

Electrical machine course teaching reform in the background of new engineering construction

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Abstract— “ Electrical Machinery ” is the electrical engineering professional basic subject featured with theory and abstract content, involving many disciplines, and closely linked with the engineering practice, which makes it hard in the teaching and learning process. In the background of the fourth industrial revolution and new engineering construction, the teaching reform of Electrical Machinery courses should be carried out to improve the talent training quality and adapt to the new economic development of science and technology. Taking Yanshan University as an example, this paper elaborates the design plan of the teaching reform, the organization and selection of teaching contents, the reform of classroom teaching method and the practice and effect of project teaching. Through practice, compared with before the teaching reform, students' interest in learning, innovation ability, and practical ability have been significantly improved.

Keywords—*Motor; teaching reform; new engineering construction; personnel training; teaching practice;*

I. INTRODUCTION

On June 2, 2016, China became a full member of the 18th "Washington Accord." This indicates that the quality of engineering education in our country is internationally recognized and the internationalization of engineering education has taken an important step forward. In March 2016, the Yanshan University professional certification organization, one of the two expeditions designated by the Ministry of Education, was highly appraised by the secretariat of the Washington Accord. Being a landmark breakthrough in the "Washington Accord" will strongly promote the international advanced concepts and quality standards of higher engineering education in China, deepen the reform of engineering education and teaching, improve the quality of personnel training, and effectively promote the exchange and cooperation between engineering education and international engineering education in China Cooperation^[1]

Under the new situation in which the knowledge economy, the new round of science and technology and the industrial revolution are thriving, the fourth industrial revolution has arrived and the traditional higher engineering education in our country, to a large extent, can no longer meet and lead the

development needs of the new economy There is an urgent need to adopt new technologies to build and develop a number of emerging engineering departments or to upgrade and upgrade a number of traditional engineering courses.

Under this background, as a specialized subject teacher, based on the responsibility of cultivating innovative talents for the national economic restructuring and social development, the teaching reform on the electrical machinery courses taught is discussed.

Based on the teaching of motor course in Yanshan University from China, the paper discusses the design of teaching reform in motor science course. The emphasis is put on the practice and effect of project teaching in detail. It changes the traditional teaching methods of motor courses, takes the active participation of students as the main body, guided by project Teaching, using a variety of teaching methods and strategies, and achieved good teaching results.

II. WORK DESCRIPTION

A. Characteristics of Electrical Machinery Courses and Traditional Teaching Methods

"Electrical Machinery " is an important professional basic course in electrical engineering and automation. Through the learning of this course, students can acquire the basic theory, basic knowledge and basic skills of the motor, prepare themselves for the study of specialized courses and lay a theoretical foundation for the relevant professional work in the future. "Motor" is one of the professional foundations. It is recognized by domestic and foreign counterparts as a hard-to-learn course [2]. It mainly discusses four typical parts of electrician course including transformers, induction motors, DC motors and synchronous motors. This involves complex motor body space structures, operating principle characteristics, and magnetic fields and nonlinear ferromagnetic materials in the motor's internal current distribution space. Some students call it a "bible," which to some extent reflects its difficulties.

Before studying "Electrical Machinery ", students learned advanced theoretical courses in mathematics and physics. However, in the practice of various equipment-specific electrical engineering used in electrical engineering, students had little chance of observing the internal structure of the motor. The electromagnetic field of the motor was invisible. All of these factors make it difficult for students to learn this course.

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For this professional foundation course, in the previous teaching process, mainly in the classroom teaching, the teacher explained the theoretical knowledge in the class, but students received little learning effect, Figure 1 is a 2015 student performance chart, The result distribution is not ideal. This problem had been bothered us. The author and other members of the motor teaching team always adhere to the "student-oriented", continue to explore new teaching methods, deepen the teaching reform, and vigorously improve the quality of teaching. In the new industrial construction background, the teaching team members decided to change the previous teaching concepts, with CDIO as the teaching philosophy, project-led teaching as the lead, the new "Electrical Machinery" teaching reform. This work has received the support of Yanshan University teaching reform project funds, and some achievements have been acquired.

