Study and Reform of a New Industry-university-research "Industrialized" Software Talents Cultivation Mode

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Abstract. In order to respond to the national and local calls for the development of software industry, the reform scheme is proposed for the cultivation mode of software talent. In such reform scheme, the software industry chain oriented post groups are analyzed under the guidance of the software industry development; the universities and enterprises cooperate to explore a new "industrialized" cultivation mode of software talents with industry, university, research integrated in the mode of "2+1+1"; the theory-practice integrated curriculum system is designed to reflect the subject development trend and to meet the software industry demands; the school-enterprise "1234" engineering practice teaching system is created to ensure the quality of talents and to improve the students' innovation ability and social adaptability.

Introduction

In recent years, the service outsourcing industry has become a national development strategy. In order to respond to the national call, Nanjing Government proposes to create a "world famous software city" and to build a platform for featured software industrial groups and public software services, thus leading and driving the development of Jiangsu Province along and across Yangtse River by the leading and span development of software industry. The rapid development of the software and service outsourcing industry requires a large number of high-quality core talents with technology, management and international vision, thus improving the overall competitiveness of the software and service outsourcing industry[1]. Responsible to cultivate talents for local economic society, the local colleges and universities shall seize the opportunity to actively explore the cultivation mode of software service outsourcing talents, to speed up cultivating high-end versatile software talents, and to solve the problem of talent bottleneck suffered by software industry, thus not only making contributions to the software industry in Nanjing and even the whole China, but also fully embodying the role of universities in the development of social economy.

Research Target and Reform Thought

Research target

Centering on the construction of "Informationization Province" in Jiangsu Province, the construction of "Famous Software City" in Nanjing city and the development needs of the emerging strategic industry, the structure of software engineering is optimized, the connotation construction is strengthened, the software industry development trend is traced, the international cooperation and university-enterprise cooperation advantages are played, the talent cultivation mode is reformed, and a scheme is constructed to cultivate international, versatile and application-oriented software talents. The curriculum connotation construction is strengthened to create more excellent courses and teaching materials, and to build the digital bilingual teaching resource library. The education is industrialized to focus on the cultivation of the students' engineering ability and innovation ability, thus realizing the university-enterprise cooperation in education, cooperation in running schools, cooperation in employment and common development.

Reform thought

CDIO[2] (Conceive, Design, Implement, Operate) is a new mode of engineering education mode jointly initiated by Massachusetts Institute of Technology, Chalmers University of Technology, Linkoping University and Royal Institute of Technology in the international engineering education cooperation project jointly developed by 23 universities in the world. As an education concept and methodology system to guide the reform in the cultivation mode of engineering talents, and as a kind framework system of curriculum design, CDIO conforms to the general rule of the cultivating modern engineering and technical talents, which cultivates the students' engineering ability carried by the conception, design, implementation and operation process, and points out that the students' engineering ability includes not only the academic knowledge, but also the lifelong learning ability, team communication ability and control of large system [3].

Having paid close attention to the education reform trend of application-oriented talents both at home and abroad for a long time, and in combination with my own practice, the following reform thoughts are put forward for the cultivation mode of software talents: the traditional education idea shall be changed by continuously learning the advanced foreign engineering education modes with reference to the CDIO education idea; the software industry chain oriented post groups are analyzed under the guidance of the software industry development, so as to set the talent cultivation goals satisfying the industry development demands; the universities and enterprises cooperate to explore a new "industrialized" cultivation mode of software talents with industry, university, research integrated by running a school on the industry base and in the mode of "2+1+1"; the theory-practice integrated curriculum system is designed to reflect the subject development trend and to meet the software industry demands; the university-enterprise "1234" engineering practice teaching system is created to ensure the quality of talents and to improve the students' innovation ability and social adaptability.

Analysis of the software industry chain oriented post groups, and creation of talent cultivation goals

Aiming at the "demand exceeding supply" of software talents in Jiangsu Province, especially the lack of high-end versatile and internationalized elites, it is further specified to cultivate software industry oriented versatile and internationalized IT engineers, so as to revise and improve the talent training scheme.

It strives to comprehensively analyze the demands of stakeholder group (students, industry, university teachers and society), especially the demands for software industry human resources, thus creating scientific and reasonable goals for talent cultivation. Strengthen the close cooperation with IT companies at home and abroad, establish the steering committee for the cultivation of talents in service outsourcing industry, and employ the relevant government departments, industry association experts, enterprise executives, and well-known experts in provincial colleges and universities as consultants. Under the guidance of such consultants, oriented by the development of software service

outsourcing industry in Jiangsu Province and Nanjing City, mirroring the successful experiences and practices from famous universities at home and abroad, the professional orientation is adjusted and improved, and the software talent training scheme is developed to further conform to the industry development trend.

