Innovation on “Software Engineering” Under Engineering Education Professional Certification

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Abstract: It’s well-known that the purpose of engineering education professional certification is to provide preparatory education quality assurance for relevant engineering and technical personnel to enter the industry. Its main task is to achieve the goal of professional training, advocating the teaching mode and teaching scheme of reverse design course. Under the background of engineering education certification, the teaching team has carried out the reform from four aspects combining with the characteristics of software engineering course. First of all, focus on the teaching objectives of engineering education certification, strengthen the construction of course content and resources, strengthen the cooperation with industry and enterprises, and increase the teaching content of enterprises; the second is to improve the teaching design, design the teaching content of software engineering course as a teaching task that is suitable for the teaching objectives, and decompose the knowledge points of the course into the project tasks; the third is to adopt diversified teaching methods, introduce micro class and flipped classroom teaching, at the same time, strengthen the practical teaching, enhance the ability of document description and graphic design practice; The fourth is to improve the evaluation mechanism, and use the way of achieving the curriculum objectives to evaluate the course, so as to make teaching more effective, learning feedback is more intuitive and easy to make continuous improvement in the later stage. The results show that the content of class-teaching and engineering practice has been enriched and improved, simultaneously, diversified teaching methods with process teaching evaluation has greatly promoted students' ability of study independently and engineering practice, and effectively improved the achievement of graduation requirements of engineering education in software engineering specialty.

Keywords: Engineering Education Certification, Course Revolution, Software Engineering

1. Introduction

Engineering education certification is an internationally accepted quality assurance system for engineering education, and also a qualified evaluation for engineering majors in Higher Education [1]. Engineering education certification has been carried out in many colleges and universities in China for many years, Yiyang Fan, Jingyi Yi and Wu Qidi refer to the core of engineering education professional certification is to confirm that engineering graduates meet the established quality standard requirements accepted by the industry [2, 3]. It is a qualification evaluation oriented by training objectives and graduation export requirements. Engineering education is an important part of China's higher education, in the higher education system, "one of the three parts of the world". Alex Kootsookos, Aden Darge and Li-min Tian point out that the core task of Engineering education certification is to achieve the degree of students' professional training objectives [4-6], advocate reverse design course teaching mode and teaching scheme, and Haiyan Wang, Yongsheng Hu emphasize the establishment of professional continuous improvement mechanism to ensure The quality and vitality of professional education [7].

Engineering education professional certification is an internationally accepted means of engineering education quality evaluation. The research shows that the professional certification of engineering education is student-centered, oriented by the development of students’ ability, with continuous improvement as the main line [8]. It is to ensure that the educated have the necessary knowledge and ability to work in the field of engineering technology by controlling the key links of
engineering education. In March 2015, China Engineering 
Education Accreditation Association issued the 2015 edition of 
engineering education accreditation standards, which put 
forward new requirements for the curriculum system of 
undergraduate engineering education specialty in China's 
colleges and universities [9, 10]. The standard emphasizes that 
the school's educational goal is to cultivate and achieve the 
engineering practice ability, emphasizes that the learning results 
drive curriculum activities, and constructs the evaluation system 
according to the students' learning output [11]. Compared with 
the higher engineering education of the world's leading countries, 
China's engineering education accreditation is still in its infancy. 
As an application-oriented university, actively responding to the 
call of the Ministry of education, vigorously developing 
engineering education, and comprehensively improving the 
quality of application-oriented talents training are the important 
contents of the strategic planning for the transformation and 
development of our university and the construction of a 
high-level application-oriented university [12]. Therefore, it is 
necessary to conduct in-depth exploration and research in the 
software engineering personnel training reform.

