Teaching Reform of Engineering Mechanics Course Based on OBE Mode with Computer Aid

Ran Lin$^{1,*}$

$^1$Yunnan Technology Business College, China, 651701

*Corresponding author e-mail: linran@yngsxy.net

Abstract. Engineering mechanics is one of the important professional basic courses in civil engineering. The theoretical knowledge in traditional teaching is taught by the teacher on the blackboard, and the students are in a non-dominant position, ignoring the learning output. In this paper, the teaching reform of engineering mechanics based on Outcome Education (OBE) mode is practiced in a complete teaching cycle, and feedback and adjustments are made according to the course evaluation. Through the support of computer big data, complete a series of teaching methods. Begin to continuously improve the teaching process and carry out continuous operations to improve student autonomy and focus on student learning output. The degree of achievement of teaching objectives is evaluated.

Keywords: Civil Engineering, Teaching Reform, Engineering Mechanics, OBE, Big Data

1. Introduction

The Engineering Mechanics course is one of the important professional basic courses in civil engineering. It is a bridge between public courses, professional basic courses and professional engineering courses. In the previous training plans and syllabus, the theoretical knowledge of the course content is all taught by the teacher, and the assessment method consists of the final exam and the experiment. This "teacher-teaching, content-oriented" teaching organization has shown significant advantages and disadvantages in practice. The advantage is that the teacher can fully control the teaching process. The theory is directly provided by the teacher after processing. If the student can follow it well, he can receive the knowledge efficiently, and therefore can get good results in the closed book examination [1-3]. The shortcomings are also very significant: First, the students are in a dominant position, thinking that "teachers are responsible for learning" and lack of initiative; second, the teacher's focus is almost entirely on the content of the lectures, ignoring the students' learning output. In addition, the theory of engineering mechanics is more abstract. Pure teaching tends to cause student burnout, and the information acceptance rate and retention rate are low. The engineering mechanics knowledge system is logically strong [4-6]. Failure to master the leading concept often leads to the failure of subsequent knowledge. Over time, some students can't keep up with the progress, vicious circle, and poor knowledge mastery, which can't meet the requirements of professional training.
2. Teaching reform ideas
Under the background of national higher education reform, cultivating high-level engineering and technical talents with practical ability and innovative spirit has become one of the main goals of engineering education. The Engineering Mechanics course requires students to master the basic knowledge and related applications so that they can apply the basic theories and methodology of engineering mechanics design calculations in civil engineering related occupations in the future. However, in the teaching process, the teacher noticed that many students reflected that the basic concepts of engineering mechanics courses are complex, the formula is complicated to derive, and the theory is not easy to understand. It is a difficult course to learn. In order to improve this situation, many engineering mechanics courses have carried out different educational reform studies. In order to improve students' interest in the course, to better grasp the core content of the course, and to acquire the necessary professional and technical skills, we should teach the engineering mechanics course to the current "teacher-teaching, content-oriented" teaching organization. The transformation of the "student-oriented, learning output-oriented" approach, that is, the teaching reform of engineering mechanics based on the OBE engineering education model.

OBE is based on the Outcomes-based Education model. Its biggest feature is to change the content of the traditional teaching model to the actual output needs of students. Based on the OBE concept, teaching reform should continue throughout the curriculum teaching activities: practice a new teaching model in a complete teaching cycle, and feedback and adjustment according to the curriculum evaluation, aiming to initiate a continuous improvement of the course teaching process and make it can continue to run, as shown in Figure 1.

3. Teaching reform methods
The reformed teaching content, teaching organization form and course assessment are all based on the student's learning output, changing the knowledge and ability requirements of the textbook catalogue form, and the teaching objectives and teaching links of the engineering mechanics curriculum should be redesigned.

(1) Setting of teaching objectives
The past teaching objectives are expressed as “mastery: basic concepts, basic principles, basic methods and basic experimental operation skills of engineering mechanics, laying the foundation for follow-up course learning”, which is too general and only emphasizes the mastery of knowledge and does not propose engineering ability. Based on the OBE mode, the following five teaching objectives are set.

