Local University Cultivation Model Research on Specialized Software Engineering Talents Under Integration of Production and Education

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Abstract. In the context of the new era, cultivating high-quality innovative talents and technical skills has become an urgent requirement to promote the development of the software industry. There are some problems in the training of specialized software engineering talents in local universities in China, such as unclear orientation, ineffective practical teaching effect and shortage of professional teachers. Based on the issues mentioned above, it is advisable to establish a clear professional orientation aligned with industry demands and develop a curriculum system and content that are in line with this specialized focus. Establishing a collaborative industry-education-research practical teaching system and deepening the collaborative innovation capability development model between industry, education, and research. By solving the two core problems of 'what kind of professional talents to cultivate ' and 'how to cultivate '. It aims to provide suggestions for the professional cultivation of software engineering talents in local colleges and universities in the era of industry-education fusion.

1.Introduction

Software is the core force which leads scientific and technological innovation, and is the core content of information technology. Software development is characterized by knowledge-intensity, creativity, virtualization, non-uniqueness and complexity. It is a persistent problem of dependence on people for software production. It could be said that the software industry is a talent industry, and software talents are the core elements of the development of the software industry. So, competition in the software industry is fundamentally a competition for talent. With the accelerated integration and penetration of software and various fields, the rise of software-defined everything and the emergence of a new generation of information and communication technologies. The market demand for software talents continues to increase, and the competence requirements for software talents continue to improve. The software engineering major in universities ,which is the core force for cultivating software talents has an irreplaceable role in the talent cultivating system. In particular, a large number of general universities become an indispensable force to help the development of the software industry, because of the large number of students.

Over the years , general universities have trained a large number of software talents for the software industry to take on positions such as software development, software testing, software operation and maintenance, software design and software analysis, etc. However, the supply and demand market of the software industry is still facing the situation that enterprises cannot recruit suitable high-quality software talents and graduates cannot find satisfactory jobs. This shows that there is still a big gap between the software talents cultivated by higher education institutions and the actual needs of enterprises. Graduates lack professional quality, engineering practice ability and innovation and entrepreneurship ability, making it difficult for them to quickly adapt to the working environment of IT companies. Especially in recent years, the emergence and application of new technologies have made the imbalance between supply and demand more prominent.

Integration of Production and Education is a mode of schooling that combines industry and education [1], emphasizing 'double subject ' collaborative education. This means that enterprises, as the main body of the market, put forward talent training requirements from the side of talent demand, and play a leading role in talent demand. Universities, as the main body of education, are oriented to the demand for talents, and cultivate comprehensive and technical talents that are urgently needed on the industrial side and the demand side [2]. Therefore, Integration of Production and Education is regarded as an important path to realize the effective connection between the supply side and the demand side of talents [3].Foreign researchers believe that education development and social development are interdependent, universities and industrial sectors are interdependent [4], and universities can benefit from the integration of

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production and education by choosing companies that can provide long-term support [5,6].

Beginning with a trial software engineering major at some of universities, The software engineering major has been developed for more than two decade. 'Specialization ' has become the consensus of all universities, and different universities have defined their own professional characteristics for their own positioning. A great deal of research and practice has been carried out in the areas of talent training mode, faculty construction, curriculum system construction, practice teaching, management system, etc., and remarkable results have been achieved. But one fact that cannot be ignored is that the contradiction between the quality of talent training in schools and the needs of society has always existed and has become more prominent with the development of the industry. Therefore, a large number of local general universities should take the opportunity to implement the Opinions of the General Office of the State Council on Deepening Integration of Production and Education. Universities should explore and implement a specialized software engineering talent development system that integrates industry and education. They should also establish and refine a demand-driven specialized software engineering talent development model. By addressing the two core questions of 'what kind of individuals to nurture ' and 'how to nurture them', universities can contribute to the cultivation of a significant number of high-quality innovative talents and technical skill professionals for the industry.

2.The status quo of software engineering talent cultivation in general universities with specialization

2.1.Exploration of domestic specialized software engineering talent cultivation

Specialized software industry talent development is a necessary requirement and significant support for achieving high-quality software development in China. Deepening the integration of industry and education is the primary approach to achieving specialized software talent development.

