Research and Construction of Talents Cultivation Model of Software Engineering Major Based on Engineering Education Certification

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Abstract: Engineering education certification is an internationally general quality assurance system for engineering education. It is a detailed inspection and evaluation process for education quality assurance and education quality improvement of higher education institutions or majors from the outside. With the acceleration of China's internationalization process, doing a good job in engineering education certification and improving the quality of engineering education is of global and strategic significance for improving the quality of higher education. Based on the core concept of engineering education certification, this paper analyzes the shortcomings of the existing talents cultivation model of software engineering major, and rebuilds an application type talent cultivation model of software engineering major that meets the engineering education certification standards in terms of talent training goals, curriculum system settings, teaching implementation process, and assessment and evaluation mechanism and other aspects. It laid a good foundation for the work of follow-up engineering education certification of this specialty.

1. Introduction

Engineering education certification originated in the United States in the 1930s. It refers to the special certification implemented by professional certification institutions for engineering professional education provided by higher education institutions. At present, it has developed into an internationally general quality assurance system for engineering education. Its core is to confirm that the graduates from engineering major meet the established quality standard requirements that recognized by the industry. It is a kind of qualification evaluation oriented by cultivation goals and graduation export requirements [1]. In June 2016, China officially joined the most internationally influential degree mutual recognition agreement of engineering education "Washington Agreement", which means that China's accredited undergraduate degree of engineering major has been recognized internationally, and at the same time, it has also put forward higher requirements for the current engineering education system.

China Engineering Education Professional Certification Association is responsible for the organization and implementation of China's engineering education certification. According to the needs of China's engineering education reform and development, the association has established an internationally effective equivalence engineering education certification system. General standards involving seven modules of students, cultivation goals, graduation requirements, continuous improvement, curriculum system, faculties and support conditions, as well as professional supplementary standards formulated by each application certification major on the basis of this general standards. There are three core concepts of engineering education certification:

1.1. Student-centered educational concept

This concept emphasizes that throughout the university stage, all students are centered to develop cultivation goals. And to make resource allocation and teaching arrangements that around various aspects of the cultivation goals and whether it is conducive to students' achievement of expected goals, including curriculum system settings, and allocation of teaching staff.

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1.2. Learning outcomes-oriented educational concept

The engineering education professional certification requires that the graduation requirements of each major must be clear, open, and measurable, and can support the achievement of the cultivation goals. This concept emphasizes that the learning outcomes of students after receiving education is guided for professional teaching design and completion of teaching process. And the effectiveness of professional education is evaluated against the core competence requirements of graduates.

1.3. Educational concept that take continuous improvement in quality as the goal

The satisfaction of students and employers is an important reference for the professional certification evaluation of engineering education. Therefore, emphasizing the certification profession must establish an effective quality monitoring and continuous improvement mechanism and can continuously track and improve and be used to promote the continuous improvement of the quality of professional talents cultivation.

Professional certification of engineering education is a very important mechanism and means in education quality assurance, engineering degree and international mutual recognition of engineers. The establishment and implementation of the professional certification system of engineering education will have profound impact on policy guidance, implementation plans and quality evaluation for talent cultivation [2]. As an important export place for engineering professional talents, universities should take engineering education certification as an opportunity, follow the core concept of engineering education certification, and combine the needs of relevant industry talents and the university's teaching positioning to reform and improve the model of talents cultivation for this major.

2. Analysis of the current situation of software engineering professional talents

The software engineering major is based on the computer science and technology discipline, emphasizing the engineering nature of software development. Its aim is that students will be proficient in basic methods and skills that necessary in work such as software requirements analysis, software design, software testing, and software maintenance and software project management based on the mastery of the basic knowledge and skills of computer science and technology etc., which to highlight the cultivation of students' professional knowledge and skills.

Since the major was added in 2002, it has gradually matured after years of development. And many domestic universities have set up software engineering majors, and a large number of professional talents enter the market every year. With the continuous upgrading of China's economic and industrial structure, the scale of service industry of software and information technology has further expanded. And technical fields such as smart phone terminals, mobile applications, cloud management, cloud logistics, and cloud mobile phones will generate huge talent gaps and more job demands, which provides a broader employment channel for software professional talents. However, the reality is that, on the one hand, a large number of software engineering graduates cannot find suitable employment units; on the other hand, companies cannot recruit engineering and technical talents that meet the needs. The fundamental reason for this situation is that there is a big disconnection between the cultivation model of software engineering major in colleges and universities and the actual needs.

2.1. Unclear positioning of talent cultivation goals in colleges and universities

Colleges and universities can be divided into six categories: research type, research and teaching type, teaching and research type, teaching type, application type, and junior colleges. Colleges and universities have formed their own school laws and talent positioning in the course of many years of schooling. Based on this, its talents cultivation goals and teaching concept both have relatively fixed models.

Software engineering major focuses on engineering applications and engineering practices. Some research universities place research at the first position and are commit to high-level talents

cultivation and scientific and technological research and development. And their engineering practice ability is relatively weak, it is difficult to adapt to the needs of enterprise and transform rapidly, so it leads to the supply and demand of software talents are unbalanced.

