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Research on the Integration of the "1+X" Certificate System with Engineering Drawing Courses in Mechanical Engineering from the Perspective of New Engineering Education

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Abstract: The New Engineering Education initiative aims to cultivate versatile and innovative engineering professionals. The "1+X" certification system serves as a key measure in vocational education reform, providing dual guidance of "academic qualifications + practical skills" for talent development in mechanical engineering disciplines. As a fundamental course in mechanical engineering disciplines, Engineering Drawing serves as a crucial bridge connecting previous knowledge with subsequent learning, exerting a decisive influence on students' engineering competencies and employability. Based on this, the study examines the necessity and existing challenges of integrating the "1+X" certification system with engineering drawing courses in mechanical engineering disciplines, in light of the demands for new engineering talent, and explores effective approaches for such integration. By restructuring the curriculum system, innovating teaching methods, and optimizing assessment mechanisms, the goal of effectively integrating academic education with vocational training is achieved. This study provides reference experiences for the reform of engineering drawing courses in mechanical engineering disciplines, thereby facilitating the cultivation of high-caliber mechanical engineering professionals under the new engineering education framework.

Keywords: New Engineering Education; "1+X" certificate system; Mechanical Engineering majors; Engineering Drawing; Course integration

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1. Introduction

The development of new engineering disciplines is aimed at supporting industrial transformation, upgrading, and technological innovation, with a focus on cultivating engineering professionals who possess interdisciplinary integration skills, innovative capabilities, and practical expertise. It sets higher standards for talent in mechanical engineering fields. Engineering drawing serves as an introductory foundational course

for mechanical engineering majors, playing a crucial role in cultivating students' abilities in reading technical drawings, creating diagrams, developing spatial imagination, and fostering engineering awareness. It also constitutes a prerequisite for their future academic studies and professional careers. The "1+X" certificate system is an innovative educational model jointly implemented by the Ministry of Education and three other departments. The "1" denotes academic credentials, while the "X" represents vocational qualification certificates. This system aims to integrate academic education with vocational skill development, thereby enhancing students' employability and job market competitiveness. However, current engineering drawing courses in mechanical engineering programs still face a series of issues, including a disconnect between teaching content and professional requirements, outdated teaching methods, and an unreasonable assessment mechanism. These shortcomings prevent the courses from effectively aligning with the development trends of new engineering education and the "1+X" integration model. Therefore, further research is needed to explore how to effectively integrate these elements and address the existing challenges. Such efforts will play a highly positive role in advancing educational reform and optimizing talent cultivation programs in mechanical engineering disciplines.

2. The inevitability of integrating the "1+X" certificate system with engineering drawing courses in mechanical engineering programs under the New Engineering Education framework

2.1. Aligning with the core objectives of new engineering talent development

In the context of new engineering education, the machinery industry is evolving toward intelligence, digitalization, and sustainability, imposing higher demands on mechanical professionals' practical engineering skills and job adaptability. Engineering drawing serves as the "engineering language" in mechanical engineering. Beyond equipping students with fundamental reading and drawing skills, it also cultivates their practical application abilities tailored to specific job requirements [1]. The "1+X" certification system emphasizes equal importance on both academic qualifications and practical skills. Its vocational qualification level standards (such as the 3D Model Design for Mechanical Products Vocational Skill Level Certificate) align with the objectives of engineering drawing courses. Integrating certification assessment content into classroom instruction addresses the previous overemphasis on theory at the expense of practice, enabling "learning and practice driven by certification," thereby cultivating technical and skilled professionals that meet the demands of the new engineering education paradigm.

2.2. Addressing the outstanding issues in current course teaching

Currently, the engineering drawing curriculum for mechanical engineering majors has the following shortcomings: Firstly, the teaching content is outdated, still focusing on traditional manual drawing and basic projection principles, failing to meet the practical demands of CAD drafting and 3D modeling required in real-world industrial settings. Second, the teaching methodology is rigid, predominantly employing a "teacher lecture + student in-class practice" approach, which lacks opportunities for immersive learning and hands-on experience. Third, the assessment mechanism is simplistic, emphasizing theoretical examinations and assignment grading while neglecting the evaluation of students' practical skills and job adaptability. The implementation of the "1+X" certification system enables curriculum reform aligned with vocational competency requirements, drives pedagogical innovation, enhances teaching methodologies, and optimizes

assessment approaches—all aimed at addressing the aforementioned challenges and improving course quality and effectiveness [2].

