Research and Practice on Teaching for C++ Programming Language

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Abstract. The courses of computer programming language are important basic specialty courses for majors of science and technology in universities. These courses are often both highly abstract and practical, and many works involved in the teaching process are worth exploring and researching. Focusing on teaching methods of “C++ programming language” course, this paper presents our ideas and practice in performing teaching work in the course. In the paper, we discuss some important works in different teaching links, including textbook selection, courseware preparation, classroom teaching, practical ability training. Our practice has proved that, by adopting appropriate teaching methods to adapt to the actual situation in the teaching process, the teachers can control teaching process flexibly and improve teaching effectiveness and quality.

Introduction

“C++ programming language” course is one of the required specialty courses for first-year undergraduates of most majors of science and technology in our university. Its teaching contents are mainly basic concepts and methods and practical skills of computer programming language, including language syntax, program structure, algorithm design, coding and other aspects of theoretical knowledge and practical skills. The course teaching aims to develop student capabilities for logical thinking and actual programming in software design. As teachers teaching this course, we have made much explorative research on works in each teaching links, including textbook selection, courseware preparation, classroom teaching and practical ability training. Considering its both highly abstract and practical features for the course, we carried out a series of relevant innovation practice of teaching methods in teaching process.

Select Appropriate Textbooks

As a main object and tool for student studying, textbook takes an important role in course teaching. Choosing one or several appropriate textbook, is the primary task to carry out teaching work. Currently, we are taking bilingual teaching mode for our course, in which we use English teaching material (both textbooks and courseware) but teach in native language, namely, Chinese. The teaching aim is to ensure both the specialty knowledge transfer and specialty English training for students[1].

On the textbook selection, we adopted a way of “English textbooks as primary teaching material and Chinese textbook as supplement” in actual teaching. We made this decision for two reasons. Firstly, as freshman just coming to university, the majority of students lack accumulation of English computer terms and have difficulty in reading professional English textbooks. When being met with some technical terms or knowledge difficult to understand in learning English textbooks, they can quickly solve such problem by reference to appropriate Chinese specialty textbooks. After all, less obstacle in study helps improve learning motivation for students. Secondly, English textbooks and Chinese textbooks have their own advantages in content selection and organization, and can take complementary advantages under reasonable use with each other. For example, English textbooks tend to use a lot of examples, figures and codes to introduce certain complicated or abstract programming knowledge, so as to make readers easier to understand the nature of knowledge.
Comparatively, Chinese textbooks focus on statement and summary of knowledge, and are more like dictionary tools. To summarize the above, it is necessary and beneficial to use Chinese textbooks as auxiliary references for English textbooks in a bilingual teaching course.

For Chinese textbooks selection, there are many well-written teaching materials written by authors with many years of teaching or research experience in C++ programming. We can choose and recommend one or several for students in a relatively easy way. Instead, it made us take a lot of thought in choosing English textbooks. In our work of textbook selection, we found that many original English technical books about C++ programming language often had different audiences for their content scope and depth. Some excellent books have rich content and incisive analysis on C++ language, but they are suitable for professional software developers or readers with programming base instead of beginner. Therefore, it is a key work to choose an appropriate original English textbook with moderate difficulty and content suitable for first-year undergraduates according to teaching objective[2]. Even after choosing an English textbook, the content quantity and organization may not completely fit for the course teaching. We always need to select knowledge content appropriate to teaching requirements for students to read and study, and even need to select part of teaching content from other materials as a supplement, so that students can achieve learning objective more easily. Reasonable use of English textbooks can allow students to learn not only specialty knowledge but also authentic English.

Our actual teaching practice has shown that, the “English textbooks as primary teaching material and Chinese textbook as supplement” mode in bilingual teaching can not only improve students’ learning efficiency and quality, but also improve their English reading skill through reading and studying English textbook.