Software engineering course is a professional basic course 
of computer science and related majors. It is mainly used to 
guide the development and maintenance of computer 
software, and it is a course with strong theoretical, practical 
and engineering characteristics [13]. Software engineering 
course is an important way to cultivate students' ability to 
solve complex engineering. Software engineering course 
mainly trains students to complete the analysis and design 
work of a medium-sized software engineering project, so that 
they have the post ability of software designers. In order to 
achieve this goal, this paper studies and reforms the teaching 
content, method and evaluation of software engineering 
course in our school of software.

2. Teaching Reform Ideas of “Software 
Engineering”

2.1. The Teaching Process Is Centered on Students' 
Development and Ability Improvement

The core concept of engineering education professional 
certification emphasizes that education and teaching is 
student-centered. Software engineering course is a 
professional basic course of computer science and related 
majors. This course is mainly used to guide the development 
and maintenance of computer software. It is a course with 
strong theory, practice and engineering. According to the 
students' cognitive law, discipline characteristics, teaching 
objectives of software engineering course, cooperate with 
enterprises, through the combination of professional standards 
and industry standards, the combination of teaching content 
and the actual information industry, the curriculum content is 
formulated according to the curriculum objectives, and the 
knowledge unit and disassembly are reasonably designed 
according to the framework of "module + teaching unit" 
Divide and allocate knowledge points and skills points. Each 
module sets up the teaching situation, and each unit organizes 
the teaching content and resources through the "task 
decomposition + micro class" under the teaching situation, so 
as to realize the integration of theory and practice teaching.

The training goal of software engineering course is to enable 
students to have independent project analysis and design ability. 
In different stages of software project development, different 
tools are used for analysis (data flow diagram, data dictionary, 
use case diagram, state diagram, etc.) and design (structure 
diagram, class diagram, box diagram, etc.) In order to facilitate 
different levels of learning, especially in MOOC University 
platform of China, open online courses, recording teaching 
materials, micro video for each knowledge point in the course, and 
attaching test questions after the micro video to test students' 
mastery. Each unit is equipped with a comprehensive unit test. 
Students pass the self-test, and they could not master the 
knowledge and technology in place. Can carry on the 
enhancement study, fully manifests the student-centered 
teaching idea, conforms to "the authentication standard" to put 
the student's training goal in the first place request. The teaching 
mode adopts online and offline hybrid teaching. For the 
knowledge points that are easy to master, students use the 
online self-study method. For the difficult points and key points, 
they should explain and practice uniformly in the classroom, 
and focus on analyzing and solving complex engineering 
problems with strong comprehensiveness. In addition, online 
discussion is used to guide students to search for materials on 
the frontier hot issues of the course by using network and 
library resources, so as to cultivate students' ability of literature 
collection and reading. At the end of the semester, the students 
are divided into groups for project development to cultivate the 
ability of learning to solve practical problems and team 
cooperation. There is competition between teams, and the 
competitiveness of students in the process of training will be 
improved. In short, the arrangement of teaching content and the 
implementation of teaching process always put student 
development as the center in the first place.

2.2. Teaching Evaluation Based on Continuous Quality 
Improvement

"Certification standard" emphasizes that the improvement of 
education and teaching quality must have continuous 
improvement mechanism and implementable measures [14]. 
Teaching evaluation mechanism is the power to promote the 
continuous improvement of teaching. Through the performance 
of students, analyze the achievement degree of corresponding 
curriculum objectives, analyze the reasons (test statistics and 
interviews, etc.), find the method of continuous improvement for 
implementation, and then continue to track the performance of 
students to achieve continuous improvement, promote the 
improvement of education quality in the cycle process, and make 
the teaching objectives more in line with the direction of 
professional training, so as to achieve graduation for students It is 
required to lay a good foundation. In terms of specific 
implementation, corresponding to the four curriculum objectives, 
the paper examines the achievement degree of each course goal 
in terms of homework, experiment and final examination
3. Reform and Practice of “Software Engineering” Course

3.1. Curriculum Construction

Centered on the teaching objectives of engineering education certification, we should strengthen the construction of course content and resources construction, simplify the teaching content, eliminate the content that is not suitable for engineering education, strengthen the cooperation with industrial enterprises, and increase the relevant content of enterprise teaching cases.

