Reform of Embedded Software Training System Based on Cultivation Mode for Engineering Talents

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Abstract. Of general standards for engineering education certification, there are 8 items related to "complex engineering problems", so the basic orientation of undergraduate engineering education is to cultivate students' ability to solve complex engineering problems. Based on OBE output orientation and CDIO engineering education concept and method, student-centered integrated training system of embedded software is constructed, aiming at cultivating professional talents with innovative consciousness and ability to solve complex engineering problems and meeting graduation requirements of engineering education certification standards.

Practical Teaching Requirements under Engineering Education Certification Standard

Importance of Practical Teaching

In 2016, China formally joined the Washington Agreement to carry out engineering education certification. Of the 12 general standards for engineering education certification, 8 are related to "complex engineering problems", so the basic orientation of undergraduate engineering education is to cultivate students' ability to solve complex engineering problems. "Complex engineering problems" refer to those problems that can only be solved by applying in-depth engineering principles and analyzing them, and must possess some or all of the following six characteristics at the same time: (1) Requirements involve many aspects of technology, engineering and other factors, and may conflict with each other; (2) They need to be solved by establishing appropriate Abstract models, and they need to be creative in the process of modeling; (3) They can not be completely solved by common methods; (4) The factors involved in the problems may not be fully contained in professional standards and norms; (5) The interests of the parties concerned are not entirely consistent; (6) They are highly comprehensive and contain many interrelated sub-problems. Therefore, it can effectively promote the rapid improvement of the quality and level of undergraduate education to meet the needs of social development by clearly focusing on the basic requirements of the cultivation of students' ability to solve complex engineering problems, grasping its connotation and decomposing it into all aspects of personnel training.

The cultivation of students' ability to solve complex engineering problems is a systematic and overall work. Besides systematic theoretical study, practical teaching plays a vital role. Embedded software project training system is a comprehensive practice link to cultivate students' practical ability, innovative consciousness and solve complex engineering problems in the direction of embedded software. It is also a comprehensive application link of many professional courses. It plays an important role in enriching students' practical knowledge of project development, consolidating and deepening their theoretical knowledge, familiarizing themselves with the whole process of enterprise project development, and improving students' ability of collaborative communication.
Requirements of Standard Course System for Practical Teaching

The third article clearly stipulates that engineering practice and graduation design (thesis) account for at least 20% of the total credits. We must set up a perfect practical teaching system and cooperate with enterprises to carry out practice and training so as to cultivate students' practical and innovative abilities. Graduation design (thesis) topic selection should be combined with the practical engineering problems of the specialty to cultivate students' engineering consciousness, collaboration spirit and the ability to solve practical problems by applying the knowledge they have learned comprehensively. The guidance and assessment of graduation project (thesis) involve enterprise or industry experts.

The requirements of the standards are clear: graduates must be able to design solutions to complex engineering problems, design systems, units (components) or process flow to meet specific needs; be able to study complex engineering problems based on scientific principles and using scientific methods, including design experiments, analysis and interpretation of data, and obtain reasonable and effective conclusions through information synthesis.

Current Situation of Practical Teaching in Embedded Software Direction

The current situation of practical teaching of Embedded software orientation of computer science and technology specialty generally includes the following.

1. The course of embedded software orientation is very practical, but it is difficult for students to apply the teaching mode of separating theory from practice, and the ability of engineering practice is poor, so it is difficult to meet the employing needs of enterprises.

2. The experimental teaching mode is outdated. Mainly continue the traditional teaching mode, that is, teachers as the main body, teachers arrange experimental content, teach experimental principles, experimental requirements, etc., students complete the experiment step by step, this teaching mode is almost difficult to reflect the main role of students in the experimental process.

3. The school provides the corresponding laboratory and experimental equipment, but the update is slow and cannot fully meet the teaching requirements.

4. The assessment method is single, and formative assessment is not paid enough attention. Teachers scored mainly on the basis of experimental results and reports. It was difficult to achieve the goal of promoting students' ability through assessment, and even more difficult to achieve the OBE output goal.

