Teaching reform using experimental classes, a tutor system and project orientation in a software specialty at a vocational educational institute

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ABSTRACT: Chongqing Vocational Institute of Engineering, based in Chongqing, China, is one of the national exemplary vocational education institutes in China. Addressing the existing problems in teaching software specialty, a reform of teaching has been developed involving experimental classes, a tutorial system and project orientation. This followed an analysis of the defects of the traditional software specialty course teaching. The result is a software specialty core curriculum educating students with good employability. The curriculum is composed of a basic level, a core software development level and an advanced level. The aim of this is to bridge the gap between education supply and labour market demand.

INTRODUCTION

With the rapid development of global information, information technology and software have become the cornerstone of modern economic activity and social life. The software industry is the foundation of China's national economy and social development, but it faces great change. The Chinese Government has issued a *Software and Information Technology Services Industry Twelfth Five-Year Development Plan*, to make the Chinese software and information technology services industry much bigger and stronger. There are requirements to adjust and optimise the personnel roles, as well as to innovate in the introduction, cultivation and development of relevant talent. In 2012, the Ministry of Industry and Information Technology outlined the demand for computer applications and software professionals. At present, there are nearly 600,000 people employed in the software industry, of which about 340,000 are professionals (including 40,000 senior, 200,000 medium and 100,000 junior professionals).

Due to international experience, the proportion of software professionals of senior, medium and junior rank should be in the ratio of 1:4:7. Given reasonable estimates for personnel requirements, China will need 100,000 senior, 380,000 intermediate and 560,000 junior professionals by 2014. Taking account of businesses, communities, organisations, schools, and other industries, the initial estimates for computer application personnel will increase by about one million people each year. The indications are that the Chinese software industry lacks a lot of junior software developers, hence, vocational education plays an important role in producing junior software developers.

There has been much research on meeting the requirements of the software industry. Much of the Chinese research has focused on teaching reform in vocational education institutes. Curriculum research of software projects has included task-oriented [1][2], task-driven [3-5] and project-driven approaches [6-8]. The main options are to have project teaching first and, then, course teaching or course teaching first and, then, project teaching or project and course teaching at the same time. Projects teaching reform has become the focus of reform of higher vocational colleges, but the effect on employment has not been significant. On the one hand, graduates of vocational education institutes cannot find jobs, but on the other hand, many enterprises cannot find the personnel they want. There is still a lack of effective connection between education supply and labour market demand. Though there have been tremendous changes in curricula, the project components are often unreal and unsustainable.

Therefore, in this article, a reform of software specialty teaching in vocational education institutes is proposed, based on *experimental classes, a tutorial system and project orientation*. The aim is to provide a reformed teaching model that can provide a real project development environment and employment for students. The reformed curriculum aims to enhance students' interest in learning, but also to inspire curiosity, to improve learning efficiency and programming ability, and so reduce the gap between education supply and labour market demand.

DEFECTS IN TRADITIONAL SOFTWARE SPECIALTY COURSE TEACHING

Chongqing Vocational Institute of Engineering is one of the national demonstrative vocational education institutions in China. The Information Engineering Department of the Institute has more than 1,000 students at present. In recent years, there has been much research on the training and the curriculum system of the software major. By introducing project teaching, very good results were achieved. In the reform of the major, the project teaching is still seriously restricted. This mainly reflects the following:

1. The course training programmes require students to learn and master the knowledge and skills of the course.
2. The boundaries between course components are clearer. Each teacher emphasises the importance of their part of the course, but attention should be paid to the systematic knowledge and integrity of the course. There is not enough contact with other courses. So, students on many of the courses *listen a lot, learn something, but make little use of the information*.
3. Courses are taken concurrently, with a course requiring 4 to 6 student hours per week. Because of the concurrency, the continuity of learning is lost. In the senior stages of software technology, a small project requires a few hours a day, which fixed classroom schedules cannot provide.
4. Teaching content is strongly dependent on the selected textbook. Information technology changes rapidly, and simply renewing textbooks cannot keep up with the pace of change of the technology. Hence, it is unlikely a textbook will meet the requirements of a software major. Most textbooks are well presented, but do not address core professional issues and, hence, do not serve teaching needs.
5. Curriculum teaching pays attention to individual learning, with evaluation by examinations reflecting the ability to learn and remember. This does not meet the requirements for a project included in a software major.
6. Most specialised courses separate project teaching from the rest of the course. Hence, there is a lack of relevance and integrity in project teaching.

