Exploration and practice of college-enterprise co-operation talent cultivating in computer science at local universities

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ABSTRACT: Co-operation between school and enterprise is important in applied education at local universities. The significance of college enterprise co-operation in dealing with the existing problems of teaching computer science at local universities is presented and discussed in this article. Also, college-enterprise co-operation is described in this article in detail, including the modular curriculum and layered practical teaching model based on project experience. The conclusions drawn are that the measures taken promote the level and quality of teaching, as well as the employment rate and quality of graduates of computer science, so meeting the requirements of local enterprise for software development technical talent.

INTRODUCTION

At present, there are problems at various levels of computer science in colleges and universities in China. These include a need to match the training objectives to the curriculum; inadequate training; that the training does not meet market requirements; that there is an imbalance between theory and practice; that too little attention is paid to developing software development ability; and that the training of students lags behind society's demand for IT skills, which causes an imbalance in the IT skills provided [1][2].

Co-operation between schools and enterprises is the only way to train students with applied practical skills in Chinese universities and is good for the development of double capability teaching staff. It would improve students' practical and innovative abilities, improve teaching quality and reduce education costs. Finally, it would enhance a college's employment rate and competitiveness and could lead to the development of technical services that earned income for local universities. Compared with prestigious universities, local universities are poorer at developing a discipline; in scientific research; and in professional development. They are weaker in research co-operation with enterprises. Thus, it is necessary to find the best way to promote co-operation between universities and enterprises [3][4].

CURRENT STATUS OF THE SOFTWARE INDUSTRY

The software industry is the core of the information industry. It is strategic and has a fundamental impact on the national economy and social development. Survey data from China's Centre for Information Industry Development (CCID) show that there is a personnel gap of at least 500,000 per year in the IT industry. China's software industry is suffering from a talent shortage at the time of rapid growth [4]. The software and information outsourcing industry is a strategic emerging industry that was given priority in the 12th Five Year Plan of Xiangyang province. Xiangyang aims to develop software and information services, such as cloud computation and the mobile Internet. At the time of rapid development, a great many skilled personnel are needed in Web application software development, mobile Internet development and software testing. Due to factors such as region, the reserve of enterprise talent is inadequate to meet the demand in Xiangyang; hence, constraining the rapid development of the software industry.

The teaching of computer science in local universities needs to incorporate advanced technology. It needs to reflect developing trends and the occupational environment in industry. Co-operation between schools and enterprises is the key to improving the quality of practical training and specialty training. School-enterprise co-operation for local universities helps to develop a market orientation and to meet societal demand [5]. It is necessary to cultivate personnel in short supply in society, so as to realise the target for the required number of highly skilled professional personnel with practical and innovative ability. It is best to promote the training quality of personnel with practical ability. Urging

organisation, such as enterprises to participate in education reform can arouse the enthusiasm of students and develop their innovative ability. This helps boost co-operation between universities and industries in education and teaching resources, as well as opening up the schools' scientific and research resources to enterprises [6-8].

SCHOOL ENTERPRISE CO-OPERATION IN COMPUTER SCIENCE

Development of School Enterprise Co-operation

School-enterprise co-operation is being developed by the authors' School (Hubei University of Arts and Science) based on the precept of *guidance and support by governmental departments, initiatives by the school and in-depth participation by the industrial enterprises*. The Government has established incentive mechanisms in policy to support school-enterprise co-operation, and to encourage local IT enterprises to participate in cultivating talent. The aim is to encourage an interactive, win-win co-operative mechanism between schools and enterprises. Therefore, this School should adjust and develop its courses to emphasise applied practical training to meet market demand. By making use of the high-quality resources of local IT enterprises, the School has established a school-enterprise co-operative practical teaching system. A scientific and technical R&D centre has been established with enterprises, and the teaching staff have been strengthened. The enterprises and the School have jointly established a co-operation leadership group. This group has developed co-operation at all levels, has worked out and implemented a training scheme and constructed training bases to satisfy the requirements of student interns.

The transformation of teaching staff to double capability trainers was promoted by teaching production, theory and practice. The local industry associations can assist to develop supervision and quality assessment of the school-enterprise co-operation. Therefore, the school-enterprise co-operation involves bi-directional services.

