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Construction and Practice of "Java Programming Fundamentals for Object-Oriented Programming" Course Group under the Background of New Engineering

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Abstract: *In response to the new requirements for programming fundamentals courses under the context of New Engineering, this paper delves into the challenges and issues faced by Java programming fundamentals courses in the current era of New Engineering. These include outdated teaching methods, monotonous and obsolete content, disconnection between theory and practice, insufficient practical operation hours, and an imperfect teaching evaluation mechanism. To address these challenges, this paper proposes a dual-targeted approach for constructing a Java development course cluster aimed at both capability and demand, achieving two value goals: cultivating students abilities and meeting job requirements. The cultivation of abilities considers the comprehensive development of students, while meeting job requirements addresses the issue of employment after graduation. The construction of a Java development course cluster oriented towards dual targets follows the principles of reverse design and forward implementation, establishing a "one body, two wings, three collaborations" Java course model. It reforms the teaching methods of the course cluster, establishes a quality monitoring and evaluation system for practical teaching in computer-related majors, and builds a co-cultivation platform. Through these reform measures, the aim is to cultivate engineering talents with excellent skills and innovative capabilities. Teaching practice has shown that this teaching model significantly enhances students learning enthusiasm and ensures the efficient realization of course objectives.*

Keywords: *Object-Oriented Programming, Programming Foundation, Basic Curriculum Reform, Co-Cultivation Platform*

1. Introduction

In the context of the new eras technological revolution and industrial reform, the cultivation of new engineering talents is no longer a traditional rote teaching method but rather one that closely aligns with society and technological innovation. It requires students to apply their practical skills in engineering projects or problem-solving at the level of engineering [1]. Moreover, the direction of new technology development tends towards interdisciplinary integration and convergence[2]. Therefore, the training of new engineering talents is no longer supported solely by single-discipline independence but requires horizontal and vertical interdisciplinary intersections, as well as effective integration of concepts and technologies[3]. Consequently, this brings new significance and connotations to the talent cultivation model of all disciplines in the field of new engineering. At the same time, the development of the economy and technology presents new challenges and opportunities for the training and output of new engineering talents, especially as emerging industries and technologies bring about new trends in talent demand, driving social progress and talent development[4]. Cultivating and honing the ability of new engineering talents to independently solve engineering problems, as well as their innovative thinking and practical skills in tackling engineering challenges, is also essential for the comprehensive training of multidisciplinary new engineering talents.

In the context of new engineering education, practical teaching in the field of computer science plays a very important role in the overall educational process. Practical teaching is a crucial component for universities to cultivate students practical and research capabilities. It is an educational activity that helps students acquire skills, engineering knowledge, and innovative abilities, thereby enhancing their practical hands-on skills and engineering literacy[5]. In the practical teaching of computer science under the new

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engineering education framework, there is still a significant lack of research on blockchain applications. To nurture more interdisciplinary, skilled, and innovative engineering talents for enterprises and society, it is necessary to base the teaching on the background of new engineering education, with an eye on artificial intelligence and blockchain technology as forward-looking directions. This involves incorporating emerging innovative elements in computer science, exploring the practicality, interest, and operability of practical teaching content, and progressively advancing teaching and research work to promote innovation and reform in the cultivation model of practical teaching in computer science.

Second, the challenges and problems faced by the basic course of Java programming in the new engineering era are explored. Previous programming fundamentals courses have centered on algorithm design, primarily using theoretical lectures with computer lab experiments as supplementary. This teaching model tends to cultivate students test-taking skills rather than applying knowledge to solve practical problems. This article reviews and summarizes the main issues of programming fundamentals courses under the current teaching model, aiming to propose improvement suggestions to enhance course quality and optimize talent cultivation outcomes.

