Education Insights

Article

Teaching Reform of Java Web Application Development Course for Engineering Teaching Certification

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Abstract: Based on the engineering education certification standards, this study carries out the teaching reform of the "Java Web application development" course, in order to improve the teaching quality and students 'comprehensive ability. Under the background of engineering education certification, there are many problems in the traditional teaching mode, which is difficult to cultivate talents that meet the needs of enterprises. In this paper, the relevant concepts of engineering education certification are deeply analyzed, the current situation of course teaching is comprehensively analyzed, the existing problems are diagnosed, and the systematic teaching reform strategies are put forward, including the optimization of teaching objectives, the update and integration of teaching content, the implementation of diversified teaching methods, the construction of practical teaching system, the improvement of teachers and the establishment of diversified assessment and evaluation system. Through this teaching reform, it is expected that students can significantly improve their Java Web development skills, engineering practice ability, innovative thinking and team spirit, promote the overall development of computer majors, and lay a solid foundation for the cultivation of high-quality Java Web development talents to meet the needs of the industry.

Keywords: engineering education accreditation; Java Web application development; curriculum teaching reform

1. Introduction

1.1. Engineering Education Certification Background

Engineering education accreditation is an internationally recognized quality assurance system for engineering education, which originated in the United States and aims to promote the international mutual recognition of engineering education and engineer qualifications. Since its signing in 1989, the Washington Accord has been joined by many signatories, with China becoming a member in 2016. The core concepts of engineering education accreditation include student-centered learning, results-oriented approaches, and continuous improvement. Its purpose is to ensure that engineering graduates meet industry-recognized quality standards and to provide quality assurance for students entering the engineering profession. Engineering education accreditation sets clear requirements for the professional curriculum structure, faculty qualifications, institutional resources, and other aspects, emphasizing student-centered education and focusing on the competencies students should achieve upon graduation [1].

1.2. "Java Web Application Development" Curse Overview

Java Web application development is one of the core courses for computer science majors, aiming to cultivate students' professional skills and engineering practical abilities in Web application development. The course covers Java programming fundamentals,

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Web development technologies, database applications, server configuration, and other related topics, with a focus on developing students' system design, coding, problem-solving, and teamwork skills. The fundamental teaching requirements of this course include integrating theory with practice while emphasizing the development of students' practical abilities. By mastering the fundamental principles and methods of Java Web application development, students will be equipped to develop basic Web application systems, laying a foundation for further professional learning and career development [2-4].

1.3. Research Purpose and Significance

The teaching reform of the "Java Web application development" course is of great necessity and practical significance. First of all, engineering education certification requires professional courses to focus on the achievement of students' graduation abilities. There are some issues with the current course teaching mode, such as unclear teaching objectives, disconnection between teaching content and actual engineering needs, overreliance on a single teaching method, and weak practical teaching components, which make it difficult to meet engineering education certification standards. Secondly, through the teaching reform, we can explore effective ways to improve students' engineering practice abilities, innovative thinking, and team spirit, enabling students to better adapt to the industry's demand for Java Web development talents. Finally, the results of this research will provide valuable insights for the teaching reform of other courses in computer science majors, promote the optimization of talent training modes, improve the teaching quality across the major, and enhance the competitiveness and development vitality of the major under the context of engineering education certification [5].

2. Theory of Engineering Education Accreditation and Curriculum Teaching Reform

2.1. OBE Concept (Outcome-based Education)

The OBE concept emphasizes reverse design, guided by the ability outcomes that students should ultimately achieve. Its core idea is that all teaching activities are centered around the competencies students should attain upon graduation to ensure that each student can meet the established learning outcomes [6-8]. mentation of the OBE concept should follow the principles of goal clarity, measurability, realizability, relevance, and timeliness. In the course of "Java Web application development" according to engineering education certification standards, it is clear that students need to possess competencies upon graduation, such as system design, coding, and problem-solving. Starting from these ability outcomes, we reverse-design the teaching objectives, content, methods, practice, and assessment for the course. The entire teaching process is closely centered on the competency development objectives to ensure that students can effectively achieve the expected ability outcomes through curriculum learning.