School-enterprise Co-operation System

According to the principle of *being oriented to foundations and practice, proficient in the profession, and familiar with engineering*, attention was paid to positioning the co-operative system in *extensive and solid basic knowledge, deep professional skills and expertise with engineering experience* guided by market and employment demand. The training methods adopted were, for example, training guided by market demand, teaching by application, professional teaching by cases and training in on-site facilities. With co-operation from Oracle (China) Corporation, the School has extensively developed the system. It includes specialty co-building (i.e. with Oracle), reform of the training pattern, evaluation system, co-building of a modular curriculum system, school enterprise co-operation and mutual recognition of credit. In addition, practical teaching has been developed, the teaching staff have been organised, school-enterprise co-operation has been strengthened and quality control improved. As a result, much badly needed IT talent with innovative awareness has been cultivated.

Computer Science and Software Engineering Co-operative Programme

A new joint programme by universities and enterprises uses the *211* approach discussed below that postgraduate education of computer science is decomposed by a goal of skills cultivation, which is *stable in core and feasible in orientation*. It focuses on innovation and curriculum reform as its foundation, with a combination of industry, university and research. The *211* means that about two years are spent on laying a solid foundation for students, and on basic and specialised courses; one year is spent on specialised courses; and one year is spent on production, engineering and scientific research.

The system provides short-term training, including in specialties and graduation design and practice. During four years, the School and enterprises run the course by school enterprise co-operation. The authors' School cultivates skills based on the demands of enterprises, and will develop skills on demand. The enterprises may participate in the process by taking advantage of their intangible assets, such as operational ideas, knowledge and technology, so as to develop the IT skills they need urgently. This improves the suitability and practicability of talent cultivation, and produces a win-win situation where universities, students and enterprises all benefit. As a result, there is a seamless merging of skills cultivation and social demand.

The establishment of the *2+1+1* pattern and the principle of a four-year teaching programme is the guarantee of quality. Students' interests are enhanced, and their engineering awareness and practical ability are strengthened.

Content of the Programme

1. The first four semesters are concerned with the foundations of developing the student's basic knowledge and skills. Teaching content includes basic scientific theory, basic professional theory and basic technical courses. Students' innovative thinking is developed through basic mathematical modules and specialised basic modules. Students understand the engineering background as early as possible, to lay a sound foundation for their follow-up specialised study. From the second semester, every student is equipped with specialised instructors, who are in charge of the student's study, selection of specialty and learning plan.

2. *Being oriented to practice* is reflected in the four years of unceasing cultivation of practical abilities. In every semester, there are teaching links to practical applications and professional practice. The development of practical ability emphasises three levels of ability: program design, system development and software engineering. The program design ability is fundamental, i.e. students must have the ability to produce high-quality programs using design tools. The system development ability is reflected in planning the functions and realisation of a software system, so that the system satisfies user requirements in terms of function and performance. The software engineering ability involves the organisation, control and management of the software development process. Program design is carried out in the four-year study. What students learn in the first semester is fundamental, and they develop a system development ability from the third semester. Software engineering is taught in the fourth semester. Students focus on system development and software engineering in enterprises in the fourth year.

3. *Determining professional direction* occurs in the fifth and sixth semesters under the guidance of tutors. Students' professional direction determines their in-depth study. Students study all aspects of engineering by project pattern and by question-oriented learning. Students are encouraged to address practical problems by applying multi-disciplinary knowledge, modern engineering tools and by strengthening their independent study. The standard of the course is enhanced by co-operation with software enterprises. Credits gained by students should be recognised by relevant certificates. The professional ability needed in software enterprises is blended with the teaching system.

4. The project and graduation project (thesis) occur in the seventh and eighth semesters in an enterprise. This strengthens students' technical abilities needed in actual projects, and develops their practical and independent work abilities. The topics for graduation projects are sourced from enterprises.

Structure of a Modular Curriculum for Computer Science

The curriculum builds on the teaching experience of Oracle (China) Corporation. Abstract abilities are mapped to ability (elements), and knowledge points are mapped to the elements. A unit of ability is formed as a combination of elements. Next, ability units and their corresponding knowledge points are combined to form modules. Hence, the traditional specialised curriculum structured by disciplinary knowledge is transformed into a specialised modular system structured by professional abilities (Figure 1).

Table 1: Abilities and requirements for school enterprise co-operation.

