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Construction of a First-Class Undergraduate Course in Engineering Drawing

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Abstract: Taking the opportunity of first-class curriculum construction, this study innovates teaching conceptions with a focus on learning outcomes. Starting from the perspective of learning effectiveness, it reshapes teaching methods and incorporates ideological and political education into the curriculum. The construction of the engineering drawing course consistently revolves around the student-centric approach, aiming to create a first-class undergraduate class characterized by High level, innovation, and challenges. A rich and open online resource repository is established to meet the diverse needs of students. The integration of in-class and extracurricular activities, coupled with multi-faceted support for student learning, is employed to achieve teaching goals. An immersive learning environment based on experiential practice is built to facilitate students in absorbing and mastering drawing knowledge, thereby strengthening their professional foundation. The integration of competition and course guides students to explore and solve problems using various learning resources, fostering their innovation capabilities. The implementation of a comprehensive procedural assessment reduces the weight of final exams, enhancing the challenge level of students' learning.

1. Introduction

The "Double First-Class" construction refers to the construction of first-class disciplines and first-class courses, marking another national strategy in China's higher education sector following the "211 Project" and "985 Project" [1]. The development level of higher education serves as a crucial indicator of a country's overall development and even its development potential. Universities bear the mission of cultivating high-quality talents for the nation, serving as the main battleground for talent cultivation and knowledge innovation. The quality of teaching directly impacts the excellence of talent cultivation [2]. The engineering drawing course is a significant basic course in relevant majors of science and engineering colleges. It primarily explores the theory and techniques of drawing and interpreting engineering drawings, possessing strong practicality and applicability. In the context of first-class discipline and course construction, the effective utilization of engineering drawing as a basic course poses a challenge for the development of numerous courses related to mechanical

drawing [3,4]. Our university's engineering drawing course has undertaken a series of teaching research and reforms [5], and has been recognized as a first-class course at the provincial and ministerial levels.

2. Course Objectives

The knowledge, skills, and abilities that students should attain through the learning of the engineering drawing course are outlined in Table 1.

Table 1: Engineering Drawing Course Objectives

Objective Category	Course Objectives
Knowledge Objectives	Understand the principles of geometric body projection.
	Comprehend the prescribed drawing methods and dimension for standard and common parts.
	Understand the expression methods in detail drawings and the dimension methods for various technical requirements.
	Grasp the expression methods and dimension techniques in assembly drawings.
Ability Objectives	Familiarity with technical standards and specifications in the mechanical field.
	Master the basic process of design drawing and pattern expression.
	Ability to read and draw detail and assembly drawings correctly according to national standards.
Quality Objectives	Cultivate students' awareness of adhering to and implementing national standards.
	Develop students' engineering professionalism by integrating theoretical knowledge with engineering practice.
	Foster students' application-oriented engineering thinking and a rigorous scientific mindset.
	Cultivate a diligent and responsible work attitude along with a commitment to excellence in craftsmanship.

3. Key Issues Addressed in First-Class Course Construction

3.1 Achieving "High level" in the Course

The focus is to address the challenges of a curriculum with extensive content but limited class hours, variations in students' spatial imagination leading to significant differences in their drafting proficiency, and the limitations of a one-size-fits-all traditional classroom teaching approach that hinders students from showcasing their diverse qualities and abilities.

3.2 Promoting "Innovativeness" in the Course

The issue lies in the fact that engineering drawing requires a strong foundation in engineering practice, yet incoming freshmen lack any knowledge in mechanical disciplines. This impedes students from establishing a comprehensive knowledge framework for the course, and restricts their ability to extend their learning beyond the classroom.

3.3 Embodying "Challenge Level" in the Course

The challenge is to address the comprehensive nature of drawing, covering aspects such as frame selection, expression methods, dimension, and shape expression. The current "2-hour final exam" format proves inadequate in accurately assessing the varying levels of students' drawing proficiency.

4. Measures in First-Class Course Construction

4.1 Tailoring Instruction to Individual Abilities, Integrating Teaching, Learning, and Practice to Achieve "High level" in the Course

The teaching team has produced a total of 33 micro-lecture videos encompassing all course content, with a duration of 631 minutes. Additionally, 16 auxiliary instructional videos on topics like mechanical processing have been created, with a total duration of 84 minutes. A complete set of 23 tutorial videos explaining practice problems has also been developed, lasting 437 minutes. The current set of self-compiled exercise books includes answers for each question. Students can scan the QR code at any time and place to obtain the solutions according to their needs. An illustration of the exercise book is provided in Figure 1.

