A plan for student-centred learning in a *Computer Programming* course

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Abstract

This paper reflects on the traditional teaching and learning methods that I used in the course of *Computer Programming* in the past. Having learned some modern education theories, I analyse some existing problems and give a plan for changes, aiming at transferring to more student-centred learning and improving the outcomes of teaching and learning.

Introduction

Chinese economics and science technology have developed quickly over the last few years. But we still have a long way to go, especially in the aspect of education. In order to use contemporary education theories and approaches, the Ministry of Education of China made a program: *Teaching Science in English*.

I am lucky to be one of the members of the training program *Teaching Science in English*, a collaborative project between the China Scholarship Council and the University of Sydney. I have had the opportunity to undergo education training in the Faculty of Education, Faculty of Science and the School of Mathematics and Statistics of the University of Sydney. During the past four months, I have learnt some contemporary teaching and learning theories, and approaches such as behaviourism, constructivism, problem based learning, case study, cooperative learning, learning from peers, concept mapping, information processing theory, group work and personal development. I also learned that the assessment approach affects the learning style. In my opinion, all the theories have the same purpose: to let students learn actively and to improve the outcomes of teaching and learning.

The old way of teaching the course *Computer Programming* and its problems are described in the second section. In the third section, I will give a plan for changes to the teaching process in the future by applying some modern education strategies that I have learnt in the University of Sydney.

Current situation of the course

The course *Computer Programming*, which I teach, is a compulsory course for students in the Mathematics Department at Fudan University. The students have a strong mathematics background, but most of them have no programming experience. The course is timetabled in the first semester of second year. It is a fundamental course for further study of *Data Structures and Algorithms*. Half of the students will take *Data Structures and Algorithms* in the second semester of third year. Many students use computers in their research for a Masters or PhD degree. Many graduates have jobs in which software is relevant, and some graduates work in software companies.

Content of the course
The content of the course consists of data type, console input/output, file input/output, the methods of programming (procedural and object oriented programming), iteration, decision, structures, recursion and list (including sequential list and single linked list), concepts and characteristics of class such as encapsulation, inheritance, polymorphism, virtual function and abstract class.

Objective of the course
Through one semester's study, I would like the students to:
1. know how to produce executable files with high-level language;
2. understand the structure of a program; and
3. be able to write computer programs to deal with some problems with high-level language.

Current teaching and learning approach
The course consisted of three hours of lectures and 1.5 hours of laboratory work each week. There were no tutorials. Last year, there were more than 160 students registered in the course. The students were divided into two classes (about 80 students each class). A teacher and a tutor were responsible for one class. The tutor's work was to help the students in the laboratory with the teacher, mark students' homework and report the results of students' homework to the teacher.

I tried my best to help the students achieve what I hoped they would. Now, let me describe the methods that I applied in the course.

Lectures with multimedia
I used multimedia in lectures. For most of each class, students sat and listened quietly while I talked and demonstrated. Sometimes I asked the students if they could understand what I said, and during the break or after class some students asked me questions about the course content or their homework. There were some excellent students who asked me questions that were beyond the content of the course. I tried to explain in detail.

Assigning homework
I assigned homework once or twice every week. The homework consisted of programming problems. Students were asked to accomplish these tasks individually. Every two weeks, they were asked to hand in their homework by email. The homework was checked by the tutor or by the teacher. For each student, the marks from each homework task contributed to his/her final mark.

FTP and email
I put all the lecture notes, all the examples that I used in classes and all the supplementary materials on the ftp. Students could download those from ftp. Students could communicate with the teacher and tutor by email, and students' homework was submitted by email.

Assessment
The teacher assessed a student according to the student's individual homework, mid-term and final examination. Usually the final term examination contributed 70%, mid-term examination contributed 15% and homework contributed 15% to the final mark. 90% of the students passed the course and 25% of the students got excellent grades.

