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Innovation in Metalworking Internship Teaching Based on Blended Learning and Project-Driven Approach

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Abstract: *This study aims to address the limitations of traditional metalworking internship teaching, such as insufficient student cognition, inaccurate course objectives, monotonous teaching modes, and scarce teaching resources. An innovative teaching model integrating blended learning and a project-driven approach is proposed. This model combines online theoretical teaching, virtual simulation, and offline practical operations with project-driven methods to achieve an organic integration of theory and practice. Additionally, curriculum ideological and political education (curriculum IPE) is incorporated to optimize teaching content, and a quantitative process-oriented assessment is implemented to comprehensively evaluate students' learning outcomes. The innovative teaching model effectively enhances students' learning interest and outcomes, fosters innovative thinking and problem-solving abilities, and improves comprehensive qualities and professional ethics. This study provides valuable insights for engineering education reform.*

Keywords: *Metalworking Internship; Blended Learning; Project-Driven Approach; Teaching Innovation*

1. Introduction

Practice teaching is an essential component of engineering education, playing an irreplaceable role in cultivating students' hands-on abilities and innovative spirit. With the rapid development of modern manufacturing, traditional practice teaching models can no longer meet the demands of modern engineering education. Therefore, innovation in practice teaching is of great importance. Innovation in practice teaching not only enhances students' learning interest and outcomes but also cultivates their comprehensive qualities and professional ethics, laying a solid foundation for their future careers. In recent years, many universities worldwide have actively explored reforms in practice teaching and achieved certain results. However, these reform measures are mostly focused on specific aspects and lack systematic innovation in teaching models [1].

In modern engineering education, innovation in practice teaching is not only the key to improving teaching quality but also a necessary requirement to adapt to social development. With the global manufacturing industry moving towards intelligent and automated directions, engineering professionals need stronger practical skills and innovative thinking. Traditional practice teaching models are often confined to classrooms and laboratories, lacking close integration with real engineering projects. This model fails to stimulate students' interest and is insufficient for developing their practical skills and ability to solve complex problems. Therefore, innovation in practice teaching needs to be systematically designed from multiple aspects, including teaching content, methods, and resources, to meet the demands of modern engineering education.

Curriculum ideological and political education (curriculum IPE) is an important way to integrate ideological and political education organically into professional courses [2]. Through curriculum IPE, students' sense of social responsibility, patriotism, and professional ethics can be cultivated. In recent years, the Ministry of Education has repeatedly emphasized the importance of curriculum IPE, requiring universities to integrate ideological and political education organically into various courses to effectively improve students' comprehensive qualities. Integrating curriculum IPE into engineering education not

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only enhances students' ideological and political qualities but also strengthens their passion and sense of responsibility for the engineering profession, fostering engineering ethics and professional spirit. For practice-oriented engineering courses, a new teaching innovation model is imperative. This paper focuses on exploring the teaching model of metalworking internship, analyzing the basic requirements and content of the course, combining the current status of metalworking internship teaching, and proposing an innovative teaching model based on blended learning and a project-driven approach. The aim is to integrate various teaching methods and means to achieve the organic combination of theory and practice and improve teaching effectiveness.

2. Course Overview

"Metalworking Internship" is an important technical foundation course in the cultivation of engineering talents and a crucial training component for students' basic hands-on abilities and operational skills. Through demonstration, instruction, design, training, and comprehensive innovative production, students complete a series of engineering training projects on their own, directly acquiring basic knowledge of modern industrial production methods and processes and receiving basic training in production process technology and organizational management. The metalworking internship course not only cultivates students' practical abilities and innovation capabilities but also enhances their comprehensive qualities and professional ethics [3].

The objective of the metalworking internship course is to enable students to master basic metalworking skills, including forging, welding, fitting, turning, milling, and other fundamental operational skills through practical teaching. Students will also understand the basic processes and technologies of modern industrial production and grasp quality control and safety management in production processes. The course aims to cultivate students' innovative thinking and problem-solving abilities through practical operations and project design. It also enhances teamwork, communication, and professional ethics through team collaboration and project implementation. The significance of the metalworking internship course lies in the close integration of theory and practice, allowing students to apply theoretical knowledge to real engineering projects and improve their ability to solve practical problems. Through hands-on practice, students can master the basic skills of modern industrial production, laying a solid foundation for their future careers [4]. Additionally, the course focuses on improving students' comprehensive qualities by fostering teamwork and communication skills through collaborative projects and innovative design, stimulating independent thinking and innovation, and providing strong support for cultivating high-quality engineering professionals.

