Research on Teaching Reform and Innovative Talent Development in Mechanical Drawing Courses Guided by the OBE Philosophy

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Abstract: The Industry 4.0 era continues to elevate the competency demands for engineering professionals. Outcome-Based Education (OBE), an advanced pedagogical approach focused on student learning outcomes, serves as a core framework for engineering education reform. As a foundational core course in engineering disciplines, Mechanical Drawing plays a pivotal role in cultivating students 'spatial imagination, engineering communication skills, and practical innovation capabilities. Grounded in OBE principles, this paper systematically analyzes the core characteristics of OBE-driven innovative talent development through the lens of Mechanical Drawing's current teaching practices. By examining dimensions including curriculum objectives, content architecture, instructional methodologies, practical platforms, faculty development, and evaluation mechanisms, the study establishes a comprehensive pathway for teaching innovation and talent cultivation. This framework provides actionable references for enhancing course quality and nurturing industry-ready innovative engineering professionals.

Keywords: OBE Concept; Mechanical Drawing; Teaching Reform; Innovative Talents; Training Path

1. Introduction

The teaching quality of Mechanical Drawing courses directly impacts engineering students' foundational competencies and career development. As new engineering education initiatives continue to advance, traditional teaching models that prioritize theory over practice and knowledge over skills have become increasingly inadequate in meeting industry demands for innovative and application-oriented professionals [1-3]. The Outcome-Based Education (OBE) philosophy, centered on student-centered learning, outcome-oriented design, and continuous improvement, emphasizes designing instruction around expected learning outcomes and optimizing resource allocation-principles that align closely with the goals of cultivating innovative engineering talent [4-6]. Conducting OBE-guided curriculum reforms for Mechanical Drawing courses not only addresses the limitations of conventional teaching methods but also provides replicable practical experiences for engineering education reform, carrying significant practical implications for enhancing the quality of engineering education.

2. Core Features of Innovative Talent Cultivation under the OBE Concept

2.1 Results-Oriented and Precisely Meeting Needs

The Outcome-Based Education (OBE) philosophy centers on students 'final learning outcomes, with results designed to align closely with industry job requirements, career development standards, and social trends. In the Mechanical Drawing course, the focus is on cultivating students' core competencies: "understanding drawings, creating drawings, and applying drawings to solve engineering problems." The program also emphasizes developing comprehensive qualities like innovative thinking and teamwork, ensuring that talent development keeps pace with industry demands [7,8].

2.2 Student-Centered, Highlighting Person-Alized Development

Emphasizing student-centered education, we address the diverse learning needs and ability levels of students. By providing varied learning resources, flexible pathways, and personalized

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guidance, we foster self-directed learning, enabling every student to achieve expected outcomes based on their current foundation and realize personalized skill development [9,10].

2.3 Reverse Design to Optimize the Teaching Loop

Adopting the reverse design logic of "requirement analysis → outcome setting → instructional implementation → evaluation feedback → continuous improvement", this approach starts from industry demands and student competency objectives. By working backward to determine course content, teaching methods, and assessment approaches, it establishes a complete "goal-implementation-evaluation-improvement" teaching loop, ensuring the entire instructional process remains focused on achieving learning outcomes [11].

2.4 Continuous Improvement and Dynamic Adaptation to Development

Establish a regular evaluation and feedback mechanism to track students' learning achievements through multi-dimensional evaluation data, and dynamically adjust teaching objectives, content and methods in combination with external changes such as industry technology update and educational concept development, so as to realize the spiral improvement of teaching quality [12,13].

3. Teaching Reform Path of Mechanical Drawing Course Guided by OBE Philosophy

3.1 Reconstruct the Curriculum Goal System and Anchor the Direction of Talent Training

Guided by the Outcome-Based Education (OBE) philosophy, this curriculum design adopts a backward design approach that starts with industry needs to define core learning outcomes. Through research with enterprises in mechanical manufacturing and intelligent manufacturing sectors, and in alignment with engineering education accreditation standards, the course objectives are structured into three dimensions: knowledge, skills, and competencies. The knowledge dimension focuses on core concepts including mechanical drafting standards, projection principles, and 3D modeling. The skills dimension emphasizes practical abilities such as spatial visualization, drawing interpretation, CAD software application, and engineering problem-solving. The competencies dimension cultivates rigorous engineering ethics, innovative thinking, and teamwork awareness. Furthermore, the course objectives are precisely aligned with professional talent development goals and graduation requirements, establishing a cohesive "goal-achievement-evaluation" mechanism.

3.2 Optimize the Curriculum Content System and Strengthen the Progressive Training of Abilities

Breaking away from the traditional "theory+exercises" framework, the curriculum has been restructured around a "progressive competency development" model. On one hand, core knowledge modules have been consolidated, eliminating outdated content while introducing cutting-edge topics like smart manufacturing, parametric design, and BIM technology. Practical elements such as 3D component modeling, assembly design, and digital engineering drafting have been integrated to ensure knowledge stays aligned with industry advancements. On the other hand, teaching units follow a "basic competency-core competency-innovative competency" progression: starting with fundamental projection principles, progressing to complex part drafting, and culminating in practical application and innovative design for real-world engineering projects. This layered approach creates a systematic progression that ensures students' skills develop step by step.

