Autonomous Learning Ability Cultivation Based on Hybrid Teaching Model of Descriptive Geometry and Mechanical Drawing

Binghui Wu, Yinghui Liu
College of Energy and Mechanical Engineering
Shanghai University of Electric Power
Shanghai, China

***Abstract*—The teaching of descriptive geometry and mechanical drawing is confronted with such problems as less theoretical class hours, great pressure in classroom teaching, difficulty in individualized learning of students, and poor initiative and enthusiasm in learning. With the rapid development of information technology, the deep integration of information technology and teaching methods is a hot spot in the research of education informatization. Based on the wisdom tools of rain classroom, according to types of knowledge points and the change of talent demand of intelligent manufacturing, this paper explores the design of teaching objectives, the construction of hybrid teaching environment and assessment methods. A hybrid teaching mode is proposed which is suitable for the characteristics of this course and the improvement of students' self-learning ability. Practice shows that the hybrid teaching mode has achieved good results in the teaching of descriptive geometry and mechanical drawing.**

Keywords—rain classroom; hybrid teaching mode; active learning ability; mechanical drawing

I. INTRODUCTION

Descriptive geometry and mechanical drawing is a course to teach students understanding graphics, skill at drawing in the field of mechanical engineering. It plays an important role in cultivating students' image thinking, innovative thinking and further learning professional and technical knowledge. However, most schools arrange this course in freshman year. The students' professional foundation is relatively weak, and their spatial imagination abilities are different. The individual difference should be fully taken into account. At the same time, under the new situation of credit system reform, the theoretical class hours of all courses are facing a decreasing trend, while this course involves a wide range of knowledge, relatively more knowledge points, and there are strong links between knowledge points, so it is necessary to carry out teaching step by step.

Highly digitalized and networked products have made tremendous changes in design and manufacturing methods, followed by changes in the demand for talent. As an important teaching mode under the background of information technology, MOCC can be used as a supplement to the lack of classroom teaching hours, and can provide a certain degree of professional basic knowledge to enhance students' perceptual understanding of Engineering problems. However, its teaching mode is relatively single, and it cannot meet the needs of students' personalized learning. And it is difficult to meet the needs of higher education students' different cognitive needs and image thinking ability training. Therefore, how to deeply integrate information technology and curriculum teaching, and adopt the hybrid teaching mode of "online+ offline" to guide students to improve their interest in learning and cultivate their active learning ability in teaching is to turn passive learning into active learning, so as to enhance their learning ability in the follow-up professional courses [1].

II. REFORM OF CURRICULUM SYSTEM AND TEACHING CONTENT

In recent years, many attempts have been made in the reform of curriculum system in domestic universities. Tsinghua University proposes to divide the content of mechanical drawing course into five parts: descriptive geometry, basic drawing, mechanical drawing, general knowledge of mechanical design and computer drawing, and to establish a modular curriculum structure for multi-hour and less-hour courses [2-3]. The teaching mode of engineering drawing in Shanghai Jiaotong university is in line with foreign countries. It combines engineering drawing course with professional course practice and engineering training, realizes the training of image thinking ability and engineering ability throughout the whole life cycle of undergraduate course [4-5].

Through researching the quality standard requirements of engineering education certification for engineering graduates, successful experience of similar courses in domestic universities was adopted in drawing lessons. This paper intends to reform the course system and teaching content of "Descriptive geometry and mechanical drawing" in our university, so as to form a hybrid teaching mode, so as to cultivate students' active learning ability.

Descriptive geometry and mechanical drawing is a basic course for students majoring in mechanical engineering. The learning results are directly related to the learning effects of other specialty courses. The course system, teaching contents and requirements of Descriptive geometry and mechanical drawing are shown in the Fig. 1.