Ability	Requirements
Software analysis and design	Master survey and analysis methods for user demand;
	Master design modes of such modelling tools and common software as IBM Rational ROSE and Power Design;
	Design and define interface protocols of software architecture and modules;
	Carry out detailed design and software workflow design by VISIO tool;
	Have writing ability for files developed by software, such as user demand, general design, database design and detailed design;
Programming	Familiar at applying ECLIPSE to carry out editing, compiling, operation and debugging; can develop modest-size programs;
	Carry out .Net program editing, compiling, operation and debugging, as well as development of modest-size programs by Visual Studio;
	Master interface design, script programming, business editing and programming, and system deployment of Web application system; develop modest-size programs;
	Make product setup programming, write such files as user manual and installation instructions by such tools as Install Anywhere;
Software testing	Familiar at application of such tools as Jtest, C++Test and .NetTest, and carry out the unit test, integration test, performance test and regression test;
	Familiar at applying such tools as TestDirector to write software test plan, test cases and test report;
	Familiar at applying such tools as LoadRunner to put up performance testing environment and perform the testing;
Software project management	Familiar at applying such tools as Project to carry out project scope definition, plan work-out, schedule monitoring, developing resource distribution and cost management;
	Master software configuration technology, and familiar at applying such tools as CVS and SourceSafe;
Mobile Internet development	Carry out programming, debugging and deployment for mobile Internet on such platforms as WinCE, Linux and Android by using such IDE as Visual Studio and ADS;
	Carry out the embedded driver development by such tools as PB;
Databases and management	Familiar at configuration and management technology of such common databases as Oracle and DB2;
	Master safety protection and performance optimisation technology of database systems;
Software engineering	Familiar with and master relevant technology and implementation for demand analysis, system design, system realisation, system testing, and system setup and debugging of software projects;

Ability and teaching requirements are shown in Table 1. In this system, an ability may be related to one or several modules. A module may involve theoretical and practical knowledge. Hence, the modular teaching curriculum breaks the traditional teaching mode.
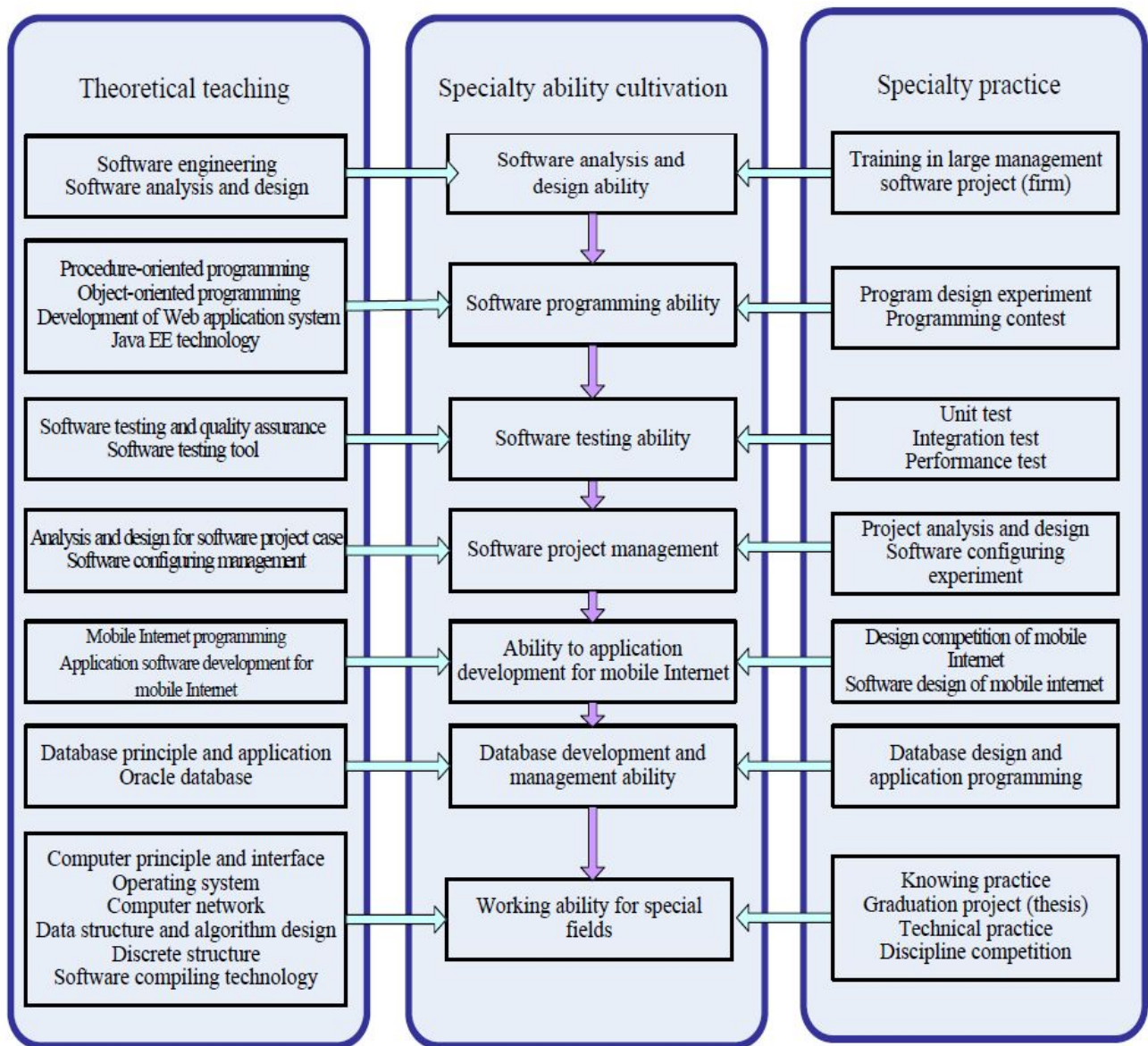