2.2. CDIO Mode (Ideation-Design-Implementation-Operation)

The CDIO model originated from the Massachusetts Institute of Technology. It takes the entire product life cycle as its framework, dividing engineering education into four stages: conception, design, implementation, and operation. The model focuses on cultivating students' systematic engineering thinking and comprehensive practical abilities. This model offers significant advantages in engineering education, as it can effectively improve students' engineering practice abilities, innovation capabilities, and teamwork skills. It is highly feasible to integrate the CDIO model into the teaching of "Java Web application development". The course content covers the complete Web application development process, from project demand analysis and system design to coding implementation, deployment, and operation, which closely aligns with the four stages of the CDIO model. By reshaping the course project process according to the CDIO model, the actual Web application development project is broken down into four specific stages, each with

distinct tasks. This approach allows students to gradually cultivate systematic engineering thinking as they complete the project and master the development skills required for the entire process, from project conception to final operation [9].

2.3. Other Relevant Educational Theories

Constructivism learning theory emphasizes the active role of students in constructing their own learning. It suggests that students should be the active constructors of meaning in the learning process. In the teaching reform of the "Java Web application development" course, this theory emphasizes that teachers should create rich learning environments, such as real Web application development project cases and problem-solving tasks, to guide students in independent exploration and collaborative learning. This enables students to actively build their understanding of Java Web development knowledge and skills through practical engagement. The theory of multiple intelligences claims that individual intelligence is multi-dimensional, including linguistic intelligence, logical-mathematical intelligence, spatial intelligence, and other forms. This theory provides valuable guidance for designing and applying diverse teaching methods in the "Java Web application development" course. Teachers can use project-driven approaches, case analysis, group discussions, role-play, and other teaching methods based on students' different intellectual characteristics to meet the needs of diverse student development and stimulate their learning potential, promoting the development of their intelligence in the field of Java Web application development.

3. Teaching Status and Problem Diagnosis of Java Web Application Development Course

3.1. The Setting and Achievement of Teaching Objectives

Teaching objectives are the starting point and end point of curriculum design, and their scientificity and rationality are directly related to the quality of the course. Under the background of engineering education certification, teaching objectives need to closely align with industry needs and certification standards, clarifying the abilities students should have upon graduation. However, the current teaching objectives of the "Java Web application development" course are neither accurate nor detailed enough, which results in a gap between the required comprehensiveness of abilities and the professional quality cultivation expected by engineering education certification. Through various research methods, it was found that some students believe that the teaching objectives of the course are only generally achieved. In particular, in terms of system design ability and innovative thinking training, students feel that they are only capable of carrying out simple module design and lack the ability to plan complex system architectures. In the process of teaching implementation, the limitations of class hours and the rapid pace of industry technology updates have led to deviations in the implementation of teaching objectives. Some teaching activities intended to cultivate innovation abilities and engineering thinking cannot be fully implemented, and it is difficult to adjust teaching objectives in time. As a result, there is a disconnect between students' knowledge structure and the actual needs of the industry [10].

3.2. The Organization and Update of Teaching Content

At present, the main teaching materials used in the course are relatively complete in terms of content system. However, there are issues with the timeliness of updates, and self-compiled materials contain outdated content and fragmented knowledge points, which cannot meet students' needs for new knowledge and systematic learning. The knowledge system of the course lacks completeness, the explanations are not deep enough, and the content updates lag behind, resulting in a disconnect between what students learn and the actual development needs. Additionally, the organization of course content lacks a systematic and hierarchical structure, and the connection between knowledge points is

not close enough, which is not conducive to students constructing a comprehensive knowledge system. The connection between practical teaching content and theoretical teaching content is also insufficient, and corresponding practical projects are not arranged in a timely manner. Most of the projects are simple function realization tasks, which differ significantly from the actual project development process and fail to support students' in-depth understanding and comprehensive application of theoretical knowledge.

