The reform of course teaching and experimental teaching of "Computer Architecture"*

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Abstract. In recent years, due to the problems in the teaching of "Computer Architecture", its reform has attracted much attention. In this paper, we will strive for the way from course teaching and experimental teaching to innovate and reform the quality education in details. A teaching philosophy based on design ideas and design methods is proposed in the course teaching, we also propose an innovative experimental teaching system and experimental assessment methods in the experimental teaching. Extensive experimental achievements show that our proposed approaches are efficient, which not only mobilize the enthusiasm and initiative of students, improve their practical ability and innovative mind, but also achieve many teaching results and achievements.

Introduction

In order to cultivate highly qualified computer professionals with innovation ability to adapt to the new situation, the innovation teaching reform must be carried out in the teaching of "Computer Architecture" [1].

"Computer Architecture" emphasizes on the cultivation of the abstract thinking ability, the top-down system analysis and innovative ability of the computer professional students, while "The experiment of Computer Architecture" is a course to research and analyze the structure and performance of the computer system from the whole system, which is good for students to understand the concepts of computer system, grasp the basic concepts, the basic structure and the basic design methods of computer architecture, and know its the current development. It lays the foundation for the subsequent courses. Experimental teaching is an important part of the course teaching in science and engineering universities and plays an important role in achieving the quality education and cultivating the innovative talents. The experimental appraisal is a method of teaching evaluation adapted to certain experimental teaching goal and plays the role of a "baton", which is a key factor affecting the experimental teaching [2].

It is very necessary to apply the knowledge of computer architecture well for the computer professional students. Therefore, the reform must be carried out from two aspects of course teaching and experimental teaching for students learning better and teachers teaching better.

The reform of course teaching

The reform of the teaching textbooks and content

To cultivate the innovative talents and improve the teaching effect, we must put the design ideas and design methods into the course teaching of "Computer Architecture" [3]. At the same time, we need to select some excellent teaching textbooks in order to achieve a better effect. Due to most of the domestic textbooks are mostly involved in the components' function of computer system instead of introducing its design ideas and design methods, so it is difficult to stimulate the students' interest in learning and cultivate the students' creative thinking ability.

Since the students' practice ability is weak, the teachers in our laboratory write "The practice course of 'Computer Architecture' based on FPGA" and "The comprehensive experimental course of computer organization and system architecture based on Quartus II" from course teaching and

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experimental teaching, which were respectively published in science and Tsinghua University Press and won the prize for “The planned textbook of ‘125’ in the province of Yunnan”, “Quality teaching materials” and “Excellent teaching textbook for the graduates of Yunnan university” respectively. The textbooks are organized from specific to general, from particular to abstract, which aim to promote the understanding of theoretical knowledge with application and cultivate the students’ creative thinking in practice. In addition, students can put what they have learned into the actual design of the computer system through a comprehensive study, which not only exercise their practical operation and ability, but also improve their creative thinking ability.

The reform of the teaching methods and means

“Computer Architecture” emphasizes on the exploration and research in order to mobilize students’ enthusiasm and initiative in the process of teaching, emphasizes on the freshness of teaching content and closely connecting the developments of subjects, and emphasizes on the interaction in class so as to guide students to explore and think actively [4]. We regard the design ideas and techniques of the computer systems as the focus of course teaching, and then teach students the design methods of the various components of computer. The specific content of course teaching we proposed can be described as follows.

(1) Pay attention to the importance of the first class in teaching. The first lesson is the best time to inspire students to explore the knowledge, lead students to understand the overall framework of computer and induce students to explore actively down to the structure of the computer‘s “core” gradually. Therefore, it’s very essential for teachers to handle the first class well.

(2) Put the design principles into course teaching. When explaining instruction system to students, we should not only introduce the structure of the instruction, but also pay attention to the design principles of the instruction system [5]. Meanwhile, when learning instructions, we should not only enable students to grasp the functional design of the instruction system, but also to master the effects on the design of CPU, the manufacturing cost and the performance caused by the instructions’ format. After understanding these design principles, students can design some instruction system which meets certain requirements.

(3) Put the practice design techniques into course teaching. In the process of teaching, we must make students master the specific-oriented design philosophy. Firstly, succinctly, that is focused but not exhaustive, leaving some details to students thinking separately and make them have an in-depth understanding of what they learned by experiment on computer. Secondly, the advanced digital systems design methods are introduced. We should explain the FPGA devices and VHDL languages to students in advance, so that students can be familiar with the simulation tools of hardware design as soon as possible. Subsequently, let students study by themselves. Through the comprehensive design of these experiments, students can achieve a relatively complete CPU system and also deepen students’ understanding of the course.

