Teaching Reform of "Engineering Drawing" under Background of the "New Engineering"

Chun-yan YAO¹,a, Ji-hong SHAN¹,b, Jiong-lin ZHU¹,c and Yi SUN¹,2,d,*

¹Key Laboratory of Special Purpose Equipment and Advanced Manufacturing Technology, Ministry of Education, Zhejiang University of Technology, Hangzhou Zhejiang, China
²Ocean College, Zhejiang University of Technology, Hangzhou Zhejiang, China

*aycy@zjut.edu.cn, bshanjh@zjut.edu.cn, czhuionglin@zjut.edu.cn, dsunyi@zjut.edu.cn

*Corresponding author

Keywords: New Engineering, Engineering Drawing, Micro-class, Flip-class.

Abstract. The construction of "New Engineering" puts forward new requirements for teaching methods. Therefore, it is necessary to adopt effective teaching methods to realize the cultivation of students' innovative ability. Under the background of the "New Engineering", the teaching methods reform of "Engineering Drawing" based on micro-class and flip classroom is important. It mainly realizes the educational concept of comprehensive and coordinated development of knowledge, ability and quality of students. It cultivates students' engineering practice ability and design ability. It effectively solves the problems of "engineering" and "innovation", ensuring that students are targeted in the process of learning. The teaching methods reform practice results show the students’ practical ability and problem-solving ability are improved, and the learning ability and awareness of communication between each other are enhanced. The teaching methods stimulate students' learning interest and enthusiasm, and effectively improving the teaching quality of the "Engineering Drawing".

Introduction

"Made in China 2025" proposes to realize the road of China's manufacturing powerhouse [1]. The Ministry of Education issued the "Notice on New Engineering Research and Practice" which states: "The development of new economy, represented by new technologies, new formats, new models, and new industries, put higher demands on engineering and scientific talents. Therefore, there is an urgent need to accelerate the reform and innovation of engineering education." Compared with traditional engineering, "New Engineering" emphasizes the practicality, cross-cutting and comprehensiveness of the discipline [2]. On the one hand, the construction of "New Engineering" should set up and develop a group of new engineering majors, and constantly improve the quality of teaching. On the other hand, it must promote the teaching reform and innovation of existing engineering majors [3,4,5].

"Engineering Drawing" is a subject that studies the expression and communication of engineering and product information. Engineering drawings are the carrier of engineering and product information, and are the language for the engineering community to express and exchange technical ideas. "Engineering Drawing" is a compulsory course for engineering students. It is a professional foundation course for students to read and draw engineering drawings and exercise engineering practice skills.

In the context of the "New Engineering" era, the course of "Engineering Drawing" needs to be reformed to conform to the trend of the times, so as to cultivate high-quality applied talents. Micro-courses are recognized by many teachers for their short and concise characteristics and in line with the learning rules of students. With the rise of micro-courses, it has brought new teaching methods. Taking the "New Engineering" as the background, this paper takes the course of "Engineering Drawing" that applied in the major of mechanical and industrial engineering of Zhejiang University of Technology as an example, and carries out the teaching methods reform of "Engineering Drawing" based on micro-courses and interaction with students. Students make preparation for
teaching by using the micro-course firstly. And then they teach themselves in the classroom. The teacher makes full use of the effective time of classroom teaching and the students' interest in learning through the exchange of roles of teachers and students. In this way, students' enthusiasm and initiative can be mobilized, and their learning level can be improved. Eventually students' ability to solve complex engineering problems in the professional field will be developed.

Requirements of "Engineering Drawing" under the Background of the "New Engineering"

The construction of "New Engineering" aims to cultivate excellent engineering and scientific talents. It changes teaching methods and assessment methods around students' interests and individuality, and updates the teaching process, teaching content and curriculum system. "New Engineering" requires more attention to students' learning effectiveness and future development. It enhances interaction between teacher and students and promotes students' all-round development. The engineering education concept centered with students and innovative engineering education methods will be formed [6].

The outline of "New Engineering" points out that there is law in teaching and there is no law in teaching [7]. Under the background of "New Engineering", the first teaching objectives of "Engineering Drawing" course is that students should master the basic theory of engineering drawings by orthographic projection and various drawing methods of work-piece expression, cultivate spatial imagination ability, and develop the basic ability to read engineering drawings. The second teaching objectives of "Engineering Drawing" course is that students are able to familiar with the basic rules of national cartographic standards, master the basic methods and skills for drawing engineering graphics, and cultivate the ability to think and solve problems independently. In addition to enabling students to master a wide range of professional knowledge, the purpose of the "Engineering Drawing" course is to cultivate students' engineering awareness and practical ability, and to develop students' ability to solve complex engineering problems in professional fields.

Problems in the Teaching and Learning of "Engineering Drawing"

"Engineering Drawing" is a compulsory engineering basic course for the majors of all engineering fields in ZJUT. It teaches students the basic theories and methods of engineering drawing and reading. It is the basic course for cultivating students' spatial thinking and design creativity. It is also a course that emphasizes both theory and practice. It is not only the basis for learning follow-up professional courses, but also an important basis for students to engage in engineering and technical work after graduation.

![Figure 1. Problems in the Teaching and Learning of "Engineering Drawing".](image)

Figure 1. Problems in the Teaching and Learning of "Engineering Drawing".

In recent years, due to the establishment of great engineering majors, the hours of "Engineering Drawing" has been reduced from the original one academic year to
the current one semester. Most students report that it is more difficult to learn than other courses. At
the same time, there are some problems in the traditional teaching methods based on teachers and
professors. First, in the class, the teacher's unilateral knowledge teaching allows students to develop
the inertia of passive acceptance of knowledge. Students only remember some basic theories, which is
not conducive to mobilizing students' initiative and consciousness. Secondly, traditional teaching
pays attention to theoretical teaching, which leads to theoretical explanations occupying a large
number of classroom hours. Students are often able to complete some course exercises, but they often
feel confused when reading and drawing professional drawings, and various errors may occur,
causing them fail to meet the objectives of the course, even leaving hidden problems for subsequent
professional courses. Some problems in the teaching and learning of "Engineering Drawing" illustrates on Fig. 1.

