A novel practical teaching system for application-oriented software engineering talents training

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Abstract. Practical teaching is an indispensable part in the cultivation of application-oriented talents. In this paper, problems existed in the software engineering talents training in the past decades are analyzed, i.e. insufficient innovation abilities in comprehensive practice and incomplete practical teaching system. Then, a novel teaching philosophy for application-oriented talents training and practical teaching as talents requirements orientation, core abilities and fused with engineering is proposed. The three requirements mean that orientate job demand based on industry, cultivate the engineering ability of students as core ability and take the merge of teaching and production as a method. Based on three requirements of software engineering talents, and taking the whole process and the cooperation as the carrier, a practical system with three types of fusion between universities and enterprises and four types of docking between teaching and industry are proposed. In the practical course system and the eight practice links, the teaching in the way of interaction between theory and practice, on-campus and off-campus alternation, learning and production blend, practice and "double creation" interwoven ways are implemented. The teaching evaluation and quality assurance would be implemented by the both sides. This system has achieved excellent results after years of practice in Zhejiang Shuren University.

Key words. Software engineering talent, Application-oriented, University-enterprise fusion, Practical teaching system.

1. Introduction

With the development of information technology and related economy, especially the new information technology industries such as e-commerce and service outsourcing, there is an increasing demand for talents that have strong practical ability, in order to meet the increasingly strong application-oriented computer software engineering talent demand. Training application-oriented talents is a key part in practice

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teaching. How to reform the practice teaching training system is the main problem in application-oriented software talents training.

In recent years, a number of scholars have paid a lot of efforts and exploration on how to cultivate computer software application-oriented talents. Shiping Ye[1], Li Hongmei [2], Chaoxiang Chen [3] and others have made some studies on the mode of cultivating talents in undergraduate colleges[4-6]. Furthermore, Jiahui Xiong[7], Chuanjun Guo[8] and others have made exploration on the construction of practical teaching system of computer and software[9-12]. However, there is not successful model and experience to construct the practical teaching system of application-oriented undergraduate software engineering talents used in the innovative way of "University-enterprise cooperation, integration of production and education".

Based on the extensive and in-depth market research about the demand of software talents, the traditional training of software talents is lack of insufficient general ability. Meanwhile, they cannot satisfy the requirement of emerging information technology industry for software development. Thus, we propose an application-oriented of talent training and practical education teaching philosophy of "demand-oriented, ability-core, engineering integration and integration of teaching and industry". Guided with this idea, we build a practical teaching system of computer software talents training with the demand of job capability, using goal-oriented and problem-oriented ideas. Moreover, we design the practical course system and eight practical steps. On the basis of the reorganization practice teaching support platform, such as laboratory, internal and external experimental base, the practice teaching platform of "three fusion" between the universities and enterprises have been constructed. We implement the learning and post "four docking" practice teaching, design and implement the practice teaching evaluation system and the quality assurance mechanism of "diversification, multi-dimensional and multi-channel", and achieve favorable results.

2. Problems in cultivating practical teaching system of applied software talents in traditional universities

2.1. *Practical teaching system cannot support position competence demand*

The traditional training of university computer software talents practice ability and innovation ability are insufficient, and cannot be better qualified for emerging information technology industry software post. In this way, the practice teaching system cannot support the training or the core ability needed by the software position. Too much emphasis on disciplines and theoretical basis thus ignored the practice of innovation ability in the personnel training orientation and specifications. In the personnel training mode, previous colleges confined to the traditional classroom and laboratory class to practice, also neglected and related combination of industries and enterprises. Furthermore, the proportion of theoretical courses is too high, conversely practical courses is seriously inadequate in the personnel training program arrangements.

2.2. Practice teaching and production are not connected

The curriculum objectives, course contents, link arrangements, teaching methods, practice approach, evaluation mechanism, and quality assurance of the traditional practice teaching curriculum system seriously divorced with industry capacity requirements, technology needs, organizational forms, production processes, and quality standards of emerging information technology industry software. The course objectives are not consistent with the job-related technical requirements. Course contents are obsolete and did not select the modern software industry popular development technology, but also not with the production standards. In the same way, practice approach and link arrangement rarely with the actual process of combining software development. The evaluation mechanism only focus on the verification of the results of the individual practice is correct or not, rather than the production of the team project test whether passed.

2.3. Teaching resources cannot meet the needs of practical teaching

The practice teaching system of cultivating application-oriented talents should be supported by the practical teaching platform of cooperation between schools and enterprises. It is necessary to have a good operation mechanism, "double teacher" practice teaching team and teaching resources of docked with software production. At present, most of the university- enterprise cooperation only stays in the outside-school practical bases, and only pay attention to the students sent to the enterprise internship, there is no deep cooperation with enterprises to establish the mechanism, without the introduction of enterprise teachers and practical teaching resources thus cannot satisfy deep-seated demands of practical teaching. Obviously, university-enterprise cooperation still remains on the surface of the internship cooperation.