3.1.1. Curriculum Content Construction

The teaching of software engineering course depends on the development cases of actual projects in the software industry, and its main teaching contents are structural analysis and design and object-oriented analysis and design. Through the mastery and practice of knowledge points of online open courses, teachers can directly enter the analysis and explanation of cases in classroom teaching, and make students consolidate the knowledge content through classroom practice feedback. The content is divided into three categories: overview, software development methods and software project management. The software engineering overview module mainly introduces the concepts of software crisis, software engineering and software process. The software development method module mainly teaches common structured methods and object-oriented methods. Software project management module mainly through a series of activities such as planning, organization and control to reasonably allocate and use various resources. The software development method module is organized in the form of "software development process + practice project topic-case-task". Among them, software development methods are divided into structured method and object-oriented method. Each software development method organizes the knowledge unit according to the software development process, and sets up a practice project topic and knowledge unit link respectively. Each project topic decomposes the actual software project into several cases, and each case is decomposed into several tasks corresponding to knowledge units, which can help learners master the basic process and tasks of software development more systematically and completely in a short time. At the end of the semester, there will be a week of professional training, there will be a week of professional training, and students will complete a small group in the practical application project, the analysis, design and implementation of the system are carried out completely according to the software engineering methodology, and the project reports and documents are written. Using online discussion, we can guide students to make effective use of network and library resources, and cultivate their literature research ability.

3.1.2. Curriculum Resources Construction

According to the syllabus of software engineering, according to the software development process and the graduation ability requirements of the course, the course content is re integrated, and the granular and diversified online open course resources of software engineering based on OBE concept are constructed. Due to the space limitation, table 1 lists the knowledge points and its resources corresponding in chapter 1 and 10.

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Knowledge Unit</th>
<th>Knowledge Points</th>
<th>Corresponding resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ch1 software engineering sketch</td>
<td>Software</td>
<td>Software and its characteristics</td>
<td>(1, 2, 6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Software classification</td>
<td></td>
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<tr>
<td></td>
<td>Software Crisis</td>
<td>Forms of expression</td>
<td></td>
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<td></td>
<td>Software engineering</td>
<td>The concept and development of software engineering</td>
<td>(1, 2, 3, 4, 5, 6, 7, 8, 9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The content of software engineering research</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Objectives and principles of software engineering</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Software engineering knowledge system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Software process</td>
<td>Waterfall model</td>
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<td></td>
<td></td>
<td>Rapid prototyping model</td>
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<td></td>
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<td>Incremental model</td>
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<td></td>
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<td>Fountain model</td>
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<td></td>
<td></td>
<td>Agile development model</td>
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<td>...</td>
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<tr>
<td>Ch10 Software project management</td>
<td>Software scale estimation</td>
<td>Software development cost estimation method</td>
<td>(2, 3, 4, 5, 6, 10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Code line calculation method</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Function point check method</td>
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<tr>
<td></td>
<td></td>
<td>COCOMO2 model</td>
<td>(1, 2, 3, 4, 5, 6, 10)</td>
</tr>
<tr>
<td></td>
<td>Personnel organization And schedule</td>
<td>Workload Estimation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quality assurance and software configuration management</td>
<td>Personnel organization schedule</td>
<td>(1, 2, 5, 6, 10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quality assurance</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capability Maturity Model</td>
<td>(1, 2, 3, 4, 5, 6)</td>
</tr>
</tbody>
</table>

Note: (1) Micro lecture video; (2) PPT (3) case teaching; (4) Quiz; (5) discussion; (6) reading materials; (7) Teaching guidance; (8) Online Q&A; (9) Online test; (10) Project tasks
3.2. Teaching Design

In view of the course content, according to the idea of engineering education certification, the teaching content of software engineering course is designed as a teaching task corresponding to the teaching objectives. The knowledge points of the course are decomposed into the task of the project, and run through the whole software development process. See Table 2 for details.