Figure 1: Modular curriculum for computer science.

Layered Practice Model Based on Project Experience

In order to satisfy the requirements of enterprises for IT personnel, the emphasis is on knowledge foundations and ability, so as to cultivate highly specialised personnel with practical and innovative ability.

Aiming to resolve problems in the traditional educational model, a layered model based on project experience was developed (Figure 2). When practising any knowledge point, students need not be aware of the knowledge points they have not yet learned. Students can realise different logic to reach different results for the project.

Students' abilities should be cultivated step by step in practical training from basic coding and intermediate procedure construction to complex enterprise R&D projects. The projects from enterprises are split up into several practical training components by difficulty level.

At first, the projects from enterprises are assigned to students directly for experience and application. After that, the projects are broken into training products by business division and technical classification to develop students' business and technical abilities.

Next, techniques involved in the training projects are incorporated into the daily teaching. Hence, *seamless docking* is achieved of the demands of enterprises for skills and the teaching at local universities.
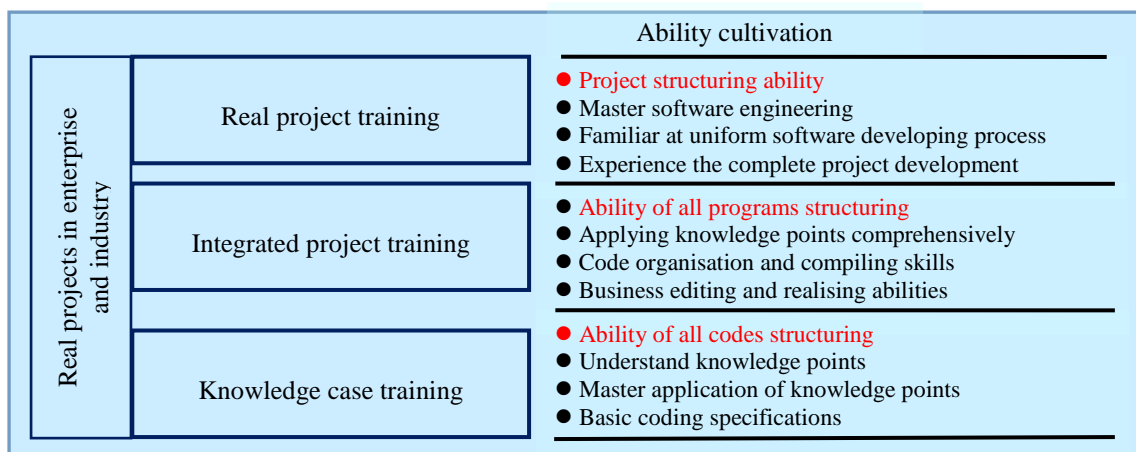
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	Ability cultivation	
Real projects in enterprise and industry	Real project training	● Project structuring ability ● Master software engineering ● Familiar at uniform software developing process ● Experience the complete project development
	Integrated project training	● Ability of all programs structuring ● Applying knowledge points comprehensively ● Code organisation and compiling skills ● Business editing and realising abilities
	Knowledge case training	● Ability of all codes structuring ● Understand knowledge points ● Master application of knowledge points ● Basic coding specifications

Figure 2: Layered practice model based on project experience.