2.3. Enhancing students' career competitiveness and employment quality

In job recruitment within the machinery industry, skills such as drawing interpretation, drafting, and 3D modeling are the primary focus of assessment. The "1+X" vocational qualification certificate serves as a certification of students' competencies. By integrating this certificate into engineering drawing curricula, students can acquire essential job skills while receiving formal education and obtain corresponding vocational competency certificates, thereby enhancing their employability. Furthermore, incorporating real-world engineering projects and job standards from enterprises during the integration process enables students to gain an earlier understanding of corporate operations, thereby reducing the transition gap between academia and the workplace, enhancing employment outcomes, and aligning with the New Engineering Education model of "industry-education integration and school-enterprise collaboration" [3].

3. Existing issues in integrating the "1+X" certificate system with engineering drawing courses in mechanical engineering programs from the perspective of New Engineering Education

3.1. The course content lacks close alignment with the "X" certificate standards

Currently, most mechanical engineering drawing courses still rely primarily on textbooks and emphasize the completeness of theoretical frameworks, while neglecting the requirements of the "1+X" vocational skill certification evaluation system. For instance, topics such as 3D modeling and digital processing of engineering drawings—covered in the Vocational Skill Level Certificate for 3D Model Design of Mechanical Products—are typically treated merely as elective modules or briefly touched upon in traditional teaching, with little systematic study or training provided. Moreover, the course content fails to keep pace with the times by incorporating new industry technologies and standards, and is disconnected from the actual job requirements of enterprises. As a result, students find it difficult to quickly adapt to their roles and perform effectively after obtaining the certificate.

3.2. The teaching model struggles to meet integrated learning requirements

Traditional engineering drawing courses predominantly employ a one-way teaching approach characterized by "teachers lecturing and students solving exercises," lacking opportunities for interaction and hands-on practice, which makes it difficult to cultivate students' engineering awareness and practical skills. The "1+X" certification emphasizes skill application and workplace relevance, requiring project-based and scenario-based teaching methods. However, some institutions lack the necessary training facilities, textbooks, and other resources to support immersive, practical classroom instruction. Moreover, many instructors lack professional experience in the industry, hindering their ability to integrate the competency requirements of the "X" certification into the curriculum, resulting in suboptimal integration outcomes [4].

3.3. The evaluation system fails to achieve the dual orientation of "academic qualifications + skills"

Currently, the assessment method for engineering drawing courses remains predominantly theory-based,

focusing on students' mastery of theoretical knowledge such as projection principles and drafting standards while neglecting the evaluation of their practical skills and job adaptability. This approach somewhat deviates from the "ability-oriented" philosophy advocated by the "1+X" certification system. Moreover, the evaluation process is overly centralized, relying primarily on teachers for assessment without involving technical professionals from enterprises or experts from relevant industries. Consequently, the evaluation results fail to objectively and fairly reflect each student's true proficiency or their possession of the required professional competencies.

4. The integration path of the "1+X" certificate system with engineering drawing courses in mechanical engineering from the perspective of New Engineering Education

4.1. Restructuring the course content to achieve seamless alignment with the "X" certification standards (Table 1)

In line with the requirements of the "1+X" vocational skill certification framework (e.g., the 3D Model Design for Mechanical Products and Mechanical Engineering Drawing vocational skill certifications), the content structure of engineering drawing courses has been reformed to align with the educational objectives of mechanical engineering disciplines under the new engineering education paradigm. On one hand, it integrates core knowledge points by incorporating the key content of certificate assessments (including 2D CAD drafting, 3D modeling, engineering drawing interpretation and modification, and part and assembly drawing production) into the main course content, thereby replacing redundant and repetitive teaching material. On the other hand, the curriculum aligns with industry needs by incorporating real-world project examples from enterprises and integrating specific drafting tasks from roles such as mechanical processing and mold development into teaching, thereby enhancing its practical applicability. Finally, a tiered structure is implemented, with learning tasks tailored to the standards of different certification levels (primary, intermediate, advanced), accommodating the varying learning abilities of students and ensuring effective alignment between "curriculum content, certification assessments, and professional roles" [5].

Table 1. Alignment table between the mechanical engineering drawing course and the "1+X" certificate content

Course module	Core teaching content	Key assessment points for the "X" certificate	Transfer mode
Fundamentals of Two-Dimensional Drawing	Projection principles, drawing specifications, and CAD software operations	Two-dimensional engineering drawing creation, dimensioning, and graphic modification	Integrate certificate assessment standards into drafting instruction, and use actual certificate exam questions for classroom exercises.
3D Modeling	3D software operation, part modeling, assembly modeling	3D part modeling, assembly design, and engineering drawing generation	Use certificate assessment projects as practical training tasks to implement project-based teaching.
Reading and Application of Engineering Drawings	Reading of part drawings and assembly drawings; digital processing of engineering drawings	Reading engineering drawings, reviewing drawings, and making digital modifications	Introduce the company's actual drawings and simulate workplace scenarios for hands-on training.