3.3 Innovate Teaching Implementation Methods and Improve Classroom Teaching Efficiency

To stimulate students' initiative and strengthen skill development, we have innovated diversified teaching methods. First, we implement a "project-driven+task-oriented" approach, using real-world engineering components (such as gears and shafts) and assemblies as teaching projects. These are broken down into phased tasks, allowing students to acquire knowledge and hone skills through hands-on completion. Second, we adopt a blended learning model combining online and offline resources. Through MOOCs, micro-lectures, and virtual simulation software, students independently study foundational theories and software operations. Offline sessions focus on clarifying key concepts, facilitating group discussions, conducting practical projects, and evaluating outcomes to enhance teaching efficiency. Third, we introduce flipped classrooms and case-based teaching, integrating real-world engineering examples from enterprises to guide students in active problem-solving and critical thinking, thereby cultivating engineering mindset and innovative awareness.

3.4 Build a Variety of Practice Platforms to Strengthen the Cultivation of Practical Ability

Practical education serves as the cornerstone for achieving the expected outcomes of the Outcome-Based Education (OBE) philosophy. Three key strategies are implemented: First, strengthening industry-academia collaboration by establishing training bases with mechanical manufacturers, incorporating real production blueprints, component models, and workflows to enable students to practice interpreting, drafting, and optimizing designs in authentic engineering environments. Second, developing virtual simulation platforms utilizing 3D modeling software and virtual assembly systems to replicate complex component design and drafting processes, thereby reducing practical costs and expanding application scenarios. Third, creating innovation platforms through organizing participation in mechanical design competitions and engineering drafting contests, encouraging students to develop innovative solutions for real-world challenges. This approach fosters learning through competition and innovation through competition, ultimately enhancing practical innovation capabilities.

3.5 Strengthen the Construction of the Teaching Staff and Consolidate the Foundation of Teaching Reform

Teachers serve as the core implementers of educational reform, requiring the development of a faculty team that combines solid teaching expertise with rich engineering experience. First, enhancing teachers 'engineering practice capabilities through school-enterprise mutual appointments and faculty internships in enterprises, enabling them to gain deep insights into industry technological advancements and job requirements while integrating real-world engineering cases into teaching. Second, strengthening teachers' mastery of OBE (Outcome-Based Education) principles by organizing regular training sessions and exchange seminars to guide educators in adopting core OBE methodologies such as backward design and diversified assessment. Third, establishing faculty incentive mechanisms that encourage teachers to conduct teaching reform research, develop course resources, and create distinctive teaching materials, with commendations and rewards given to those demonstrating significant reform achievements to boost their enthusiasm for innovation.

3.6 Build a Multi-dimensional Evaluation System to Ensure the Quality of Achievement

Breaking away from the single-exam evaluation model, we are establishing a diversified assessment system combining "process evaluation + summative evaluation + competency assessment". Process evaluation focuses on students 'classroom participation, task completion, and online learning performance, accounting for no less than 40% of the total score. Summative evaluation adopts a combination of "theoretical exams + practical assessments", with theoretical exams emphasizing core knowledge mastery and practical assessments focusing on skills like drawing preparation and software application. Competency assessment evaluates students' engineering problem-solving abilities and innovation capabilities through project presentations and defense of innovative design proposals. Additionally, an evaluation feedback mechanism is established to collect opinions through multiple channels such as student evaluations of teaching, teacher reflections, and corporate assessments, enabling timely adjustments to teaching strategies to ensure continuous improvement in teaching quality.

3.7 Improve the Mechanism for Continuous Improvement and Dynamically Adapt to Development Needs

Establish a closed-loop system of "evaluation-feedback-adjustment-optimization" for continuous improvement. First, conduct regular industry demand research and graduate tracking surveys to analyze evolving job competency requirements, enabling dynamic adjustments to curriculum objectives and content. Second, perform systematic analysis of teaching

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processes and assessment data each semester to identify issues and develop targeted improvement measures. Third, strengthen collaboration with peer institutions and industry associations to adopt best practices in educational reform, incorporate the latest industry technical standards and pedagogical concepts, and continuously refine teaching reform plans to ensure talent development remains aligned with industry trends and educational innovation needs.

4. Conclusion

The OBE-oriented curriculum reform for Mechanical Drawing is a systematic project requiring coordinated efforts across multiple dimensions including course objectives, content, teaching methods, practical training, faculty development, and evaluation systems. By restructuring the teaching framework, innovating instructional models, strengthening practical components, and improving support mechanisms, this initiative can effectively address traditional teaching challenges. It enhances students 'engineering fundamentals, practical innovation capabilities, and professional competencies, laying a solid foundation for cultivating innovative engineering talents aligned with Industry 4.0 demands. Moving forward, continuous deepening of OBE implementation is essential. By integrating industry technological advancements and educational reform trends, we must optimize teaching reform pathways to drive higher-quality development in both the course's instructional quality and talent cultivation standards.

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