Around this point, universities have carried out a series of effective research and practice on the cultivation of specialized software engineering talents. Xidian University [7] has integrated industry-teaching collaborative education into many aspects such as training objectives, training conditions, training modes, curriculum systems, and training initiatives. Their focus is on nurturing specialized software talents that align with the development needs of the software industry. Jimei University [8] adopted the mode of university-enterprise cooperation to strengthen practical teaching and optimize the structure of the faculty. This has closely integrated the development of national economy and society and the needs of employers to promote professional development and talent training. They emphasized that through the university-enterprise cooperation model, students' vocational skills and employability can be continuously enhanced. This contributed to the cultivation of urgently needed practical and project-oriented software professionals for the economy and society. North Min zu University [9] implemented reforms and innovations in the '3+1 ' teaching model. It emphasized the cultivation of high-quality engineering and technical talents with strong innovative abilities, aligning with the needs of economic and social development. Guangdong University of Education[10]embarked on the development of specialized software engineering programs in the context of New Engineering + Engineering Education Accreditation. This involved changes in educational philosophies, innovative training models, and the construction of a new system for specialized education. Fudan University [11] has implemented an educational approach guided by industry demand, driven by research progress, and promoted by industry practices. This approach focused on nurturing highly innovative and internationally competitive software professionals and emphasizes internationalization and innovative features in specialized software engineering. China University of Geosciences [12] has taken multiple measures in cultivating software engineering majors. First, they clearly defined the objectives and principles of the cultivation system. Secondly, the structure of the professional training system was designed to ensure systematicity and effectiveness. At the same time, they have adhered to the comprehensive ability training concept of 'speciality + software ' and emphasized the cultivation of comprehensive quality. In addition, by increasing project-driven practice and innovation ability training, they help students accumulate experience and enhance innovation ability in real projects. Finally, they focus on consolidating the educational connotation of the engineering ideology of software to ensure that students have the ability of practical engineering application. Their goal is to cultivate software engineering talents with comprehensive abilities in software engineering and domain expertise, who are able to gain an in-depth understanding of software design, development and application in specific domains, and who are able to apply software technology to solve domain-specific problems.

2.2.Problems facing the training of software engineering majors in general universities with specialization

The core of the specialized software engineering talent training is to solve the problem of 'what kind of people to educate, how to educate '. In general, Integration of Production and Education emphasizes the joint participation and collaborative promotion of talent training by enterprises, schools, governments, industries and associations. It better answers the question of 'what kind of person to cultivate'. At the same time, it also provides macro guidance for solving the question of 'how to educate '. Although universities had carried out a lot of research and practice in the specialized software engineering personnel training people, and achieved

significant results, but specific to the general universities, still face many problems.

1) The positioning of talent training is unclear, and the teaching program lags behind the development of the industry.

Although the training program for software engineering majors in regular universities explicitly states the goal of 'cultivating applied software engineering talents', there has not been a revolutionary adjustment in the teaching plan and curriculum system. Furthermore, during the process of curriculum system design and teaching implementation, there has been a failure to break through the traditional teaching methods for talent development. In terms of teaching content, there is a lack of dynamic embodiment of the frontier of the discipline and the development of the industry and technological innovation. The school does not place sufficient emphasis on the cultivation of students' professional qualities and practical abilities. An effective, career-oriented talent development model has not been adequately established. As a result, students' practical and innovative abilities cannot effectively adapt to the ever-evolving technologies in the software industry.

2) The effect of practical teaching in talent cultivation is not prominent enough, and engineering ability is lacking.

The cultivation of applied talents in software engineering major cannot be separated from the important content of practical innovation ability cultivation. However, at present, the content and structure of software engineering practice teaching in colleges and universities are not reasonable, and some of them are difficult to be put into practice. Insufficient software and hardware resources in teaching experiments, curriculum design, internship and training places, etc. are needed to cultivate innovative practice ability. The teaching link of innovative practice ability jointly carried out by schools and enterprises cannot be put into practice. The proportion of comprehensive practice of software projects is seriously low, and the practical training of college students in actual projects is seriously insufficient.

3) There are insufficient teachers of software engineering to meet the training requirements of applied software engineering talents.

