

The Assessment Method Reform of “Machine Design” Course Based on OBE Education Concept

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Abstract: In order to strengthen students' grasp of the knowledge of "Machine Design" and to improve students' ability to solve complex engineering problems and innovate, based on the OBE education concept, this paper analyzes the problems existing in the course of "Machine Design" and reforms the assessment method of "Machine Design" course. The reform highlights the character of the course and the main position of the students, and gives play to the incentive role of the assessment method. Starting from the concrete practice, under the premise of ensuring students' good adaptability, a number of measures focusing on cultivating students' engineering ability and innovation ability are introduced in the assessment. Students' attention to practical projects, academic performance and competition results have been significantly improved, which reflects the effectiveness of this reform to a certain extent.

Keywords: OBE education concept, Machine Design, Assessment method.

1. Introduction

Outcome-based education (OBE), which requires teaching to be student-centred and outcome-oriented, is the core spirit of professional accreditation in engineering education [1-3]. Under the concept of OBE education, around the requirements of engineering certification, the teaching of mechanical and electronic engineering should ensure that the training requirements for engineers are met, and the graduates of mechanical and electronic engineering should have the ability to solve complex engineering problems and a certain degree of innovation.

"Machine Design" course is a core course for mechanical and near-mechanical majors, mainly studying design theory and method of general parts of general size[4]. The teaching content is complicated, knowledge points are numerous and scattered, relatively abstract and very practical. There are many problems in teaching, such as students' unclear understanding of knowledge points and the difficulty of combining theory with practice. The knowledge points are too scattered, so that the whole knowledge system is divided, and the theory can not be landed for a long time, resulting in students' lack of attention, lack of enthusiasm for learning, little interest in the major, and lack of professional identity[5]. In addition, the "one test" assessment method limits the development of students' individuality and comprehensive quality, is not conducive to stimulate innovation, and is not conducive to the cultivation of applied engineering talents [6-7]. Therefore, there is an urgent need to carry out the reform of the assessment method of "Machine Design" course, do a good job in the process of assessment, take students as the center, and fully mobilise students' learning enthusiasm and subjective initiative.

2. Overall Goal of Assessment Method Reform

2.1. Highlight the nature of the course, highlight the student's main position, and establish the whole process assessment method.

The nature of "Machine Design" course is a design course centred on the design of general-purpose parts of general dimensions, which is a core professional course more closer to engineering practice than the basic course, and involves a larger amount of calculation of the basic course content, which is not suitable for setting in-depth examination questions in the examination paper.

Most of the prerequisite courses of "Machine Design" are arranged in different semesters with "Machine Design", and there is a time gap of varying length. Due to the time difference, many knowledge of the prerequisite courses are seriously forgotten by the time they learn "Machine Design" course. For the students of local applied undergraduate colleges and universities, the above problems are even more serious because of their relatively weak foundation, insufficient concentration and low enthusiasm for learning.

However, the contemporary college students have active thinking, strong practical ability, easy to accept new ideas, and strong adaptability. Therefore, it is necessary to establish a whole-process assessment method that takes students as the main body and focuses on cultivating engineering ability.

Adhering to the teaching concept of "student-centred" in the teaching process, through the experiential teaching of "case discussion, scenario simulation, practical training," mobilising students' learning enthusiasm and subjective initiative.

2.2. Create good external conditions to ensure the smooth progress of the assessment process.

A good assessment environment is the objective conditions for the smooth progress of the assessment process, which

mainly includes sufficient time for course practice, high-quality experimental resources, free and active classroom atmosphere and fair and impartial judging standards[8]. Only by fully creating a good external environment for each assessment session, can we improve students' acceptance and participation in the assessment method and achieve the goal of using the assessment method to promote the cultivation of engineering ability[9-10].

