

## Exploration and Practice of Constructing Ability-oriented Engineering Practice Education Model of "One Center, Two Platforms and Four Levels" with Engineering Characteristics

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**Abstract.** In the "Engineering with a big E" context, relying on the Construction of National Computer Experiment Teaching Demonstration Center, this paper regarded the ability-oriented as key content, built engineering practice education model of "One Center, Two Platforms and Four Levels" with engineering characteristics, updated the idea of experiment teaching and improved experiment teaching method and means, established a wide range of experiment teaching system. Practice shows that the experiment teaching system and mechanism could greatly improve the students' practice and innovation abilities, research skills and employability.

### Introduction

Under the background of the Engineering Education Professional Certification and the plan for Educating and Training Outstanding Engineers of Ministry of Education, improving the students' engineering practice ability is an important part of improving the talent training quality in Colleges and universities [1]. In recent years, the domestic universities strengthened practice teaching reform, updated the experiment teaching content, optimized experiment curriculum system, standardized practice teaching management, optimized experiment teaching resources, and actively promoted the research-based teaching, to improve students' ability of practice and innovation [2].

### Problems in Computer Experiment Teaching

We investigated engineering practice education models and experiment teaching architectures of many universities with the different levels, especially in engineering colleges and universities, such as Harbin Institute of Technology, Southeast University etc.. The universities have their own characteristics in their management philosophy and discipline advantages. These different experiment teaching systems and engineering practice education modes are of great significance [3].

In the Quality Engineering of Ministry of Education, up to now, there are twenty-six National Experiment Teaching Demonstration Centers in the computer discipline [4]. Our Computer Experiment Teaching Demonstration Center as one of them, after years of construction has made some achievements, but like many domestic colleges and universities, there are many problems in the experiment teaching (especially in computer hardware experiment teaching).

(1) Students' engineering practice ability is weak

Students out of school are the university's "products", whose social acceptance is the main basis for measuring the effectiveness of teaching. What the market needs is inter-disciplinary talents who have solid basic theories, the ability to analyze and solve problems, and the ability to take the initiative to acquire knowledge [5]. However, it is very different from reality. For example, in 2010 during professional engineering certification of Ministry of Education in computer science and

technology, it was clearly pointed out that engineering practice ability of students (especially the application ability of computer hardware) needs to be further improved.

(2) The experiment teaching of computer hardware has not been taken seriously

Since the establishment of Computer Science in 1958, hardware design and application has been a feature of the major. However, in 1980s, with the development of computer technology, computer hardware experiment teaching in our university has plummeted, the computer science and technology has insufficiency in the field of computer hardware. At present, the amount of teachers who could have class and instruct experiments in computer hardware is small. Many hardware experiments (such as the Computer Organization, Microcomputer Principle and interface Technology, Computer Architecture, etc.) are at a low level.

(3) The experiment content is monotonous and obsolete, and the method of experiment examination is single

With the development of computer technology, computer engineering experiment has been changed from traditional single computer experiment to system experiment and network experiment [6]. However, the computer hardware experiment in our university has not only many old content, but also lack of experiment teachers. Similarly, verification is still mainly stressed in the experiment assessment method.

### **Consideration of the Current Situation of Computer Experiment Teaching**

(1) How to integrate the experiment content of several courses

It must have a good solution to link the courses, so it is possible to integrate the teachers of these courses as a team. The six computer hardware courses have their own characteristics, and there are mutual connections between courses, so it is very important to develop comprehensive experiment board which could integrate these courses and construct connections among the Computer Organization, Assembly Language Programming, Computer Architecture, the microcomputer principle and interface technology, and other courses.

(2) How to improve students' ability of engineering application and innovation

Innovative experiment teaching could improve students' engineering application ability. The innovative experiment is beyond the experiment syllabus, including: taking part in the National Undergraduate Electronic Contest and other technological invention and creation activities, participating in the research projects of the teachers and academic activities, completing the high level items for the competition and getting good research results. It is supposed that experiment environment including hardware and software such as excellent technical guidance, advanced equipments and tools, and open sites for experiment and processing, should be provided. Support actively the students to participate in various activities in science and technology, and scientific research of teachers. Take advantage of these scientific projects to support the extension of the experiment content, use the theoretic knowledge and experiment skills to do research and make, the research results and practical experience were used in experimental teaching, which could promote the reform of experiment content, further improve the quality and level of innovative experiment teaching, and explore new ways of cultivating high-quality and high level innovative talents.