The teaching methods are traditional and outdated, with monotonous and single content in the current educational system. Teachers play a central role, while students passively receive information, neglecting the cultivation of their independent inquiry and innovative abilities. The tedious learning of programming and grammar has not been closely integrated with subsequent professional knowledge, leading to a lack of motivation among students, making it difficult for them to master practical skills or apply what they have learned in practice. The teaching content is singular and lagging, failing to adequately incorporate cutting-edge technologies such as cloud computing, the Internet of Things, mobile technology, big data, and artificial intelligence, leaving engineering graduates struggling when faced with new technological applications and innovation challenges[6]. Moreover, the current curriculum lacks interdisciplinary integration and innovative teaching content, lacking typical interdisciplinary course design, which to some extent limits the potential of computer foundational education in fostering students computer application skills and innovative thinking. To address this challenge, the teaching system urgently needs improvement, including the integration of cross-disciplinary knowledge, promoting students mastery of emerging technologies, and stimulating their creativity and problem-solving abilities.

The disconnect between theory and practice is becoming increasingly prominent in the current educational model. Students focus excessively on acquiring theoretical knowledge while neglecting the importance of practical application. Course content overly emphasizes grammar and programming rules without integrating real-world scenarios, making it difficult for students to truly grasp the essence and application skills of programming languages. Moreover, there is a lack of necessary connection between course content and professional practice, leaving many freshmen with few opportunities to engage in actual projects. This prevents them from fully understanding the critical role of programming languages in their future studies and career development. Such a disconnection not only undermines students learning outcomes but may also dampen their enthusiasm and motivation. Therefore, it is necessary to innovate the current educational model to better bridge theory and practice, ignite students passion for learning, and enhance their ability to solve real-world problems.

Insufficient practical operation hours make it difficult to meet the courses training needs. Under current teaching hour constraints, balancing theoretical instruction with practical operation in foundational programming courses is particularly challenging. Faced with mandatory curricula, teachers often have to focus on explaining basic concepts, grammar rules, and code principles, which inevitably sacrifices students hands-on practice time. Due to a lack of adequate practical opportunities, students cannot independently complete practical tasks, leading to significant deficiencies in their hands-on skills. The absence of training in problem analysis and solving complex problems, as well as the lack of systematic cultivation of advanced thinking required for enterprise-level practical training, makes it difficult for students to meet industry standards in terms of comprehensive abilities and professional ethics. This situation urgently requires improving teaching strategies to enhance students practical capabilities[7].

2. Analysis of the connotation of new engineering

As the new round of technological and industrial revolution drives the transformation of knowledge production models, to meet current industrial production needs and future social development demands, some emerging technologies have emerged, leading to the development of new forms of engineering disciplines. Some industries are also being used to transform and upgrade traditional engineering

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disciplines. The development of emerging technologies has restructured a new type of engineering discipline with unique characteristics, including interdisciplinary integration capabilities, innovation and entrepreneurship capabilities, and practical application abilities in engineering.

One of the most significant features of New Engineering is its broader scope of disciplines and specialties compared to traditional engineering. Typical representatives include fields related to intelligent manufacturing and artificial intelligence. In fact, New Engineering can be seen as an upgraded and transformed version of traditional engineering. In an era of rapid economic development, the advancement of New Engineering can be considered a major educational strategic decision, a new requirement that closely follows the times. At the same time, the cultivation of New Engineering talent is an essential component in meeting the demands of the new era.

3. Positioning of computer field personnel training

In the context of new engineering, how to cultivate applied talents for the new era is a critical issue. For the field of computing, the focus is on developing practical engineering skills and innovation and entrepreneurship capabilities. In recent years, the development of emerging technologies has driven advancements and applications in computing, such as big data, cloud computing, artificial intelligence, and smart manufacturing. These technologies have also brought about a qualitative leap in the industrial chain. The application of artificial intelligence has extended from industrial and military sectors to daily life, while the mode of industrial production has shifted from traditional mass production lines to large-scale intelligent operations.

In response to the demand for talent in the field of computing, practical teaching is of paramount importance. Practice is an effective means to expand knowledge and enhance capabilities. Under the new engineering education framework, a new model for cultivating talent in the computer domain has emerged. The goal of higher education in talent cultivation is to achieve better alignment between universities and society, optimize practical teaching resources and base creation, leverage emerging computer technologies, deepen reforms in practical teaching, increase the intensity of engineering practice, and strengthen competition-driven education. Effective practical teaching components are crucial. However, the main arena for aligning talent with society remains universities. In response to various emerging technologies in the field of computing, such as big data and artificial intelligence, and their broad application areas, including smart manufacturing, intelligent healthcare, smart cities, smart homes, and intelligent robots, the extension and application of related theories are also emphasized.

