Course Construction under the Background of New Engineering

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Abstract. In the context of “New Engineering”, this paper has made some explorations on the construction of software engineering courses. The background of course construction is analyzed to identify the weak links in course construction. The top-level plan of “four in one and three in combinations” has been formulated to provide a unified framework for construction. It elaborates on the course content to keep up with technological development, combine online teaching with optimized teaching methods, cooperate with schools and enterprises to educate students, and promote learning through competition. Practical results show that students gradually acquire the basic theory, design development technology, and application innovation capabilities of software engineering, and realize the zero-distance docking between academic and employment.

Introduction

To promote the reform and innovation of engineering education, the Ministry of Education successively proposed the “Fudan Consensus”, “Tianda Action” and “Beijing Guide” in 2017. Subsequently, the Ministry of Education issued the “Notice of the Ministry of Education on Higher Education Research and Practice”[1], officially launched the “New Engineering Research and Practice” project, and comprehensively kicked off the construction of the “New Engineering”.

Course construction is an important part of the new engineering reform and innovation. Based on implementing the fundamental task of establishing a virtuous person, we must strengthen the ability to solve engineering problems, closely integrate the curriculum system and the practice system, and emphasize the integration of industry and education[2].

“Software Engineering” is a comprehensive and practical course. In the context of the country’s vigorous development of new engineering, software personnel training faces an unprecedented crisis, and there are many problems that need to be solved: outdated content that cannot meet technological development and industrial needs; practice derails from enterprises and cannot adapt to market needs; the cramming teaching method does not meet the ability requirements.

Under the connotation requirements of “New Engineering” construction, this paper finds out the breakthrough point of course construction of software engineering. The top-level plan of “four in one and three in combinations” has been formulated to provide a unified framework for construction practice. On this basis, the specific methods of course construction are elaborated, including four aspects of keeping up with the technological development and updating the course content, strengthening the combinations of online teaching and optimizing teaching methods,
collaborating with schools and enterprises to educate students, and promoting learning through competition. The results of the two-year teaching application show that students have gradually acquired the basic theory, design development technology, and application innovation capabilities of software engineering, and realized the zero-distance docking between academic and employment.

**Course Construction Background**

The teaching purpose of the software engineering course is to train students to have engineering software thinking and be competent in software engineering technology research, design, development, management, and service. In recent years, we have been building software engineering courses, and the measures we have taken include the use of case teaching and project teaching methods to shorten the gap between the teaching content and practical application; the use of teaching methods of the combinations of MOOC class and Rain classroom to expand the knowledge of students; through the joint construction of the school and enterprise, the experimental equipment was updated, and the internship training environment was provided.

The implementation of various course construction measures has enriched the teaching content, improved students’ practical ability, and improved the quality of software talent training. However, with the in-depth development and extensive application of technologies such as artificial intelligence, big data, and the Internet of Things, the software industry has become one of the pillar industries of the information society, software development projects are the priority and highly valued industries of the current large and medium-sized cities\(^3\). Especially in the context of “New Engineering”, the training of software engineering talents faces new challenges.

First, the training of software talents should highlight engineering practice ability. Affected by traditional engineering education, the disconnection between the theory and practice of software engineering courses has become more and more serious, too much emphasis on the instillation of theoretical knowledge, neglecting the cultivation of practical ability in real situations. As a result, the students still lack the basic practical skills of software engineers after graduation, and cannot meet the requirements of enterprise employment\(^4\). To meet the requirements of engineering education returning to engineering practice, course construction should focus on the cultivation of engineering practical ability, and build an integrated teaching system in and out of the class, inside and outside the school. Students can learn software engineering theory, practice engineering projects and cultivate independent software engineering ability in the environment close to the enterprise.

Secondly, software talent training must adapt to the development of new technology. The deep integration of artificial intelligence and software engineering has provided brand-new methods, technologies and tools for software engineering research, improving software quality and development efficiency. On the one hand, the teaching content of software engineering must be continuously updated with the development of technology, such as using the Internet to collect data and using big data analysis to obtain user needs; introducing agile development methods to meet the needs of rapid software release in the era of large media; using intelligent software engineering to improve the efficiency of software development and testing. On the other hand, students must be able to learn independently and have the ability to learn new knowledge to adapt to the rapid development of technology.

Thirdly, software talents must meet the requirements of complicated industrial structure. In recent
years, with the development of “Internet +” and various new technologies, the future industry types are more diverse, the structure is more complex, and the upgrade speed is faster. The software industry has become one of the most promising emerging industries. The shortage of software talents has become the main bottleneck restricting the development of China’s software industry[3]. The software engineering course should focus on the characteristics of strong practicality and fast innovation of the information industry. It should face the industrial needs and train students with strong practical ability. Meanwhile it must adapt to the evolving industrial needs and develop students to have the ability to learn for life. Only in this way can students adapt to the needs of the new industry and alleviate the contradiction of lack of talent in industrial development[5].

Course Reform Practice

Do the Top-level Design Well and Formulate Construction Plan

Taking the new needs of software talents under the background of “New Engineering” as the starting point, we put forward the “four in one and three in combination” course construction plan (see Figure 1).

![Course construction plan](attachment:course_plan.png)

Figure 1. Course construction plan.

The idea of “four in one” divide the course into four parts: theoretical teaching, experimental teaching, practical teaching and graduation design. These four parts coordinate with each other to form the main body of course construction. The idea of “three combinations” is to integrate the technology and resources of online education, competitions and enterprises into the teaching to form a strong support for theoretical teaching.