3. Current Status of Metalworking Internship Teaching

With the development of engineering machinery and the increasing demand for students' qualities and abilities, the current "Metalworking Internship" course has become relatively outdated in terms of teaching models and methods. Traditional rote teaching methods are increasingly unable to meet the needs of high-quality talent cultivation. The main issues are as follows:

3.1. Insufficient Student Understanding of Internship Content, Nature, and Importance

In current metalworking internship teaching practices, there is a widespread problem of insufficient student cognition of internship content, nature, and importance. Students often passively follow the teacher's guidance without a deep understanding of the internship goals and significance, making it difficult for them to independently engage in design and production activities. This passive learning mode not only suppresses students' initiative and enthusiasm during the internship but also severely affects the achievement of teaching effectiveness. The superficial understanding of internship content directly weakens their interest and motivation to learn, thereby impacting the improvement of learning outcomes. In traditional metalworking internship teaching, teachers often focus on one-way knowledge transmission while neglecting the cultivation of students' ability to understand and apply knowledge [5]. This teacher-centered approach fails to effectively stimulate students' interest and proactivity, resulting in low student engagement and a lack of exploratory and innovative awareness during the internship.

3.2. Inaccurate Course Objectives

The internship content lacks specificity and has a significant gap compared to actual social needs. The

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teaching content for different majors is identical, lacking flexibility and diversity, and does not adapt to the varying professional foundations of students. This phenomenon leads to students being unable to acquire knowledge and skills related to their majors during the internship, affecting their career development. The inaccurate positioning of course objectives not only impacts students' learning outcomes but also their career prospects. In traditional metalworking internship teaching, the content often overly emphasizes theoretical knowledge transmission while neglecting the cultivation of practical application abilities. This teaching model fails to meet the demand for high-quality engineering professionals in society, resulting in graduates who struggle to adapt to real-world job requirements.

3.3. Monotonous Internship Model

Due to the constraints of traditional concepts, the internship has not completely escaped the master-apprentice teaching paradigm. Some advanced and effective teaching methods and means have not yet been timely integrated into the teaching process. This phenomenon results in a monotonous internship model, which struggles to stimulate students' interest and enthusiasm for learning, thereby affecting the effectiveness of teaching. In traditional metalworking internship teaching, the teaching model often overemphasizes the teacher's explanation and demonstration while neglecting students' independent learning and practical operations. This teaching model finds it difficult to arouse students' interest in learning, leading to a lack of initiative and proactivity among students during the internship.

3.4. Insufficient Teaching Resources

Traditional applied universities face several major defects in their metalworking internship course resource systems. First, these universities often lack resources, lacking internship opportunities and facilities that match real working scenarios, and are unable to provide students with sufficiently realistic working environments and equipment for practice operations. Second, the content and teaching methods of metalworking internship courses lag behind industry trends, and outdated internship content fails to reflect the latest industrial technologies and industry trends, making it difficult for students to adapt to real work needs. Finally, the internship plan is unreasonable, and the evaluation system is incomplete, failing to comprehensively and objectively assess students' practical skills and application abilities. The scarcity of teaching resources not only affects students' practical operation abilities but also their learning outcomes. In traditional metalworking internship teaching, teaching resources often overly depend on school laboratories and equipment, neglecting cooperation and exchange with enterprises. This teaching model fails to meet students' practical operation needs, resulting in a lack of practical opportunities during the internship.

4. Innovative Ideas for Course Teaching

To overcome the shortcomings of traditional metalworking internship teaching, this paper proposes an innovative teaching model based on "blended learning" and "project-driven approach." This model integrates online theoretical teaching and offline practice and operations, combined with project-driven teaching methods, aiming to improve students' practical abilities, innovation capabilities, and teamwork skills.