Teachers are the leading of teaching, and the level of the teaching team will directly affect the teaching quality and competitiveness of the school. Specialized talent development places higher demands on teachers, requiring them to possess profound theoretical knowledge. Teachers are expected to quickly grasp new software development methods, development technologies, and tools. They should also have extensive experience in enterprise project development and management. However, some teachers in general universities have been engaged in teaching basic courses for a long time, and they are not familiar with the current mainstream technologies and tools in the industry. Another part of the teachers are engaged in scientific research work alone, and they have no practical project work experience. This results in teachers being unable to promptly incorporate emerging new technologies, methods, and tools into their course instruction based on practical project development experience. Consequently, they are unable to meet the training requirements for applied software engineering professionals.

3.Exploration of industry-teaching collaborative education model for software engineering talents in general universities with specialization

In the context of the national emphasis, there is a focus on the development of the software industry. The objective includes nurturing and constructing a batch of distinctive demonstrative software universities. Additionally, there is an aim to explore a China-specific approach to industry-education integration for software engineering talent development. Furthermore, there is a plan to establish a batch of exemplary high-quality models for software engineering talent cultivation. Ultimately , the overarching goal is to drive the historic leap from a large to a strong software industry in our country. General universities should be based on their own reality, actively introduce external resources, create a high-level faculty, and explore the effective specialized software engineering talents collaborative education model.

1) Clearly oriented to the industrial needs of the special positioning, to solve the problem of 'what kind of people to educate '.

Firstly, focusing on the key directions of national software industry development (in the fields of key basic software, large-scale industrial software, industry application software, new platform software, etc.). Combining cloud computing, big data, artificial intelligence, blockchain and other new-generation ICT technologies, general universities should make good use of the resources and platforms provided by cooperating enterprises. general universities should also carry out industry associations and local governments, and sort out the specific needs of industries for talents in the context of the industrial Internet, digital economy, information consumption and Internet+. Then general universities make full use of the social evaluation data, carefully analyze the advantages and shortcomings of the current talent training, and thoroughly clarify the existing foundation of the construction of software engineering major in our university. Afterwards, we actively communicate with the sister colleges and universities to find out the gaps and deeply analyze the reasons for the gaps. Finally, drawing on the advanced experience, combining the requirements of local economic construction and our own reality, we will establish characteristic of our software engineering major, find our own positioning, and improve the relevance and overall level of software talent training.

2) Formation of a distinctive curriculum and course content to support 'how to educate ' at the curriculum level.

Curriculum is an important support for the cultivation of specialized talents with specialization, and it is also the main factor that the objectives of talent cultivation can be achieved. The discipline of software engineering is an artificial science with software as its basic research object, including theories, principles, methods, techniques, tools

and systems involved in the activities of researching and analyzing, developing and operating, using and evolving software. Taking software abstraction as a perspective, the discipline of software engineering can be divided into four subfields: software language and software theory, software construction methods, software operation support, and software metrics and quality assessment. With the development of big data, cloud computing, Internet of Things, and artificial intelligence technologies, the application of software engineering shows a deep cross-fertilization trend with these technologies. Therefore, the design of the curriculum framework and content for software engineering programs in universities must emphasize uniqueness. It should also be closely aligned with the new generation of information and communication technologies. Achieving their own training goals necessitates continuous adjustments and improvements to the teaching content and structure. First, enterprises should be invited to participate in the construction of the curriculum system and course content, so as to have a deep understanding of the real needs of the industry and to implement the industry needs into the curriculum system and course content. Second, the educational focus should be on nurturing students' expertise in theory, technology, skills, and engineering experience. This involves optimizing the curriculum framework, continually adjusting courses to align with the actual needs of the software industry, and adding courses that closely integrate with engineering practices and cutting-edge technologies. This ensures the sustainable development of software engineering professionals. Third, a curriculum adjustment mechanism should be put into practice, following a 'top-down ' and 'bottom-up ' cyclic approach. This means scientifically designing course content, having a forward-thinking approach in content arrangement, and ensuring that the latest research findings and potential industry hotspots are promptly included in the curriculum. Each course should have clearly defined knowledge points and competency development goals, ensuring a close coupling between the curriculum framework, course content, and specialization.

