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Construction and application of engineering materials curriculum system under the combination of "production and education + science and education"

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Abstract: With the increasing demand for high-skilled talents, higher vocational education plays an increasingly important role in cultivating application-oriented talents. Taking engineering materials course as an example, this paper aims to discuss the construction and application of higher vocational education curriculum system under the dual integration mode of "production-education integration" and "science-education integration". Firstly, it analyzes the existing problems of the current curriculum system. Secondly, the curriculum system is designed with "one body, two wings, three wheels drive" as its framework, where "industrial cross" and "integration of science and technology" serve as the two wings. Ideological and political education acts as the central axis, driving interdisciplinary collaboration, science and education teaching, and the integration of production and education. Additionally, it includes the establishment of a comprehensive curriculum evaluation system. The research results have important theoretical and practical significance for promoting the reform of higher vocational education and improving the quality of personnel training.

1. Introduction

Facing the rapid progress of scientific and technological advancement and the vigorous development of modern industries, the matching degree between industrial demands and talent cultivation urgently needs to be improved. The report of the 20th National Congress of the Communist Party of China proposed "to promote the integration of vocational and general education, the integration of industry and education, and the convergence of science and education, and to optimize the type positioning of vocational education", pointing out that through the promotion of the integration of vocational education and general education, the combination of industry and education, and the convergence of scientific research and education teaching, to optimize the positioning of vocational education [1-3]. This reflects the integrated development concept of education, talent, and scientific and technological innovation, emphasizing the key role of industry-education integration and science-education convergence. Against this background, curriculum reform has become the core link to promote educational change and improve the quality of talent cultivation.

The realization of curriculum reform depends on source innovation and technological innovation, so it is urgent to break the shackles of original thinking, reform the mode of engineering education, and establish an innovative curriculum system. This paper, using the engineering materials course as a case study, begins by surveying and analyzing the course's current state. It then proposes and constructs a curriculum system characterized by "one body, two wings, three wheels drive." The "two wings" refer to the intersection of industries and the integration of science and technology. The central axis is ideological and political education, which drives interdisciplinary crossover, science and education teaching, and collaborative practices between production and education. Finally, the paper establishes a robust curriculum evaluation system to ensure quality and effectiveness.

2. Analysis of current course status and problems

In higher vocational education, Engineering Materials is a key course aimed at providing students with the necessary knowledge of materials science and engineering to meet the needs of future engineering technical positions. However, with the rapid development of science and technology and the continuous change of industrial demands, the course still exists out of sync with the development of The Times in some colleges and universities. The following is a detailed analysis of the current situation of the Engineering Materials course.

2.1. The course content is out of touch with industrial practice

In some colleges and universities' Engineering Materials courses, the teaching content may be too focused on traditional material science knowledge, such as ordinary concrete materials, steel bar materials, etc., and the introduction of emerging materials, such as nanomaterials, biomaterials, intelligent materials, etc., is insufficient [4].

In the rapidly developing field of engineering technology, the limitations of single material science knowledge are becoming increasingly apparent, and it is necessary to integrate with other disciplines such as mechanical engineering, electronic engineering, etc. However, some courses lack this kind of interdisciplinary integration and cannot meet the needs of students to use knowledge comprehensively to solve complex engineering problems.

2.2. Teaching methods do not match student needs

In terms of teaching methods, many courses still use traditional lecture methods, lack of interaction and discussion, which is not conducive to stimulating students' interest in learning and innovative thinking.

In some higher education, the practical training part of the Engineering Materials course has not been given due attention, which is contrary to practice as the cornerstone of truth [5]. The laboratory equipment is outdated and difficult to simulate the real industrial environment; the experimental content is out of touch with industrial practice, and students cannot deeply understand the performance and application of materials through practice. This leads to the knowledge students learn is difficult to directly apply to future engineering practice.

2.3. Teaching resources are out of sync with industry development

Laboratory equipment is an important tool for students' practical operation and skill training. However, some colleges and universities' laboratory equipment is outdated, and there is a generation gap with the equipment and technology used in the industry. This disconnection means that students cannot become familiar with and master the current technology and equipment used in the industry, affecting their adaptability after employment.

Teachers are the leaders of teaching activities. However, the professional development of some colleges and universities' teachers is constrained, and there is a lack of opportunities for close cooperation with the industry, leading to outdated teacher professional knowledge, which makes it difficult to bring the latest industry knowledge and technology trends into the classroom.

