2	Team work and tutorial	2-3 persons/team
Week 3	Discussion and tutorial	
Week 4	Discussion and tutorial	
Week 5	Demonstration and presentation	Including conclusions

Cooperation

Teaching reform must be supported by the administration of the university. It is not an individual undertaking, and so it is very important that all parties involved, including teaching staff and senior administration, cooperate.

Conclusions

Gradual change is probably better than revolutionary change. Most effective changes should be gradual. The introduction of one or two innovative approaches to a course is often far more effective. The teaching reform in China has to be systematic and there are challenges and barriers to this process.

The expectation of students

The students generally expect to be told what to do and to have all the answers given to them. They are accustomed to be taught in this conventional way. Changes will make

them uncomfortable and they will need to know and understand why their learning style must change.

The challenges of colleagues

Fundamentals of Computer Programming is a basic course and every semester there are about 450 students attending it. The students are divided into three classes that are taught by different teachers. Synchronisation in teaching is necessary, because the classes have the same assessments. Staff involved need to be supported in this change.

The challenges to ourselves

Teaching from a constructivist perspective is hard work and requires more preparation and thus more time. Teachers might not get it right the first time.

Limitation of ‘hardware’

In China the number of students in each class is excessive, and may not be suitable for student-centred teaching. Perhaps the size of class should be reduced.

Though there are many barriers, we should be confident for the future and make great efforts to fulfill the present goals.

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