4. Practice teaching mode of computer field under the background of new engineering

The idea of building Java courses with both ability and demand as objectives.

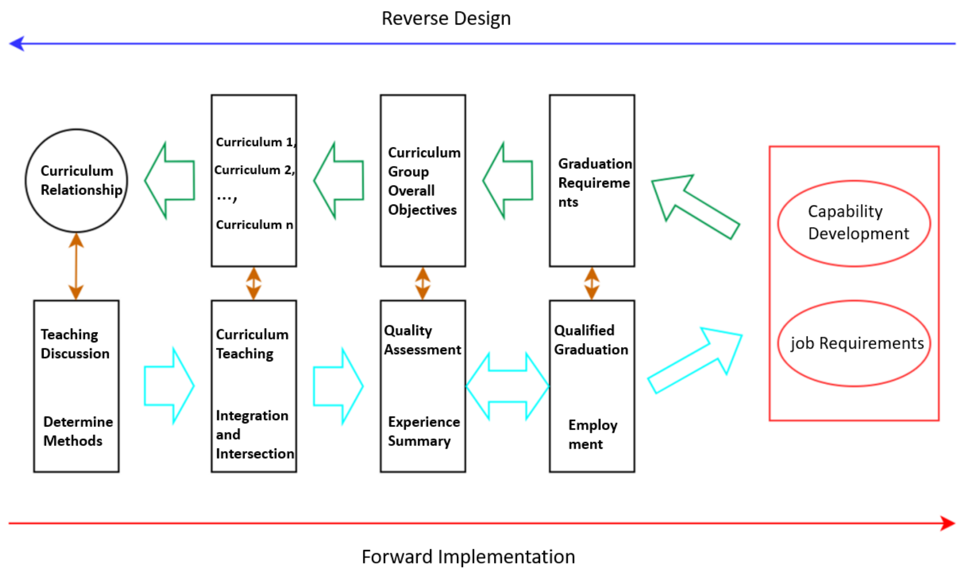

Figure 1: Design and implementation process of Java development course cluster with dual objectives of capability and demand

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The construction of a Java development course cluster aims to achieve two value goals: cultivating students abilities and meeting job requirements (see Figure 1: Design and Implementation Process of a Java Development Course Cluster Focused on Both Abilities and Requirements). The cultivation of abilities considers the comprehensive development of students, while meeting job requirements addresses the issue of employment after graduation. The construction of a Java development course cluster oriented towards dual goals follows the principles of reverse design and forward implementation, building an "integrated body with two wings and three collaborations" Java course model. It reforms the teaching methods of the course cluster, establishes a quality monitoring and evaluation system for practical teaching in computer-related majors, and builds a co-cultivation platform.

In the reverse design phase, starting from capability development and job requirements, professional training objectives are established, clarifying graduation requirements related to software development, thereby determining the overall goal of the course cluster; based on the overall goal of the course cluster, specific courses to be offered are determined, the relationships between courses are clarified, forming a scientifically sound and reasonable curriculum system; the overall goal of the course cluster is decomposed top-down into each course, forming teaching objectives for each course, thoroughly researching the role of each course in achieving the training goals, reasonably determining the teaching content and hours for each course, and formulating a teaching plan; when integrating and optimizing course content, ensure that knowledge points are not duplicated, omitted, or disconnected.

During the positive implementation phase, based on the teaching objectives of each course, the teaching team conducts instructional discussions to determine teaching methods; instructors are responsible for the specific implementation of course instruction; to assess whether the overall goals have been achieved, quality evaluations are conducted, and continuous summaries and experience accumulation are carried out; students who meet the graduation requirements and pass social scrutiny can apply for jobs and satisfy corporate needs. Among these, course instruction is the critical link in determining the effectiveness of course cluster development. The teaching process must overcome the narrow focus on individual courses, emphasizing the integration and coherence between courses to avoid a situation where they appear well-structured but lack substance. Practical courses are designed comprehensively, spanning the entire four-year undergraduate period, gradually enhancing students professional and vocational skills. Feedback from graduates and employers is a key indicator of the quality of talent cultivation.