The construction plan takes theoretical teaching as the centre and radiates parallel to experimental teaching, practical teaching and graduation design. The specific instructions are as follows: the knowledge points of theoretical teaching are the basis of experimental teaching and practical teaching. For example, a single knowledge point can be used as experimental teaching content, such as data flow diagrams and test cases; complex systems composed of multiple knowledge points can be used as practical teaching content, such as student attendance systems and teacher performance evaluation systems; application cases that solve practical problems can be used as graduation design topics. Experimental teaching, practical teaching and graduation design as the operation part of theoretical teaching, enhance students’ understanding of theoretical knowledge, gradually train students’ systematic thinking and engineering practice ability.

The construction plan uses the technology and resources of online teaching, competitions and
enterprises as the teaching support. First, the rich network course resources are included in theoretical teaching, and the course teaching can also be posted on the Internet to meet the needs of students anytime, anywhere. The second is to use various competitions to promote practical teaching and graduation design, stimulate interest in learning, and increase opportunities for innovation and entrepreneurship. The third is the collaborative education of schools and enterprises. Through the use of technology sharing, platform co-construction, technical guidance, and school-enterprise cooperation, new technologies and new equipment are introduced into school teaching, helping students to complete practical training and graduation design in enterprises. They can also invite engineers to teach courses to shorten teaching content and the needs of the enterprise.

**Adapt to Technological Development and Update Course Content**

Software engineering is a comprehensive course; its purpose is to use engineering ideas to obtain high-quality software products. Software is a kind of thinking product, which is designed and realized by people. How to efficiently develop high-quality software has always been a research focus of computer science.

The course content is updated in two ways. First, based on traditional software engineering, tools and frameworks are used to support the software life cycle process and reduce the burden of manual management. In the requirements stage, we use Rational RequisitePro requirements management tools to provide information query, tracking and management for each stage of software engineering. In the system design stage, we use PowerDesigner to complete database design and use Axure RP for rapid prototyping. ROSE tool is used for the whole process of object-oriented from requirements design. Second, appropriate expansion of new methods, such as requirement analysis using network questionnaires and big data analysis to identify needs; adding the Python programming language and Tensorflow framework in the coding stages; in the testing stage, introducing the use of artificial intelligence to implement software testing and defect location.

**Strengthen the Combination of Online Education and Optimize Teaching Methods**

The increase in the course content will inevitably cause contradictions in the limited hours. Using network resources to carry out mixed teaching is the most effective way to solve this contradiction. First, make full use of MOOC platform resources, such as software engineering courses online in the Xuetang Online, students use their spare time to study. Secondly, self-made video resources for students to learn such as the added content, the use of software engineering tools, project explanations. Finally, enterprise engineers can conduct online teaching and provide online technical support for students.

So far, we have completed 28 new technology videos and 18 online lectures. These methods expand the knowledge of students, increase the real project design experience, and shorten the distance between course teaching and enterprise application.

**Strengthen School-enterprise Cooperation and Innovate Collaborative Education Mechanism**

Through in-depth cooperation between schools and enterprises, we can introduce enterprise resources in the teaching process, train students with practical projects, improve students’ ability to solve complex engineering problem and enable students to quickly meet the requirements of employers after graduation.
The specific approach has the following four points:

Technology sharing: we have established technical cooperation with the School of Information Science and Technology of Northwest University, Nanjing Yunchuang Big Data Technology Co., Ltd. etc. to carry out technical exchanges and project cooperation to improve the technical level of instructors.

Experimental teaching: we have built three laboratories with Lanqiao Software College and Xi’an Silk Road Software Co., Ltd. to update teaching facilities and enrich teaching content.

Practical training and graduation design: relying on the company’s latest technology and actual project cases, enterprise engineers will teach the case projects by way of speaking and practising. The graduation design is mainly based on engineering applications, and based on practical training projects and scientific research projects in graduation internships; students can complete graduation project in the enterprise.

Oriented by Competition, Promoted by the Competition to Achieve Results

Taking the “Internet +” College Students Innovation and Entrepreneurship Contest, the China Software Cup, the Blue Bridge Cup National Software and Information Technology Professionals Competition and other subject competitions as the carrier, the approach of promoting learning through competition are adopted to guide students to comprehensively apply knowledge and skills in various subjects to solve more complex design or engineering problems.

The topic of the competition can be discussed by teachers and students, and the students can complete the competition work in teamwork. For the above-mentioned competitions, teachers and enterprise engineers jointly provide technical guidance. This measure greatly enhances the enthusiasm of students’ independent learning and innovative practice. It can cultivate students the ability of innovation and entrepreneurship.

Conclusion

Under the background of “New Engineering”, the software engineering course construction should emphasise the concept of engineering education, with inheritance and innovation, intersection and integration, coordination and sharing as the main approach, and strive to improve students’ engineering awareness, engineering quality and engineering practice ability.

After two years of exploration and practice, we have initially opened up a four-in-one collaborative development path of theoretical teaching, experimental teaching, practical teaching and graduation design. We work closely with enterprises to achieve innovative practical ability training covering software processes. Students will acquire the basic theory, design development technology, and the application innovation capabilities of software engineering. These measures also realize the zero-distance docking of academic and employment, and recognized by students, enterprises, and society.

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