3) To build a practical teaching system with industry-teaching synergy to support 'how to educate ' at the level of practical skills.

Practical teaching is an important part of the training of software engineering application-oriented talents, and is also the main way for students to cultivate and exercise their practical ability. Therefore, building a practical teaching system with industry-teaching synergy is an important guarantee for the implementation of specialization. First, to give full play to the enthusiasm, initiative and creativity of enterprises in the process of talent cultivation, the scientific research capacity of universities should be combined. High-quality practical education bases to meet the specialization of talent cultivation should be set up, and a resource-sharing platform integrating talent cultivation, scientific research, achievement transformation and social service should be constructed. Secondly, a scientific and reasonable practical teaching system should be constructed. This system encompasses four levels of practical teaching: 'experiment, engineering practice, professional internship, and graduation design.' Within this framework, case-driven, project-driven, and engineering-driven teaching methods should be implemented. Specialized training should align with the stringent criteria set by enterprises. This approach aims to enhance students' software skills while simultaneously fostering their communication and adaptability. This enables students to improve their software skills and at the same time cultivate their communication skills and flexibility. Among them, professional internships should take place in practical education bases and be taught by business tutors. The topic of graduation design is also required to be close to the enterprise, close to the demand, and guided by the school and the enterprise jointly and collaboratively. Thirdly, according to the new practical course system, general universities will build a ladder training program of software professional skills, practical ability, and innovation literacy. The fourth aspect involves strengthening the quality control of practical sessions. This includes formulating quality control norms that encompass various aspects such as grouping, division of labor, workload, and effect. Additionally, scientific evaluation rules will be established to improve the current practice of solely relying on laboratory reports and evaluation reports. The aim is to address the issue of inconsistent standards and the practice of students 'passing the class by taking a ride'. Ultimately, the goal is to motivate students and enhance the responsibility of teachers, achieving the purpose of motivating students and increasing teachers' sense of responsibility.

4) Enhance the collaborative innovation capability development model between industry, education, and science to support the question of 'how to nurture ' innovation capabilities.

First, in the process of research, teaching, and learning, there is a focus on knowledge innovation, dissemination, and continuity. This involves making full use of the advantages of university research platforms and research teams that have long been engaged in research projects. Students are actively engaged in research projects through methods such as mentorship programs, student innovation and entrepreneurship projects, and industry competitions. Second, the 'specialized discipline + software engineering ' model is employed, leveraging the university's industry background to organically integrate software engineering with domain knowledge. This allows students to actively participate in projects, promoting continuous practice and development. Students not only acquire software engineering expertise but also gain a broad understanding of domain-specific knowledge. Third, the 'bring in ' strategy is implemented, with some specialized courses taught by collaborating companies. Senior lecturers, senior project managers, and R&D engineers from these companies are selected to undertake teaching responsibilities, providing students with insights into the specific knowledge needed in the industry. Fourth, the 'send out ' strategy is encouraged. Faculty members are encouraged to participate in various professional training programs to broaden their horizons and gain exposure. Simultaneously, the university closely collaborates with partner companies in teaching and research, encouraging teachers to immerse themselves in

these companies, undergo on-the-job training, and enhance their engineering practice experience through participation in corporate project development.

4.Conclusion

The independent control of key basic software, large-scale industrial software, industry application software, emerging platform software and embedded software require a large number of high-quality specialization of software talents. Integration of Production and Education and collaborative education is an effective way to achieve the goal of specialization software personnel training. General universities should seize the educational opportunity of collaborative education between industry and education. With the construction of a distinctive demonstrative software universities as an opportunity, the specialized positioning of programs will be defined. A distinctive curriculum system, course content, and practical teaching system will be constructed to meet the needs of the software industry. The construction of industry-education integration practice bases will be strengthened to provide students with real-world work experience and skill training opportunities. Innovations will be made in industry-education integration collaborative education mechanisms to nurture specialized talents with software thinking and advanced software engineering methods. Comprehensive and deep implementation of industry-education integration collaborative education models will be carried out to cultivate versatile professionals who possess industry knowledge, proficiency in algorithm modeling, and the ability to promote industrial technology software development.

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