3. To enhance the comprehensive practical ability as the core to build the innovative practice teaching system of university-enterprise cooperation

According to the concept of "demand-oriented, ability core, engineering integration", and after extensive research and in-depth analysis sort out the application-oriented of computer software talents should have "software development capability, business process analysis capability, communication and project management skills" three core practical ability. Among them, the software development capability refers to grasp the object-oriented programming design, have the application-oriented system analysis, design, implementation, data processing, and mobile terminal application-oriented development capabilities. Business process analysis capability refers to the ability to analyze and optimize the business process of software, can analyze the actual problems and propose solutions and also have design system structure and the ability to combine information technology with business objectives. Communication and project management skills is the ability to communicate

and manage projects in a software development project team, with basic skills in foreign language, such as reading and writing, listening and speaking.

In view of the basis of analyzing the three abilities, revised the talents training plan and constructed the whole process, coverage and integrative practical teaching system of the school -enterprise cooperation. Through the construction and reform of key areas of practice teaching platform, teaching system, curriculum practice teaching staff and practice innovation system to enhance student's comprehensive practical innovation ability, post competency and career development potential, as shown in Figure1.
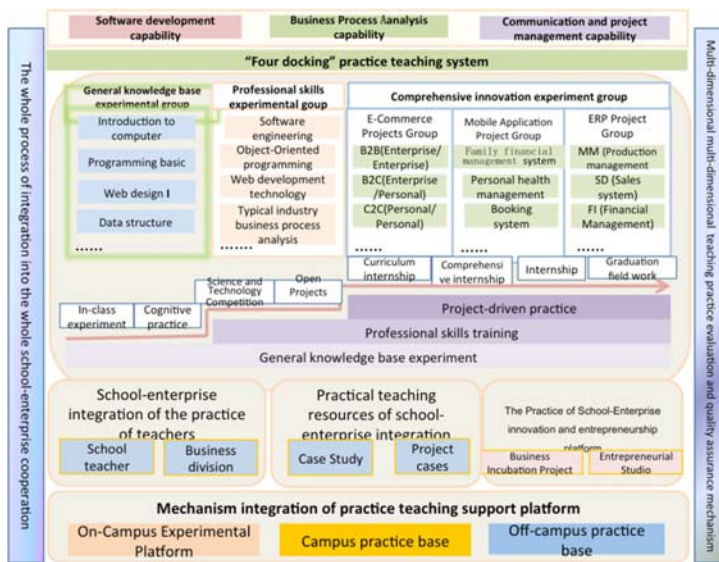

Fig. 1. Computer software talents training practical teaching system framework

The practical teaching system is supported by the "three fusion "practice teaching platform of school and enterprise, adopting the 2+1+1 progressive ability training mode. First of all, the first and second year arranging the basic experimental stage, following this, arranging the professional skill training stage .Finally, arranging the project comprehensive development capacity-building stage. According to the requirements of the three core competencies of professional application-oriented, the system designs eight courses of experiment and practice. On the one hand, the establishment of the three basic skills required for professional practice group, professional skills class practice group and integrated innovation project course group. On the other hand, the university-enterprise jointly organizes the practice teaching and step-by-step ability cultivation, and through the practice teaching evaluation system and the quality assurance mechanism of "multiple, multi-dimensional and multi-channel" to guarantees the effect and the quality.

4. Constructing a new practice teaching platform of "three amalgamation" between college and enterprise in order to meet the needs of practical teaching purpose

4.1. Mechanism integration with new governance construction practice teaching support platform

In order to support the development of three core competencies such as software development capability, business process analysis capability, communication and project management ability, the new way comprehensively combed the experiment, practice platform, integrating and constructing specialist laboratory and practice base completely. The new governance based on the integration of school and enterprise to build the computer software talents training practical teaching support platform.

In order to gain better support from government, industry and enterprise, hence founded by executives, experts and schools, professional leaders who from government authorities, provincial computer software industry association, and provincial service trade association, well-know computer software companies jointly formed the school computer software talents training guidance committee and practical teaching guidance committee .In accordance with principle of "process co-management, mutual benefit and win-win, sharing and collaboration" build a talent cultivation and practice teaching community—the alliances of computer software talents training and practice base, based on the new close integration of university-enterprise cooperation mechanism of "supply and demand docking, sharing of resources, benefit-sharing, win-win-three benefits" to establish personnel training and practice base in schools and enterprises.