3. Assessment Method Reform Practice

3.1. Assessment link

" Machine design" course is based on the concept of monitoring the whole process of assessment. The total grade of the course is divided into two parts: the usual grade and the final grade, with the usual grade accounting for 40% and the final grade accounting for 60%. The usual grade consists of four parts: (1) case study presentation, accounting for 10%; (2) case and knowledge discussion, accounting for 10%; (3) post-class homework and class quizzes, accounting for 10%; (4) applied experiments, including experimental programmes, experimental operations, experimental reports, etc., accounting for 10%.

3.1.1. Case Study Presentations

Teaching Objectives:

(1) To deepen the cultivation of basic knowledge and practical ability of machine design and to exercise the communication ability and teamwork ability through the experiential teaching method of team-based students' on-stage presentation;

(2) Get the preliminary exercise of consulting literature, reading related technical data and investigating and researching ability;

(3) To gain further insight into engineering practice.

Implementation Programme:

Aiming at the important knowledge points of key chapters, find their practice cases in engineering practice or life, read and analyse the related knowledge content, carry out the modelling of mechanical problems and design calculations, and then summarize, sort out and write a report to be made into a PPT. take the group as a unit, every four people form a group to analyse the same case. Before the class, lots will be drawn to decide the main reporter of each case to present on stage, the presentation time is 10 minutes, and the teacher will comment after the presentation is finished. At the end, each person will submit an analysis report, including the electronic version of the PPT and the electronic and paper version of the Word document, in which the task and contribution of each student should be indicated.

Case finding direction can be about industrial robots, transporters and other engineering problems, but also about washing machines, dishwashers and other problems in life, etc., the research direction and content of the study as broad as possible, can broaden students' knowledge, enhance students' self-learning ability, and give full play to the student's dispersive thinking and subjective initiative.

Case study presentation time: the next week after the end of the corresponding chapter of the case (can be adjusted according to the actual teaching situation) the first fifteen minutes of the class.

Examples of cases:

Examples of machine design practice cases are tried as follows:

(1) Design of transmission device for belt conveyer. (Belt

drive)

(2) Design of gear transmission in two-stage cylindrical gear reducer. (Gear drive)

(3) Selection and checking of bearings in two-stage cylindrical gear reducer. (Rolling bearing)

(4) Design of shaft in two-stage cylindrical gear reducer. (Shaft)

(5) Design of bionic robot structure. (Integrated design)

(6) Mechanical design creative gizmos. (Integrated design, Innovation and Entrepreneurship)

(7) Optimised design of six-axis palletising robot arm. (Structure optimisation; CAE)

(8) Six-axis palletising robot dynamics simulation analysis. (Dynamics calculation; CAE)

3.1.2. Case and Knowledge Discussion

Teaching Objectives:

(1) Deepen students' learning of the basics of machine design;

(2) Based on theoretical analysis, cultivate the ability of logical thinking in scientific analysis, modelling of mechanical problems, mechanical analysis, design calculation and its engineering application;

(3) Exercise students' communication ability and expression ability.

Implementation Programme:

In the discussion class, the teacher proposes the problems to be discussed, 2-3 per class. Students work in small groups to analyse the problems under the guidance of the teacher, build mechanical models and carry out mechanical calculations. At the end of the session, each student will submit an analysis report, including the analysis process and final conclusions.

Discussion class time: the seventh or eighth week, all students must attend, otherwise the discussion grade will be zero.

Examples of problems in discussion class:

Discussion problems can be combined with engineering practice or with secondary projects on campus.

1. Discussions in conjunction with the on-campus secondary project, Six-axis palletising robot is shown in figure 1.

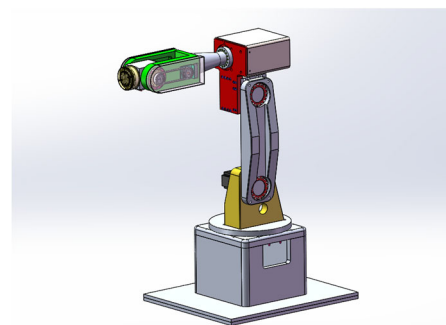


Figure 1. Six-axis palletising robot

2. Discussed in conjunction with practical engineering problems.

(1) Question: What is the best arrangement of worm gearing in multi-stage transmission? Bevel gear drive why often arranged in the high-speed stage?