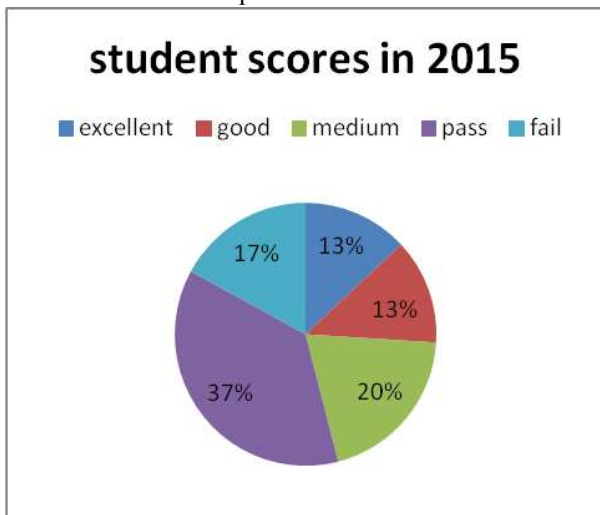


Fig. 1 student scores chart in 2015

B. "Electrical Machinery" Teaching Reform Design

1) Teaching content reform

As the content of this course is more difficult for the students, it is necessary to understand the profound theories in simple language in order to comprehend them. However, due to the more content and lack of time, it is impossible to complete the book within a limited period of time. Therefore, the teaching content reform is required.

Students not only need to master the basic theory, but also need to solve the actual engineering problems. In order to make students willing to learn this course, teachers organize teaching content should be cautious. Learning the motor course, the use of electromagnetics to analyze the motor principle is necessary, so the teaching content must first electromagnetism related to basic theory to be taught to students, which will make it easier for students to learn the course. Transformers, synchronous machines, asynchronous machines and DC motors are ultimately energy conversion components. In a sense, it can also be called an electromagnetic component. Therefore, the teacher needs more attention in the teaching of electromagnetic induction motor.

In learning these four typical motor process, understand their structure is the basis, on this basis, to clarify the relationship between the electromagnetic induction motor. Our approach is to reduce motor lectures in classroom lectures, the

combination of project-based teaching and video playback to complete this part of this way of understanding in real life than in the classroom to explain their own imagination is much better.

In the teaching content, each kind of electrical machinery has its own characteristic and there are many differences among them, but each electrical machinery also has a lot of things in common. Identifying differences and similarities between motors for comparative teaching is helpful for students to gain a deeper understanding of this course and for easy access to the course, for example, to compare the operating characteristics of all motors. Let students be interested in the motor, the esoteric "motor" is no longer esoteric, "Bible" is no longer "Bible."

Increase project-based teaching content.

2) Reform of classroom teaching methods

In order to improve teaching effectiveness, various measures need to be used at the same time. In order to improve students' initiative, we have chosen a gradual and orderly teaching mode, which makes students become the main body of classroom teaching activities and change the former teacher's "one-word" situation.

a). Attract students' attention

In the process of classroom teaching, teachers should change the teaching concept, make the students become the main body of classroom teaching activities, improve students' learning initiative and increase students' interest in learning.

As mentioned above, "motor" course has a strong theoretical, involving real machinery and equipment. First, teachers should make students aware that motors have been applied to all aspects of our lives, such as aerospace, defense construction, power systems, manufacturing, and everyday life. In the process of learning each motor, the first step is to enable students to understand the application of the motor, the development history and research status quo. Then lead the students to answer the following questions: What is a similar device? What are the advantages and disadvantages? Where is the development space? Make students understand that learning electrical knowledge is useful, but there are still some problems that need them to explore and solve, students' interest and enthusiasm can be naturally excited [3].

In the implementation of teaching content, improve students' attention and guide students to think, you can ask questions, so that students can learn and explore these issues. During the learning process, students can ask questions and discuss. In our teaching practice, the key to teachers is guidance. The teaching content is almost completely understood by the students under the guidance of teachers. For example, when discussing the electromagnetism of some motors, students already know that current flowing through a winding creates a magnetic field and that an alternating magnetic field through the winding senses electromotive force. Based on this theory, teachers can lead students to analyze the induction process of the motor itself, and then guide them to write out the basic equations of the motor by using the basic circuit principle, from which they can draw the phasor diagram and equivalent circuit.

b) Some teaching tools application

When it comes to the motors involved, we play a video of how the motor is being manufactured in the factory. By

watching the video in class, students can visually understand the structure of the motor, the assembly process and its applications.

A difficult problem in the teaching process is the magnetic field distribution in the motor, because the magnetic field in the motor distribution is invisible, students feel more difficult to understand in learning. With the help of electromagnetic field analysis software, the flux can be calculated and the lines of force can then be displayed in a color chart and cloud chart. At the same time, teachers can encourage students to learn the relevant software and simulate the magnetic fields of some simple motors.

Another difficulty of "motor" is the structure and pulsation of AC motor windings, and the principle of rotating magnetic field produced by AC windings. For this part, teachers use the corresponding Flash courseware to produce the corresponding process of winding connection, the magnetic field generated by the winding process. In addition the working principle of the transformer Flash, Sightseeing elevator company case of Osma Elevator Co., Ltd. is also a good lesson for students to demonstrate.