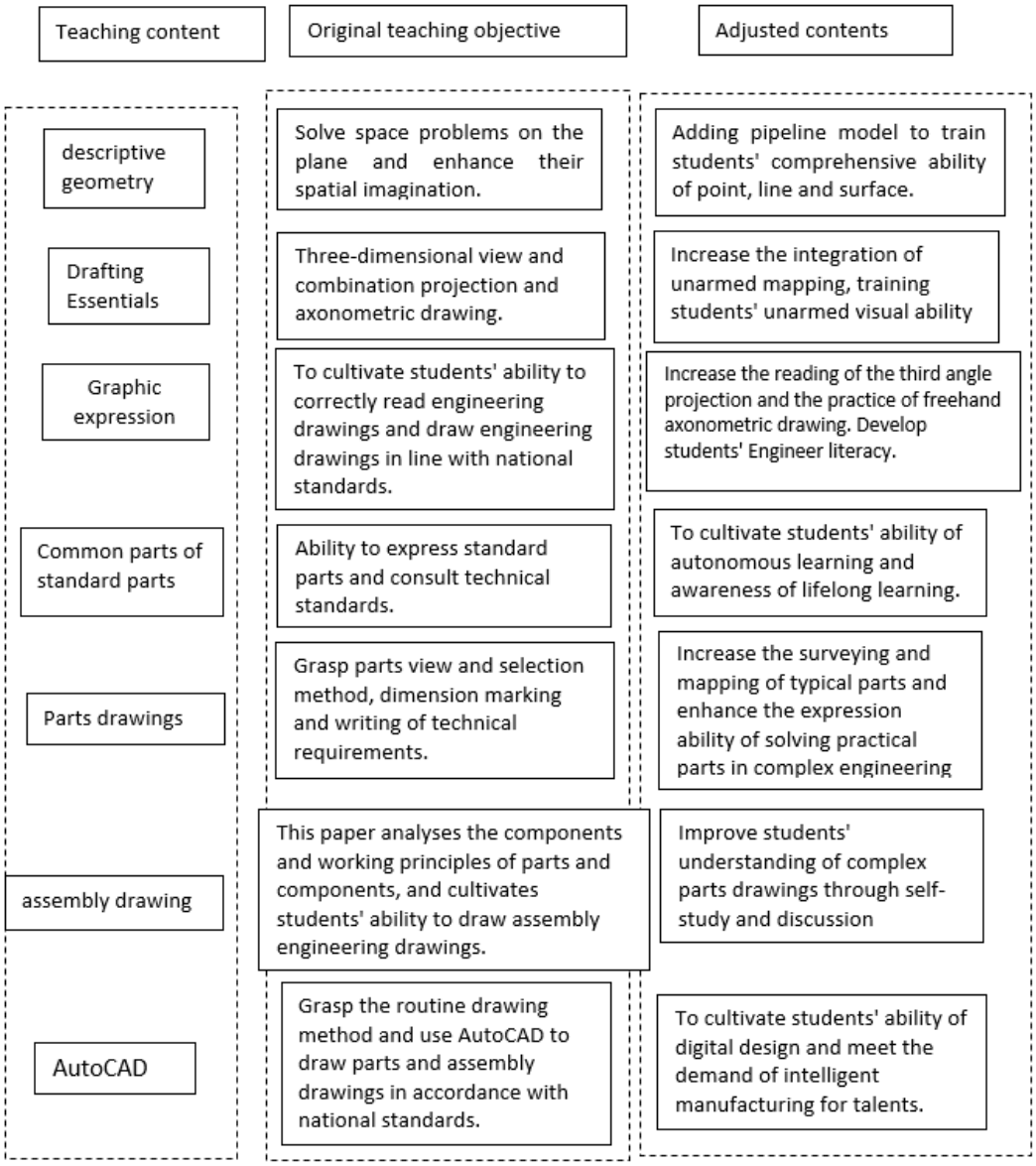

Fig.1 Course system of descriptive geometry and mechanical drawing

III. PRESENT SITUATION OF HYBRID TEACHING MODEL

Over the years, various colleges and universities in China have carried out continuous exploration and reform of teaching methods in accordance with the characteristics of the Mechanical drawing course. A variety of teaching methods such as "demonstration method", "heuristic method", "case method", "interactive method" have emerged, as well as various teaching methods such as blackboard, PPT, video and physical model. These teaching methods and means play a certain role in stimulating students' interest in learning and improving their initiative in learning [4-5].