Reform for the Teaching of "Engineering Drawing"

Micro-learning Mode

According to research in psychology and communication, the limit of attention of an ordinary
person is 10 minutes. The micro-course generally takes about 10 minutes of teaching time, which is
within the acceptance of the students' attention. Based on the existing Zhejiang Province's excellent
drawing courses, the micro-course design and production, the original 45-minute teaching content is
decomposed into several teaching micro-courses of about 10 minutes, making students can learn
micro-courses anytime, anywhere.

Student Teaching Team

About 4 to 6 students form a teaching team (can be a voluntary organization). The teaching team
members work in a division of labor, design teaching according to the teaching contents arranged by
the teacher, complete the teaching PPT or other forms of teaching. In this process, the teacher
provides teaching materials about relevant teaching contents, and the students can help each other,
communicate with each other, work together, complete the tasks, and achieve the expected learning
goals.

Teaching Design

Make full use of the effective time of class teaching, and divide class teaching time into two
processes: student teaching team teaching and teacher evaluation. According to the content of the
"Engineering Drawing", the teacher arranges the corresponding teaching tasks (learning content) for
the students. Students learn the content arranged by teacher through the micro-courses, and then
cooperate to design the class teaching. The form of teaching can be diversified. The student teaches
the teaching tasks in their own teaching methods and teachers then carry out the teaching comments.
In this way, students' interest in learning can be stimulated.

Effect about New Teaching of "Engineering Drawing"

In 2018, we carried out micro-course design and construct the WeChat public platform of the
"Engineering Drawing" based on the existing "Zhejiang Provincial Engineering Drawing Quality
Course". It makes students learn micro-courses anytime, anywhere. And it is a benign supplement to
class teaching.

The WeChat public platform mainly contains three parts: "Teaching Information", "Independent
Learning" and "Student Style", as shown in Fig.2. "Teaching Information" includes teaching plans,
and course's evaluation. The teaching plans give the specific teaching plan for this semester, so that
students can have a general understanding of contents. The course's evaluation are given to the
assessment method in the current semester. Teaching videos and some exercises for the course are
given in "Independent Learning". In order to facilitate the students to understand the structure of the
conceptual form, a three-dimensional model is given in the problem solving. In addition, the "Student Style" provides a stage for students to show themselves.

Figure 2. Screenshots of Some Contents of Wechat on "Engineering Drawing".

In view of the particularity of the "Engineering Drawing" course, teaching trial practices with the micro-class and flip-class mode were carried out. In the early stage of the course, the basic knowledge about points, lines, faces and bodies were taught by the teacher. And when entering the content of the combination and body expression program, the class teaching was divided into two parts: the student lecture and the teacher evaluation. Students prepared the teaching PPT or other forms of teaching through the micro-course. The first half of the class was given to the students. The content of the course is taught in their own teaching methods. The teachers then carried out the teaching comments on the relevant content. In this way, students' interest in learning could be stimulated through the teacher-student role exchange and their learning content be consolidated. In the class, students were given full play to the enthusiasm for teaching and understanding of the teaching contents. Students taught themselves replace the original boring content with their own teaching language and style, which was convenient for other students to understand. Fig.3 is a photo of the student teaching in class. The students' teaching fosters students' expressive ability. It is consistent with the "Mechanical Engineering Graduate Design" index point 10 "Communication: able to effectively communicate and communicate with industry peers and the public on complex engineering issues".

Figure 3. Photo of Student Teaching in Class.

The flip-class mode in which the role of students and teachers interchanged is conducted in a pleasant, relaxed, and practical atmosphere. The teaching effect was good, and the final examination of the same grade has achieved initial results. Fig.4 is a comparison chart final examination scores distribution of the 2018th grade mechanical and industrial engineering majors in ZJUT, among which the C5 is the teaching practice with the micro-class and flip-class mode. Compared with the results of the regular class, the proportion of students who scored more than 90 points in the new curriculum reform class reaches 56%, and the excellent rate of achievement was much higher than other classes.
Summary

The construction of "New Engineering" with innovation ability cultivating as the core puts forward new requirements for teaching methods. Therefore, it is necessary to adopt various effective teaching methods to realize the cultivation of students' innovative ability. The era of artificial intelligence is changing the traditional teaching model. The process of teaching and learning is not just in the class. It extends beyond the class, such as using QQ, WeChat, micro-courses, and MOOC. The paper carried out a practical teaching reform for "Engineering Drawing" in mechanical and industrial engineering majors under the micro-class and flip-class mode. Students complete the learning tasks arranged by the teachers and achieve the understanding of the basic knowledge points before class is begun. They carry out various expansion exercises in the class. Under the background of the "New Engineering", the construction of the micro-course course of "Engineering Drawing" based on micro-class and flip-class is important. It mainly realizes the educational concept of comprehensive and coordinated development of knowledge, ability and quality with students. It cultivates students' engineering practice ability and design ability. It also solves the problem of "engineering" and "innovation". This will enable students to better consolidate theoretical knowledge and improve their practical skills and problem-solving skills. The teaching reform of the "Engineering Drawing" course fully reflects the new requirements for the cultivation of talents in the construction of "New Engineering".

Acknowledgement

This research was financially supported by the "New Research and Practice Projects of the Ministry of Education" and College of Mechanical Engineering, Zhejiang University of Technology.

References


