Reform of teaching and practice for outstanding ITO engineers

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ABSTRACT: The required core competencies of outstanding information technology outsourcing (ITO) engineers were analysed and the results outlined in this article. Several shortcomings are discussed that exist in the outstanding ITO engineers' training in traditional software-related specialties at undergraduate universities. An overall plan has been proposed to train outstanding ITO engineers through university-enterprise integrated co-operation, with the training in quality, knowledge and abilities of outstanding ITO engineers as objectives. Moreover, a theoretical and practical course has been proposed, and a reform and construction plan put forward that consists of general education, basic specialty courses, specialty courses and specialty practice teaching. In addition, a number of relevant matters have been raised for teaching teams involved in university-enterprise co-operation (UEC). The effectiveness of this reform has been proved through successful practices at Zhejiang Shuren University.

INTRODUCTION

The data provided by the Business Process Outsourcing Association of the Philippines shows that in 2012 the total amount of Philippines' business process outsourcing (BPO) reached $US13.6 billion. The National Software and Service Companies in India (Nasscom) have revealed that the information technology business process outsourcing (IT-BPO) industry grew 11% from 2012 to 2013. According to the statistics from China's Ministry of Commerce, China, has undertaken a number of international service outsourcing contracts worth $US43.85 billion and a growth of 34.4% per year. Besides which, the amount of contracts executed is $US33.64 billion and the growth is 41.1% per year. Year 2012 witnessed the inadequacy of talents in China's service outsourcing industry.

Talent inadequacy has become a crucial restraining factor for the country's service outsourcing industry's development. According to McKinsey's prediction, in the next five years, the development of offshore service outsourcing in China will face an insufficiency of 400,000 qualified staff.

Information technology outsourcing (ITO) has been the primary business in service outsourcing. In 2012, China's ITO, BPO and knowledge process outsourcing (KPO) have accounted for 56.1%, 15.5% and 28.4% respectively of total service outsourcing. Currently, the employees of the ITO industry primarily are university graduates and undergraduates. According to the data provided by China's Ministry of Commerce, there were a total of 21,159 service outsourcing enterprises and 4.289 million employees in China at the end of 2012. Among the employees were almost 2.91 million people who are university undergraduates and graduates, and which accounted for 67.8% of the total. These undergraduates are majoring mainly in computer software. However, their knowledge, ability and quality are far from satisfying the demands of current service outsourcing enterprises. Therefore, how to train outstanding ITO engineers to satisfy the ITO enterprises' demand has become a common concern for universities, governments and enterprises.

In recent years, a number of computer educators have conducted studies and exploration into how to train qualified outsourcing talent. Tian et al [1], Zhong et al [2] and Yu et al [3] have studied outsourcing talent training models in undergraduate universities. Deng et al [4], Zhang et al [5] and Yuan et al [6] have expended much effort on training models and creating plans for providing outstanding software engineers. However, little attention has been paid to developing talent and teaching reform to provide outstanding ITO engineers in undergraduate universities. In this article, the authors have analysed the core competencies required for outstanding ITO engineers and the shortcomings that exist in traditional computer software education. They also have proposed a university-enterprise co-operation (UEC) course system and a practice system using a top-level design. Several ideas are suggested for the construction and reform of a number of theoretical and practice courses. Measures to support teachers in this environment are put forward, for example, developing the teaching staff.

CORE COMPETENCY REQUIREMENTS OF OUTSTANDING ITO ENGINEERS

High-level ITO talent needs to account for approximately 5% of the total, including software architects. The intermediate-level talent needs to account for almost 35%, involving project management and senior software engineers. General technicians account for about 60% of the overall skills need and include data management and maintenance, software coding and testing personnel. From the aspect of academic requirements, most ITO companies need talents with undergraduate degrees, followed by diploma and Master's degrees.

In different service areas, the industry background of ITO is also different. Hence, industry background and related processing abilities are necessary for the ITO engineer. In addition, other common core competencies of outstanding ITO engineers include: information technology skills, foreign language skills, and occupational qualities and skills. The first core competency is made up of seven specific skills. One or two programming languages should be mastered. Analytic ability is required for developing algorithms and databases, and for data processing. Moreover, technical document writing skills are required, some software testing techniques and the usage of common tools. Besides these, the ITO engineer should be able to develop application software for one or two software development platforms.