3.3. The Application and Innovation of Teaching Methods

Traditional teaching methods still account for a high proportion of the course, approximately 60%. Teachers mainly deliver knowledge in a one-way direction, with few opportunities for interaction between teachers and students. As a result, students passively accept knowledge, which often leads to learning fatigue and lack of attention, thereby affecting the overall teaching effectiveness. The implementation frequency of practical teaching methods, such as project-driven and case-based teaching, is low. Some teachers fail to decompose projects, allocate tasks, and guide processes according to the standard requirements, limiting the improvement of students' practical abilities. The exploration and application of new teaching models, such as flipped classrooms and online-offline hybrid teaching, are still in their early stages. There are challenges such as insufficient teaching resources, uneven independent learning abilities among students, incomplete platform functions, and poor connectivity between teaching links, all of which impact the effectiveness of teaching model innovation.

3.4. Implementation of Practical Teaching Links

The laboratory infrastructure is relatively well-developed, with sufficient computer equipment and network environments. However, the update and maintenance of experimental equipment are not timely, and some server configurations can no longer meet the operational requirements of current mainstream development tools. This affects the development environment's construction and students' experience. The difficulty of experimental project design is low, innovation is insufficient, engineering practice is lacking, and the actual project development process is not fully simulated. As a result, there is a disconnect between the knowledge students acquire and its real-world engineering application. While the number of internship and training bases is sufficient and several enterprises have established cooperative relationships, the depth of these partnerships is inadequate. Enterprise guidance to students is mainly limited to specific task operations, preventing students from fully accumulating engineering experience.

3.5. The Status of the Teaching Staff

The educational background of teachers is mainly postgraduate, and a relatively high proportion of teachers hold intermediate professional titles. However, only 40% of teachers have practical project development experience, which limits students' ability to master and apply practical development skills. Additionally, teachers' participation in engineering education certification training and teaching seminars needs improvement. Some training contents are too theoretical and lack practical case analysis and operation guidance, making it difficult for teachers to apply the training content effectively to their own teaching reform. In the course teaching reform, there are differences in the enthusiasm, innovation, and teamwork ability of teachers. Some teachers are enthusiastic about the teaching reform but face challenges such as poor communication and unreasonable division of labor in team cooperation. Other teachers are more passive about the teaching reform and lack innovation awareness, which affects the overall impact of the course teaching reform.

3.6. Construction of Assessment and Evaluation System

The course assessment method still relies on the traditional final examination. The assessment is mainly based on attendance and homework completion, making it relatively one-dimensional and unable to comprehensively evaluate students' learning processes and overall abilities. The assessment content primarily focuses on the memorization and understanding of basic theoretical knowledge, while practical abilities, innovation skills, and team cooperation are not assessed sufficiently. As a result, students tend to focus on memorizing book knowledge to pass exams, neglecting the flexible application of knowledge and the improvement of comprehensive abilities. During the assessment process, there is subjectivity in evaluating regular performance, and the transparency of the assessment process is insufficient. Teachers do not provide timely feedback on the specific scores and evaluation criteria for each assessment, which reduces students' trust in the results and affects their enthusiasm for learning.

4. Teaching Reform Practice of "Java Web Application Development" Based on Engineering Education Certification

4.1. Optimization of Teaching Objectives

According to the engineering education certification standards, the teaching objectives of "Java Web application development" are refined into three dimensions: knowledge and skills, process and methods, and emotional attitude and values, ensuring that the objectives are specific, measurable, and achievable. Additionally, a dynamic adjustment mechanism for teaching objectives has been established, allowing the target requirements to be updated in a timely manner in response to industry developments and changes in enterprise needs, ensuring the timeliness and practicality of teaching objectives. Specific measures include forming a teaching objectives revision team composed of teachers and enterprise experts, collecting industry dynamics, enterprise needs, and student feedback at the end of each semester, and revising the teaching objectives for the next semester to better align with industry development trends and the actual needs of enterprises.