In a word, in order to improve the teaching effect, teachers can flexibly adopt various teaching methods and tools so that students can feel the learning process not only useful but also interesting.

3) *Project - based teaching design and implementation*

Beginning with the spring semester of 2017, motor course project teaching will be conducted. The teaching team first developed a project-based teaching program and project teaching manuals. The project manual is divided into eleven parts: Project Overview, Project Objectives, Main Contents, Project Process Arrangements, Basic Requirements, Assessment Methods, Research Project Report Requirements, Team Group Descriptions, Requirements for Learner Presentation, Reference Sources, and Grading Rules.

a). *Main Contents*

This course includes a three-level project around AC motors and DC motors. It covers the structure, working principle, magnetic field distribution and operation characteristics of AC motors and DC motors. There are totally eight project topics.

In the form of groupings, students select one of the project topics as a group and work around the topics selected: each team first participates in the disassembly of the DC motor (or AC motor) and grasps the DC motor (or AC motor) Structure; using spare time to find, read and analyze the relevant knowledge content, to develop a workable program different from his group; summarize, organize and write the project report, made of PPT; each team to participate in the defense, the statement time 5-8 minutes , And finally by the respondent teacher to ask questions, the total defense time is not more than 10 minutes; each team submits a PPT electronic version, a project report of the electronic version and paper version. The details are as follows:

(1) DC motor structure and four quadrant operation characteristics analysis

To disassemble and install the DC motor, master the structure of the DC motor and the composition of the winding, analyze the basic working principle of the DC motor, analyze the working magnetic field of the DC motor, analyze the

starting characteristics, speed regulation characteristics and braking characteristics of the DC motor.

(2) of the asynchronous motor structure and four-quadrant operation characteristics analysis

Disassemble and install the squirrel cage induction motor, grasp the structure of the squirrel cage induction motor and the composition of the winding, analyze the basic working principle of the asynchronous motor, analyze the rotating magnetic field of the asynchronous motor, analyze the starting characteristic, speed regulation characteristic And braking characteristics.

b). *Project process arrangement*

Timing: The course starts on the first week and ends on the thirteenth week.

Project Location: Disassembly experiment for the C-floor motor drag laboratory, project respondent set at 13 weeks. Table 1 shows the contents and time planning of the project.

TABLE I. PROJECT CONTENT AND SCHEDULE

| course | Schedule | Main Contents | Remarks |
|----------------------|----------|---|---------|
| Electrical Machinery | Stage1 | AC motor and DC motor disassembly | 4 hours |
| | Stage2 | Find information, discussion, program demonstration, write a project report | 6 hours |
| | Stage3 | Project Summary and PPT Defense | 2 hours |

c) *Assessment method*

The instructor comprehensively evaluates the performance of each group of students based on student attendance, motor disassembly and assembly, research reports, and PPT responses. During the project, teachers can grade each student according to attendance and performance of individual, and add or subtract points on the basis of the average score of each group.

d) *Team group situation*

Every 4 to 5 students as a group, cooperate with each other to complete the dismantling of the motor, the project theme information to find, discuss, determine the program, writing papers and PPT speech defense. Each team should indicate in the project report each person's contribution to the overall work and the proportion of work, the proportion can not be equally divided. The extent and depth of the research will affect the final grade of each group, encourage students to choose their own course of interest for innovative design and in-depth study.

e) *Lecture presentation report*

All the discussion topics should be based on the prescribed time on the teacher and all students took the stage to report. The main purpose of the presentation is to let the teacher and other students understand your main content and work. The group's classmates must all report before the stage, appoint the main report reporter before reporting. Presentation time of each case is no more than 5 minutes, and there are 5 minutes to discuss the time. Each group must strictly control the presentation time. Every student should practice well in advance to avoid overtime. The presentation PPT document

should clearly state the topics for discussion and research, a brief introduction to the topics to be discussed, the main contents, conclusions and conclusions. Figure 2 shows the project-- based teaching site pictures.



Fig.2 Project-- based teaching site picture

C .Electrical Machinery Course Teaching Reform Course Performance Evaluation and Effect

In order to stimulate students' motivation to learn, teachers need to pay more attention to process evaluation. The total score of the course consists of five parts. Assign different weights to each section and calculate them so that the student's grades are fair and reasonable. The course score grading principle is shown in Table 2. In project teaching, plagiarism and plagiarism found in the research project results will be zero.