<table>
<thead>
<tr>
<th>Projects</th>
<th>Purpose and requirement</th>
<th>work breakdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 1: Structured methodology</td>
<td>Understand the process of feasibility analysis, tasks and analysis methods in the demand analysis stage, complete the feasibility study report and requirement specification of the target system with the learning group as the unit, determine the function and performance of the system, and lay the foundation for the design in the later stage.</td>
<td>task1: feasibility analysis</td>
</tr>
<tr>
<td>Model 1: Analysis on the management system of College Students' attendance</td>
<td>To understand the content of overall design and detailed design of structured methodology. There are SD method, Jackson method, HIPO method and other design methods. Design principles and heuristic rules are applied in the project design process to optimize the design.</td>
<td>task1: data design</td>
</tr>
<tr>
<td>Project 1: model 2: Design of attendance management system for College Students</td>
<td>Combined with the training course, to discuss how to use programming language and object-oriented programming style to realize system functions flexibly.</td>
<td>task1: Interface design</td>
</tr>
<tr>
<td>Project 1: Model 3: Detailed design of attendance management system for College Students</td>
<td>To master the basic concept of programming, programming style and structured programming method.</td>
<td>task1: test design</td>
</tr>
<tr>
<td>Project 1: model 4: system implementation</td>
<td>Combined with the training course, to discuss how to use programming language and object-oriented programming style to realize system functions flexibly.</td>
<td>task4: model test</td>
</tr>
<tr>
<td>Project 1: model 5 System testing</td>
<td>The purpose and principle of software testing, the characteristics and basic steps of software testing, the main methods and technologies of software testing.</td>
<td>task5: overall test</td>
</tr>
<tr>
<td>Project 1: Model 5: System running</td>
<td>Combined with the training course, the application of software development tools and computer aided software engineering is discussed.</td>
<td>task1: instruction for use</td>
</tr>
<tr>
<td>Project 2: Object oriented methodology, experimental teaching management system is divided into analysis and design model</td>
<td>To master the requirements analysis, design and implementation of object-oriented methodology, and apply the object-oriented method to practical training courses</td>
<td>task1: object model</td>
</tr>
</tbody>
</table>

3.3. Teaching Method

The traditional teaching methods don't take into account the differences of students' learning. Most of them urge the backward students by asking questions, exercises or homework after class. The effect often leads to the students with poor learning initiative always in a backward situation. Therefore, the software engineering course logs into the online open course MOOC platform, records the course knowledge points into the micro class release network, which is convenient for students to carry out fragmented learning before class. By adopting the teaching method of "flipped classroom", the mode of "teaching in class and internalizing after class" is transformed into the mode of "imparting before class and internalizing in class". In the classroom, teachers connect the knowledge points through case teaching. Solving practical problems, students have a sense of substitution, learning interest can be naturally mobilized. Encourage students to establish problem awareness in the learning process of online courses and actively participate in class discussion [15]. Classroom teaching discussion is a good opportunity to strengthen students to solve complex engineering problems. Under the guidance of teachers, students complete problem analysis and modeling, code implementation and testing after class, and comprehensively practice course knowledge contents such as programming language, database, software testing, etc. Students in the network classroom to complete the corresponding test questions, teachers can timely grasp the students' knowledge points and knowledge application situation, and take corresponding countermeasures.

In addition, in the classroom teaching, the "seminar" teaching method is interspersed to carry out classroom discussion on open topics. Usually, teachers will select classic software designer test questions over the years, and students will analyze the problems by consulting materials, combing their own knowledge, and communicating with each other. The use of this teaching method can better train and evaluate students' mastery and comprehensive application of knowledge, and effectively improve the quality of teaching.

