Curriculum and Teaching Methodology (2024)
Clausius Scientific Press, Canada

DOI: 10.23977/curtm.2024.070103
ISSN 2616-2261 Vol. 7 Num. 1

Teaching Research and Reform of Engineering Drawing Course for Education Digitization

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Keywords: Education digitization, Engineering drawing, Teaching research, Teaching reform

Abstract: In the teaching process of engineering drawing course, the spatial imagination of the students is enhanced by the sufficiently using of the digital resources, the combination of online and offline and the match of 3D model and 2D engineering drawing. Appropriate addition of parts processing technology and assembly videos can help students to understand the drawing information. By adjusting the order of the teaching content and transiting from assembly drawing to parts drawing, the ability of students to read and create technical drawings is gradually developed. With the training of engineering innovative design thinking ability as the main line, through courses, competitions and projects, students can improve their ability to express parts and assembly drawings, thereby improving their engineering design ability. The implementation of the whole process assessment enhances students' learning challenges and integrates ideological and political education into the curriculum, achieving a perfect combination of imparting knowledge and education.

1. Introduction

"Engineering Drawing" mainly studies the basic principles, methods and relevant national standards of drawing and drawing, and cultivates students' basic qualities of drawing and reading engineering drawings [1]. As a basic and compulsory course of technology for undergraduates majoring in science and engineering, its teaching effect directly affects the students' follow-up course learning. In recent years, the teaching content and methods of "engineering drawing" course have changed greatly, and the teaching effect has been significantly improved [2,3]. However, students' mastery of the course is still unsatisfactory [4]. For example, although students have spent two semesters learning a large amount of the content on physical expression and doing a large number of exercises, freshman students still know little about professional knowledge and do not understand the purpose of the drawn parts and the working principle of the assembly, so they will not express the parts or the assembly if there is a slight change. In the subsequent course design and graduation design, there are many errors in the drawing and dimensioning of part drawings and assembly drawings. To solve these problems, this paper will integrate digital education technology, make effective use of teaching resources and fully utilize teaching platform, and propose teaching research and reform of

engineering drawing course oriented to education digitalization, so as to effectively improve the quality of education and teaching.

2. Overall plan for teaching research and reform of engineering drawing course for education digitization

By making full use of digital resources, integrating both online and offline modalities [5], and establishing diverse virtual and real environments, the instructional approach synchronizes 3D models with 2D engineering drawings to enrich students' spatial imagination. Additionally, parts assembly processing technology and other actual production video drawings are added to help students to understand the drawing information and realize the construction of new “teaching” and “learning” spaces. The order of teaching content is adjusted, transitioning from assembly drawing to parts drawing, from the whole to the part, and gradually developing students’ ability to read and draw engineering drawings. With the training of engineering innovative design thinking as the main line, through courses, competitions, projects and other links, students’ ability to express parts and assembly drawings is improved, which in turn improves their engineering design ability and lays a solid foundation for contributing to the training of ability to solve complex engineering problems. The overall plan of the reform is shown in Figure 1.

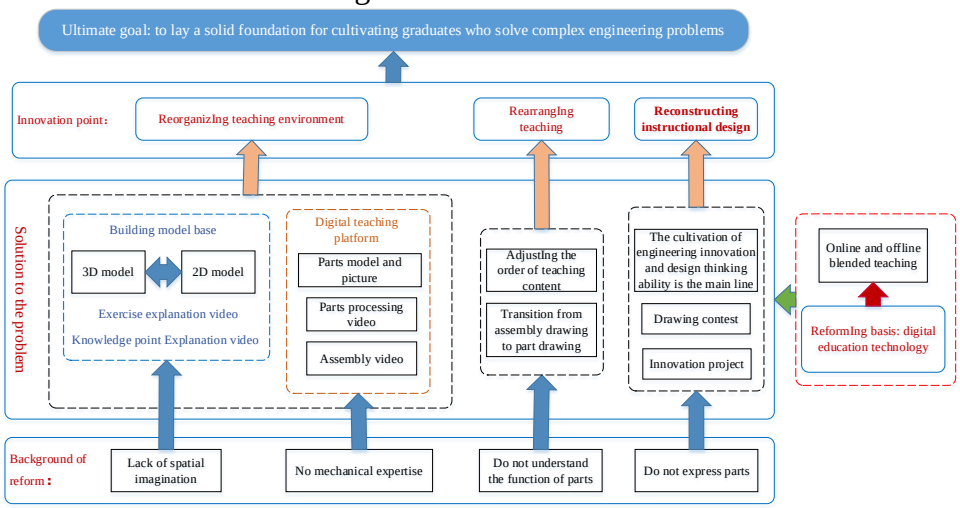

Figure 1: Overall design scheme of engineering drawing teaching reform.