Foreign language skills require the ITO engineer to master communication skills in basic Japanese or English, and to have reading and writing abilities to work with professional and technical documentation. Familiarity with the necessary foreign cultural background is required, especially, the company-based culture within which the service is delivered. Occupational accomplishments include: good communication abilities, co-ordination skills of teamwork and development, management capabilities of project organisation, and good professional qualities and moralities.

SHORTCOMINGS IN TRADITIONAL COMPUTER SOFTWARE-RELATED EDUCATION

At present, there is a wide gap between graduates of computer software-related specialties and the actual demands of enterprises. General outsourcing enterprises have to spend 6 to12 months and a lot of money on training these graduates. In contrast to enterprise demands, several drawbacks exist in traditional computer software talent training and teaching.

First, there are blurry training objectives and hierarchy orientations. Currently, universities and colleges in China lack their own characteristics of computer software-related training. Few differences exist in the training objectives, course systems and teaching methods, among national *211* or *985* project universities (a Ministry of Education initiative to raise research standards and strategies), general universities and colleges, and vocational colleges. They all tend to train by providing students with a deep foundation of knowledge across a wide range of areas. At the same time, ITO enterprises require diverse but often less deep talents; especially a large number of technicians able to code, test and maintain. As a result, graduates in a computer software specialty have difficulties in employment while ITO enterprises cannot find the talents they need.

Second, the course system has been constructed according to the principle of gaining complete knowledge of a discipline. In China, universities focus on the study of the theory of a discipline. The education orientation always has been to focus on the theory and to pay attention to the completeness of that knowledge by striving to cover everything. The educational system looks down on students trained in professional practical abilities. With higher education becoming more popular, teaching that emphasises theory instead of practice does not focus on the skills needed for a career-oriented education. This results in the embarrassing situation that graduates are unable to adapt to IT outsourcing enterprises since, though they have good knowledge, they have weak practical ability.

Moreover, teaching materials lag behind and teaching methods are unitary. Currently, teaching materials provide to the student classic and mature knowledge, but they generally have not kept up with developments in technology. Meanwhile, the ITO industry is a high-tech service industry, which has arisen in recent years. The development technologies that enterprises use are often new technologies. Meanwhile, universities generally lack teaching staff with practical engineering experience. Teachers are often not familiar with current novel techniques used in enterprises. This circumstance leads to a direct gap between teaching materials, syllabus, teaching content and the actual needs of enterprises. In addition, the works that ITO engineers are engaged in are project development, testing and technical maintenance. But traditional teaching methods prefer to teach by textbooks, with little attention on actual projects teaching. This teaching method produces graduates who find it difficult to adapt to the needs of their posts.

Last but not least, there is no relevance between the student's professional ethics education and their occupational accomplishments. At present, most universities and colleges in China deal with this aspect of education in the context of the courses on ideology and politics. The corresponding teachers teach first and second grade. There are unique professional particularities in ITO professional ethics and professional qualities, education and teaching should be carried out to support this. For instance, ethical issues in ITO system development and data maintenance are difficult to cover within the lower-grade classes on ideology and politics. It can be carried out in higher grades taught by professional teachers and project management staff from enterprises. Besides which, the subject is effective in senior years, only when communication skills and teamwork on software, testing and maintenance are taught and guided by teachers with project development and management experience acquired through practice.

DISCUSSION ON TRAINING PLANS FOR OUTSTANDING ITO ENGINEERS

Training Objectives and Overall Structure

Training objectives should be oriented towards training outstanding outsourcing engineers, who have excellent information technology outsourcing professional qualities, with a sustainable disciplinary knowledge base. They also should be proficient in the outsourcing language and be familiar with the outsourcing development, management processes and outsourcing specifications.