Reflection on the Course
For the past four months, I have learned many contemporary education theories in the seminars with Associate Professors Mike King and Mary Peat. I have reflected on what I have done in the course. I feel there are many aspects that I could do better in order to improve the quality of teaching and learning. The problems existing in my course are:

1. I used the traditional teaching and learning approach: knowledge transmission;
2. it was teacher-centred and students learnt passively;
3. the students lacked teamwork training during the whole teaching and learning process; and
4. monotonous assessment was applied. Students were assessed only by the teacher according to individual work.

So I plan to make some changes in the teaching process after I go back to China.

Plan for using student-centred learning strategies

I have learned many contemporary education theories during the last four months. I think each teaching and learning approach has its advantages and its disadvantages. A single approach is not superior to other approaches in all situations, nor is it appropriate to all subjects (Lianfang and Taylor 2003). I would like to combine some of the strategies and apply them to the course *Computer Programming*.

The purpose is to transfer a teacher-centred teaching and learning approach to a student-centred approach. The changes I plan to make are:

1. adding tutorials and changing the lecture style;
2. using mathematical problem based case studies by students in groups for some topics; and
3. applying comprehensive assessment.

Adding tutorials and changing the lecture style
It is in tutorials that most learning takes place (Henderson and Britton 2003). I plan to condense the lecture content, reduce the lecture hours and add one or two tutorial sessions per week. The size of a tutorial class will be about thirty. In tutorials, students can communicate with a tutor and interact with their peers. Students can also form small groups to discuss questions about their individual homework or group assignment.

I would like to change the lecture style also. Instead of talking all the time during the lectures, I will answer the questions presented at the end of the last lecture. At the end of each lecture, I will hand out sheets with the next lecture's topics and questions about the topics. Students are asked to preview the content of the lecture. In the lecture students can learn concepts and methods by trying to answer the questions. With this approach students can learn interactively.

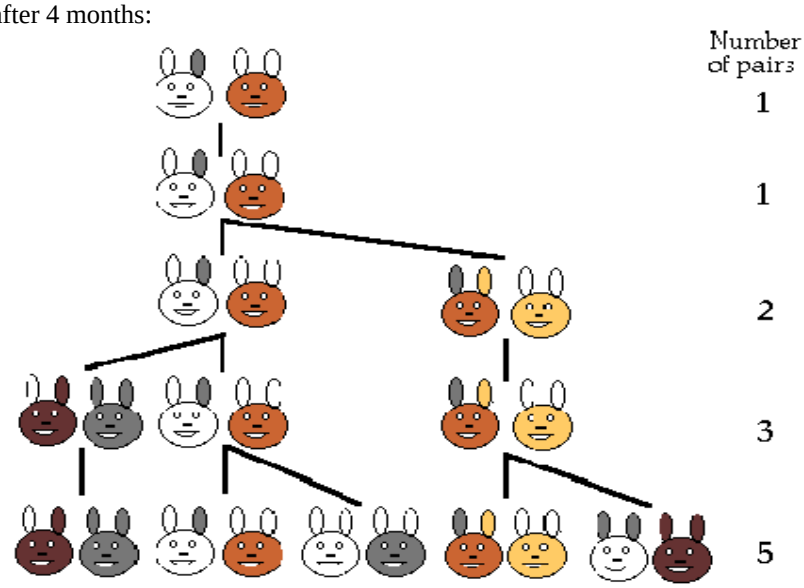
Using mathematics problem based case studies by students in groups for some topics
I always presented the problems in the beginning of the lectures and solved the problems by myself at the end of the lecture, or in the next lecture. I plan to use problem based case studies to teach some topics in the course. Students will work on these case studies in groups.

Society requires teamwork skills and lifelong learning skills. When the students graduate from the university, they have to work in teams, especially for software development. In fact nowadays, no matter how smart or industrious an individual is, he/she cannot accomplish a project alone.