3. Teaching problems of engineering drawing course

3.1 Spatial imagination lack of students leading to interest lack in learning drawing process

Drawing course is a mandatory basic professional course for freshmen majoring in engineering. Its primary focus lies in the comprehension of three views, demanding students to conceptualize three-dimensional spatial shapes based on two-dimensional engineering drawings. Therefore, learning drawing demands a certain level of spatial imagination. However, some students have weak imagination from 2D to 3D space and cannot keep up with the teaching progress, resulting in low interest in course learning, and even a vicious circle, abandoning the study of drawing.

3.2 Weak mechanical expertise of students which gets in the way of cartographic learning

Part drawing and assembly drawing need abundant engineering practice, while freshmen have almost no understanding of mechanical parts, no professional knowledge of machinery, and no

exposure to mechanical processing. Most of the students are unfamiliar with casting, turning, milling and other processing methods, and do not know the specific meaning of process structures such as chamfering, thread cutting groove, and grinding wheel groove these process structures. Therefore, when drawing pictures, rote memorization of the drawing of these structures has a high error rate. Traditional instructional methods, including step-by-step classroom instruction on blackboards and the utilization of multimedia courseware, prove challenging for students to grasp, leading to low learning efficiency.

3.3 Poor understanding of the function of parts which bring blind identification and drawing

At present, the teaching of drawing is to first teach standard parts and common parts, such as thread, key connection, gear, etc., followed by part drawing, and finally assembly drawing. This teaching sequence makes parts isolated from assembly and separated from its use scenario, resulting in students not knowing the function of parts, rote memorization of the drawing method and connection method, and it is easy to draw wrong.

3.4 No opportunity to express parts in practical applications

After the one-year drawing learning, students still lack a standardized concept of drawing. They do not know how to choose the sheet, the drawing proportion, or the linear drawing standard. They do not differentiate between thick and thin lines, or use appropriate expression methods to represent mechanical parts. They also do not mark the size and technical requirements in the drawing.

3.5 Final exam emphasizes the result and its form is single

The drawing assessment should include sheet selection, expression methods, dimension, form analysis and drawing, et al[6]. However, the "2-hour final examination" can only allow students to complete one paper, which can basically assess the ability to draw graphs according to the requirements of the questions and students' form analysis ability. Therefore, it is hard to evaluate their drawing level comprehensively and accurately.

4. Digital-oriented engineering drawing teaching research and reform measures

Based on the above analysis, this paper proposes the research and reform of engineering drawing teaching with “digital-oriented teaching” as the key point, and the specific measures are as follows.

4.1 Effectively using digital teaching resources, improving the three-dimensional model library, improving the video exercise library, making up for some students' shortcomings, and effectively improving the teaching effect

Through the comprehensive utilization of digital resources, integration of online and offline modalities, and the creation of diverse virtual and real environments, the instructional methodology aligns 3D models with 2D engineering drawings to enrich students' spatial imagination. The 3D model library is improved, the practice library that transforms from 3D to 2D and the exercise video explanation library are established, to compensate for the shortcomings of some students’ insufficient spatial imagination, enhance their spatial imagination and cognitive space, boost their power of observation and skill learning effect, and lay a solid foundation for the subsequent professional course learning and product design drawing.

4.2 Based on online teaching, creating the cartographic teaching environment of understanding and practice, and constructing a new type of "teaching" and "learning" space

Numerous teaching contents that may be challenging to demonstrate within the confines of a traditional classroom setting, including diverse processing methods and illustrative examples of processing typical parts, can be effectively showcased through the use of video both within and outside the classroom. Systematic and authentic multimedia courseware is constructed by gathering information from machinery-related enterprises and the internet on the processing method of typical parts, their actual usage in the machines, as well as the images and pictures of the assembly of parts and their usage scenarios. Based on online teaching, teaching videos are used to create parts processing and manufacturing scenes, and parts assembly and processing technology and other actual production videos are added appropriately to help students understand drawing information. The construction of the new space of "teaching" and "learning" helps to improve the accuracy of students' drawing.