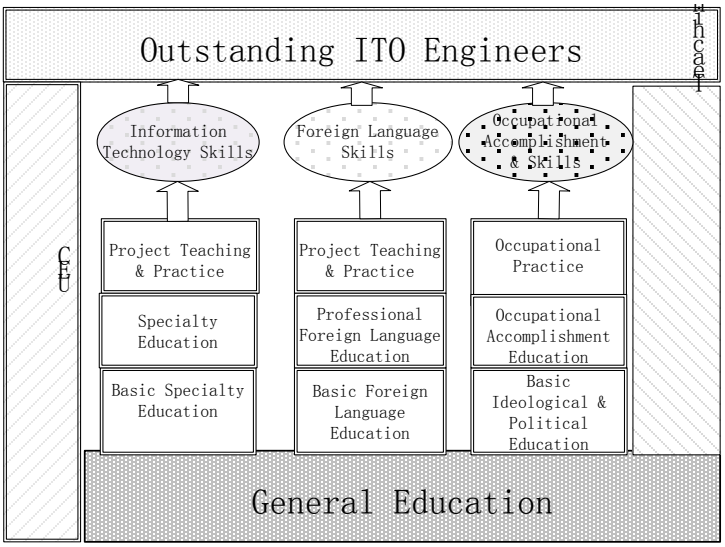

Figure 1: A framework of outstanding ITO engineer training.

A framework of training plans is presented in Figure 1. This takes training objectives as a top-level design and a core of market-required information technology skills, foreign language skills, and occupational accomplishment and skills. In the framework, university-enterprise co-operation (UEC) would participate in the whole process, from general education to graduation; and teaching quality monitoring would exist throughout the whole process of education.

Academic Year Arrangements as *1+2+1+Short Semesters*

The ITO industry requires 1 to 2 years' practical experience generally when recruiting technical personnel. But traditional undergraduate universities employ an education system of 3.5 + 0.5 academic years, where students must study on-campus for 3.5 years and are, then, supposed to complete a graduate project and a thesis. These students would have just one to two months' practical experience. To enable graduates to gain the actual project experience that enterprises need, the structure of the academic calendar should be *1+2+1+short semesters*. In the first academic year, students should study general education. In their second and third academic years, they should study the theoretical foundation of their specialty, as well as professional basic courses and professional courses. In the last whole academic year, they should participate in a project within the university-enterprise co-operative base or the co-operative enterprise itself followed by preparation for graduation. In addition, in order to strengthen the practical teaching and to ease the pressure created by the enterprise practices of the seventh semester on the course, three short semesters should be arranged, mainly on-campus dealing with project practice.

DISCUSSION OF CURRICULUM SYSTEM CONSTRUCTION AND CURRICULUM REFORM

Overall Architecture of a Curriculum System

Through research on ITO enterprises and IT training institutions, and taking into account of the knowledge and ability demands of ITO engineers, a major reconstruction should be made of courses and curricula that are currently organised in the traditional way. A core competency training-based course structure is presented in Figure 2.

There are several ways to design a curriculum system. First, lesson hours on theory should be largely reduced and practical lesson hours should be greatly increased. Lesson hours in the traditional teaching of computer software have a ratio of theory to practice lesson hours of about 8:2 (including basic common courses). For outstanding ITO engineers requiring a strong practical ability, this proportion is inappropriate. The appropriate ratio should be 6.5:3.5 or 6:4. This means the proportion of practical lesson hours and credits accounts for 35% to 40% of the total lesson hours and credits. Moreover, the unnecessary basic common courses and specialty courses should be greatly reduced. In traditional computer software specialty teaching, physics and even chemistry courses are essential basic common courses, while

electrics and electronics, and microcomputer principles are essential basic professional courses e.g. metalworking practical courses needs to be part of an engineering discipline and not unnecessarily introduced elsewhere.