Preparation of Teaching Plan and Multimedia Courseware

To ensure teaching quality of each class, we need to fully understand textbook content and elaborately organize teaching content and design teaching process before each class. There are two main aspects in our works:

First of all, we carefully organize teaching content according to teaching target for each class to guarantee a reasonable but necessary amount of knowledge corresponding to that class by making appropriate adjustment to textbook contents in corresponding sections. Sometimes, addition or deletion to textbook contents is necessary. It requires teachers to be familiar with teaching materials and all knowledge points in advance. In addition, we need to carefully organize and plan teaching program in class based on teaching content and courseware. Class program should consider knowledge basis and way of thinking of students, and adopt a transition way from difficult to easy on knowledge transfer. For important or complicated knowledge, additional explanation and demonstration should be designed to help students to understand. Some good teaching ways could be introduced in teaching program to improve class teaching. For example, classroom interaction, such as questions, presentation, or discussions, could be designed to deepen impression of students on knowledge learning. Furthermore, reflection questions and exercises after class should be designed to help students digest what they have learned.

Secondly, multimedia courseware needs to be prepared based on class content in advance. Multimedia teaching is a new modern educational technology, which integrates lectures, presentations and other functions and has features of vividness, visualization and intuition[3]. Compared with traditional blackboard means, the multimedia teaching way has the following advantages: First, The dynamic effects of multimedia courseware can make complicated or abstract theory visualized and vivid, and bring students into simulation scenarios, so as to enhance students' study interest. Next, it saves lots of time for teachers from writing on the blackboard, so that teachers can spend more time on analysis and explanation of knowledge and the teaching process can be more coherent. For example, when explaining the execution process of a program, teachers can first show knowledge to students by PowerPoint slides, then use a Flash animation to exhibit dynamic execution
process of the program. The teaching mode, which we call “Explaining with animation”, can lead the thinking of students to the right direction and allow students integrate rational knowledge and perceptual knowledge of what they learn, so as to help students understand and master the knowledge much better. What’s more, the multimedia teaching can also make classroom atmosphere more active and prevent boring single-side presentation. Our practice has shown that using multimedia courseware for teaching can not only motivate students' interest in learning, but also improve efficiency and quality of classroom teaching.

**Organization of Classroom Teaching**

Compared with traditional teaching, bilingual teaching has its particularity. It is a core problem for teachers to solve that how to make students obtain improvement in both specialty knowledge and English ability in limited classroom time. For this issue, we have taken much exploration work on organization of classroom teaching through studying literatures, questionnaire survey, collecting feedback, classroom observation, peer communication and other ways. We conclude our teaching experience into the following points.

Firstly, the teachers' guidance and inspiration are particularly important because teaching contents of bilingual teaching are too much for classroom teaching. For bilingual learning, students must first overcome difficulties in foreign language reading before understanding and grasping specialty knowledge. However, if too much time is spent on explaining English syntax, terms and sentences in classroom, the course will become a foreign language learning course. Also, it will occupy considerable class time which should have been spent on teaching specialty knowledge. To avoid such situation, it is necessary to guide students to make a targeted preview before class. For example, teachers can list some important terms or texts in textbook and encourage students to learn through language tools or reference books; or give them some questions relevant to teaching materials and require students to study corresponding materials in advance and prepare class presentations or discussions. Through this, we can not only allow students solve most of the language understanding barriers outside class, but also allow students obtain certain understanding of class contents before class, which may help students keep up with teachers’ explanation in class and accomplish knowledge understanding and absorption. In addition, the preview encouragement can urge students to learn actively, helping develop students’ ability to study and think independently.

Secondly, teachers should adopt various forms of teaching means to stimulate study enthusiasm of students and activate classroom atmosphere. In the class, teachers should learn to utilize teaching methods flexibly to create interactive teaching atmosphere and avoid a scripted teaching way[4]. Multimedia teaching prevents teachers from spending much time in writing on the blackboard, teachers can have more time to interact with students. For example, ask students to answer some questions from time to time, encourage students to ask questions or make statements, or allow free discussions among students. All this measures are able to strengthen interaction and communication between teachers and students or among students. For the aspect of teaching language, we mainly use native language to lecture in class while supplemented by English when needed. This is a comprehensive consideration on both English level of freshmen students of non-English majors and the teaching objective of specialty course. After all, the primary objective of the course is that students can learn specialty knowledge, rather than purely to learn English knowledge. It is appropriate for teachers speak in Chinese to ensure accurate transfer of knowledge to student. Though, we encourage students to answer questions or discuss problems in English, creating an environment for students to practice specialty English.