2.4. The curriculum system is not connected with market demand

Course setting is a key link for higher vocational education to connect with market demand. However, the course setting of some colleges and universities' Engineering Materials courses has not fully considered the current and future market demand, and the knowledge and skills students learn may not meet the recruitment requirements of enterprises, leading to a decline in employment rates and quality.

There is a lack of effective industry feedback and participation in the construction and teaching process of the curriculum system. This lack of feedback mechanism means that the course content and teaching methods are difficult to adjust and optimize in a timely manner according to the changes in the industry.

2.5. Teaching evaluation and student development

The existing evaluation system has some obvious limitations, especially in the field of higher vocational education, a main problem is that the evaluation system tends to overemphasize the mastery of theoretical knowledge and relatively neglects the cultivation and evaluation of students' innovative ability and practical problem-solving ability [6].

In the teaching process, due to the large number of students, teachers face challenges in tailoring teaching programs for each student to meet their unique learning characteristics and needs. This generalized teaching method may limit the exploration of students' potential and the cultivation of personalized skills.

3. Construction and implementation of curriculum system

Based on the OBE teaching concept, with learning outcomes as the goal and scientific research innovation as the orientation, reverse design the curriculum structure and content to construct a curriculum system that integrates ideological and political education, interdisciplinary, science-education teaching, and practical reform.

3.1. Integration of ideological and political elements oriented by quality

Integrating ideological and political elements in the construction and implementation of the curriculum system under the "industry-education + science-education" dual integration is an important way to achieve the fundamental task of cultivating people with moral, intellectual, physical, and aesthetic grounding. This process involves not only combining the content of ideological and political theory courses with professional course knowledge but also cultivating students' sense of social responsibility, professional ethics, and innovative spirit. First, the concept of ideological and political education should be integrated throughout the course teaching. For example, when discussing the impact of scientific and technological innovation on society, students can be guided to think about how to achieve social equity and justice through science and technology [7]. Second, through school-enterprise cooperation, combine ideological and political education with industrial practice. Third, the curriculum system should focus on cultivating students' sense of historical mission and responsibility. Finally, the construction of the curriculum system should also strengthen students' critical thinking and independent thinking abilities, encourage students to think about existing technologies and social development models, and cultivate them to become socialist builders and successors with ideals, responsibilities, and innovative capabilities.

3.2. Restructuring of interdisciplinary course content

Reconstructing the "basic knowledge - professional knowledge - curriculum frontier - innovation and integration" integrated course content, "industrial intersection" and "integration of science and technology" deepened curriculum reform, and established online and offline mixed course groups and three-dimensional teaching materials, as follows.

The content of the reconstructed curriculum should emphasize on strengthening the core status of basic subjects such as mathematics and physics, so as to build a solid scientific foundation for students. At the same time, professional knowledge should be closely aligned with the actual needs of the engineering material industry, and industry experts should be introduced to participate in course design and teaching through school-enterprise cooperation to ensure the practicability and foresight of the teaching content [8].

In the practice and experience of innovation integration, engineering materials course emphasizes the combination of professional knowledge and innovation and entrepreneurship education to cultivate students' practical ability and innovative spirit. Innovative projects and entrepreneurial competitions are incorporated into the curriculum design, encouraging students to apply their knowledge to solve real-world engineering problems. Through innovative practice platforms inside and outside the school, such as business incubators and technology transfer centers, students are provided with practical opportunities to practice innovative thinking and practical skills in the process of solving specific problems [9-10].

This cross-integration teaching concept aims to break the boundaries between traditional disciplines and promote the mutual integration and knowledge integration between different engineering fields. For example, integrating electronic engineering with computer science helps students master the application of materials in microelectronics technology and intelligent manufacturing [11-12]. Through the design of interdisciplinary course projects and laboratory work, students are able to experience the practical application of knowledge from different disciplines in the process of solving engineering problems, thereby developing their comprehensive thinking ability and the ability to solve complex engineering problems.

3.3. Reform of science-education convergence teaching methods

To create a student-centered classroom, we must construct an approach that integrates teaching and research. This involves incorporating scientific research findings into textbooks, classrooms, and practical applications. By deeply integrating information technology with teaching, we can enhance the educational experience. Additionally, through the combination of in-class and out-of-class activities, as well as integrating competitions with teaching and learning, we aim to comprehensively improve students' innovative abilities.

Through methods such as project-oriented learning and problem-oriented learning, stimulate students' interest in learning and inquiry spirit. The course content is closely integrated with industrial demands, introducing industry cases and actual engineering projects, allowing students to learn and master professional knowledge in the process of solving actual problems.