4.1 Build "1+2+3" Java development course group

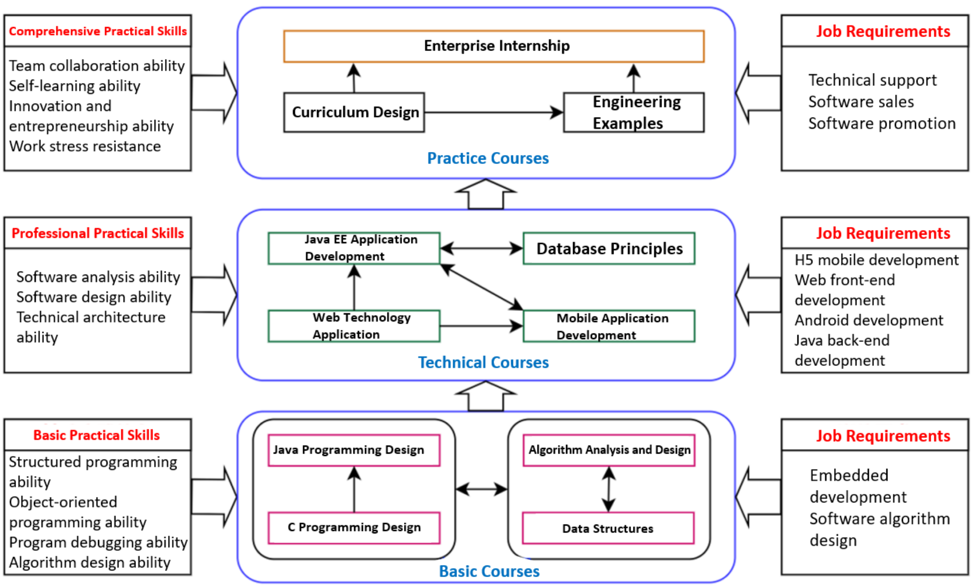

Figure 2: Course Settings oriented to capabilities and needs

The overall goal of the software development course cluster is to cultivate students ability to analyze problems and design and develop software, enabling them to propose feasible solutions for complex engineering issues and possess excellent professional skills. To achieve this goal, a software development course cluster centered on Java technology has been constructed, including courses such as C language programming, data structures, Java language programming, database principles, Web technology

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application, algorithm analysis and design, Java EE application development, mobile application development, as well as practical courses like course design, engineering training, and enterprise internships. This forms an organic connection of "programming language—basic theory—application development technology—comprehensive ability" in the Java development course cluster. The course settings, capability cultivation, and job requirement correspondence of the course cluster are shown in Figure 2.

Constructing a "One Body, Two Wings, Three Synergies" Java Development Course Cluster involves one core, centered around students; two wings, with the course cluster aiming at both capability development and job requirements; and three synergies, dividing the course cluster into three levels of collaboration: foundational courses, technical courses, and practical courses. Each course within the cluster has its own positioning, with a unified syllabus that supports each other in terms of teaching objectives, ensuring progressive capability development. The C language and Java language courses serve as prerequisites and follow-up courses. Offering these two representative computer languages helps students grasp the characteristics and learning methods of different types of languages, facilitating their independent exploration of other programming languages. Unlike the relatively stable content of foundational courses, technical courses must keep pace with technological advancements, incorporating new technologies and tools to effectively align with job requirements. This ensures that teaching objectives closely match job skills, reflecting the flexibility and openness of the course cluster. The relationship between the teaching objectives of technical courses and job requirements is shown in Table 1. Practical courses aim to cultivate students comprehensive practical abilities and are also a crucial part of enhancing professional skills.