(2) Analysis: according to the characteristics and needs of high-speed stage, medium-speed stage and low-speed stage, combined with the characteristics of worm drive and bevel gear drive.

(3) Mechanical modelling can be carried out to complete the mechanical analysis and get the conclusion.

3.1.3. Post-class homework and class quizzes

Teaching Objectives:

(1) To master the design principles and methods of general-purpose parts and the general rules of machine design, and then to have the ability to comprehensively apply the knowledge gained to research and improve or develop new parts and components and design simple mechanical devices.

(2) Ability to apply standards, specifications, manuals, atlases and consult relevant technical data.

Implementation Programme:

After-class homework: to complete the after-class homework, firstly, students are required to briefly describe their thoughts before answering. Secondly, students are required to answer the questions with clear steps and add necessary textual descriptions to make the logic clear and the answers complete.

Classroom quiz: first of all, pay attention to students' learning process assessment. According to the characteristics of the "Machine design" course, more knowledge points, more key points, after every two (each three or four chapters, a total of four) content of the lecture, a classroom quiz of the stage of learning content. Can use the "class cubic" "learning through" and other commercial software, flexible arrangements for the crowd answer, answer, quiz and mutual evaluation and other small links, because the software automatically generates the statistical results of the students' knowledge mastery, so that students understand their own mastery of knowledge in a timely manner and in class. As the software automatically generates the statistical results of students' knowledge mastery, it allows students to know their knowledge mastery and ranking in the class in a timely manner, so as to stimulate the students' sense of winning and classroom participation. At the same time, it also facilitates teachers to analyse students' learning situation and adjust their teaching plan. Of course, this feedback information from students in the classroom also provides an objective basis for teachers to give students' regular grades.

3.1.4. Applied Experiments

Teaching Objectives:

(1) To enable students to further master the structure, types, characteristics and applications of various commonly used parts;

(2) To be familiar with the connection methods commonly

used in various machines and the structure, type, performance and application of the relevant connection parts;

(3) Understand the characteristics and applications of various transmissions, and be able to design and calculate the transmission;

(4) through the gearbox disassembly experiments, can make students have intuitive understanding of the various parts of the gearbox, further understanding and mastery of the structural significance of the parts, processing technology, installation methods, for mechanical design of integrated courses to consolidate the foundation.

(5) To enable students to master the basic test methods of mechanical parts characteristics, the use of commonly used test instruments and data processing methods, to cultivate students to use experimental methods to study and design the preliminary ability of machinery, the ability to find out problems and comprehensive analysis of the problem, as well as the ability to innovate independently.

Experimental Requirements

The total number of hours in the experimental course is 8, divided into 4 experiments. Through the experiment, students can get to know the typical parts, study the static and dynamic characteristics of the bolt group, study the efficiency of gear and worm transmission, and understand the function and design method of each part by disassembling and assembling the reducer. Students are required to be able to complete the pre-study on their own, understand the experimental programme, carry out the experiment and write the experimental report.

3.1.5. Final Examination

It is a closed-book written test, and the score of the test paper is converted into 60 points.

3.2. Evaluation Criteria

Each assessment session adopts a percentage standard. Except for the test paper grade which is converted into 60 marks, all other sessions are converted into 10 marks.

Table 1 lists the standards of excellence corresponding to each assessment component, which are evaluated as excellent (90-100 points), good (80-90 points), medium (70-80 points), poor (60-70 points), unqualified (less than 60 points) in five grades according to the degree of completion of the students respectively. The standards of excellence for each assessment component are shown in Table 1.