4.1. Student-Centered Teaching Philosophy

Adhering to the teaching philosophy of "learning first, teaching based on learning, and autonomous development," this approach emphasizes the student's primary role while leveraging the teacher's guiding function [6]. It focuses on igniting students' interest in learning, stimulating their motivation, and cultivating their spirit of independent exploration to create a self-rewarding virtuous cycle. Students are encouraged to fully utilize their initiative and creativity in learning practice, master the correct learning laws in exploration, form unique learning abilities, and enrich and develop their personalities. Teaching methods such as problem-guided, student-led, discussion-based, and case-based approaches are adopted, driven by online and offline tasks, to effectively guide learning strategies and continuously stimulate learning motivation.

Through multi-dimensional interactions among teachers and students, among students themselves, and between online and offline platforms, in-depth discussions and intellectual collisions promote the internalization and transformation of knowledge. Students are encouraged to identify problems, inspired to analyze problems, and guided to solve problems. In a subtle manner, students gradually progress from

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shallow to deep levels, achieving independent exploration, logical analysis, and summarization. Teaching shifts from knowledge transmission to imparting methods of thinking about, analyzing, and solving problems, promoting students' transition from knowledge acquisition to capability development and quality improvement.

4.2. Teaching Approach Based on "Capability Alignment with Positions and Knowledge Support for Capabilities"

Adopting the teaching approach of "capability alignment with positions and knowledge support for capabilities," each carefully selected and refined knowledge point is linked with actual equipment to enhance the targeting and directionality of teaching content. This approach cultivates students' abilities to "learn theory, apply theory, and expand theory," effectively addressing the relationship between broad and specialized theoretical teaching. It forms a content system where theoretical frameworks meet professional needs, principles and technologies cover equipment performance, and cutting-edge integration adapts to societal development. Meanwhile, the design of teaching content should be diverse, rich in form, and possess breadth and depth while maintaining targeting and directionality to meet the specific needs of related majors. Teaching content and knowledge modules are reasonably decomposed based on teaching objectives, with core knowledge points carefully selected and refined. A multimedia information-based teaching material library based on fragmented knowledge points is constructed, along with an equipment image library and case library. Practical videos and images are used to stimulate students' interest in learning, enhance their intuitive understanding of metalworking internships, and deepen their understanding of technical performance, working principles, and practical applications through case analysis.

4.3. Project-Driven Teaching

Project-driven teaching is a project-oriented teaching method that cultivates students' innovation and practical abilities by engaging them in the design and implementation of real projects [7].

4.3.1. Project Design

Teachers need to design challenging and innovative projects based on teaching content and students' actual situations. The projects should have a certain level of difficulty and openness, allowing students to fully utilize their imagination and creativity during the project completion process. For example, designing small mechanical device fabrication projects enables students to apply their metalworking internship skills in the project, enhancing their ability to solve practical problems.

4.3.2. Project Implementation

Students need to design and implement projects in groups. During the project implementation process, teachers can provide necessary guidance and assistance, but students should independently complete most of the project work. Through project implementation, students can improve their teamwork, innovation, and practical abilities and develop engineering practice literacy.

4.3.3. Project Evaluation

Teachers need to comprehensively evaluate students' project outcomes. Project evaluation includes not only the quality evaluation of project results but also the evaluation of students' performance during the project implementation process. Teachers can organize project presentations and peer reviews to allow students to learn from each other and improve their comprehensive qualities during the evaluation process.

5. Establishment of Innovative Teaching Model

5.1. Integration of Curriculum IPE

Curriculum IPE is an important way to integrate ideological and political education organically into professional courses. It can cultivate students' sense of social responsibility, patriotism, and professional ethics. In the metalworking internship course, integrating curriculum IPE not only enhances students' ideological and political qualities but also strengthens their passion and sense of responsibility for the engineering profession, fostering engineering ethics and professional spirit. For example, when teaching metalworking internship courses, ancient leading technologies such as the cast iron tempering treatment

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technique invented by ancient people during the Warring States Period and the thousand-year heritage of Jingdezhen porcelain can be introduced to inspire students' national pride and carry forward the meticulous national spirit. At the same time, by explaining the development trends of modern manufacturing and major national projects, students' sense of social responsibility and professional spirit can be cultivated. These measures not only enhance students' ideological and political qualities but also strengthen their passion and sense of responsibility for the engineering profession, fostering engineering ethics and professional spirit.