4.2. Teaching Content Update and Integration

Taking the actual project process of Java Web application development as the main line, the course knowledge system is reorganized, redundant knowledge points are integrated, and cutting-edge technology topics such as microservice architecture and front-end and back-end separation technology are added to broaden students' technical horizons. At the same time, school-based characteristic textbooks or teaching materials are prepared to integrate engineering cases, practical guidance, and professional quality training content, improving the practicability and forward-looking nature of the teaching content. The specific approach is to restructure the content of traditional teaching materials based on the actual project process, removing chapter restrictions, integrating similar knowledge points, deleting outdated content, and adding new technology application cases. For example, when explaining Servlet and JSP, the user login module in the actual project is explained, allowing students to understand its application in real-world projects while learning theoretical knowledge.

4.3. Diversified Teaching Methods

Through the project-driven teaching method, the course content is broken down into multiple small projects, and students are divided into groups to complete the project needs analysis, design, coding, testing, and other links. The case teaching method is applied to explain theoretical knowledge, helping students understand abstract concepts and principles through actual cases. Additionally, the flipped classroom teaching mode is tested in some key and difficult knowledge units. Teachers release learning materials in advance and organize students to discuss, answer questions, and expand knowledge in

class, improving students' initiative and participation. For example, when explaining Java design patterns, learning materials are released in advance so that students can study on their own before class, and in-depth understanding of the application scenarios and implementation principles of design patterns is achieved through group discussion and case analysis in class.

4.4. Practice Teaching System Construction

A progressive practical teaching system of "basic experiment-curriculum design-practice training-innovation and entrepreneurship" is established. The cooperation with enterprises is strengthened to set up stable off-campus practice bases, introduce real projects from enterprises, and arrange on-site guidance by enterprise engineers. Simultaneously, training in engineering professional standards such as program code standards and document writing standards is conducted to cultivate students' professional quality and improve their engineering practice ability and innovative thinking. Specific measures include signing internship training cooperation agreements with several software companies and arranging for students to participate in enterprise internship training every semester for four weeks, engaging in actual project development. During the internship, enterprise engineers serve as instructors, guiding students one-on-one. Furthermore, the enterprise conducts professional standards training courses, including code standards, document writing standards, and project management standards.

4.5. The Teaching Staff Has Been Improved

A teacher training plan for enterprises is formulated, regularly arranging teachers to participate in project development in cooperative enterprises to enhance their engineering practice ability. Enterprise technical experts are invited to serve as part-time teachers to undertake practical course teaching tasks and conduct technical lectures and experience-sharing sessions. At the same time, teachers are organized to participate in engineering education certification training and teaching ability improvement workshops, and teachers are encouraged to conduct research and practice in teaching reform, aiming to build a team of teachers with high engineering practice and teaching abilities. Specific measures include sending two teachers to cooperative enterprises every year for temporary training, participating in enterprise project development, and improving teachers' engineering practice ability. Every semester, technical experts from enterprises are invited to conduct technical lectures and experience-sharing activities to broaden the technical horizons of both teachers and students. Teachers are regularly organized to participate in engineering education certification training and teaching ability improvement workshops, and encouraged to carry out research and practice in teaching reform.

4.6. A Diversified Assessment and Evaluation System Was Established

By combining process assessment and summative assessment, the weight of process assessment is increased to comprehensively evaluate students' learning processes. Various assessment methods such as project reports, code reviews, team evaluations, and oral reports are used to assess students' comprehensive abilities. At the same time, an evaluation feedback mechanism is established to provide timely feedback on assessment results to help students identify deficiencies and improve their learning, ensuring fairness, impartiality, and effectiveness in the evaluation process. The specific method is to increase the proportion of process assessment in the overall evaluation, incorporating classroom performance, homework completion, and project practice results, accounting for 50% of the total score. The final assessment is in the form of a project defense, where students are required to submit a project report, code, and demonstration video, accounting for the remaining 50% of the total grade.