Comprehensive practical skills job requirements: enterprise internship team cooperation ability technical support self-learning ability software sales course design engineering training innovation and entrepreneurship ability software promotion work stress resistance practical courses professional practice ability job requirements Java EE application development database principles H5 mobile development software analysis capability Web front-end development software design capability Web technology application mobile application development Android development technical architecture capability Java back-end development technology course basic practical ability job requirements Java language programming algorithm analysis and design structured programming capability embedded development object-oriented programming capability software algorithm design C language programming data structure program debugging capability algorithm design capability basic courses.

4.2 Reform the teaching method of curriculum cluster

And employ various teaching methods to ensure the quality of instruction tailored to each course. Based on the characteristics of the Java development course cluster, efforts should be made to achieve three transformations: the teaching philosophy should shift from knowledge transmission to skill cultivation; the teaching focus should transition from teacher-centered to student-centered; and the teaching approach should move from a closed classroom to an open one. For different teaching contents, different teaching methods should be adopted, and the alignment between technical course instruction and job positions is clearly shown in Table 1: Technical Course Instruction Objectives and Job Position Alignment.

Table 1: Teaching objectives of technical courses and the relationship between positions1

Course	Teaching Objectives/Job Skills	Target Positions
Web Technology Application	Master HTML5,CSS3,JavaScript front-end basic technologies and Ajax,jQuery,Vue,Bootstrap,LayUI and other front-end frameworks,master JSP,Servlet,JavaBean and other basic technologies as well as basic web server technology,proficient in using development tools like Dreamweaver,Eclipse	H5 Mobile Development,Web Front-end Development
Java EE Application Development	Master the integration of Spring,Spring MVC,MyBatis three major frameworks as well as Spring Boot,Maven and other mainstream Java EE technologies,proficient in using development tools like IntelliJ IDEA	Java Back-end Development
Mobile Application Development	Master the environment setup of Android Studio,and grasp programming technologies such as sdk,Activity,UI,networking,etc.	Android Development

4.3 Establish the quality monitoring and evaluation system of computer professional practice teaching

The practical teaching quality of computer science majors has a profound impact on students career development, employment prospects, as well as the social reputation, enrollment effectiveness, and sustainable development capabilities of universities. In the context of new engineering education, universities must prioritize enhancing the quality of practical teaching and continuously optimize the quality standards and management systems for practical teaching. By implementing institutional constraints and incentive measures, they can strengthen teaching and learning styles, elevate the core status of practical teaching, and comprehensively improve and refine policies and systems related to enhancing the quality of practical teaching.

In addition, universities should organize multiple parties to participate in the supervision and evaluation of practical teaching, including outstanding student representatives, academic leaders in computer science, school management, career guidance teachers, and industry experts. Regular self-assessments should be conducted to build an internal quality assurance system. Universities should also be student-centered, continuously optimizing and improving, establishing an internal quality assurance system based on professional assessment indicators, and collaborating with external evaluation agencies to conduct evaluations of graduate training quality and graduate development, forming a professional assessment system that integrates the training process and training quality.

4.4 We will build a training system and build platforms for mass entrepreneurship and innovation

First of all, expand the coverage of innovation and entrepreneurship education, let students actively participate in innovation and entrepreneurship activities, and carry out multi-dimensional incentive strategies for second course credits to improve students enthusiasm for participation.

Secondly, we should improve the lecture system of innovation and entrepreneurship education, open operational, universal, professional and advanced courses, and form a comprehensive and distinctive course system of innovation and entrepreneurship.

Thirdly, we should pay attention to the cultivation of innovation and entrepreneurship education process, build a three-level academic system at school, college and department levels, and guide everyone to actively participate in innovation and entrepreneurship activities by relying on the college website, official account and other online platforms.

5. Conclusion

In the context of new engineering education, practical teaching has become a critical component of talent cultivation. To achieve the goals of new engineering education, it is particularly urgent to reform practical teaching in computer science programs. Universities need to deeply understand the essence of new engineering education, clarify their positioning in cultivating computer professionals, and actively seek effective strategies for practical teaching reform. While reinforcing students foundational technical skills, the focus should be on developing their practical operational abilities and entrepreneurial and innovative skills.

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