We closely integrate teaching with scientific research to achieve knowledge innovation and deepening. Through scientific research projects, laboratory research, industry cooperation, and other ways, students can directly participate in scientific research and technological development, which not only enhances students' practical abilities and innovative thinking but also improves their ability to solve complex engineering problems.

3.4. Implementation of industry-education collaborative practice plan

We have established a dual-track internship program that encompasses "basic experiments - professional experiments - innovative experiments" and "understanding practices - production practices - engineering applications." Utilizing the practice platform facilitated by school-enterprise cooperation, which promotes open sharing and connects internal and external resources, we aim to enhance students' abilities to solve complex engineering problems.

The dual gradient practice education model. According to the progressive in-depth teaching structure of "basic experiment → professional experiment → innovative experiment", students can start from mastering basic experimental skills, and gradually develop to be able to carry out scientific exploration and technological innovation independently. The practice teaching path of "understanding internship - production internship - engineering application" allows students to further participate in actual engineering application projects on the basis of understanding the engineering background and production process, and improve their ability to solve actual engineering problems.

We collaborate with enterprises to create open and shared practice platforms, including engineering technology research centers and school-enterprise joint laboratories, which offer students the chance to engage with cutting-edge technologies and participate in real-world production processes. By fostering internal and external linkages and integrating resources from both domains, we establish a sustainable mechanism for school-enterprise cooperation. This collaboration enables resource sharing and leverages the complementary strengths of both educational institutions and industry partners. Schools can use their scientific research advantages and talent advantages to carry out technology research and development and talent training with enterprises, while enterprises can provide schools with practice platforms and technical support to help students better understand industry demands and development trends.

4. Curriculum evaluation system

Break the traditional qualitative evaluation method of students, construct a comprehensive evaluation system based on three dimensions of student development, teacher growth, and classroom ecology, and carry out dynamic tracking and qualitative and quantitative comprehensive analysis in the specific implementation process.

4.1. Multi-dimensional evaluation of student development

Through a variety of evaluation methods such as student self-assessment, peer evaluation, teacher comments, and industry expert reviews, a comprehensive insight into students' learning progress and personal development can be obtained. In addition, combining formative evaluation and summative evaluation can objectively reflect students' learning outcomes while encouraging students to continuously progress and surpass themselves in the course learning. This evaluation method helps to cultivate students' comprehensive quality and lays a solid foundation for future engineering practice and career development.

4.2. Systematic evaluation of teacher growth

The systematic evaluation indicators for teacher growth can include teaching content and methods, practice and scientific research, industry connections, student guidance, lifelong learning, teaching effectiveness, and more. Through such systematic evaluation, teachers can be motivated to continuously improve their professional quality and teaching abilities, better adapt to the educational trend of industry-education integration and science-education convergence, and contribute to the cultivation of high-quality engineering materials professionals.

4.3. Comprehensive evaluation of classroom ecology

Under the background of industry-education integration and science-education convergence, the ecology of the Engineering Materials course is comprehensively evaluated through various methods to assess the health of the classroom. First, observe and record student participation in the classroom, including attendance, enthusiasm for discussion, and proficiency in experimental operations. Second, the frequency of teacher-student interaction is also an important aspect of evaluating classroom ecology. Frequent and effective teacher-student interaction can promote the exchange of knowledge and collision of thinking, and improve the activity of the classroom.

5. Conclusions

This paper deeply studies the Engineering Materials course and explores the construction and application of higher vocational education curriculum systems under the dual integration model of "industry-education integration" and "science-education convergence". Based on the analysis of the existing curriculum system, we have identified and pointed out the existing problems, and on this basis, proposed a new curriculum system construction plan.

(1) A curriculum system with "industry-industry intersection" and "science-engineering integration" as two wings, and ideological and political education as the core, has been constructed. This system aims to achieve the organic combination of interdisciplinary, science-education teaching, and industry-education collaborative practice to cultivate high-skilled talents with innovative spirit and practical ability.

(2) To ensure the effective implementation of the curriculum system, a comprehensive curriculum evaluation system has been established. This system not only focuses on students' mastery of theoretical knowledge but also pays attention to students' practical skills and innovative abilities to ensure the cultivation of high-quality talents that meet social needs.

(3) The theoretical and practical significance of this study lies in providing new ideas and methods for the reform of higher vocational education curriculum systems. By implementing the curriculum system proposed in this study, the quality of talent cultivation can be effectively improved to meet the social demand for high-skilled talents. Although this study has proposed an innovative curriculum system construction plan, various challenges may be encountered in the practical process. Future research can further explore how to optimize curriculum content, improve the effectiveness of teaching methods, and how to better integrate industrial resources to achieve in-depth industry-education integration.

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