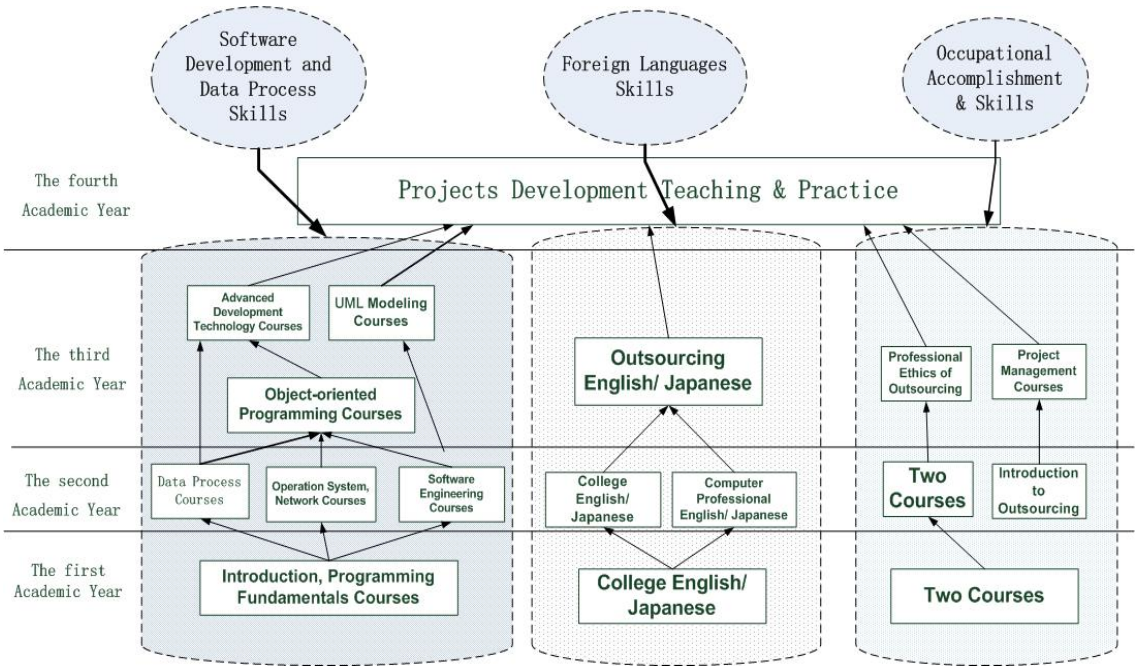

Figure 2: A core competency training-based course structure.

Meanwhile, the requirements for outstanding ITO engineers place more attention on software development and the data processing, rather than hardware, so that the physics course, physical experiments, electrics and electronics, microcomputer principles and metalworking practice can be ignored. In addition, the courses should be arranged such that they focus on three main areas: foreign language ability, data processing, and software development and testing. The courses related to the major professional skills should be organised as a continuous progression. With foreign language ability, the related courses should be arranged to run consecutively, such as College English or College Japanese, Computer Professional English or Computer Professional Japanese, and ITO English or ITO Japanese.

With data processing, some relevant courses should be arranged to run consecutively, such as Data Structure, Database, and Database System Development. With software development and testing, the related courses also should be arranged consecutively, such as Programming Fundamentals, Object-oriented Programming, Software Engineering, Web Development Technology and Project Development Examples. Furthermore, in order to broaden students' horizons and increase students' knowledge, some elective courses should be provided, such as Computer Information Security, Management Information System, Multimedia Technology, Electronic Commerce and Introduction to Management.

Currently, the mainstream development platforms in the market are the .Net platform and the JAVA platform. In order to satisfy the needs of different ITO enterprises and the development needs of the students, a complete curriculum system can use architecture as 'platforms + 2 modules'. In this architecture, two specialised modules should be set up. The specialty teaching would start in the fifth semester with the students able to choose freely between the two modules.

Target-guided Curriculum Reform and Construction

The curriculum reform and its structure should use application courses as the means to achieve skills training. These skills include ITO technology skills, foreign languages skills, occupational accomplishments and skills. First, according to the training objectives, the teaching objectives of each course can be determined and, then, subsequently, the convergence determined between various courses within the course group and the teaching. For example, for the IT data processing-related courses, such as data structures and databases, students should be trained to grasp the ability to design databases, and to efficiently process the data.

For software development, students should master algorithm design and programming and be proficient with the development platform used to develop outsourcing software. Moreover, according to the course objectives and the needs of enterprises, universities should construct teaching materials in collaboration with enterprises. Besides which, depending on the course, teaching methods could be reformed to implement open, case-based and project-based teaching. For instance, the course, JAVA Advanced Programming, implements a three-stage programme with set objectives and, then, introduces a projects-driven phase guided by case-studies as shown in Figure 3. Finally, the curriculum assessment methods can be reformed to focus on the stages of study which will enhance students' motivation.