University-enterprise cooperation in exploring a new "industrialized" talents cultivation mode

Establish the mechanism of university-enterprise joint training, set up the leading group of university-enterprise joint training, and jointly formulate the specialty training scheme and enterprise training plan according to the industrial demands for talents.

The "2+1+1" mode (as shown in Fig. 1) is adopted to cultivate talents in three stages: basic professional education, industry-oriented professional education and enterprise-oriented vocational education. In the "2+1+1" mode, it focuses on the study of basic theory and technology principle in the first two years, but focuses on the education of engineering practice, especially the practice ability and vocational quality. The mode of theory-practice integration teaching is adopted in the last two years, by which the theoretical teaching is integrated into engineering practice project completely in accordance with the industry demands, and the "doing-asking-learning" mode is adopted to cultivate the students' ability to find and solve problems in practice.

Software industry and enterprise

Enterprise-oriented vocational education
(the fourth year)

Industry-oriented professional education
(the third year)

Basic professional education
(the first two years)
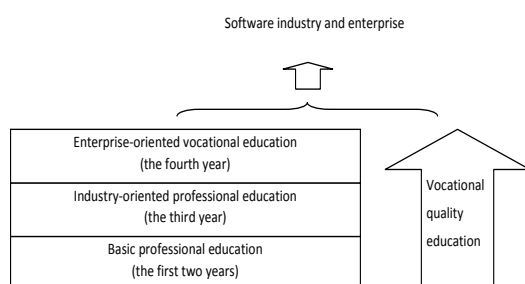
Vocational quality education

Figure 1. "2+1+1" cultivation mode of software engineering talents

Education environment may be deemed as the university in the industrial park, so the cultivation of engineering quality and professional ethics runs through in the whole process of talent training. Based on the study of training target, teaching mode, teaching contents, practice platform, teachers and other factors having an effect on application-oriented engineers in the background of "industry-university-research" cooperation, the industry-university-research education plan is implemented and optimized to explore a new and effective cultivation mode of "industrialized" talents. Such cultivation mode not only motivates the industry enterprises to deeply participate in the training process, but also ensures the schools to cultivate engineering talents in accordance with the general standards and industry standards, sharing the same purpose of training the students' engineering practice and innovation ability.

Design of theory-practice integrated curriculum system to reflect the subject development trend and to satisfy the software industry demands

Cultivation of software industry oriented versatile talents, and reconstruction of knowledge structure of multi-disciplinary integration

Software is an emerging industry facing different industries, the development of which requires the practitioners to have multi-disciplinary backgrounds and theories. Due to the existing division of majors in colleges, the students understanding information technology usually lack the basic knowledge in the enterprise management; due to the division of arts and science, the students knowing business management understand little or even nothing about information technology. Based on the demands for software versatile talents and the principles of "solid foundation, integration of arts and sciences, combination of general and specialized knowledge", this topic integrates the knowledge system between different disciplines to reconstruct the knowledge structure

for post groups, which not only improves the students' ability of social adaptation, but also develops the versatile talent knowing both the industry knowledge and the information technology.

Formulation of capacity-based integrated curriculum system by learning the foreign outstanding engineering education concepts

Mirroring the advanced engineering education concept as CDIO and the precise society, industry and graduate findings, cultivate the students' engineering practice and innovation ability, and formulate the curriculum system with theoretical teaching, experimental teaching and engineering practice integrated in strict accordance with the Software Engineering Specifications in Institution of Higher Learning [4] issued by the Ministry of Education Software Engineering Steering Committee. Based on capacity cultivation, oriented by engineering design, and with comprehensive engineering practice as the backbone, the integrated curriculum integrates the disciplinary theory course, training practice integration, theory and practice, thus helping to training the capabilities of basic practice, professional practice, research innovation and entrepreneurship, and social adaptation [3]. The four capabilities above may be further classified by the professional training targets of software engineering, which may be integrated into the theory course and practice teaching, and implemented in the integrated curriculum, thus enabling the students to satisfy the demands of service outsourcing industry in the aspect of knowledge, ability and quality.

Comprehensive import of industry generality, prospective knowledge, capacity and occupational quality to facilitate the cultivation of innovative and entrepreneurial abilities

Software engineering is a new discipline linking the IT discipline and business discipline. The rapid development of software engineering requires the practitioners to have industry generality, prospective knowledge and ability reserve to support and even promote the sustained and healthy development of software industry. Therefore, attention must be paid to the rapid update of course structures and teaching contents, and the key generic and cutting-edge technologies in the service outsourcing industry must be integrated into teaching, thus constantly enhancing the innovative ability of students.