2.2. Curriculum system of software engineering major does not match talent needs

In the past, the curriculum system setting did not take into account the characteristics of engineering education certification. The outdated curriculum content led to a disconnection between students' learning and industry, resulting in a large number of "high scores and low abilities." The direct consequence of the curriculum setting that places more emphasis on theory than on practice is the serious imbalance between students' practical ability and theoretical ability. This kind of asynchrony has led most people to engage in idle theorizing. The traditional teaching mode also adopts standardized forms, lacking flexibility, restricting the individual development of students. So it is difficult to integrate into the fast-growing software industry.

3. Construction of Talent Cultivation Model for Engineering Education Certification

The certification of engineering education emphasizes that engineering education in colleges and universities should return to engineering, highlighting the application and practicality of engineering [2]. It is required that the setting of professional curriculum system, the allocation of teaching staff, and the allocation of school conditions all focus on the core task of achieving students' graduation ability, and emphasize the establishment of a continuously professional improvement mechanism and culture to ensure the quality and the vitality of professional education. Based on the core concept of engineering education certification, the software engineering major will build a comprehensive talent cultivation model from the aspects of talent cultivation goals and curriculum system formulation.

3.1. Formulate talent cultivation goals of software engineering by student-centered

The cultivation goal is a general description of the career and profession achievements that graduates of the major can achieve in about 5 years after graduation. The cultivation goal of software engineering major is to cultivate the applied senior professional talents that meet the needs of national, local economic development and the development of the software industry. The talents should have a solid grasp of basic theories, professional knowledge and engineering technology in mathematics, natural sciences, and software engineering. They should have sound personality, sense of social responsibility, innovative spirit and international perspective, and have the ability to select and use advanced technologies and tools to solve complex software engineering problems through practical research. They also should able to engage in system development, quality assurance and project management in software engineering related fields. The specific content is as follows:

- Goal 1: Be able to rationally design the business logic, system functions and performance, and user experience of software products. Be able to analyze, review, and implement design plans, and verify and confirm software products to ensure the quality of software product and improve product competitiveness according to engineering standards.
- Goal 2: Be able to effectively track and manage the organization and implementation of software projects, and to dynamically assess the impact of software projects on society, health, safety, law, culture, and environment factors.
- Goal 3: Be able to adapt to various roles in the project team and be able to communicate effectively with other members; be able to communicate effectively with partners during the project process and complete system connection, communicate effectively with users, and get users’ recognition.
- Goal 4: Be able to track development trends of software technology, integrate and make choice on technologies, and show responsibility and progress in lifelong learning and professional development.
- Goal 5: Be able to consciously adhere to engineering ethics and professional code of ethics, be passionate in his job, and have a good humanistic quality, legal awareness and innovative spirit.

3.2. Formulate graduation requirements for professional talents of software engineering by student-centered

Graduation requirements are a detailed description of the knowledge and core competencies that students should master when they graduate, including the knowledge, skills, and literacy that students have acquired through their professional studies [3]. Guided by the engineering education certification standard, combined with the school's school-running characteristics and concept, and orientation of talent cultivation, the software engineering major focuses on training students' following core competencies in the four-year teaching:

- Core competence 1: Have a consciousness of innovation, master rich basic knowledge in mathematics, natural sciences, and engineering sciences, and be able to use its basic principles and professional knowledge to analyze, research, solve, and evaluate complex engineering problems.
- Core Competence 2: With ability to analyze problems and ability to design and develop software projects. The competence that can propose feasible solutions to complex engineering problems and design corresponding support systems.
- Core Competence 3: Have strong engineering practice capabilities. Be able to select appropriate technology, resources or engineering tools to predict and simulate complex problems.
- Core Competence 4: Be able to propose analyzation, evaluation and solutions to complex engineering problems or engineering practices.
- Core Competence 5: Have project management capabilities, and can effectively communicate with industry peers and the public for complex engineering issues.
- Core Competence 6: Have certain literacy in humanities and social responsibility, and consciously abide by engineering professional ethics and standards in engineering practice, and actively fulfill their responsibilities.
- Core Competence 7: Have certain international perspective, and can understand or evaluate the impact of practice of complex engineering problems on environmental and social sustainable development.
- Core Competence 8: Have the subjective consciousness of independent learning and lifelong learning, can continuously study and quickly adapt to the development of related fields.

The formulation of core competencies is based on the educational goals of schools and colleges, and on the basis of professional cultivation goals. It is completed with reference to the needs of the job market and the evaluation mechanism of teaching quality. It will continue to be revised in the subsequent implementation to obtain better results.

3.3. Build curriculum system of software engineering major by student-centered

Focusing on the achievement of the software engineering major's cultivation objectives and the cultivation of core competencies to complete the curriculum system setting of this major. The curriculum system includes four categories: general courses, basic disciplinary courses, professional courses, and practical courses. Among them, the professional courses set up 4 curriculum groups from different direction based on the current development trend of the software industry and the talents needs of the industry.