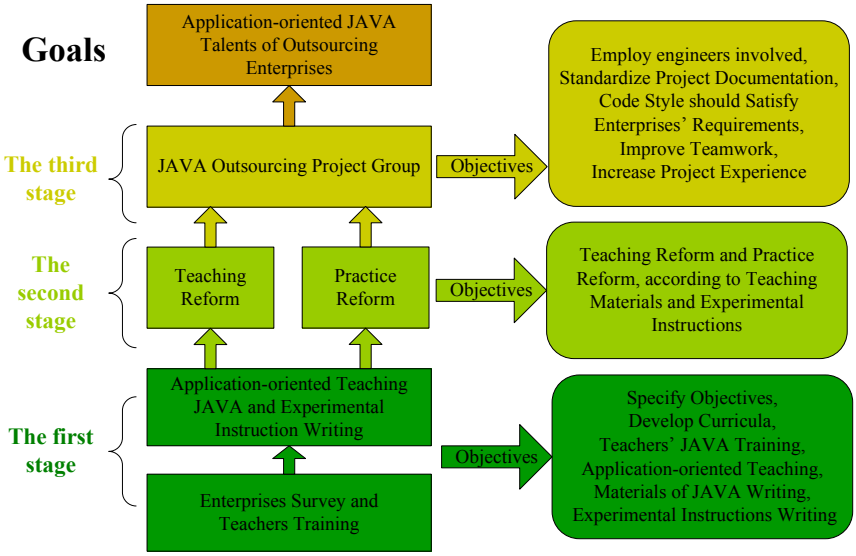

Figure 3: Three stages of JAVA advanced programming.

DISCUSSION OF PRACTICE SYSTEM CONSTRUCTION AND UEC PRACTICES

Overall Architecture of a Practice System

Several on-campus and off-campus practice and teaching bases have been established and an innovative practice platform has been built, such that practical teaching can be enhanced. In this way, a whole process and progressive practice system can be implemented, from curricular experiments, curriculum design, academic research, holiday post practice and graduate design, to UEC projects.

The teaching, including curricular experiments and curriculum design should be strengthened. Each main course and professional skills-type course should include internships and the ratio of practice lessons should be no less than 20% to 30% of class hours. Each main course should set at least one internship. In the design and implementation process of the experiments, the UEC model should be introduced throughout. The experiment courses group and projects group should be established to achieve a ladder of abilities-training objectives, from professional general education and professional skills training, to comprehensive project implementation. The overall architecture of the practice system is shown in Figure 4.

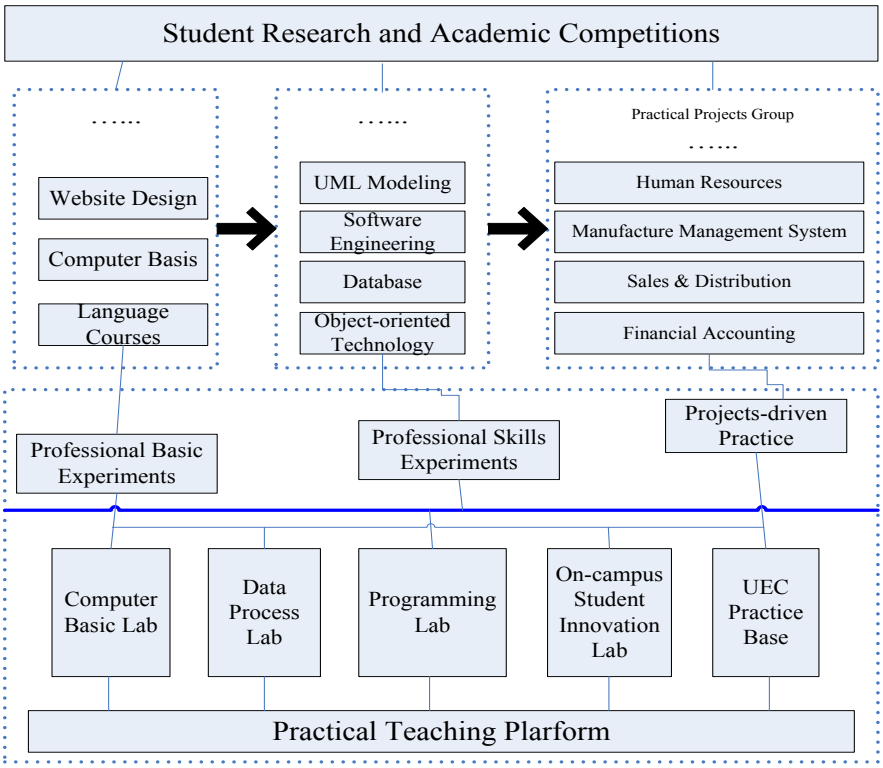

Figure 4: Architecture of the practice system.