1) Master the basic concept of engineering mechanics, simplification and balance of force system, balance of object system, friction balance, internal force technology of plane simple truss, tension and compression of bar, torsion of circular shaft, bending of beam, theory of plane stress state, stability of pressure bar, etc.

2) Master the application of rigid body equilibrium equation, master the calculation of internal
forces of components, master the analysis of the strength, stiffness and stability of basic components.

3) Master the basic mechanical properties of materials and basic experimental methods, learn to apply basic concepts, basic theories and basic analytical methods to analyze and solve engineering problems, and lay a necessary foundation for learning a series of follow-up courses.

4) Master the routine measurement methods and operational skills of the main engineering elements in engineering mechanics, observe and analyze engineering phenomena, process experimental data, obtain effective results, and use the above information to verify relevant theories and summarize correct conclusions.

5) After finishing this course, students should have certain mechanical thinking ability, observation ability, analytical ability, calculation ability and basic experimental ability, and be able to solve related problems encountered in study and work, and at the same time, lay a good foundation for analyzing and solving more complex practical engineering problems.

The newly established teaching objectives define the student's learning outcomes, namely Outcomes, which emphasizes the relationship between knowledge mastery and application, as well as the corresponding engineering capabilities gained through knowledge application. The course is designed to ensure that students achieve the above-mentioned expectations when they finish class and graduate. Therefore, teaching organization, implementation and evaluation are based on this.

(2) Setting of teaching links

In order to cultivate students' engineering knowledge, problem analysis, design/development solutions, research and communication skills, the course teaching process is divided into four parts: classroom teaching, discussion class, course project and experiment.

1) Classroom teaching aims to develop students' basic understanding of engineering knowledge, problem analysis and design/development solution capabilities, and to teach the basic concepts, formulas and related calculation methods of the course, including statics and mechanics of materials.

2) Discussion class aims to develop students' understanding of engineering mechanics engineering knowledge and communication ability, discusses the development of engineering mechanics, the balance of objects, the main assumptions of materials, the deformation forms of components, internal forces and internal force diagrams, and the stress and strength of components.

3) The course project trains students' problem analysis, design/development solutions and communication skills. Taking the beam design of combined forces as the content, combining the teaching process of tensile and compressive strength conditions, torsion strength conditions, shearing and bending strength conditions of components, students are required to complete the reasonable design of beams.

4) Experimenting and cultivating students' research and communication skills, conducting confirmatory experiments on the basic principles and laws of the course, including the determination of friction factor, the determination of the center of gravity, the tensile and compression experiments of low carbon steel and cast iron, the test of normal bending stress, torsion failure experiments, fatigue and impact resistance experiments.

4. Analysis of teaching reform and teaching operation of engineering mechanics based on obe mode

In the fall semester of the 2016~2017 school year, the engineering mechanics teaching reform and teaching practice of civil engineering majors were completed, the students' achievement of learning output was assessed, and the questionnaires set by the students on the course teaching were collected. The achievement of teaching objectives is calculated from the results of each link. The test paper is decomposed according to the teaching objectives, corresponding to the targets 1, 2, and 3, and the weights are 0.4, 0.45, and 0.15, respectively. The weights of targets 1 and 5 corresponding to the discussion link are both 0.5. The weights of targets 2, 3, and 5 corresponding to the project link are 0.2, 0.6, and 0.2, respectively. The weights of targets 4 and 5 corresponding to the experimental session are 0.8 and 0.2. The statistics of each teaching session are shown in Table 1. The achievement of each teaching goal is 83.4%, 63.1%, 76.7%, 91.2% and 93.8%, respectively, indicating that they have been
achieved; but the achievement of goal 2 is low, indicating that some students are The correct understanding of the physical meaning of the three equations of constant total flow and the learning output of the integrated application part need to be consolidated relative to other parts.