PROPOSED REFORM OF TEACHING

The reform of the course project is aimed at developing highly skilled talent to meet the needs of enterprises. In this article is proposed a new model with enterprise-relevant experimental classes, a tutor system and a professional project. This teaching reform breaks with the traditional model by establishing experimental classes for specialist training, implementing a tutorial system and providing a real professional project. Tutors teach students according to their aptitude. The comparison with traditional teaching is illustrated in Figure 1.

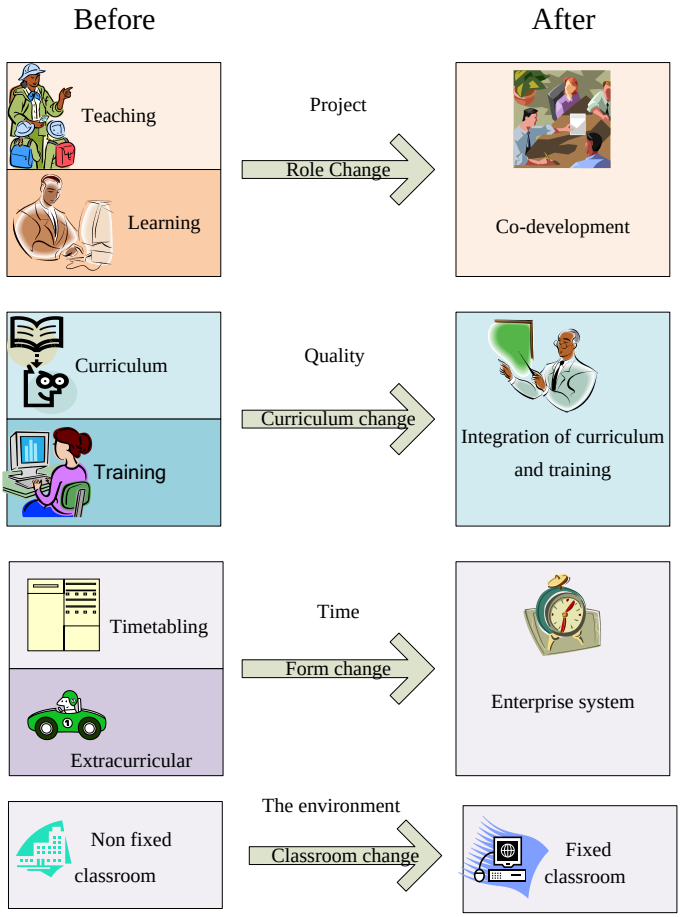

Figure 1: The proposed teaching reform.

The reform process has the following main features:

1. Experimental classes to integrate theory and practice: the school provides a software development training room and students use their own computers. The training room is the students' software development *space* and will allow the integration of theory and practice. Except for extracurricular activities, practical studying is completed in the training room. These changes to the curriculum increase the project teaching content and enhance the ability of students to complete the project. The changes reflect moving from being curriculum- and lesson-oriented to being software development industry-oriented.
2. Professional teaching project: teachers will lead students to research and develop projects. This will ensure the authenticity and enterprise-relevance of the teaching project. It enables students to engage with the operation of enterprises, market requirements, project execution and the skills needed to work in the real world. This changes the traditional roles of teacher and student, to project manager and software engineer.
3. The tutorial system: each class has about six students, with one tutor who is an outstanding teacher. The tutor guides students in the research and development of at least two innovative software development projects. Five or six engineers or project managers from enterprises are employed as part-time teachers. They have strong theoretical knowledge and rich practical experience of software development. Such senior development engineers exchange knowledge and skills with teachers and students.