Finally, teachers should attach importance to combination of theoretic knowledge and practical application in class, and avoid falling into a boring theoretical teaching situation. “C++ programming language” course appears strongly theoretical on knowledge of syntax, semantics, and programming theory. Simple enumeration of knowledge is likely to make students interested in dull. To avoid this, when introducing conceptual or principle knowledge, we explain them accompanying with examples
or practical application. Contents that students are familiar with or interested in are introduced to attract their attention and arouse their enthusiasm. For instance, when teaching the concept of recursive algorithm, we will take the problems of Fibonacci sequence and Hanoi Towers for examples, which can be solved by recursive algorithm, to make it clear.

In short, bilingual teaching should be positive and interactive. We should try all our best to encourage students to get involved, play their initiative and complete the teaching task of the course together with teachers.

**Design of Experiment Course**

“C++ programming language” course is a highly practical course, so the experiment course is an important and indispensable part of whole teaching. For students, programming on computer is an extension of the theoretic teaching, and also a basic training method of developing their practical ability[5]. Students can learn to think, analyze and solve problems only through practical exercise. Sufficient and effective practice could not only help students correct understand deviation in learning, but also effectively improve their ability of problem solving by programming. In the actual teaching, our design of experiment course includes the following two aspects.

Firstly, write targeted experiment instruction book. In writing the guidance book, we choose representative and comprehensive programming problems as programming exercises. We design two kinds of programming experiments: validation experiments and design experiments. Validation experiments are designed for cooperation with the theoretical course and are directly relevant to knowledge points taught in class. These experiments are designed close to the textbook contents. Design experiments refer to more comprehensive and difficult programming exercises, which often relate to practical applications of actual problems. These experiments examine students' ability of analyzing problem and using what they have learned to solve problems synthetically. Design experiments are more difficult than validation experiments, but the basic programming knowledge and methods for solving them come from the latter. We pay much attention to difficulty and relevance of these experiments. Validation experiments are designed with less difficulty. Design experiments are designed based on two aspects: relevance to validation experiments and practical applications. The former is to ensure coherence between the two kinds of experiments, so that students have no idea where to begin when dealing with design experiments. The latter is to ensure the practicability of the experiments and lead students to think more beyond what they learn in class.

Secondly, develop students’ ability to debug and handle error. For simple problems, it possible for students to write correct code quite easily and quickly. For most programming problems which involve more complex programming, however, students have to check and modify their code to obtain right results now and then. Therefore, it is very important for students to grasp the debugging tools and be familiar with debugging methods[6]. For this problem, teachers can guide students to learn step by step how to debug program and modify their codes by introducing debugging tools and method and illustrating actual operations through debugging examples. In addition, an error table listing common programming errors, possible reasons and corresponding examples, can allow students to know how to analyze errors and learn gradually to handle programming errors when meeting program error. There is a Chinese saying that teaching a man to fish is better than give him fish”. The objective of education is to make students able to solve problem themselves.

**Summary**

Taking “C++ programming language” course for example, this paper discusses some important teaching links during the teaching process, including textbook selection, courseware preparation, classroom teaching and experiment teaching. We design and perform teaching work based on several key factors, such as teaching content, teaching object and student’s knowledge basis, and achieve good teaching effect. As teaching work involves with factors in many aspects, we still need to explore,
practice and improve our work persistently. In future work, we will try more appropriate modern
teaching methods and tools in the course teaching, so as to make it improved and matured gradually
and achieve excellent teaching results.

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References
[1] Chen Zhaoxue, Research and Practice on Hybrid Bilingual Teaching of C++ Object-oriented
Programming Course for Non-computer Majors, Computer Education. 10 (2011) 81-83.
[2] Luo Rui, Guo Jian-jun, Reflections in the Construction of Textbooks for Bilingual Teaching in
[3] Bai xia, Gao Fei, Research on Teaching Reform in C++ Object-oriented Programming,
Computer Knowledge and Technology. 9 (2013) 351-355.
[4] Lu Yunhong, Zhou Shiping, Exploration on Teaching Methods for C/C++ Programming,
Computer Education. 22 (2014) 90-93.
[5] Liu Qun, Li Jian, Reform and Practice in Experimental Teaching for C++ Language Programming,