Skill-Based Teaching Model for Undergraduate Computing Education *

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Abstract: The rapid development of software industry is promoting the requirements of computing professionals. This poses a challenge for undergraduate education as graduates are commonly lack of practical skills and experiences. Teaching transformation is more urgent than ever to bridge the gap between university and industry. So we establish a curriculum particular for practical skills training and experiment teaching, and put forward an open experiment teaching model. In addition, we set up a talents training base in collaboration with industry and work out three cooperative modes. It reaches the expected objects and realizes trilateral wins of university, graduates and industry.

Key words: skill-based teaching; open experiment; cooperative education
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1 Introduction

The increasing development of software industry is now promoting the requirements of software talents. According to the statistics of the Ministry of Information Industry, the requirements are at least 400 000 people each year in China and the demands of software talents are increasing. It needs about 425 000 people in 2006 and the requirement growth rate is 20% per year approximately. The shortage of computer professionals draws extensive attentions all over the higher education.

Academic institutes (esp. universities) are recognized as the main provider of computer professionals in China, supplying over 70% of all software engineers in 2003[1]. The majority of them are graduates with Bachelors degree, small with Masters degree and less with PhD. Incomplete statistics show that there are 771 units setting computer science / engineering or software engineering majors throughout the country. The amount of computing graduates is much less than that of job positions simply from the statistics. However, a large quantity of graduates cannot find appropriate jobs. Employers complain that it is difficult to recruit graduates with practical experience and stronger computer skills. The dilemma is that our current educational system has no close relationship with industry requirements, and over-emphasizes on theoretical teaching, neglecting the software skills and practice ability. Therefore it is crucial to reform the educational system for computer majors to meet the needs of software industry.

The gap between subjects and techniques taught to computer undergraduates and those applied and practiced in software companies is becoming a bottleneck of the Chinese software industry sustainable development[2]. The solutions are: ① to improve experiment teaching and strengthen the practical skills training; ② to develop cooperation between university and enterprise. In this paper, we propose some ideas and experiences in skill-based teaching.

2 Experiment Teaching and Practical

Traditional experiment teaching mainly focuses on demonstration and validation. The experiment subject is just an attachment to the theoretical teaching frame. Students usually carry out a small programming or simple design independently. Few comprehensive and complex experiments are arranged in the class. This teaching pattern is not beneficial for students to develop practical skills and creative ability. Therefore it is urgent to improve experiment teaching.

In the design of experiment curriculum, the basic principle would be beneficial for undergraduates to:

- stimulate them to form subjective initiative to cognitive activities;
- enhance their abilities of knowledge migration and integration of learning and doing;
- lead them to develop the scientific style of work.

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and study;

◦ cultivate them with innovative spirit.

With respect to the curriculum content, we focus more on the latest techniques (for example, Java, .NET, Oracle) in order to lessen the difference between university and industry. The framework of experiment curriculum is categorized into three levels. Level 1 provides some fundamentals for undergraduates in computer or related majors. Level 2 focuses on the practical skills training and the latest programming languages. Level 3 is the senior phase for undergraduate education. We arrange two comprehensive experiment courses: course design and graduation project. Students are divided into groups, usually 3 to 5 people as a team, in course design. Each team can do a simulated software development, for example website or management information system, relatively simple compared with real-life engineering. Graduation project is the most important practice which encompasses all the knowledge and skills learned in previous semesters. Furthermore students should submit their dissertations after completing the project. Thus students can get full practical training on every side for their professional career.

In our revised Computing Curriculum 2005 for undergraduates, we set up a systematic and independent experiment teaching system. In the process of establishing curriculum, we pay attention to the following issues:

◦ put optimization of course content in the first place;

◦ depply a rank of excellent teachers with practical experience;

◦ try out open experiment teaching pattern.