5. It is difficult for teaching and practice, schools and enterprises to merge. Curriculum construction cannot be virtuous circle.

Reform Target of Embedded Software Training System

Embedded software training system is an important link and way to cultivate students' practical ability, innovative consciousness and ability to solve complex engineering problems. The reform objectives include:

1. Embedded software training system includes the implementation of application software system and application hardware system. Project design emphasizes comprehensiveness, reflecting the scale, difficulty, complexity and comprehensiveness of problems and systems. Students gradually master the construction of complex engineering, and in the process of construction, reflect the comprehensive application of knowledge, technology and methods.

2. Comprehensive projects should be combined with theoretical teaching, pursue practice under the guidance of theory, avoid practice simply for the sake of practice, and guide students to solve problems through analysis rather than application of principles according to their goals.

3. In terms of teaching arrangement, it should guide students to collect relevant information and learn new technologies, help them master experimental techniques and methods, carry out multi-party collaboration with people, objects and systems, and achieve teamwork.
(4) Enriching students’ practical knowledge of project development, familiarizing themselves with the whole process of enterprise project development, improving students' ability of collaboration and communication, and having the desire to constantly update knowledge and good learning habits.

(5) Form an OBE-oriented practical training system with the aim of cultivating students' ability to solve complex engineering problems, which can be virtuous circle and perfect, including complete practical training projects, advanced and sufficient experimental equipment and conditions, optimized curriculum resources, advanced assessment methods and all-round school-enterprise cooperation.

Foundation of Reform Work

Deeply Study the Connotation of Engineering Talents Training Mode

Computer science and technology specialty is a comprehensive discipline which combines science and engineering. It is formed and developed by the integration and infiltration of theory and technology in multi-disciplinary fields.

Firstly, students can receive professional computer engineering training in this system, and use advanced engineering methods, technologies and tools to analyze, design, develop and maintain software and hardware systems. Secondly, students can master the engineering methods, core technologies and platform tools in the process of large-scale software development, and have the ability of collaboration and engineering.

Modern computer engineering projects are often complex in structure, and often contain many non-engineering factors in the process of solving. With the penetration of computers into all areas of human life, It’s need to should pay attention to the continuous integration of new technologies, which requires engineers to adopt new technical routes and develop new engineering methods to deal with these engineering problems from a new perspective. Faced with these problems, schools should cultivate high-quality engineers with the ability to solve complex engineering problems.

Revision of Training Program Based on Engineering Education Certification

Based on OBE and CDIO engineering education concept, the revised training program is student-centered, aiming at cultivating professionals with innovative consciousness and ability to solve complex engineering problems, and meeting the graduation requirements of engineering education certification standards. The newly formulated training program designs three training routes, namely, in-class main line, extra-curricular ability auxiliary line and quality education auxiliary line, to train students in an all-round way from three dimensions of knowledge, ability and quality. A progressive project system has been set up in the course to train students’ ability to analyze and solve practical problems with the project as the carrier. After class, relying on the industrial environment, setting up practice bases inside and outside schools, and participating in the evaluation by schools and enterprises, students can get better exercise and learning in engineering practice, and gradually strengthen the engineering education certification of solving complex engineering problems, which requires students to have an important ability after graduation.

Formulate Implementation Steps of Reform

The teaching reform based on OBE must take students' meeting export requirements as the ultimate goal of teaching reform, and defining the expected learning output of graduates is the most important key link. First of all, Educators must have a clear idea of the abilities and levels that students should achieve when they graduate. Then, according to the development trend of the specialty at home and abroad and the orientation of the school, it seeks to design a suitable curriculum system to ensure that students achieve these expected goals. The implementation of the reform is mainly divided into three steps.

(1) The first stage: the preparatory stage and the research stage.
The teaching reform based on OBE must take students' meeting export requirements as the ultimate goal of teaching reform, and defining the expected learning output of graduates is the most important key link.