- J2EE software development curriculum group: including Java programming, JavaWeb development technology, Web front end design, J2EE framework and programming, etc.;
- data analysis curriculum group: including UI design, Python programming and data analysis, machine learning, artificial intelligence, etc.;
- Mobile intelligent development curriculum group: including UI design, mobile application development technology, application development of mobile intelligent device, etc.;
- Software testing and quality assurance curriculum group: including software testing technology, automation testing tools, etc.

According to the cultivation goals of software talents and the requirements of core competence cultivation, a practical teaching system that is closely integrated with the theoretical teaching system is established [4]. The practical teaching system is divided into four levels according to the law of students' engineering practical ability cultivation. They are point (it refers in particular to an

experimental course that matches the theoretical course, focusing on the understanding and mastery of knowledge points, and assessing the mastery of basic knowledge), line (several separate course designs, focusing on the integration of knowledge in a single course, assessing the ability to analyze problem problems, and the ability to design and develop simple projects), plane

(comprehensive curriculum design, focusing on the design and implementation of the overall implementation of the project in the professional field, assessing the ability to solve complex problems, teamwork, and personal communication ability etc.), solid (professional training and internships, docking with actual jobs, highlighting the cultivation of comprehensive professional quality, assessing innovative consciousness and ability to learn independently). In addition, it also includes a variety of practical teaching links such as project training, enterprise internship, graduation design, social survey, competition and professional certification.

Engineering education certification puts forward clear requirements in terms of professional knowledge content, professional training hours, and teachers' engineering background. Its purpose is to guide engineering education to truly return to "engineering" and to give priority to the cultivation of engineering skills. Therefore, in terms of the course system setting, the software engineering major always attaches equal importance to practice and theory, strengthens the curriculum practical teaching, simulates real projects in the software industry, improves the overall planning ability of students' software development, and lays the foundation for students' future competent work.

3.4. Reform curriculum teaching method by results-oriented

Results-oriented is an educational model based on learning outcomes. Student outcomes is the original force that driving the operation of the education model. On the basis of mastering the core competencies that students should achieve when they graduate, teachers should find suitable teaching methods to ensure that students reach the expected goals after the end of their studies. Results-oriented establishes a student-centered education concept, and designs personalized teaching plans based on factors such as student personality characteristics and career development planning to promote the overall development of students and enhance their employment competitiveness. With the continuous optimization of network technology, using computer networks to build a three-dimensional trinity teaching system, changing students as the main body and teachers as the leader, organically combining classroom teaching, practical teaching and network teaching, and motivating students' aspiration for knowledge from the inside out. Through this way not only extends classroom teaching, but also cultivates students' independent learning ability and innovative thinking ability. At present, some courses of the software engineering major adopt an online independent learning platform. Students can simplify, concrete and visualize abstract problems by watching teaching videos, courseware, lesson plans, and simulation operations. In addition, MOOC / SPOC's online and offline teaching resources, flip classrooms and other new teaching modes are actively introduced. Practice has shown that the use of mixed teaching can not only enhance the understanding, mastery and memory of knowledge, but also stimulate the learning potential of students, which has a strong role in promoting learning effect [5].

3.5. Establish assessment mechanism of teaching quality with continuous improvement as the core

One of the core concepts of engineering education certification is to establish a quality monitoring mechanism for the teaching process. Each major teaching link has clear quality requirements, and the curriculum system setting and curriculum quality evaluation are carried out regularly. Establish a mechanism for evaluating the achievement of graduation requirements, and conduct regular evaluations of the achievement of graduation requirements. Therefore, in the direction of the reform of the curriculum assessment system, we strive to combine process assessment with result-oriented assessment. The assessment content is based on curriculum standards. It advocates flexible and diverse assessment principles, considers student differences, and focuses on the evaluation of the learning process. In addition, the test platform is used to build a test question library, standardize the types and scores of test questions in the test papers, standardize the

teaching and management of the curriculum, and organize the knowledge. The final grades of the course are comprehensively assessed by the mid-term and final examination, experimental lessons, assignments and other scores, and classroom teaching and experimental links are strictly managed; for the courses without examinations and intensive practical courses: examination forms such as comprehensive computer-based examination assignment and group project design can be adopted to objectively reflect the students' mastery of what they have learned. Intensive practical training courses on campus and enterprise internships can be introduced into enterprises to jointly organize assessments and evaluations.

To establish a tracking and feedback mechanism for graduates and a social evaluation mechanism involving outside school personnel, and regularly analyze the achievement of cultivation goals. In this way to guide the continuous improvement of training objectives, curriculum system, teaching mode, etc.

4. Conclusion

Engineering education certification has a positive role in promoting the international recognition of talents. However, this is not a phased work, but a process that requires long-term persistence and continuous improvement. Application-oriented colleges and universities should take this as an opportunity and take the core concept of engineering education certification as the standard to continuously adjust the cultivation mode of professional talents to enhance their innovative ability and employment competitiveness.

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