4.3 Constructing a new teaching process, adjust the interpreting sequence of engineering drawing teaching content, and improving students' ability to read and draw engineering drawing

Starting with a relatively simple assembly drawing, the fundamental concepts are introduced and explained, concepts such as threaded connections, key connections, and gear meshing are illustrated through assembly drawings. By explaining assembly drawing from simple to complex, this teaching method aligns with the way students naturally comprehend things. Then, from the assembly drawing, draw parts and transition to the explanation of parts drawing. The non-standard parts are divided into shaft sleeve class, roulette cover class, fork and box class, and explained respectively, so that students can read and draw parts drawing based on the understanding the function of parts, which helps to improve the drawing level. Finally, based on their knowledge of parts drawing, students can carry on to more complex assembly drawing. The most fundamental teaching objective of engineering drawing is to train students' ability to read and draw engineering drawing.

The existing teaching arrangement and the reformed teaching arrangement are shown in Figure 2.

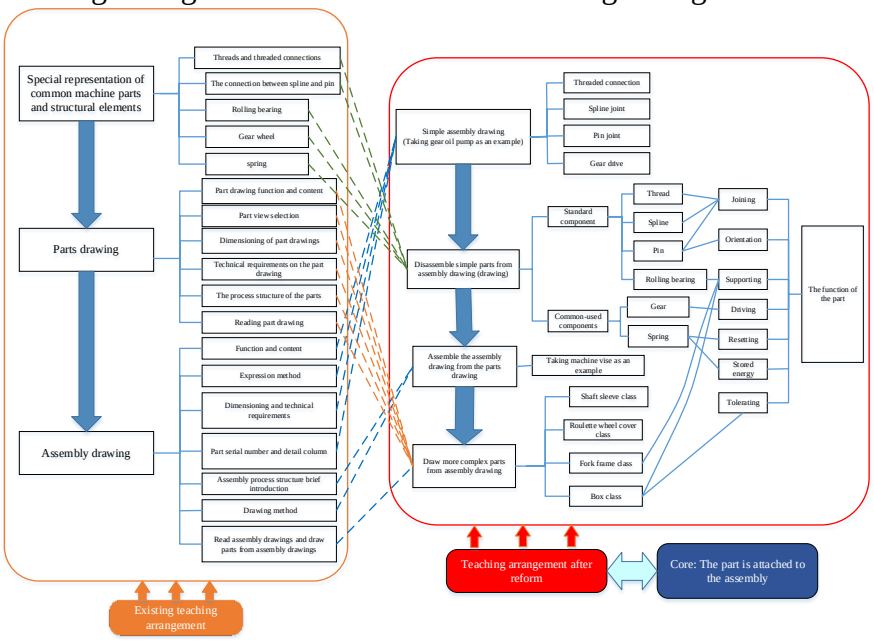

Figure 2: Existing teaching arrangements and reformed teaching arrangements

4.4 Integrating digital education technology, reasonably designing and planning online and offline mixed teaching programs, and improving students' drawing ability to express parts through courses, competitions and projects

Leverage the teaching platform to implement a blended approach that incorporates both online and offline instruction. Offline teaching means explaining difficult points and key points in class, while relatively simple knowledge points are put into online teaching. Only in this way can a mechanical drawing teaching system be developed with the training of engineering innovative design thinking ability as the main line, and the drawing information of parts can be understood from the function of parts. Also, the practical teaching of component expression method can be improved. Students are strictly required to draw according to the drawing process, emphasizing the standardization, science and seriousness of drawings, and effectively improving students' ability to draw and read parts drawings. Through courses, drawing competitions, innovative projects and other links, students' ability to express parts drawing and assembly drawing can be improved, which will then improve the teaching quality, thus achieving a good teaching effect. This approach is conducive to strengthening students' engineering design ability.

4.5 Implementing the whole process of assessment to improve the "challenge degree" of students' learning, and integrating ideology and politics into the curriculum to achieve the perfect combination of imparting knowledge and education

By adding online learning and assessment, comprehensive work, part drawing and assembly drawing assessment and 3 in-class quizzes, a full program-process assessment is achieved. The final grades of engineering drawing courses in our school accounted for 70% before 2018, 60% from 2019 to 2022, and decreased to 50% since 2023. Formative evaluation and final evaluation were comprehensively adopted to evaluate students' grades, effectively improving the "challenge degree" of learning. At the same time, the ideological and political elements of the course were incorporated. While teaching drawing knowledge in class, the typical characters and events related to drawing were presented by means of pictures and videos, which conveyed positive energy and fostered students' rigorous, serious, responsible and meticulous work quality, as well as the spirit of meticulous, practical and dedicated "craftsman". The education and teaching goals of imparting knowledge, training ability and leading value were truly achieved.