(3) How to evaluate experiment teaching

In order to carry out better the experiment teaching for the hardware, it is necessary to construct scientific and reasonable experiment assessment methods corresponding to examination and evaluation for the experimental design of the students. The use of a variety of experiment evaluation system, such as putting the competition works, innovative projects and other works into the scope of the experiment assessment, could improve students' interests in learning.

## Ideas and Measures to Solve the Problems

### Emphasis on Regarding the Ability-oriented as Key Content

Although the specialty level of computer hardware is high in our university, also a number of high level faculties were introduced and cultivated, but the hardware level of the students majoring in Computer Science and technology declined instead of going up. Why? We think that it dues to the lack of high-quality hardware experiment platform, faculties and experiment content. Therefore, we choose to cultivate students' engineering practice ability as the guide and core content. It is showed that our goal is very clear, that is, we are sure to raise the level of hardware experiment of our major and improve students' the practical engineering ability (Especially the ability of hardware design and application). At the same time, students have popularly preferred software to hardware, that is, students are not willing to, even are afraid of the hardware problems or experiments.

Therefore, after investigation, we believe that the fundamental reason why the ability of students majoring in computer science and technology is relatively weak (especially the ability of hardware design and application) is not theory teaching, but the lack of actual engineering practices. Accordingly, we choose the experiment platform as the starting point; the purpose is to be able to improve the engineering application ability of students in the practical ability training.

### Integrating Some Courses

The main courses of the undergraduate in the undergraduate curriculum system are "Computer Organization", "Computer Architecture", etc.. The main course related undergraduate courses also include "Assembly Language Programming", "Microcomputer Principle and Interface Technology", and so on. These courses, especially the main courses, have not only relatively strong order, but also a strong correlation between the course content. The experiment levels of main computer hardware courses is shown in Figure 1. Among them, experiments with partial software attribution lie in the dashed box.

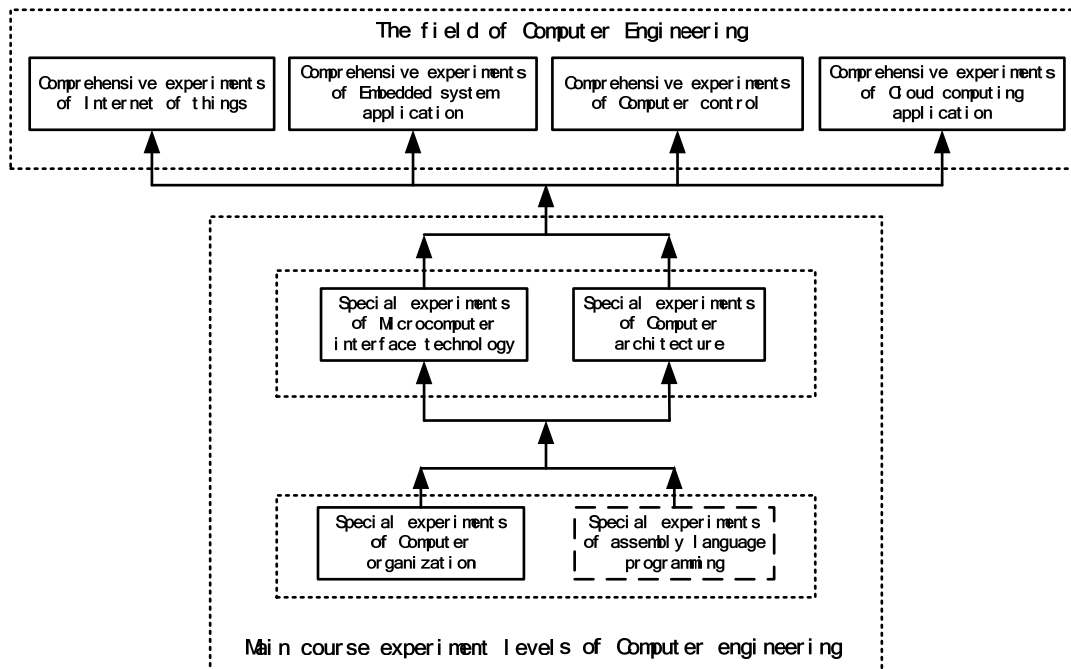


Figure 1. Experiment Levels of Main Computer Hardware Courses.

Specific measures include the following two aspects:

(1) The hardware curricula have the matching special experiments, which are synthetically designing. Aiming at engineering designing experiments a series of experiments were developed,

and the relationship among the same series of experiments was time sequence and mutual support. For example, in Figure 1, the two hardware courses "Computer Organization" and "Computer Architecture" constitute a framework of the hardware experiment series. The experiments of these two courses must be related to each other in content, and adopt the almost experiment method and platform.