Open experiment is the transformation of experiment teaching which embodies the idea of student-centered higher education. Students can design and conduct experiments to address a problem of their choice in the laboratory[3]. From start to end, it needs students individually to carry out a series of work such as subject selection, design, perform and report under a limit tutoring. This experiment pattern helps bring up the subjective initiative and creative ability. In our university we have set up a preliminary open experiment scheme. The main ideas are:

◦ Open experiment subjects: All the courses are composed of mandatory experiments and selective ones. The mandatory platform is for training students' basic operations and skills. In the selective platform, students can choose one or more items in the experiment list provided by teacher, and then make conductions individually.

◦ Open facilities: All the experiment facilities are open to students. Students can book position in the laboratory so as to carry out their selective experiments.

◦ Open assessment: The experiment grading is all-round, not limited to scoring the report, but all aspects of the experiment, such as compliance with requirements, quality of software, study attitude, the amount of work done, etc.

3 Collaboration between University and Industry

The best solution to the shortage of skilled talents is to transform academic goals to industry-oriented education. Collaboration between university and industry will benefit students, society and economy in the long run. Tianjin University of Finance and Economics (TJUFE) set up a software talents training base in cooperation with Cosmos Scientific Systems (Tianjin) Inc. in 2005, aiming at training Japanese-oriented packaged software talents. TJUFE is responsible for recruiting students and foundational education, while Cosmos is in charge of practical skills training. This teaching model can take advantage of each partner and make organic cooperation between undergraduate education and industry requirements. This cooperative education helps students master industry oriented skills, understand the enterprise culture and get practical experience.

The teaching model should be in conformity with the characteristics of higher education, but also accord with transformation of undergraduate education. So in the training base, we adopt three training modes: short term, medium term and long term[4].

◦ Short term: It starts from the last half of the 3rd academic year. The training target is computer or related major undergraduates. The company (Cosmos) is responsible for teaching Japanese and practical skills in short term centralized class. After one-year training, Cosmos selects graduates for employment on the basis of their qualifications, or recommends them to get jobs in other IT companies.

◦ Medium term: It starts from the last half of the 2nd academic year. The university (TJUFE) and company (Cosmos) cooperates in undergraduate education. Cosmos provides Japanese class and practical skills training for a year. And then students get a one-year-long internship in Cosmos. Compared with the short term mode, it gives students early exposure to enterprise and practical trainings, and helps students prepare for their professional career and study the theoretical courses on their will.

◦ Long term: It starts from the first academic

year. Undergraduate curriculum is jointly designed by two partners (TJUFE and Cosmos). In the first two years, students study foundational courses including Japanese in university campus. Some of specialized courses are lectured by Cosmos senior engineers. In teaching model, it converts the traditional model (repeating just what the textbooks say) to case teaching. In the 3rd year, the Professional Japanese is taught by Cosmos software engineer, which lays stress on practicality of social intercourse and project negotiation. Meanwhile, Cosmos is in charge of practical skills training. In the last year, students take their internships in Cosmos.

In the curriculum design, we rely mainly on the short and medium term, and enact the corresponding schemes. Short term training focuses on: Japanese, Programming in Java (or.NET), Enterprise Culture, Oracle and Project Management. Medium term training is divided in two phases. In the first phase, key courses are Japanese and Java (or.NET) fundamentals. In the second phase, Cosmos offers: Professional Japanese, Software Development Practice in Java (or.NET), Enterprise Culture, Oracle and Project Management etc.

With respect to the long term training, we have not put it into force yet due to existing teaching pattern fettered by traditional system and complicated reasons. We are intended to add Japanese Language and increase class hour of skill-training courses in Curriculum 2006 to meet the needs of information industry.

4　Summary

It is imperative that we should improve the undergraduate computing education to meet the requirements of information industry in China. We take two effective measures to develop the students' practical skills and experiences in this paper. One is to strengthen experiment teaching. We set up an experiment curriculum for practical skills training and propose an open experiment scheme to foster students with innovative ability. The other is to educate students grasp industry oriented knowledge and skills in collaboration with industry. We have signed a long-term cooperation agreement with Cosmos to construct the training base. Investigations indicate that the expected teaching effect is obtained and the shortage of industry oriented graduates is relieved to a certain degree. Future work will further develop and perfect the collaboration with enterprises, improve teaching methodology and curriculum so as to enhance the overall competitiveness of graduates.

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