Students are encouraged to participate in provincial and national computer competitions, so as to apply for school and provincial *Science and Technology* projects, as these can develop their research and innovation capacity on the basis of students' experiments. It also enables students to develop their practical and application abilities.

Practical Teaching in UEC

Carrying out university-enterprises co-operation with ITO enterprises can be an efficient way to improve students' practical ability and to increase their experience. At present, there are several different ways to approach UEC. Some universities prefer outsourcing all specialty education to enterprises e.g. the IBM Institute. Some universities choose outsourcing enterprises to help train students, such as the Tata Group. Also, some universities elect to build up the UEC practice base; Totyu Group and Insigma Group are examples. In the authors' opinion, the third method is more suitable for universities. In this way, the outsourcing talents base can be built up by universities and enterprises jointly. The practice classes can be set up and the teaching programmes can be developed jointly. With regards to teaching, the enterprises play a dominant role and the university also participates. Students would have a 3 to 5 months post-teaching practice before graduation.

TEACHING STAFF CONSTRUCTION AND OTHER PROTECTION FACTORS

The teaching staff are crucial to developing outstanding ITO engineers and implementing core competencies training based teaching. Different methods were tried in this study to improve the university's professional levels, such as the training of staff, and the introduction and appointment of experienced staff. On the one hand, teachers are allocated to software outsourcing enterprises to participate in the project development process and to improve their professional level. On the other hand, a project named Thousand Outstanding Engineers and Role Models was implemented, whereby experienced ITO engineers are appointed to co-operate with on-campus teaching and to participate in the teaching. It introduces excellent personnel who have studied abroad and returned bringing with them advanced system development models and philosophy [7].

Motivating students is an important factor in successful teaching. After their introduction to university, students should be guided and educated by stimulating their enthusiasm for learning and raising their career expectations. Their education on ITO professional qualities could be enhanced through related courses, as well as recurrent successful alumni seminars and professional managers' reports. Their teamwork skills can be enhanced through practice in project development teams, and their recognition of the corporate culture can be promoted by exposure to corporate practice.

The quality of teaching is fundamental for developing talent. In order to improve ITO engineers' continuous training quality, the university's academic departments and faculties have to strengthen their supervision of teaching, monitor the teaching quality of courses both theory and practice, keep abreast of graduate feedback from enterprises and, then, revise accordingly to form a closed loop.

PRACTICES IN ZHEJIANG SHUREN UNIVERSITY

Zhejiang Shuren University has explored the training of outstanding ITO engineers since 2008. The talent-training programmes have at their core the development through training of outstanding ITO engineers. Novel curricula covering theory and practice were constructed at the University, along with revolutionary reform of application courses. Several UEC teaching teams and practice bases have been established with a number of well-known software outsourcing enterprises e.g. Tata Group, Totyu Group and Insigma.

A complete process with a deep collaboration on courses in theory and practical teaching has been carried out. In the recent four years, significant results have been achieved on the training of outstanding ITO engineers. Nearly 200 students, from the Totyu class, Tata class, and Insigma class of UEC, have obtained highly paid jobs in outsourcing enterprises, such as the Totyu Group, Tata Group and Insigma. The employment rate has reached 99%, which is almost 12% higher than that in general undergraduates of a computer specialty at this University. Their average salary has reached 3,350 renminbi (RMB) per month, which is 1,200 more than the general undergraduates receive.

CONCLUSIONS

The information technology outsourcing industry is a promising industry that at present lacks talent. Traditional software-related education at undergraduate universities does not satisfy the requirements of the ITO industry. This requires a substantial and deep reform of the training model and curriculum system.

The outstanding ITO engineer training programme should be adjusted and oriented towards the skills, knowledge and qualities required by enterprises, requiring a reconstruction of the curriculum including the practice system. Meanwhile, course objectives and teaching content should be determined as part of the structure of training outcomes, and the courses transformed to be more application oriented. Implementing the whole process of UEC teaching can be an effective way to train outstanding ITO engineers.

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