Table 1. Criteria of excellence for each assessment component

Assessment Sessions	Criteria for excellence
Case Study Presentation	Access to information, skilled use of knowledge, able to clarify their own views and ideas, able to co-operate and communicate with other students to solve problems together, PPT presentation is logical and clear.
Case and Knowledge Discussion	Capable of grasping the main points of problem analysis, deep understanding of the basic theories learnt, independent thinking, able to establish a mechanical model, correct mechanical calculations, active participation in the discussion, able to articulate their own views and ideas, arguing the problem in a clear and precise manner.
Post-class homework and class quizzes	Actively participate in the quiz, answer correctly, strictly follow the requirements of the assignment and complete it in time, completely and accurately grasp the basic content of each chapter and the key points, difficult knowledge, have the ability to cite one to reflect the other, answer the questions correctly, the steps are complete, the logic is clear, and the format is neat.
Applied experiments	The format of the laboratory report is complete, complete with attachments, the measurement method is correct, the experimental data is recorded accurately, the idea is clear, the measured data or graphs can be analysed and draw the correct conclusions, and fully equipped with the experimental project is expected to cultivate the ability of
Final Examination	A paper grade of 90 or above

It should be noted in particular that the specific assessment

forms and evaluation criteria involved in the assessment are

fully and clearly introduced in the first class, urging students to pay attention to the learning of this course, motivating them to exert their subjective initiative, and improving the effectiveness of the reform of the assessment method.

4. Analysis of Rationality and Innovation

(1) Strengthen the process of assessment: the use of case study presentations, case and knowledge discussion, classroom quizzes, post-course assignments and applied experiments and other ways to carry out the process of assessment, to avoid a test to determine the grades, which is conducive to the cultivation of students' self-consciousness and creativity in learning.

(2) Strengthening students' sense of independent learning and cultivating their communication and teamwork skills: Through the "case study presentation", students are guided to think and explore actively. Change students' traditional view of learning, let students turn passive learning into active exploration, stimulate students' subjective initiative and learning enthusiasm. Focus on cultivating students' teamwork and communication skills.

(3) Focus on the examination of students' comprehensive analysis and problem-solving ability: knowledge discussion class, through the creation of practical scenarios, provide background information, design some flexibility, broad knowledge, comprehensive application of knowledge ability of the "problem solving" type test questions, including the parts of the analysis of the force, material performance analysis and failure analysis, etc., to let students According to the materials provided, independent analysis and exploration, from which to put forward high-quality problems, and put forward their own solution to the problem. There is no single way to solve the problem and the answers are diversified. In the marking criteria, emphasis is placed on examining students' comprehensive analysis ability and stimulating students' sense of innovation.

5. Evaluation of the Effectiveness of The Assessment Method Reform

The reform of the assessment method has been applied to the 2019 and 2020 grades of students in the institute, and after the case study presentation, case and knowledge discussion assessment, the two classes of students are clearer and more accurate in terms of the overall level of the design of gears, the design of shafts, the calibration of the bearing life and the standardisation of the document writing compared with the students of previous years in the mechanical integrated course design after "Machine Design" course. Many students also used Adams, SolidWorks and other software to complete the simulation and analysis of other mechanisms, applying what they have learnt flexibly. Students also showed obvious interest in the tournaments, put more energy, and achieved good results in many tournaments. The exploration of the reform of the assessment method has achieved initial results, and the existing assessment methods will be continuously improved in the future, so as to promote learning by examination, urge students to correct their learning attitudes, and promote the steady improvement of learning ability, application ability and innovation ability. The examination will be used to promote reform, urge teachers to collect a wide

range of information, prepare topics that are closely related to engineering, and establish a virtuous cycle of teaching and assessment.

6. Conclusions

The study aims to strengthen students' knowledge and improve their ability to solve complex engineering problems and innovate by reforming the assessment methods of the "Machine Design" course under the OBE educational concept. By highlighting the characteristics of the course, the students' leading role, and the role of motivation, multiple assessment methods, such as case study presentations, discussion sessions, assignments, and experiments, were used to successfully stimulate students' enthusiasm and subjective motivation in learning. After the reform, students have achieved significant improvement in academic performance and innovation, reflecting the effectiveness of the reform of the assessment method. The reform is reasonably innovative and emphasises students' independent learning, teamwork and problem-solving skills, providing a positive impetus to students' all-round development.

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