THE CORE CURRICULUM SYSTEM

The proposed teaching reform has a core curriculum, with experimental classes, a tutorial system and a project orientation, and is shown in Figure 2. The system has the following levels:

1. Basic ability level consists of compulsory and professional courses. The compulsory courses include computer mathematics, university English, science and technology writing and sports. Professional courses include C-programming, computer operating systems and professional English.
2. Core software development level includes algorithm analysis and design, application programming and project development and control. Algorithm analysis and design is composed of foundation algorithms, the concept of data mining and its application, and data analysis techniques. Application programming is composed of object oriented programming, database application development, Web programming and UI (user interface) technology, software engineering and team working, Web development and intelligent terminal application development. Project development and control is composed of object oriented programming, project training, intelligent Web project training, and enterprise project training and a real world project.
3. Object-oriented programming is composed of basic algorithm design, object oriented programming, database application development and object oriented programming projects. Intelligent Web application is composed of the concept of data mining and applications, Web program design and UI technology, software engineering, team development and intelligent Web projects. Enterprise project development is composed of data analysis techniques, the Web project design and development and enterprise level project training. The real environment development is composed of a dynamic scripting language, intelligent terminal program development and a real-world project.
4. Advanced level, which mainly involves optional courses and *technical post-analysis*. The optional courses are chosen from the School's elective courses. Technical post-analysis involves enterprise personnel helping students become aware of the latest application technology.

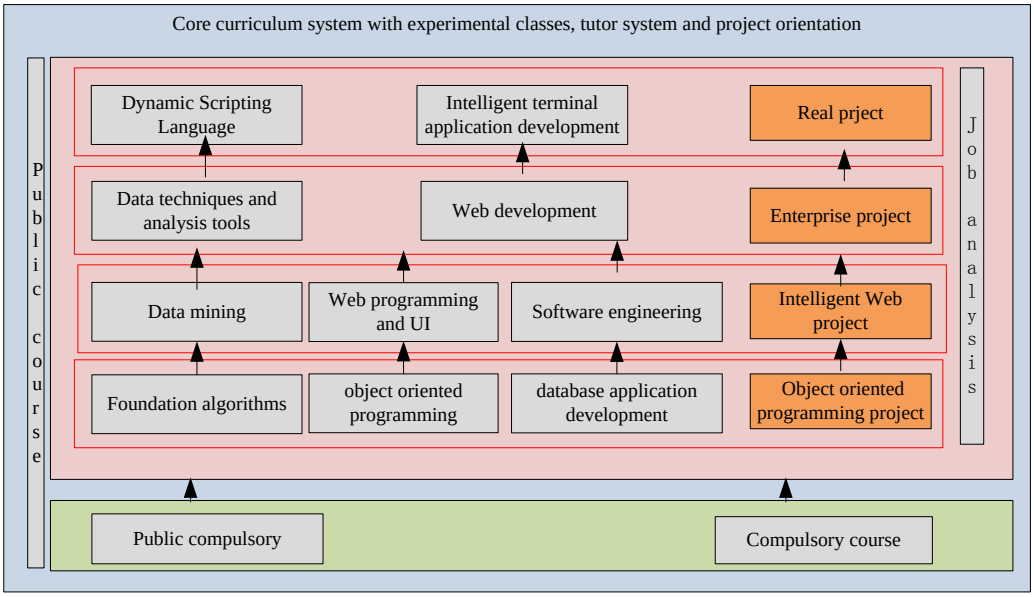

Figure 2: Core curriculum.

CONCLUSIONS

The teaching reform focuses on teaching students according to their aptitude and using realistic enterprise projects. The innovative reform involves the formation of a separate experiment class, a tutorial system and the implementation of project-driven training. The first year involves basic knowledge of software development. The second year involves Web and intelligent Web application development projects.

The last semester implements intelligent terminal applications and enterprise application project development. The aim is to cultivate more competitive, innovative software technology application talent in vocational education. The teaching reform has been implemented in Chongqing Vocational Institute of Engineering's software engineering course, and an experimental class has been established jointly with the Chinese Academy of Sciences. In the teaching process, results will be monitored for reference and to evaluate students' experience of the course.

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