4.2. Teachers integration, relying on thousands of project to build cross-border university-enterprise cooperation in teaching practice team

Relying on the school "thousands of teachers", "thousand" project of the "business training division" to establish an interdisciplinary, university-enterprise integration practice teaching team to implement the practice of teaching. Enterprise engineers participate in the whole process of practical teaching projects and curriculum design, organization, implementation, assessment. In this team, teachers as corporate project managers, project team members and corporate trainers full participate in project development, business process design and staff training. At the same time, team teaching according to different stages uses different models. For instance, using of team teaching, guidance and evaluation model in school curriculum stage and comprehensive practice stage. In the enterprise internship, graduate internship and employment post trial stage, using enterprise distribution positions and real projects, tutor full guidance and assessment, teacher tracking management model.

4.3. Resource integration based on enterprise technology projects to develop jointly practical teaching resources

Based on the actual project of the enterprise, university-enterprise according to the demand of the industry technology and capacity decompose the knowledge points and skills demand combined with characteristics of the curriculum study and practice. Constructing a "leaf-branch-stem" case project system based on curriculum case resources and enterprise integrated practice projects. Obviously, greatly improve the student's interest in learning and comprehensive practical ability after the implementation of the teaching.

University-enterprise joint implement the theory and practice of teaching, and designed 10-20 case resources for each core class, such as "Database" and "Object-Oriented Programming". The project includes project proposal, requirement analysis instruction book, and summary design instruction booklet and so on, which are provided by the enterprise. The two partners have jointly produced 10 large-scale real projects, such as "PICC member management system" and "subway management system" for the comprehensive project practice course. On the basis of combing the knowledge, skills and cases, university-enterprise cooperation joint to development of teaching materials and practical guidance.

5. To meetthe job requirements and career development as the goal, implementating the "four docking" new practice teaching

5.1. Docking practice comprehensive ability and software job demand, comprehensive innovation practice teaching curriculum system

Based on the detailed analysis of the practical courses needed in the three core competencies, such as software development, business process analysis, communication and project management, a new curriculum system for professional practice and professional practice courses is designed. The curriculum system to consolidate the basis of professional ability, strengthen the ability of integrated applications to enhance the capacity of job positions and other three-level progressive capacity arrangements.

According to the needs of the three core competencies, the construction of business process analysis, software development, communication and project management three practice groups. The connection between the courses in the course group and the concatenation of the knowledge points in the course. Moreover, set the classroom experiment, independent project training, business practice and other aspects of comprehensive practice. From the first and second years of professional knowledge of basic practice courses, the third year of comprehends application-oriented of practical courses to the fourth year of the industry-related positions in the practice of literacy courses, progressively training to build a practical teaching curriculum.

In the courses of credit arrangement, a substantial increase in practical hours

and credits. Independent practice courses with graduation practice and other credits accounted for more than 40% of the total credits. Further, the courses of practice core professional more than 50% in the total class hours.

5.2. Docking practice content and software professional standards, deepening the reform practice teaching methods

Staring from the actual position of computer software industry and according to the National Professional Standard of Computer Programmer and the requirement of service outsourcing software development industry standard, refine the relevant positions required skills and technical requirements to become the standard of curriculum practice teaching. Through the three stages of training and practice, such as "understanding of the standard", "familiar with the standard" to "use standard", students graduate into the workplace can consciously in accordance with technical standards and work requirements specification operation.

According to the typical software post technical requirements and the goal of subdividing ability, the teaching content, teaching method, organization form and evaluation mechanism are reformed in the practice teaching. Depth analysis of refining post technical and capacity needs like Java/.net development engineer, UI design, Web front-end development engineers, test engineers and through the optimization of curriculum materials and practice cases into the relevant practical content of these courses. The professionalism of the cultivation of integration into the daily teaching and practice, emphasizing coding norms, programming habits and other basic professional norms. In the comprehensive project practice, students are required to use the object-oriented language to complete the standards and industry main stream technical requirements of database programming, multi-threading technology. At the same time, students are required to master the various stages of the preparation of the main document and establish software quality awareness; master writing integrated test case technology and can use cases for software testing.

5.3. Docking practice teaching process and software development process, solid training students post competency

Combing the practice teaching link and reconstructing the eight links of practice teaching process system, which is closely connected. For instance, professional cognitive practice, professional in-class practice, professional practice courses, innovation and entrepreneurship practice, comprehensive project training, vacation post practice, professional graduation practice, employment trial. Meanwhile, through the interaction of theory and practice, On-campus and off-campus alternation, learning and production blend of practice to implement "from junior to senior", "from simple to comprehensive", "from practice to post" progressive training comprehensive practical ability (as shown in Figure 2).