(2) On the basis of the main courses experiments of the Computer Engineering, the following four aspects were designed: the Internet of things, the Application of Embedded System, Computer Control and Cloud Computing. The comprehensive experiments and comprehensive experiment development board were designed to integrate main courses of computer engineering.

### Building the Practice Teaching Architecture Whose Core is Ability-oriented

The computer science and technology requests the student to have the very strong practical ability, at the same time the society puts forward higher request to the computer talents. Therefore, aiming at the existing problems in computer experiment teaching, starting from the aspects of teaching content and teaching methods, this paper has studied ideas and methods of computer experiment teaching reform with computer ability training as the core,

According to the curriculum system, specialty characteristics and social requirements for computer professionals, this paper constructed the practice teaching system with "one center, two platforms and four levels", focusing on improving the overall quality of students, cultivating the spirit of innovation and practical ability, and practice teaching, as shown in Figure 2.

A center is ability-oriented as the core and central content. The two platforms refer to the in-class practice teaching platform (including experiment, practice, curriculum design, etc.) and the extracurricular practice teaching platform (including social practice, employment practice, etc.). The four levels include: the basic specialty quality training level, whose main content is "Basic programming courses + Theory improving course+ Programming training"; the comprehensive specialty ability training level, whose main content is "Experiment+ Practice + Course design"; the engineering application ability training level, including "Enterprise engineer teaching in university+ Off campus specialty practice base"; the engineering innovation ability level, including "Student technology competition +Found an undertaking". These four levels highlight the training of practical ability from low grades to high grades in university.

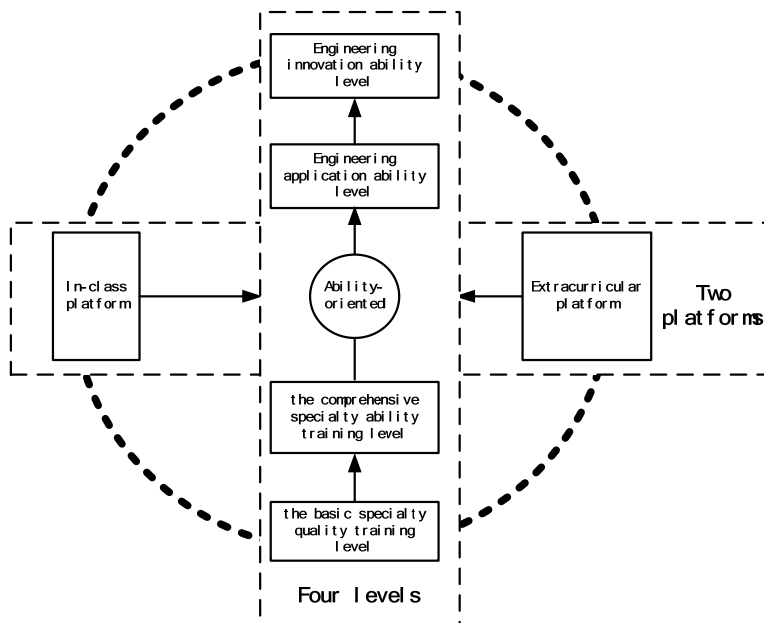


Figure 2. the Practice Teaching System with "One Center, Two Platforms and Four Levels".

## **Innovative Open Experiment Teaching Mode**

The goal of the experiment teaching reform of the Demonstration Center is to establish a full-time, open and multi-level teaching mode based on satisfying specialty practice teaching for students. All teaching resources of the Demonstration Center, including experimental equipments, experimental sites, experimental instruments, teaching faculties and computer application platforms and other resources, are fully open for all teachers and students of the university.

Taking the innovative talents training as the goal, this paper carried on the omni-directional reform to the teaching pattern, strengthened the contact and cooperation with laboratories in and out of university, and enhanced the practice teaching quality.

The management mode based on Web and the three-dimensional management for experiment are introduced into the Demonstration Center, and a unified platform is constructed to complete the experiment teaching management. So students could achieve the experiment booking, preview, questions answering and experiment teaching management through the remote access to Demonstration Center's website.

## **Summaries**

Relying on National Computer Experiment Teaching Demonstration Center as platform, based on the engineering characteristics and advantages of our university, this paper tried to explored and practiced in the practice teaching, and constructed engineering practice education mode with ability-oriented as core and engineering characteristics of "One center, Two platforms and Four levels". Practice has proved that the experiment teaching system and mechanism greatly improved the students' practice ability, innovation ability, scientific research ability and employability.

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