With the development of information technology, the demand for qualified students in intelligent manufacturing has changed greatly. Students' acquisition of knowledge in school often lags behind the needs of enterprises. The learning ability they acquire in school will be the necessary skills for them to adapt to social development.

The research of blending learning in foreign countries originated from blending learning in the early 20th century. In 2000, the White Paper on Educational Technology put forward the idea of blended learning for the first time. In 2002, reference [6] introduced the concept of Blended Teaching for the first time.

At present, the online teaching mode based on network has become the trend of university teaching reform in our country, including the excellent resource sharing course and video open course, which are the key construction projects of the 12th Five-Year Plan of the Ministry of Education, as well as the introduction of micro-courses, SPOC, MOOC and other ways from abroad. In recent years, the research focuses on the design of hybrid learning, the mechanism of hybrid learning

and the construction of hybrid learning environment. He Kekang[6] first introduced the concept of "hybrid teaching" in 2002. In recent years, the domestic scholars' research mainly focuses on the effectiveness of hybrid teaching in improving students' learning effect. That is, the application model research and hybrid teaching design research. Chen Xiliang and others have explored the construction of teaching resources, the reform of teaching contents and the construction of evaluation system, taking the course of "University Computer Foundation" as an example.

IV. Design of Hybrid Teaching Model to Promote Students' Learning Initiative

Integrating information technology with mechanical drawing teaching, making full use of limited class hours, adopting effective teaching methods and teaching modes, qualified students are cultivated suitable for the rapid development of manufacturing in China. Through the use of “Online + offline” and “pre-class preview + Classroom Interaction + after-class extension” of the hybrid teaching mode, active learning ability of students' was improved [7-9].

A. Pre-class Preview Content Design

Descriptive geometry and mechanical drawing is mainly to cultivate students' spatial logical thinking ability and image thinking ability. Its theory and practice are relatively strong, the content of the course is complex and abstract, and the connections between knowledge points are strong. The whole teaching process must be gradual and interrelated. Pre-class preview content is not simply pushing classroom content, but predicting the teaching objectives of each class. At the same time, it can stimulate students' interest in learning with interesting examples. It can also enhance students' perceptual understanding of abstract problems with engineering application examples.

Classroom teaching should not be a simple lecture, but to design a classroom with students' interactive participation. Due to limited teaching hours, effective classroom interaction comes from understanding and interest in content. Therefore, it is particularly important to promote the preview content before class.

B. Classroom Interactive Content Design

Teachers play an important role in student-centered classroom teaching. Specifically put forward requirements for students' participation, such as asking questions to encourage students to actively participate in interaction. Because freshmen are not familiar with each other, they need to be guided by teachers to allocate partners. After questions were asked, students should think in a limited time and discuss in time to complement each other. And then share the results with their classmates. Teams that perform well are rewarded with regular points to stimulate students' enthusiasm for discussion. With the deepening of learning, some group design topics can be added. Take the configuration of the combination as an example, give a certain time, let the students design freely, through the combination of the simple forms learned in different ways, design the combination of different shapes. Students are required to display and introduce their own works in the form of posters to enhance the cultivation of students' innovative thinking ability. At the same time, their design works can be combined with the actual needs of the project to stimulate students' desire to recognize the actual parts of the project[10].