3.4. Practical Teaching

Engineering education accreditation emphasizes the
importance of highlighting professional characteristics and the core position of engineering application ability. For the software engineering course, highlighting the practicality not only needs to be continuously infiltrated in the classroom teaching process, but also needs to be gradually guided and strengthened in the experiment and training courses. The difference between software engineering course and general programming language course is that the experimental content is system analysis, graphical design results (such as structure diagram, data flow diagram, use case diagram, etc.) and written description (such as use case description, data dictionary, pseudo code, phased document, etc.), and various graphs in analysis and design stage are drawn by using Visio or rational rose. Based on this, practical teaching focuses on the examination of design ideas, so the description of documents and design drawings are the focus of practical ability. The practice part is also the training of students' ability to write reports and design manuscripts.

3.5. Teaching Evaluation

The assessment of software engineering course mostly adopts the way of "usual performance + experimental score + final score". Each assessment method has corresponding achievement
der the process. The following takes goal 4 as an example to illustrate. As the goal achievement degree of assessment objective 4 focuses on communication, communication and document writing, it is difficult to reflect the assessment content in the paper volume of the final examination. Therefore, there are only two assessment methods: ordinary assessment and experimental assessment. In the two assessment methods, homework and discussion can partly reflect students' writing reports and design manuscripts, the ability of presentation and speech, effective communication and communication of complex problems in software engineering field, so it accounts for 40%. The experimental part, including the content of experiment and training, can fully test the students' ability goal, so it accounts for 60%. Similarly, for goal 3, the ability to design solutions to complex engineering problems in the field of software engineering can be tested. The comprehensive questions in the final examination paper can fully reflect the students' achievement in goal 3, so it accounts for 60%, while the remaining 40% can be reflected in the regular homework and experimental process, so each accounts for 20%. This is no longer the case.

<table>
<thead>
<tr>
<th>curriculum objectives</th>
<th>Proportion of assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective 1. Master the engineering foundation and software engineering knowledge related to natural science and engineering technology to solve complex engineering problems, and have the basic scientific literacy of system development engineer.</td>
<td>Test</td>
</tr>
<tr>
<td>Objective 2. Master the thinking methods needed to solve complex software engineering problems, have good problem analysis ability, being able to apply the basic principles of mathematics, natural science and engineering science to identify, express and analysing complex engineering problems in the field of software engineering through literature research.</td>
<td>Homework, Practice</td>
</tr>
<tr>
<td>Objective 3. Be able to design solutions for complex engineering problems in the field of software engineering, develop software systems that meet specific requirements, and embody innovation consciousness in the design / development process.</td>
<td>Test</td>
</tr>
<tr>
<td>Objective 4. Have the ability, methods and skills of communication, be able to effectively communicate and communicate with peers in the industry and the public on complex issues in the field of software engineering, including writing reports and design manuscripts, making statements, clearly expressing or responding to instructions, and being able to communicate and communicate in a cross-cultural context.</td>
<td>Homework, Practice</td>
</tr>
</tbody>
</table>

4. Conclusion

Under the background of engineering education certification, the teaching team of software engineering in Pingdingshan University has carried out a series of reforms on "software engineering" course for many years. Relying on the network course resources, in the selection and arrangement of teaching content, from the shallow to the deep, step by step, through the classroom explanation of comprehensive application cases, strengthen the application of students' knowledge and skills; in the teaching method, do not stick to one pattern, flip the classroom, case teaching, project training, research-based teaching, guide students to learn and communicate independently, and emphasize the analysis and return of knowledge. In the teaching evaluation, according to the degree of achievement of the curriculum objectives, process assessment is adopted to emphasize the comprehensive application of knowledge and the ability to solve complex engineering problems. Through the teaching reform, we can fully mobilize the students' learning enthusiasm, improve the teaching quality and lay a good foundation for the engineering education graduation requirements of cost major students.

Project Source

New engineering project of Pingdingshan University: research and practice of curriculum reform based on cdio-obe engineering education mode ---- Taking "software engineering" course as an example. (No.: 2018-xgk10).

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