The reform of experimental teaching

The reform of the experimental teaching philosophy

According to the policy of “strengthen the foundation, broaden the specialty, emphasize on practice and improve quality”, we built a multi-level experimental teaching system of “validation-design-comprehensive-innovative”. We pay attention to the dominant position of students, stimulate the interaction among teachers and students and build a multi-level experimental teaching system to improve the overall quality of students. Since the traditional experimental teaching mode that is “teaching everything” has produced some adverse effects. So we turned the traditional experimental teaching philosophy into “lead step by step”. The teachers should focus on the role of ‘lead’, changing the idea of “want students to learn” into “enable students to want to learn”. We can make students study experiments actively, think more, ask more and stimulate students’ learning enthusiasm and thinking ability.

The reform of the experimental assessment methods

The experimental result is an objective reflection including their practical ability, the operational skills and the ability of solving problems during the experiments and a comprehensive evaluation of

the students' experiments [7]. The assessment of the experimental result should be involved in the experimental attitude, experimental ability and experimental results. The experimental assessment should be carried out according to the specialties of students and formulate the corresponding assessment criteria. We can change the students' attitude to the courses, increase the enthusiasm of learning, promote the students' understanding of the experimental content and enhance the students' practical ability. Also we can enable teachers to master the information about the degree of students' understanding in experiments accurately.

Therefore, we should adopt the method of "live score", taking all aspects of the experimental process into the assessment elements and then figuring out the students' scores on the spot. Through observation, the teachers can learn the experimental attitude and practical ability of each student. Through the questions and answers, we can learn the degree of students' mastery in the theoretical and experimental learning. After that, the evaluation results should be feedback to students timely in order to help students correct their mistakes and improve their deficiencies. The specific content of experimental assessment can be described as follows.

(1) The school academic departments should issue a guidance document named "The standardized assessment methods of students' experimental scores", aimed to strengthen the students' practical operation ability in experimental teaching and take the experimental teaching into the standardize management areas of school's academic departments. The document should be involved in five major aspects, namely the attendance, the experimental theories, the experimental operation, the experimental reports and the test of experimental operation.

(2) Combine the appraisal of the basic experimental grades, the researching experimental grades and the final grades together to get the most appropriate personal practical experimental grades

The appraisal of the basic experimental grades generally involved preparation, operation and reports [8]. The appraisal of the preparation should be carried out before the experimental operation. Students should complete a more detailed preparing report, be familiar with the instruments and be able to draw the experimental design figure. The appraisal of the operation should be involved in the sequential, the correctness, the timeliness and be carried out in the way of "class group", namely everyone has one instrument and completes the experiment independently. It is a very important part in the experimental teaching. While the appraisal of the experimental report which is written after class should focus on the reasonable of the data's manipulating process, the conciseness of the principles' narrative, the seriousness of the report and the clearness of the experimental error analysis. All of them play an important role in the improvement of the future experiments. If students have a good idea on the improvement or extension of the experiment, we should give them extra scores according to the relevant policy. In this way, we can further improve their learning initiative and further excavate their thinking ability and innovative ability.

For the researching experiment, we carry out the open experimental teaching, which requires students to complete a researching experiment in their spare time of an academic year. The appraisal of the researching experiment mainly focuses on the background, the meaning and purpose of the experimental topic, the experimental principles and methods as well as its innovation. Finally the students are required to submit their experimental scientific and technological achievements and write the researching experimental reports independently. Then teachers should encourage students to collate their papers on their experimental achievements and publish them.

Since the final exam is taken generally after the course, so the examination paper should contain not only basic knowledge and common problems, but also the problems with a certain difficult degree, in order to enable students to finish the paper through positive thinking.

The achievements

Through learning this course, students understand the basic knowledge of "Computer Architecture", master the basic analysis methods of the performance and improve the ability of analyzing problems. The reform not only improves the students' practical ability, but also is good for promoting the level of teachers' scientific research. The teaching reform of "Computer Architecture" won the first prize in our school's teaching achievements and teachers published

more than 30 academic papers. The students guided by the teachers in our lab won 16 prizes in various scientific and technological innovative nationwide contests and published more than 20 papers in total and the like.

We have made some achievements through the reform of “Computer Architecture”. As it puts forward new requirements to our experimental teaching system with the continuous development of information science, so how to cultivate the students with strong ability and innovative spirits in experimental teaching is the key aim of the experimental teaching reform. It is not only important to cultivate the talents with high quality and improve the level of teaching in universities, but also the issue we need to explore and practice continually.

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