Table 1. Correspondence and weight of the scores of the course teaching and teaching objectives.

|                      | Teaching goal 1 | Teaching goal 2 | Teaching goal 3 | Teaching goal 4 | Teaching goal 5 |
|----------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Examination paper    | 1148            | 972             | 367             | -               | -               |
| discuss              | 166.2           | -               | -               | -               | 166.2           |
| project              | -               | 65.6            | 196.8           | -               | 65.6            |
| experiment           | -               | -               | -               | 255.28          | 63.82           |
| sum                  | 1575            | 1645            | 735             | 280             | 315             |
| Degree of achievement| 83.4%           | 63.1%           | 76.7%           | 91.2%           | 93.8%           |

Among them, the test scores are normally distributed: excellent 14.28%, good 42.86%, medium 34.29%, and 8.57% pass, which also reflects the flexibility of some students to apply the basic principles, rather than the memorization of a single "knowledge point", but Some students have poor comprehensive use, and the degree of discrimination between test papers is good.

In addition, an anonymous questionnaire was designed to compare the achievement of learning outcomes to assess students' self-awareness of learning. The students' self-evaluation of the achievement of the five teaching objectives were: 77.6%, 71.5%, 64.1%, 71.2%, 55.6%, except for the target 2, which was lower than the scores of the teachers in the course evaluation. This also shows that the achievement of course learning output is based on the outline evaluation, paying attention to the students' mastery and achievement of the course content, while some students are more eager to learn the content of life or professional guidance in the questionnaire. Because during the questionnaire survey, students have not yet studied professional courses such as water pollution and air pollution control, and have not yet conducted curriculum design. They also lack active contact with engineering mechanics knowledge content and follow-up professional courses and daily phenomena. Therefore, they are especially shown in the third and third The 5 goals are less successful. In the future teaching links, we should pay more attention to explaining the relationship between engineering mechanics content and the follow-up course content, and explain the relationship in case form. Moreover, in addition to the evaluation of students who are studying engineering mechanics, a questionnaire survey can be conducted again for the students at the next level to understand whether the students have a deeper understanding of the supporting role of engineering mechanics in the follow-up course of professional courses. .

Moreover, 82.86% of the students believe that the post-teaching engineering mechanics course can make them understand the knowledge system of civil engineering, and explain the principle of “backtracking design” of the project, which supports the index points in the professional graduation requirement matrix.
5. Conclusion
In the 21st century with the rapid development of information, based on the OBE engineering education model, the teaching reform of engineering mechanics is based on the learning output of students. With the aid of computer means, the teaching objectives, teaching links and assessment methods of the engineering mechanics course can be redesigned and practiced in a complete teaching cycle. The engineering mechanics course teaching reform based on the OBE teaching model, and feedback and adjustments based on the course evaluation, start the continuous improvement of the course teaching process, improve student autonomy, pay attention to student learning output, and continue to operate.

Acknowledgement
Research and Practice on the Construction of Applied Undergraduate Specialty Fine Curriculum --A Case Study of the Construction of Engineering Mechanics.

References
[1] SUN Xu-hua. The Construction of English Teaching Mode in Senior High School Based on OBE Theory[J]. Overseas English, 2018(5).
[2] Jiang Wei,Sun Litong,Zhang Xiwen. Research on achievement assessment method for course objectives of bridge engineering based on OBE[P]. Proceedings of the 2019 4th International Conference on Social Sciences and Economic Development (ICSSED 2019),2019.
[3] Ford R, Vigentini L, Vulic J, et al. A Massive Open Online Course (MOOC) on engineering mechanics: data analytics informing learning design and improvement[J]. Australian Journal of Mechanical Engineering, 2019(3):1-10.
[4] Bir D, Ahn B. Applicability of online Mechanics of Materials course for engineering undergraduate students[C]// Frontiers in Education Conference. 2016.
[5] Ru DONG,Ya-Ning ZHANG,Juan DU. Engineering Mechanics Course Teaching Reform in the Concept of Modern Engineering Education[P]. 3rd International Conference on Education and Social Development (ICESD 2017),2017.
[6] Weiwei ZHU,Jun DU,Zhigang QIU,Guojian FENG,Xia LI. Mechanics of Materials Course Reform Exploration of Civil Engineering in Kunming University[P]. 3rd International Conference on Society Science and Economics Development (ICSSED 2018),2018.