4.2. Innovating teaching models to enhance practical skill development and engineering mindset cultivation

Based on the skill-oriented reform of the "1+X" certification system for drafting courses, a novel teaching model has been developed, integrating project-driven approaches, school-enterprise collaboration, and online-offline blended learning. On one hand, the reform adopts a project-based teaching approach, using actual corporate drafting tasks as the foundation. The course content is broken down into small, manageable projects (such as drafting methods for reducer components or mold assembly drawings), enabling students to acquire relevant theoretical knowledge and practical skills through hands-on project completion, thereby cultivating an engineer's mindset. On the other hand, efforts should be intensified to strengthen school-enterprise cooperation. With the support of mechanical manufacturing enterprises and vocational competency assessment institutions, corporate technical personnel are invited to participate in classroom instruction. By leveraging the enterprises' practical training resources, immersive on-the-job internship programs are conducted, enabling students to gain insight into real work environments [6]. The third aspect involves adopting a blended teaching approach that combines online and offline elements. Students engage in self-directed learning and training via smart vocational education platforms and CAD virtual simulation software, while conducting hands-on practice and project discussions in class, and participating in simulated certification exam tests, enhancing the flexibility and effectiveness of teaching. Furthermore, the integration of advanced technologies such as 3D scanners and 3D printers has diversified teaching methods, better aligning with the evolving demands of emerging industries [7].

4.3. Improving the evaluation system to achieve dual assessment of "academic qualifications + skills"

Overcoming the limitations of traditional single-evaluation methods, a diversified comprehensive assessment mechanism has been established, integrating "process evaluation + summative evaluation + skill certification evaluation," in line with the "1+X" certification system. On one hand, process evaluation is strengthened, assessing students' classroom performance, completion of practical training projects, and assignment quality, accounting for no less than 40% of the total score, with particular emphasis on evaluating their learning attitude and hands-on capabilities. On the other hand, refine the summative assessment by reducing the weight of theoretical knowledge evaluation and increasing the emphasis on practical skills assessment. Design the summative test questions based on the "X" certificate evaluation standards, focusing on assessing students' ability to interpret and create diagrams as well as their job adaptability. Subsequently, incorporate skill certification evaluations by including students' acquisition status of "X" certificates into the course assessment criteria. Students who obtain certificates at corresponding levels will receive corresponding course score rewards, motivating them to prioritize the development of professional competencies. Additionally, corporate technical personnel were invited to participate in the assessment to ensure the authenticity and validity of the results. This reflects a dual-assessment approach that integrates "academic education with skills training" [8].

4.4. Strengthening faculty development and enhancing integrated teaching capabilities

A strong faculty is the prerequisite for effectively integrating both aspects. It is essential to cultivate a team of dual-qualified teachers who possess solid theoretical knowledge, proficient technical skills, and a thorough understanding of certification requirements. On one hand, efforts will be intensified to enhance the training

of the teaching staff by sending teachers to participate in training programs related to the "1+X" certification system, CAD skills workshops, and corporate internships, thereby improving their technical competencies and their ability to deliver certified instruction. On the other hand, the institution hires technical professionals or certified vocational examiners as external lecturers to participate in its educational activities, thereby enhancing teaching resources and providing students with hands-on practical training. Simultaneously, an effective teaching and research system must be established. While conducting teaching research activities for integrated curricula, efforts should also include case study exchanges and explorations of teaching reforms. This will enable every teacher to master this innovative teaching model and effectively apply it in their daily work, ensuring the successful implementation of the entire process.

5. Conclusion

In the context of the New Engineering Education initiative, integrating the "1+X" certification system with engineering drawing courses in mechanical disciplines serves as an effective approach to advancing curriculum reform and enhancing talent quality in these fields, aligning with the requirements for cultivating talent and driving industrial development under the New Engineering Education framework. The integration of the "1+X" certification system with engineering drawing courses in mechanical disciplines still faces challenges, including insufficient coherence in course content, mismatched teaching methodologies, and an underdeveloped assessment framework. To achieve effective alignment between academic qualifications and vocational competency development, a series of measures is required—such as refining course content, innovating teaching approaches, enhancing assessment mechanisms, and strengthening faculty development. Through integration, the purposefulness and effectiveness of engineering drawing courses can be significantly enhanced, fostering students' engineering technical mindset and practical skills, thereby improving their employability. This approach lays a solid foundation for cultivating highly skilled, application-oriented professionals in mechanical engineering within the context of the new engineering education paradigm. In the future, we must continuously strengthen school-enterprise collaboration and actively explore more effective integration approaches. These efforts should be adjusted in response to industry developments and evolving certification standards, ensuring the continuous refinement and enhancement of integrated teaching methodologies.

Disclosure statement

The authors declare no conflict of interest.

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