5.2. Improvement of Course Resources

Metalworking internship is an important link in combining students' theoretical knowledge with practical operations, and it is crucial to build a complete metalworking internship course resource system. This system should include key components such as theoretical foundation education, practical training facilities, internship instructors, and course design [8]. By timely paying attention to industry development trends and technological changes, and adjusting course content according to industry needs, students' employ ability can be improved, and talents with practical abilities and innovative thinking can be delivered to the industry. Additionally, constructing a practical teaching resource library, including courseware, videos, electronic textbooks, and practical cases, is also an important measure to enhance teaching quality. Clarifying the steps of course resource development helps improve work efficiency and accuracy, promotes multi-department collaboration, and ensures the smooth progress of resource development and integration.

5.3. Clarifying Teaching Objectives and Optimizing Teaching Content

To cultivate students' innovative practical abilities, it is necessary for students to deeply understand the basic principles, characteristics, and applications of metalworking internship [9]. Through independent design and hands-on practice, students will be able to master this advanced technology. The specific teaching objectives and content of the "Metalworking Internship" course include:

5.3.1. Theoretical Foundation Education

Theoretical foundation education is the basis of the internship course, covering the basic principles, process flows, and operational skills of the metalworking industry. Teaching resources include textbooks, lecture notes, and teaching videos, aiming to provide students with a solid theoretical foundation and enable them to systematically grasp the core knowledge of metalworking internship.

5.3.2. Safety Education

Strengthening safety awareness and safety theory is crucial. As students move from the classroom to the training lab, facing new and unfamiliar equipment and processes, they need to understand the principles, methods, and application scenarios through intuitive demonstrations (such as textual and graphical processing demonstrations). Subsequently, through the processing demonstration stage, students can further deepen their understanding and mastery of safe operations.

5.3.3. Practical Operation Skills

Practical operation is the core of the metalworking internship. Through practical operations, students can master the use of metalworking tools and equipment, enhancing their practical skills. Practical teaching not only cultivates students' teamwork and communication skills but also strengthens project management abilities. Additionally, practical teaching can stimulate students' innovative awareness and problem-solving capabilities, fostering creativity and an innovative spirit.

5.3.4. Optimization of Teaching Content

The design of teaching content should be diverse, rich in form, and possess breadth and depth while maintaining targeting and directionality to meet the specific needs of related majors. Teaching content and knowledge modules are reasonably decomposed based on teaching objectives, with core knowledge points carefully selected and refined. A multimedia information-based teaching material library based on fragmented knowledge points is constructed, along with an equipment image library and case library. Practical videos and images are used to stimulate students' interest in learning, enhance their intuitive understanding of metalworking internship, and deepen their understanding of technical performance, working principles, and practical applications through case analysis. By clarifying teaching objectives and optimizing teaching content, the effectiveness of the metalworking internship course can be effectively enhanced, cultivating students' practical and innovative abilities and laying a solid foundation

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for their future careers.

5.4. Implementation of Project-Based Teaching

By engaging students in the design and implementation of real projects, their innovation and practical abilities can be cultivated. In metalworking internship teaching, teachers can design challenging projects based on teaching content and students' actual situations, allowing students to design and implement projects in groups. Through project-driven teaching methods, students can apply their theoretical knowledge and practical skills in real projects, enhancing their ability to solve practical problems.

5.4.1. Project Design

Project design is a key component of project-driven teaching methods. Teachers need to design challenging and innovative projects based on teaching content and students' actual situations. The projects should have a certain level of difficulty and openness, allowing students to fully utilize their imagination and creativity during the project completion process. For example, designing small mechanical device fabrication projects enables students to apply their metalworking internship skills in the project, enhancing their ability to solve practical problems.

5.4.2. Project Implementation

Project implementation is the core of project-driven teaching methods. Students need to design and implement projects in groups. During the project implementation process, teachers can provide necessary guidance and assistance, but students should independently complete most of the project work. Through project implementation, students can improve their teamwork, innovation, and practical abilities and develop engineering practice literacy.

5.4.3. Project Evaluation

Project evaluation is an important part of project-driven teaching methods. Teachers need to comprehensively evaluate students' project outcomes. Project evaluation includes not only the quality evaluation of project results but also the evaluation of students' performance during the project implementation process. Teachers can organize project presentations and peer reviews to allow students to learn from each other and improve their comprehensive qualities during the evaluation process.