Relying on the practice of the League base, part or all directly participation the enterprise likes "object-oriented programming curriculum design" and other main
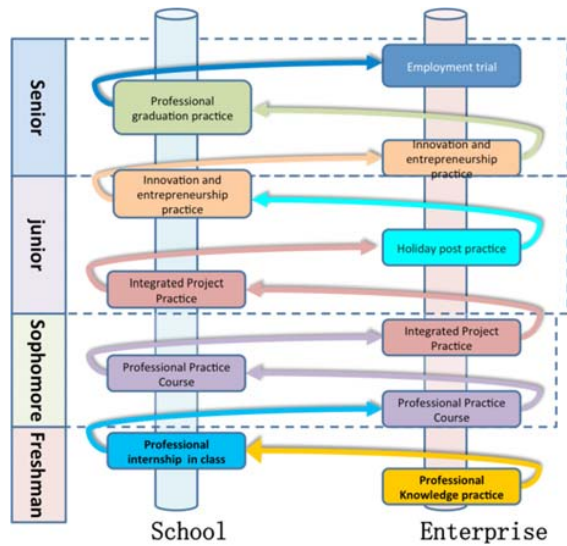
Fig. 2. The process of teaching practice diagram

courses. The purpose is to enable students to learn the process directly with the software enterprise production process. For example, "Project development example" practice course-teaching simulation with the whole process of seamless operation in the enterprise with the actual mode of development of the actual production process docking software. Firstly, course to the real development of software projects as a case project in the contract stage. Allowing students to simulate registration, demonstrate system development, tender production, bidding and other projects bidding process. And then, make students visit the actual project team in the project start-up phase, and division of labor, management system to establish the process after the simulation project team formation. In the project design phase, make the students field research project contractor needs, preparation project development documents. According to enterprise development mode organization form, students sub-iteming the project participate in development stage. In the test and acceptance phase is the use of group cross-test method for performance, pressure testing.

5.4. Docking incubator project and software industry market and focus on improving students' ability of innovation and entrepreneurship

On the one hand, carry out innovation and enterprise education activities under the practice base alliance. On the other hand, through innovation and entrepreneurship counseling report, Sharon Forum, set up innovative entrepreneurship courses. Furthermore, through the establishment of innovative business team and setting up students' innovative research and development funding projects to guide students innovation and entrepreneurship. Through the establishment of business incubation projects, innovation and entrepreneurship studio also support students in the form

of a registered company to promote innovation and entrepreneurship. Relying on the professional production, "software research and development center", the teacher's studio and "Mentoring" mechanism to attract students participate in teacher's research. In the mean time, enhance their ability to innovate entrepreneurial combat.

Docking software industry market, choose development base project, which is concerned by the base alliance enterprise and has good business prospect. Meanwhile, set up the innovation and incubation project all in order to make the practice project more in line with the development direction of new information industry software. Enterprises will also be part of the school project development, design and testing so that students in the form of participation in the project team. According to market prices, provide students labor and other costs.

5.5. The implementation of university-enterprise condominium multi-dimensional evaluation, comprehensive protection of the quality of practical teaching

In accordance with the principle of "university-enterprise condominium, process monitoring, target management", constructing the evaluation system and quality assurance mechanism. Through the practice teaching team to evaluate students comprehensive practical abilities such as software development, communication and coordination, business analysis, project management and teamwork. Constructing "school, enterprise, students" multiple teaching supervision mechanism and monitoring the whole process of teaching practice and the state. Through the regular lectures, expert evaluation, corporate feedback teaching supervision, follow-up survey of graduates and other means to conduct a comprehensive monitoring of the teaching process and feedback to ensure the quality of practical teaching operation.

6. Reform effectiveness and conclustion

In recent years, through the improvement and implementation of the practical teaching system, students of Zhejiang Shuren University have made considerable progress in lots of areas, e.g. academic papers, national and provincial students scientific projects, software copyright, and national and provincial competition awards. Meanwhile, graduates have a good situation of employment. According to the Mycos's survey of 2012 graduates, Zhejiang Shuren University computer software graduates have high employment rate as 96%, more than 85% of students entering the software service outsourcing enterprises. The average monthly income after graduation six months is higher than the province's non-985 undergraduate college graduates average income of 21.8%. At present, some graduates have become Dongzhong Technology, Insigma group, Tata Group and other well-know service outsourcing business sector manager, project leader and technical backbone. In other words, high employment rate, high professional compliance rate, we achieve the high salary level, high corporate culture integration and high professional development potential.

University-enterprise cooperation is an effective way to cultivate talents of engineering software. "Three fusions, four docking" teaching practice system integrates

the advantages of both sides of the university and enterprises to software engineering talents training to build a good practice teaching platform. The system is based on the three competencies required for training positions, which are arranged in the practical course and in practice. This system implementing the way of docking employment and career development, evaluate the effectiveness of learning and the quality of teaching from the actual needs of the post. The system has achieved good results after years of practice in Zhejiang Shuren University. Exploring and improving the practical teaching system to meet the demand of the industry to develop software engineering personals will be continued.

Acknowledgement

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