The professional quality of the software engineer reflects the value of software practitioners, which determines the future of software engineer. The essential professional ethics of a software engineer shall include the software professional ethics, self-management skills, expression ability, interpersonal skills, teamwork capacity, ability to solve problems, innovation ability, project service ability, learning and adapting capacity, and career planning. The whole talent cultivation process shall focus on the cultivation of professional ethics of a software engineer. In the basic professional education phase during the first two years, the industry-oriented professional education stage during the third year, and the enterprise-oriented vocational education stage during the fourth year, whether it is the theory or practice courses, attention is always paid to the cultivation of students' professional quality (as shown in Table 1).

TABLE I.   RELATIONSHIP BETWEEN COURSE AND VOCATIONAL QUALITY TRAINING

Stage	Course	Vocational quality training
Basic professional education (the first two years)	Basic professional course Professional course Course design	Self-management skills, expression ability, ability to solve problems, learning and adapting capacity
	Cognition practice	Software professional ethics, expression ability, interpersonal skills, teamwork capacity, career planning
Industry-oriented professional education (the third year)	Professional practice	Software professional ethics, self-management skills, expression ability, interpersonal skills, teamwork capacity, ability to solve problems, innovation ability, project service ability, learning and adapting capacity, career planning
Enterprise-oriented vocational education (the fourth year)	Project practice	Software professional ethics, self-management skills, expression ability, interpersonal skills, teamwork capacity, ability to solve problems, innovation ability, project service ability, learning and adapting capacity, career planning
	Graduation practice	
	Graduation design	

Creation of university-enterprise "1234" engineering practice teaching system to ensure the quality of talents

For the software talents, practical ability is of the largest importance. The traditional computer science major has accumulated rich experience in the cultivation of the students' basic knowledge and practical ability, and has made great achievements. However, the cultivation of students' engineering ability and professional quality is also very important for the software engineering major. Therefore, it is quite urgent to form a cultivation mechanism with basic theory, experimental teaching and engineering practice integrated by constructing the engineering practical teaching system, which not only enables the students to develop in a comprehensive and balanced way, but also adapts to the needs of modern software industry.

In line with the idea of "deriving from industry, rooting in industry, and serving the industry", supported by the government, the enterprise education and engineering practice resources may be constantly introduced, and the cooperation with enterprises may be fully developed to establish the "1234" engineering practice teaching system [3:58], which will be then integrated into the whole talent training scheme. "1" refers to one teaching idea, the one paying equal attention on the engineering ability cultivation, the basic theory teaching, and the professional ability training. As one of the core tasks of talent training, the engineering practice teaching system is established by fully reforming the talent training mode, adjusting the course system, enriching the teaching contents, and improving the teaching methods, thus fully reflecting the cultivation thought of engineering ability and professional quality. "2" refers to the campus practice base and off-campus practice base, the full-time and part-time teachers; "3" refers to the three levels of experimental teaching systems, including the basic operation skills training and validation experiments, the module design and integrated application, the system design and innovation practice. "4" refers to the four practice abilities, including the basic practice ability, the professional practice ability, the research innovative ability, the entrepreneurship and social adaptability. The three layers are targeted at the cultivation of the first three abilities above; the fourth ability above is cultivated by the comprehensive practice project opened in the complex laboratory jointly built by the campus practice base, off-campus practice base and enterprises.

Furthermore, the university-enterprise complementary teaching staff may be formed, and the internship and employment base may be established together with various well-known software enterprises in the plan of "one valley and two gardens (China Nanjing Software Valley, Jiangsu Software Park, Nanjing Software Park)". As the talent receiving unit, enterprises may fully

participate in the curriculum and teaching process, while the school teaching management departments may supervise its implementation.

Conclusions

Various colleges have cooperated with Jiangsu Software Park and some well-known software companies to create an alliance to cultivate industrialized software talents for software industries, especially focusing on the cultivation of students' engineering practice ability. The talent cultivation are "guided by social demands, oriented by software applications, based on capacity cultivation, integrated with industry, university and enterprise, and jointly completed by schools and enterprises".

As a long-term process, the cultivation of software talents is still worth of our study. The talent cultivation mode and its various links shall be continuously explored, reformed and improved in the practice, thus training more senior application-oriented software talents adapting to the developing society.

Acknowledgment

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