TABLE II. COURSE SCORE GRADING PRINCIPLE

| Serial number | Assessment items | Evaluation Standards | Remarks |
|---------------|------------------------------------|--|---|
| 1 | Classroom performance (10points) | Attendance, Class Participation, Class Exercises, and Class Tests | |
| 2 | school assignment (10points) | According to job completion | |
| 3 | Experimental results (10points) | The laboratory teacher gives the experimental result according to the experimental situation, including experimental design and organization, experimental wiring and operation, experimental data processing and experiment report. | |
| 4 | Course research project (20points) | The project result consists of 3 parts: (1) The first part, motor disassembly experiment, 5 points; (2) the second part, the motor characteristics of the project report, 10 points; (3) The third part, project evaluation and defense. PPT file submitted during the defense, and the use of PPT to assess the contents of the project and defense, 5 points. | During the project, teachers can be based on individual attendance and performance, each student scoring, in each group based on the average score of individual scores plus or minus points. |
| 5 | Written test scores (50points) | Calculated based on the actual score of the paper. | |

As shown in Figure 3, the results of the course in 2017 are excellent 20%, good 36%, medium 30%, pass 10% and fail 4%. Visible results basically in line with the normal distribution, compared to Figure 1, the 2015 statistics, to be much more reasonable. Figure 4 shows the comparisons of the results of this course in recent years. It can be seen that after the project-based teaching reform started in spring 2017, the grades of 2017 have undergone great changes. The excellent rate, good rate and medium rate are obvious Promotion, passing rate and failing rate have dropped significantly, basically in line with the normal distribution. This shows that the project-based teaching reform has raised students' interest in this course, from passive learning to active learning. This course is no longer a "bible". It shows that the project-based teaching method is in line with the characteristics of the post-

95 students and the project-based teaching reform has achieved some success.

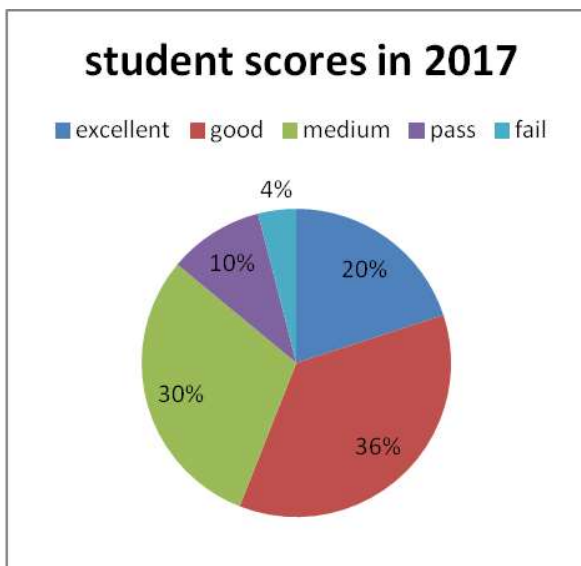


Fig. 3 2017 student scores chart

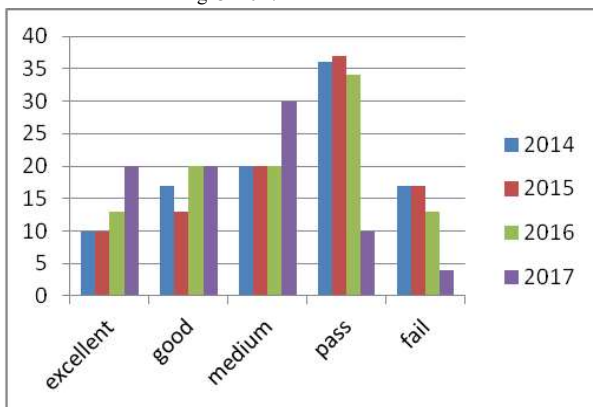


Fig. 4 Comparison of course scores in recent years

III. RESULTS ACHIEVED AND PROBLEMS ENCOUNTERED

Based on the teaching of motor course in Yanshan University, this paper introduces the characteristics and the traditional teaching methods of the motor course, and discusses in detail the teaching reform design scheme, the organization and choice of the teaching content, the reform of the classroom teaching method in order to attract the students Attention, from the previous passive access to the present active participation. It mainly introduces the practice and effect of project-based teaching in detail, changes the traditional teaching methods of motor courses, takes the active participation of students as the main body, takes the project-based teaching as the guide, and uses a variety of teaching methods and strategies to obtain good teaching effect. It has cultivated students' autonomous learning ability, innovation ability and practical ability to solve practical problems, and played a certain role in personnel training under the background of new engineering.

Project-based teaching has changed the traditional teaching methods of motor courses and achieved good teaching results. Students develop their own abilities. The shortage is that the student lesson planning time is not enough, may exceed the school's planned time, the other is that the students in each group, some one paid more, learned well, and some paid less, it is not easy to judge.

Acknowledgment

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