Due to the limited teaching hours, it is impossible to set up enough group discussion segments in the classroom. In order to improve the enthusiasm of students and monitor the effect of listening. Time-limited rush response segment are put forward in appropriate contents, and red envelope rewards are given to those first few which give the right answer. The results of the answers can be projected onto the big screen. According to the students' understanding of the questions, teachers can give on-time feedback and clarify the confusing questions quickly. This kind of interactive mode is also based on the newly developed rain-classroom teaching methods in recent years. Teaching practice shows that this style of teaching method can greatly stimulate the enthusiasm of students to listen carefully.

C. Design of Knowledge Development Segments after Class

The characteristic of this course is that segments are closely related and interlinked. Extension after class is the continuation and deepening of classroom content. At the same time, it can lead to the content of the next classroom teaching[11-12]. Considering the heavy learning task and large amount of homework in mechanical drawing course, too many design segments for knowledge expansion after class will not be conducive to the improvement of students' enthusiasm. Thus, eight expansion segments were designed to enhance students' self-learning ability and engineering awareness.

- In the comprehensive exercises of points, lines and surfaces, pipeline model is added to cultivate students' spatial imagination, while also imperceptibly letting students have a deep understanding of the projection characteristics of points, lines and surfaces.
- Introducing the mode of student-to-student examination in the basic body part, designing questions in groups, answering questions and evaluating groups can strengthen the communication between students and fully enhance students' understanding of basic body projection.
- Bare-handed drawing is introduced into composed part. In the course of training, main dimensions were allowed to measure by rules and other dimensions by visual measurement. Emphasis is laid on cultivating students' rigorous drawing attitude, accurate visual ability, accurate bare-hand drawing ability and coordination ability of hand, eye and brain.
- Configuration design is introduced into the assembly part, which clarifies design objectives, the number of basic units and the form of combination. Students can design the assembly freely. This kind of open practice can deepen students' understanding of graphics, stimulate students' interest and enhance their innovative thinking.
- After the course contents of standard parts and common parts, typical type of standard parts will be listed for students to find its specifications. This segment is

designed to improve students' ability of accessing materials and cultivate their ability of self-learning unconsciously. At the same time, we should cultivate their engineering consciousness and respect standards.

- In order to expand students' understanding of typical parts and sense of teamwork, group mapping has greatly increased students' enthusiasm. By introducing open discussion into the expression scheme of parts, students can consciously explore and gradually enhance their awareness of active learning so as to be able to face complex engineering problems in the future.
- In the assembly drawing segment, responding segment and students' mutual evaluation segment are introduced to help the students understanding the assembly drawing deeply.
- In the AutoCAD segment, some after-class topics are put forward, such as parametric design and sketch drawing. The purpose of using these means is to enhance students' ability of digital design, and train students to become qualified students necessary for intelligent manufacturing.

V. DIVERSIFICATION OF ASSESSMENT METHODS

Descriptive geometry and mechanical drawing is a course of strong applicability and practicality. It is difficult for a single final examination result to reflect the students' mastery of the course and their real ability. After years of exploration, combined with the characteristics of the course and the teaching objectives of the ability of drawing and reading, many exploratory reforms have been made in the examination methods, such as emphasizing process evaluation and diversified comprehensive evaluation, adjusting the proportion of the usual and final examinations, highlighting the importance of classroom performance, homework and stage examinations[13-14]. In this process, the situation of students under passive supervision remains unchanged, and the improvement of teaching effect is not obvious.

The course of descriptive geometry and mechanical drawing has undergone two rounds of hybrid teaching mode reform, exploring the ways of "online + offline" and "pre-class + in-class + after-class", effectively supervising the whole process of students' learning and improving their enthusiasm and autonomy in learning. The results of the course are composed of the usual results and the examination results. The ordinary results are divided into two modules, and the examination results are divided into four modules. Usual performance consists of attendance, classroom activity and homework completion effect. Examination results are composed of pre-class preview module, in-class activity evaluation, after-class expansion module (project assessment) and final examination results. The assessment indicators in the four modules are put forward according to the teaching objectives in the teaching system.