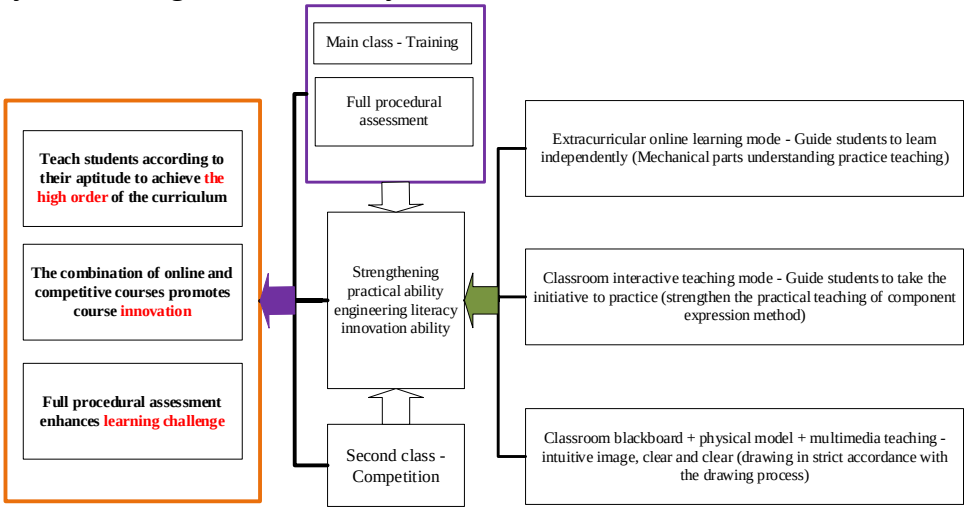

Figure 3: The characteristics and innovation of engineering drawing course

Through the construction of digital resources, engineering drawing course created an immersive

learning environment based on knowledge and practical application. Engineering drawing course also adopted a teaching system focused on engineering design as the main approach, which facilitated students' acquisition and mastery of drawing knowledge and solidified their professional foundation. The characteristics and innovation points of the course are shown in Figure 3.

5. Conclusion

Starting from education digitization, the engineering drawing teaching environment is reorganized, online and offline are integrated, and a new type of "teaching" and "learning" space is created, which promotes teaching reform and innovation. Starting from education digitization, the engineering drawing teaching environment is reorganized, online and offline are integrated, and a new type of "teaching" and "learning" space is created, which promotes teaching reform and innovation. The teaching design of engineering drawing is reconstructed, taking the training of engineering innovative design thinking as the main line, improving students' engineering design ability through courses, projects and competitions, etc., and laying a solid foundation for developing the ability to solve complex engineering problems. The "full-procedure-process" assessment is carried out, the "engineering moral education" course of thought and politics is fully implemented, and the engineering drawing course is made into a first-class course.

Acknowledgements

This work was supported by 2023 Undergraduate Teaching Research and Reform Project of University of Shanghai for Science and Technology (Office of Academic Affairs, University of Shanghai for Science and Technology [2023]5); 2023 Construction Project of Undergraduate Demonstration Course with Ideological and Political Content (Office of Academic Affairs, University of Shanghai for Science and Technology [2023]18).

References

[1] Zhang Jingying, Yang Wei, Tong Xianying, etc. Constructing a New System of Three-Dimensional Engineering Graphics Teaching Based on OBE [J]. Journal of Graphics 2019; 40(1): 201-206.
[2] Ding Qiao, Han Liyan, Sun Yihong, etc. Innovative Exploration and Practice of Mechanical Drawing Course Teaching [J]. Higher Education in Chemical Engineering 2023; 40(5): 40-43.
[3] Wang Yan, Du Xiuhua, Yang Rui, etc. A New Mixed Teaching System Based on OBE for Cartography Course [J]. Journal of Graphics 2021; 42(4): 696-702.
[4] Zhu Wenbo, Ji Haihui, Li Haiyuan. Reform and Practice of Mechanical Drawing Teaching Integrated Theory with Practice [J]. Journal of University of Shanghai for Science and Technology 2019; 43(2): 185-195.
[5] Zhang Hai, Lu Xuecheng. Discussion on the Construction of the Engineering Drawing Course under the Background of "First-Class Course" Construction [J]. Journal of Science and Education 2023; (4): 78-82.
[6] Zhu Wenbo, Li Haiyuan, Xu Xinli. Practice of Whole Program Process Examination in Engineering Drawing Course [J]. The Guide of Science & Education 2022; (4): 23-25.