Therefore, on the one hand, it conducts extensive research on other stakeholders such as universities, teachers, graduates, employers and so on. At the same time, it collects and summarizes relevant job descriptions and employment needs on major recruitment websites. On the other hand, teachers should be organized to participate in academic conferences and forums on teaching to fully understand and learn the essence and concepts of engineering education and results-oriented education. In addition, the organization of meetings and symposiums, by enterprise personnel and teachers on embedded series of related courses, training objectives, related technologies and other aspects of detailed research and discussion, formulate personnel training objectives.

(2) The Second stage: Implementation Phase

According to the research content of the subject, It should formulate scientific and reasonable personnel training plan and teaching plan, carry out the comprehensive reform and construction of embedded curriculum series related courses, promote school-enterprise cooperation in an all-round way, and constantly accumulate experience and lessons.

(3) The third stage: summary stage

To sum up the course of the training system, summarize the experience and lessons, form the results, provide the reference basis for the next round of reform and implementation, constantly enrich the cases, accumulate material, and form a virtuous circle.

Practical Reform and Implementation under Professional Certification Standard

Establishing Scientific and Reasonable Training Teaching System

Practical projects must be carefully screened for appropriate carriers. To enable students to experience the construction of complex engineering (system) and embody the comprehensive application of knowledge, technology and methods in the process of construction, the practice-oriented teaching system will be based on the reconstruction and adjustment of the theory and core teaching system. Practice teaching system must be from simple to complex, from small scale to scale, step by step, and make students experience major practice as comprehensively as possible, in order to pursue the practice conforming to OBE output.

Reforming the Organization and Assessment of Practice Teaching

(1) Transforming teaching subjects and reforming teaching methods.

According to the graduation requirements of practical teaching activities, carry out teaching activities around the expected learning output. Teachers are the organizers, guiders and appreciators of practical teaching. On the one hand, students are encouraged to design experiments independently, practice actively and accomplish tasks effectively, so as to master the basic skills of professional practice; on the other hand, strict requirements and appropriate guidance are given to students.

(2) Reforming Curriculum assessment

Under the training mode of Engineering talents, the teaching evaluation based on OBE focuses on learning results, and should follow the principle of "emphasizing process assessment, laying equal stress on skills and qualities". The "final result" is not to ignore the results of the learning process. The curriculum should be designed according to the principle of reverse design and evaluated by stages and steps according to the final peak results.

Improving Integrated Teaching Resources

(1) Form basic teaching documents such as curriculum standards, teaching calendar, teaching plan, etc. Form standard requirement analysis documents, design documents, test documents and other project documents.
(2) According to the requirement of ability training, breaking the chapters and boundaries of teaching materials, organizing teaching with knowledge points as units, constantly accumulating and forming material resources such as micro-videos, coursework, test questions, case databases, compilation and summary of competition items, and forming a virtuous circle.

(3) Introducing enterprise resources can not only strengthen the assessment of students' learning process, but also provide students with real enterprise cases.

(4) Create a "pocket laboratory" or "carry-on" laboratory to provide students with portable experimental equipment to facilitate students to use the free "debris" time to study independently.

**Strengthen Cooperation between School and Enterprise**

(1) Work with enterprises to create laboratories related to embedded courses.

(2) Introducing enterprise process monitoring and quality assurance system, including project document management, project development process management, daily and weekly meeting system, to make it an important support for teaching process monitoring and quality assurance.

(3) Promoting two-way communication between school and enterprise personnel.

**Summary**

Embedded software training system includes application software and hardware system implementation, emphasizing comprehensiveness, reflecting difficulty, complexity and comprehensiveness of the project. At the same time, students should be guided to collect relevant information, learn new technologies and master experimental techniques and methods so as to gradually become high-quality talents with the ability to solve complex engineering problems.

However, the reform of practical training system is a long-term and complex project. With the advancement of teaching, it is bound to encounter many problems and difficulties. Therefore, we need to constantly explore and improve, so as to give full play to the role of training system in personnel training.

**References**