SPECIFIC MEASURES FOR SCHOOL-ENTERPRISE CO-OPERATION

Strengthen leadership and perfect co-operation. Establish a work group of experts consisting of leaders of the school, Government, enterprises and public institutions to provide policies for school-enterprise co-operation. It should address academic issues, consider specific activities and develop quality criteria. Establish a school-enterprise co-operation executive group consisting of school functionaries, business cadres and relevant personnel from enterprises and public institutions. This group is responsible for implementing the co-operation programme by addressing disciplines, specialties, curriculum and specific teaching.

Select a co-operation unit and specify co-operative teaching content. Select the school and enterprise, specify co-operative content for disciplines and specialties, develop the co-operative scheme, including organisation, management, teaching staff, co-operative agreement and forms. Both co-operative parties are the principals. Develop the teaching objectives and plan, construct the curriculum, organise the teaching and assessments and organise the joint team.

Teaching standards, and characteristics of co-operation. In order to guarantee and ensure the quality of the teaching in the school-enterprise co-operation, develop quality criteria for practical teaching, training and the project thesis (graduation project). Establish and maintain internal quality monitoring systems. Construct training bases and practical teaching platforms, with rules and regulations to guarantee good operation and high utilisation. Make good use of all co-operative platforms in the school-enterprise co-operation. Make efforts to attract enterprises, build up the teaching inside and outside the school. The comprehensive practical teaching integrates practice and training, research, technical and application development.

Quality assurance, evaluation, management and supervision. Establish internal audit and management review systems for the school-enterprise co-operation. Develop project management by objective and performance-appraisal systems, and set up a disciplinary evaluation system. Employ industry and enterprise experts to participate in the evaluation of students. Use third-parties to evaluate the quality of the teaching. Implement, and constantly improve the evaluation scheme of the teaching.

Teaching staff with dual capability. The teaching staff should be developed as an industry-university-research combination. Insist on the principle of *employing top teachers, cultivating excellent members, co-operation between school and enterprise, and combine full-time and part-time teachers*, so as to expand the sources of teaching staff and optimise the teaching team. By using incentives and noting the requirements of the discipline, take measures to attract and employ top teachers. Full-time teachers, part-time teachers and enterprise technicians should be employed so as to build up an excellent teaching team with dual capacity and structure.

Employ teachers competent in applied fields from enterprises and let them participate in instruction or teaching for the main practical teaching. Given the lack of young teachers' practical engineering experience, delegate teachers to relevant enterprises to participate in project research and technical work by taking advantage of, for example, the 1000-Talent Cultivation Plan of Hunan Provincial Education Department. By this means, they can obtain some practical, engineering experience.

Young technicians may come to the School for further study-related courses or complete parts of research tasks for enterprises under the instruction of professors. In exchanges with enterprise, teachers and enterprise technicians jointly study and deal with technical problems and have a high-level technical consultation. According to the School's mantra of *entering enterprises, community and the countryside*, encourage teachers to participate in social services. Establish a long-term social service mechanism, with expansion of the school-enterprise co-operation, and with a teacher's quality and training project based on society's demands.

CONCLUSIONS

Based on enterprise demands and employment, the authors have outlined in this article the school-enterprise co-operation between their School and IT enterprises through the use of practical training methods of IT training agencies in order to cultivate adaptable computer postgraduates. The curriculum stresses programming ability and software development, as well as the development of specialised abilities.

Moreover, the layered practice model based on project experience is put forth in this article to improve students' applied software development ability. To sum up, the measures taken promote the School's level and teaching, as well as employment rate and quality of computer science graduates. By this, the local enterprise requirements for software development technical talent are met.

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