5. Teaching Reform Implementation Steps and Safeguard Measures

5.1. Implementation Step Planning

The teaching reform is divided into three stages. The first stage is research and preparation, which includes conducting enterprise needs research, graduate follow-up surveys, peer course comparison analysis, organizing teachers to study engineering education certification standards and advanced teaching reform experiences, and formulating the overall plan and implementation plan for the teaching reform. The second stage is pilot implementation and improvement, where new teaching objectives, content, methods, and assessment systems are piloted in select classes. Student feedback is regularly collected, and seminars are held to adjust and optimize the reform. The third stage is comprehensive promotion and improvement, where the pilot results are extended to all classes within the major, ongoing feedback from all parties is collected, and further improvements to the reform plan are made.

5.2. Establishment of Safeguards

A leading group and a working group for curriculum teaching reform were established to clarify roles and ensure the smooth progress of the reform work. Management systems related to teaching reform, such as teacher performance evaluation methods, student learning process management methods, and others, are formulated to provide institutional support for the reform. Efforts will be made to secure financial support from schools, enterprises, and other channels to meet the funding needs for teacher training, textbook preparation, laboratory construction, and practice base maintenance. Strengthening the development of course teaching resources includes the creation of an online course platform, enriching teaching videos, courseware, case bases, test banks, and other resources. Advanced teaching management platforms and online learning tools will be introduced to provide technical support for teachers in resource production, teaching process management, and student learning data analysis, aiming to improve teaching efficiency and management accuracy. Virtual simulation technology and artificial intelligence-assisted teaching tools will be employed to diversify teaching methods, push learning resources more precisely, meet students' personalized learning needs, and improve learning outcomes.

6. Teaching Reform Effectiveness Evaluation and Continuous Improvement

6.1. Construction of Evaluation Index System

An evaluation system, including three categories of indicators—students' ability improvement, teaching quality, and professional development—was constructed. The students' ability improvement indicators covered programming, system design, problem-solving, teamwork, and engineering professionalism. The teaching quality indicators include the rationality of the distribution of course assessment results, the change in make-up examination rate and excellence rate, and students' satisfaction with course teaching. Professional development indicators focus on the performance of the course in professional evaluation, engineering education accreditation, and the promotion of the overall reputation of the profession, as well as its impact on enrollment and employment.

6.2. Assessment Data Collection and Analysis

A variety of methods were used to collect evaluation data, including questionnaire surveys, interviews, student work analysis, and enterprise feedback. Statistical analysis was employed to quantitatively analyze the collected data and deeply examine the impact of teaching reform on various indicators. By comparing the data differences before and after the teaching reform, the remarkable results of the reform are clearly presented, and the existing weak links are accurately identified.

6.3. Continuous Improvement Strategy

Based on the evaluation results, a special improvement plan is formulated for the identified weak links, clearly defining specific improvement goals, measures, responsible persons, and time nodes to ensure that the improvement work has a clear direction and operability. A continuous tracking and dynamic adjustment mechanism for teaching reform is established, with regular reviews and summaries of the reform experience. Attention is paid to the development trend of industry technology and updates in educational concepts, allowing timely adjustments to the reform strategy. Additionally, exchange and cooperation with similar institutions both domestically and internationally are strengthened, actively drawing on advanced teaching reform experiences. This approach continuously enriches and improves the content and methods of curriculum teaching reform, promotes the in-depth development of teaching reform, and further improves the quality of curriculum teaching and students' comprehensive abilities.

7. Conclusions

Focusing on the requirements of engineering education certification, this paper implements a comprehensive teaching reform of the "Java Web application development" course, covering the optimization of teaching objectives, content updates, method diversification, practice system construction, teacher improvement, and evaluation diversification. After the reform, students' abilities in programming, system design, and problem-solving were significantly improved. The distribution of course assessment results became more reasonable, the make-up rate was reduced, and the excellence rate was increased. Additionally, students' satisfaction was greatly improved.

At the same time, the course performed well in professional evaluation and engineering education certification, effectively promoting the overall development of the profession and providing a successful example for the teaching reform of other courses. In the future, the curriculum reform will continue to deepen, follow the frontier of Java technology, integrate emerging technologies such as artificial intelligence and big data, and cultivate high-quality talents adapted to future trends. Additionally, exchanges and cooperation between colleges and universities will be strengthened to explore the overall optimization path of the computer professional curriculum system, improving professional competitiveness and influence.

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