With this strategy, I will present the story and the problems to the students. Students will be asked to form small groups and all the members of one group will cooperate with each other to deal with the problem. Each group will give a report, demonstration and oral group presentation.

Examples of problems I will use for group work are the rabbits problem for iteration and the tower of Hanoi for recursion. The students are mathematics students. Most of them have a strong mathematics background. They may know the mathematical solutions to simple cases, but they don't know how to deal with these problems in complicated cases with computers.

The number of rabbits after 4 months:



Through this problem, the students will learn the following knowledge and principles by themselves:

1. the content of the topic (iteration);
2. three different loop statements (while, for, do);
3. how to avoid infinite loops and off-by-one error; and
4. how to use 'break' and 'continue' statements.

Example 2: The Tower of Hanoi

The Tower of Hanoi puzzle was invented by the French mathematician Edouard Lucas in 1883. You are given a tower of eight disks, initially stacked in increasing size on one of three pegs. The objective is to transfer the entire tower to one of the other pegs, moving only one disk at a time and never a larger one onto a smaller.

Students are asked to output every step of the moving process. In solving this problem, the students will learn:

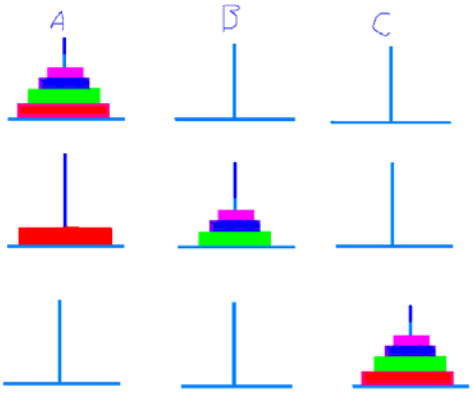
1. the method of recursion;
2. the strategy of solving a problem by solving an easier problem using recursion;
3. how to avoid infinite recursion; and
4. finding solutions for the simplest inputs.

The goal of using mathematics problem based case study by students in groups for some topics, is to encourage teamwork skills and the ability to self-study. This strategy will develop students' generic skills of oral presentation and communication with others. It will also encourage students to learn from peers.

Example 1: The rabbits problem

This problem originated in the year 1202, when Fibonacci was presented with a problem of how quickly the rabbit population will grow in ideal conditions: *A certain man put a pair of rabbits in a place surrounded on all sides by a wall. How many pairs of rabbits can be produced from that pair in a year, if it is supposed that every month each pair begets a new pair, which from the second month on becomes productive? (We assume that rabbits never die, and whenever a new pair of rabbits is produced, it is always a male and a female).*

Tower of Hanoi with 4 disks:



Applying comprehensive assessment

The assessment system affects students' learning approach. In the past, monotonous assessment of students was employed. A student was assessed only by the teacher according to his/her individual work. So the students learnt individually and had no tendency to cooperate with each other. I would like to combine the group work assessment with individual work assessment, and combine peer assessment with teacher assessment.

A student's final mark will come from four parts:

1. the teacher assesses a student's group work by the group reports, demonstrations and presentations (20%);

2. the teacher assesses a student's individual work by quizzes, individual homework, mid-term and final examinations (60%);
3. a student will be assessed by his/her coworker in the same group (10%); and
4. A group will be assessed by other groups, with the mark awarded contributing to the final mark of each student in the group (10%).

Summary

Teaching and learning is a very complicated activity. It is a cooperative work between the teacher and students. All teaching and learning methodologies aim at improving the quality of education. My plan is to change strategies and aim for a more student-centred approach to teaching and learning. The purpose of the change is to improve the outcomes of teaching and learning in the course.

Just as there is no perfect thing, there is no perfect teaching and learning method. On one hand, combining several methods in my future teaching is a challenge for me. On the other hand, at the beginning some students may not be accustomed to my new strategies and there may be other barriers occurring. Anyway, I think I should do my best to face all the challenges.

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