VI. TEACHING EFFECT AND SUMMARY

This online and offline teaching mode makes full use of students' fragmentary time and significantly improves students' active learning time. Difficulties encountered in the learning process can also be solved in time. Online resources are also a powerful aid to the final review, helping students quickly sort out the knowledge points and contents of the course.

Combined with hybrid teaching mode, the teaching contents in this course are classified re-combing. According to the characteristics of each knowledge point, after-class project which based on development training are rationally designed. So as to organically combine the traditional teaching mode with online learning, and form a hybrid teaching mode suitable for the characteristics of this course. Students' understanding of this course and their ability to learn independently lay a solid foundation for the development of their lifelong learning ability.

Hybrid teaching is a long-term project, which needs continuous exploration and improvement.

REFERENCES

[1] B. Sh. Tong, L. Tian, J. Feng. Problems and achievements of engineering graphics teaching reform in recent 10 years [J]. Journal of Engineering Graphics, 2008, Vol. 4, pp. 1-5

[2] L. P. Huang, M. Ch. Meng. Course reform of engineering graphics on course contents and course system [J]. Journal of Engineering Graphics, 2005, Vol. 6, pp. 156-159.

[3] L. Tian, B. Sh. Tong, J. Feng. Research and practice on the new architecture of mechanical engineering graphics course. [J] Journal of Engineering Graphics, 2005, Vol. 5, pp. 126-131.

[4] Y. Sun, J. Fan, X. L. Meng. Construction of cartographic ability training model based on modern design method [J] Education and Teaching Forum 2014, Vol. 52, pp. 36-237.

[5] J. R. Tan, G. D. Lu, Sh. Y. Zhang, Y. D. Shi. On combination of common platform and integrated promotion in engineering graphics course system [J] Journal of Zhejiang University of Technology, 2000, Vol. SI, pp.5-8.

[6] K. K. He. A Deep Educational Revolution: E-learning and Teaching Reform in Colleges and Universities [J], Modern Distance Education Research, 2002, Vol. 3, pp. 13-20.

[7] Marc T KIVINIEMMI. Effects of a blended learning approach on student outcomes in a graduate-level public health course. [J]. Kiviniemi BMC Medical Education, 2014, Vol. 14, pp. 1-7

[8] Wendy W. Porter, Charles R. Graham, Kristian A. Spring, Kyle R. Welch. Blended learning in higher education: institutional adoption and implementation [J]. Computers & Education, 2014, Vol. 75, pp. 185-195.

[9] X. L. Chen, F. Jiang, J. Lai, W. Peng. Research on the reform of college computer basic teaching based on hybrid teaching model [J]. Computer Education, 2016, Vol. 6, pp. 143-146.

[10] Scott Freeman, Sarah L Eddy, Miles McDonough, Michelle K Smith, Nnadozie Okoroafor, Hannah Jordt, et al. Active learning increases student performance in science, engineering, and mathematic [J]. Proceedings of the National Academy of Sciences of the United States of America, 2014, Vol. 23, pp. 8410-8415.

[11] Ch. F. Chen. Practice and reflection on the teaching model of "active learning" [J]. Educational Exploration, 2012, Vol. 1, pp. 45-47.

[12] Y. G. Li, X. L. Ma, D. M. Li., D. W. H, R. Dong. The reform and practice of engineering graphics courses in applied university [J]. Journal of Graphics, 2017, Vol. 1, pp. 119-122.

[13] Ch. H. Ruan, Q. B. Huang, J.G. Huang, L. Zhang, X.Q. Li. Constructional design and practice of blended learning mode for course of engineering graphics based on information technology [J]. Journal of Graphics, 2016, Vol. 6, pp. 846-850.

[14] L. Tian, B. Sh. Tong. Research and practice on the quality guaranteed of mechanical drawing course [J] Journal of Engineering Graphics, 2006, Vol. 5, pp. 126-129.