5.5. Strengthening Teaching Support

Teaching support is an essential guarantee for teaching innovation. Traditional applied universities face several major defects in their metalworking internship course resource systems, such as scarce resources, lack of industry connection, absence of industry mentor support, unreasonable internship plans, and incomplete evaluation systems. To overcome these defects, the following optimization measures are proposed:

5.5.1. Strengthening Faculty Development

Teachers are pivotal to teaching innovation and must possess profound professional knowledge, extensive teaching experience, and robust information technology application skills. Prior to the commencement of each semester, teachers should collectively prepare lessons, share teaching insights, and update their teaching designs and cases with cutting-edge industry knowledge. This process facilitates the renewal of teachers' knowledge structures and enhances their teaching capabilities. Regular teacher training and academic exchanges are essential to elevate teachers' professional literacy and teaching standards, ensuring that they can effectively guide students' learning and practical operations.

5.5.2. Actively Conducting Laboratory Construction

Regularly assess the existing technologies and equipment in the laboratory, including their performance, efficiency, maintenance costs, and whether they meet current and future teaching needs. Focus on the advancedness and practicality of equipment and technology, understand industry development and social demand, widely solicit students' innovative needs, and introduce new technologies and equipment. By optimizing laboratory resource allocation, ensure that the laboratory can provide students with an advanced practical operation environment, enhancing their practical abilities and innovative thinking.

5.5.3. Strengthening School-Enterprise Cooperation for Joint Talent Cultivation

School-enterprise cooperation, through resource sharing, complementary advantages, and mutual

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benefits, jointly conducts engineering technology talent cultivation, scientific research, and technological innovation activities. This cooperation model closely integrates classroom teaching with practical teaching and professional knowledge with industry frontiers, providing students with diversified practical opportunities, identifying real production problems, and enhancing their abilities to analyze and solve problems, aiming to cultivate engineering technology talents with innovative spirits and practical abilities. Through in-depth cooperation with enterprises, industry mentors are introduced to provide students with experience and guidance in real engineering projects, enhancing their practical abilities and professional ethics.

5.6. Quantitative Process-Oriented Assessment

Quantitative process-oriented assessment is an important part of teaching innovation and can comprehensively evaluate students' learning outcomes [10]. It covers students' participation, practical operations, project results, and theoretical knowledge, combining various assessment methods to improve the scientific and fairness of the evaluation. For example, students' participation can be assessed through classroom interaction and online learning; practical operations can be evaluated based on actual performance; project results can be assessed through project presentations and reports; and theoretical knowledge can be evaluated through written exams. This assessment method not only enhances students' interest and effectiveness in learning but also cultivates their comprehensive qualities and professional ethics.

The specific implementation of quantitative process-oriented assessment requires decomposing students' learning process into multiple specific assessment points and setting clear evaluation criteria and weights. In metalworking internships, the following aspects can be implemented:

(1) Pre-class preparation (10%)

(2) Classroom participation (20%)

(3) Practical operation skills (30%)

(4) Project results and innovation capabilities (20%)

(5) Teamwork and communication skills (10%)

(6) Theoretical knowledge assessment (10%).

6. Conclusion

The innovative teaching model for metalworking internship proposed in this paper, based on "blended learning" and "project-driven approach," has achieved significant teaching effectiveness through the construction of a scientific and rational course system, optimization of teaching content, adoption of diversified teaching methods, and implementation of quantitative process-oriented assessment. Online theoretical teaching provides students with rich learning resources, enhancing the flexibility and autonomy of learning; virtual simulation teaching strengthens students' understanding and interest in practical operations, reducing the risks associated with actual operations; offline practical operations, through personalized guidance and teamwork, cultivate students' practical abilities and team spirit. The project-driven teaching method, through the implementation of real projects, enhances students' innovation and problem-solving abilities. Quantitative process-oriented assessment, through multi-dimensional evaluation methods, comprehensively and objectively reflects students' learning outcomes, providing teachers with a basis for timely adjustment of teaching strategies.

Future teaching reforms should further optimize online teaching resources, improve offline practical operation facilities, strengthen the application of project-driven teaching methods, and continuously improve the quantitative process-oriented assessment system. At the same time, teacher training should be enhanced to improve teachers' information technology teaching capabilities and project guidance abilities. Additionally, cooperation with enterprises should be strengthened to introduce more real engineering projects, allowing students to engage with the latest industrial technologies and industry trends in practice, enhancing their professional ethics and employability.

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