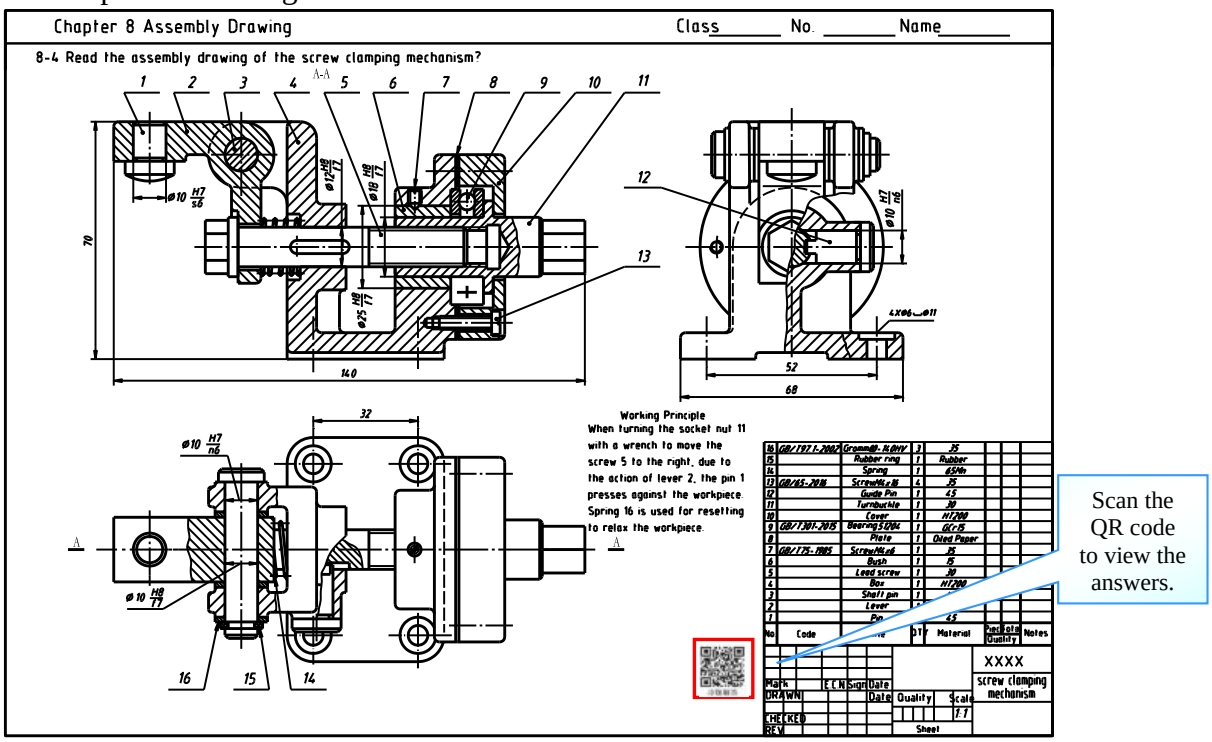

Figure 1: Each question in the exercise set is accompanied by a detailed answer, allowing students to access solutions anytime, anywhere

The establishment of an online resource repository, combining in-class and extracurricular elements, and providing multi-faceted support for students is undertaken to achieve teaching goals and create a first-class course. The rich and open online teaching resources cater to the diverse needs of students. For students with weak foundations in drawing, they can repeatedly watch micro-lectures and detailed tutorial videos. Meanwhile, students with strong drawing skills can opt for challenging and competitive tasks to enhance their abilities. Simultaneously, online resources enable teachers to effectively utilize the 32 class hours. They can place straightforward content for independent student learning after class, and can focus on explaining key and challenging points during class. The teaching

system for mechanical drawing is developed with engineering design as the main focus, strictly following national standards for detail and assembly drawing. This approach significantly improves teaching quality, achieves favourable teaching outcomes, and effectively realizes the "High level" of the course.

4.2 Immersive Learning Environment, Combined with Competitions, to Promote "Innovativeness" in the Course

In the process of theoretical teaching, in order to address the knowledge gaps of first-year students, videos on part manufacturing methods, structural engineering knowledge, typical applications of parts, technical requirements for parts, and videos on disassembly and assembly of components or machines are incorporated. This approach broadens the knowledge of part processes, assists students in understanding component structures, and enhances their practical skills in detail and assembly drawing.

Purposefully designed extension activities extend interaction beyond the classroom, laying a solid foundation for extracurricular drawing competitions. The course construction establishes an immersive learning environment by increasing the reading volume of detail and assembly drawing and enhancing the teaching of detail and assembly expressions. These additional teaching contents align completely with the requirements of various national and provincial-level drawing competitions. The teaching team has guided students to achieve a 100% success rate in competitions for three consecutive years. The combination of competitions and teaching guides students to apply their theoretical knowledge in practical settings, encouraging them to use diverse learning resources to explore and solve problems. This approach cultivates students' innovative abilities, fostering the "innovativeness" of the course.

4.3 Implementing Comprehensive Procedural Assessment to Enhance the Challenge Level for Students

To increase the challenge level of student learning, a comprehensive procedural assessment has been implemented, incorporating additional components such as comprehensive assignments, assessments for detail and assembly drawing, and three in-class quizzes. The comprehensive procedural assessment involves adjusting the weight of final exams, which was 70% before 2018, decreased to 60% from 2019 to 2022, and further reduced to 50% starting from 2023. Regular assessments include online learning participation, class attendance and performance, exercise set assignments, comprehensive projects like three-view drawings/detail drawing/assembly drawing, and three in-class quizzes. The evaluation of student grades combines formative and summative assessments, effectively elevating the overall "challenge level" of learning.

Each subcategory in the grade assessment follows a percentage scale, as detailed in Table 2.

While teaching drawing knowledge in the classroom, typical figures and events related to drawing are introduced through pictures and videos to convey positive energy. Emphasis is placed on adhering to national standards in drawing and reading drawings, and the implicit elements of ideological and political education in the course are explored in depth. The main theme is to cultivate students with a serious and responsible attitude and a rigorous and meticulous work style, integrating ethical education into the teaching design and practice of engineering drawing courses. Taking the "craftsman spirit" of the new era as a starting point, the substantial connotations of the craftsman spirit, such as excellence, dedication, continuous focus, pioneering innovation, and the pursuit of perfection, are integrated into the curriculum.

Table 2: Grading Criteria for Each Assessment Component

Type	Grading Criteria (Percentage Scale)				
	100-90	89-80	79-70	69-60	59-0
Online Learning	Complete video watching on time, 100-80% completion, active participation in online discussions, completion of online assessments.	Timely video watching, 95-70% completion, occasional participation in online discussions, completion of online assessments.	Video watching with 90-60% completion, basic lack of participation in online disc ussions, basic completion of online assessments.	Video watching with 80-50% completion, no participation in online discussions, incomplete online assessments.	Completion below 50%, incomplete online assessments.
Attendance & Performance	No absence, no tardiness, focused attention in class, active class participation.	One absence or two tardiness, less active class participation.	Two absences or four tardiness, passive class participation.	Three absences, sleeping in class.	Four or more absences result in disqualification from the exam.
Exercise Book Assignments	Diligent drawing with minimal errors.	Fairly diligent drawing with some errors.	Not diligently drawn with a few errors.	Many errors present.	Too many errors.
In-Class Quizzes	1. Deduct 1 point for each missing dashed line in the drawing. 2. Deduct 2-5 points for each error based on the difficulty of the shape. 3. Score based on the type and quantity of questions, with a total score of 100 points per quiz.				
A2 Detail Drawing	1. Layout of views (5 points); 2. Title block completion (5 points); 3. Dimension (15 points, including 5 points for dimension line arrows, 5 points for labeling conventions); 4. Line conventions (10 points, distinguishing thickness, conformity of dashed lines and dotted lines, 5 points each); 5. Section lines (5 points, 45-degree angle, uniform intervals); 6. Technical requirements (Chinese characters) (5 points); 7. Technical requirements labeled in the drawing (dimension tolerances, surface roughness, geometric tolerances) (10 points); 8. Drawing execution (45 points, deducting 2 points for each minor mistake).				
A2 Assembly Drawing	1. Layout of views (5 points); 2. Title block completion (2 points); 3. Bill of materials completion (6 points); 4. Sequence numbering (5 points); 5. Dimension (10 points, including 2 points for dimension line arrows, 3 points for correct labeling, 5 points for completeness); 6. Line conventions (10 points, distinguishing thickness, conformity of dashed lines and dotted lines, 5 points each); 7. Section lines (10 points, 45-degree angle, uniform intervals, consistency for the same part); 8. Technical requirements (Chinese characters) (2 points); 9. Drawing execution (50 points, deducting 2 points for each minor mistake).				
Final Written Exam	Grades determined based on the grading criteria of the exam paper.				

5. Conclusions

The first-class curriculum construction of engineering drawing focuses on enhancing students'

abilities in detail and assembly drawing. The main mode of instruction is through classroom teaching, supplemented by online teaching, aiming to break the silence in the classroom, revitalize the learning environment, and effectively utilize the classroom as the main platform and channel for teaching. Tailored teaching methods are employed, integrating teaching, learning, and practice organically to achieve the "high-level" nature of the course. An immersive learning environment, combined with competitions, promotes the "innovativeness" of the curriculum. The implementation of a comprehensive and process-oriented assessment enhances the "challenge level" of students' learning.

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