

# Practice and Exploration of Service-oriented Engineering Training Teaching System under the Concept of OBE Engineering Education

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**Abstract**—Aiming at the problems such as the convergence of teaching contents and evaluation methods, the limited participation of students in the teaching process and the inadequate cultivation of practical and innovative abilities, this paper puts forward a method of adopting OBE teaching concept to carry out service-oriented reform of engineering training teaching system. This paper also designs the service method from three aspects: the formulation, realization and evaluation of expected learning results, which provides a reference model for the sustainable development of engineering training.

**Keywords**—Engineering training; OBE; Engineering education; Education reform

## I. INTRODUCTION

Engineering training is a compulsory course for training high-quality engineers and technicians. It plays an irreplaceable role in improving and developing students' innovative consciousness, practical ability, labor concept and scientific style of integrating theory with practice. The curriculum reform of practical, open and comprehensive engineering training has been carried out continuously in domestic colleges and universities, which has played an important role in promoting the quality of engineering training teaching [1]. However, in the process of internationalization of Engineering education, the quality of personnel training must reach the corresponding level of professional certification of Engineering education. Under this background, engineering training needs to pay more attention to the training of practice, engineering quality and innovation ability. The concept of results-oriented engineering education is the mainstream idea of engineering education reform in developed countries of higher education in Europe and America. It is also the recognized accreditation standard of Engineering Education in the member countries of the

Washington Agreement. It plays an important role in the construction of curriculum and evaluation system of higher education in the United States, Japan and Europe [2-4].

China joined the Washington Agreement in 2016 and became one of its signatories. The concept of OBE engineering education has gradually been adopted as the standard of engineering education professional certification by domestic universities. Some domestic universities have redesigned their engineering courses according to OBE standards and achieved some reform results [5-7]. However, there are obvious differences between eastern and Western civilizations in traditional culture, education mode and thinking mode. The practice of OBE concept in domestic engineering training courses is still in the exploratory stage. Guided by the concept of OBE engineering education and combined with the actual situation of engineering training teaching in China, this paper starts with the redesign of engineering training teaching and puts forward the teaching goal of realizing and continuously improving engineering training by means of service. Practice shows that the service-oriented engineering training teaching system under the concept of OBE has a significant effect on improving the quality of engineering training teaching and the level of training innovative engineering and technical personnel.

## II. SIGNIFICANCE OF SERVICE REFORM OF ENGINEERING TRAINING

After years of exploration and practice, educational experts have basically reached a consensus on the teaching system of Engineering training. That is to build an inclusive and open teaching system of "thick foundation, multi-level, multi-module, comprehensive and innovative". In the specific implementation, the teaching process is divided into cognitive

training, comprehensive training and innovative training. The training content of each level is composed of several modules, and the operation of the teaching process is driven by products or projects [8]. However, in teaching practice, due to the convergence of evaluation methods, students are required to complete the same tasks in a certain time, resulting in more basic and verifiable modules, less comprehensive and innovative modules, and students' initiative and enthusiasm to participate in practice are not mobilized.

The teaching process of engineering training can be roughly divided into curriculum design, curriculum implementation and curriculum evaluation feedback. The implementation of curriculum mainly depends on the improvement of curriculum design and curriculum feedback. The teaching ideas of "student-centered" and "learning-centered" have become common understanding. The concrete manifestations are as follows: Firstly, teachers are no longer the masters of teaching activities, but create scenarios and provide support for the development of teaching activities; secondly, teachers are no longer the designers of teaching contents, only presuppose teaching objectives, but give students the right to achieve the goals in what ways, and make corrections when students deviate from the presupposed goals in the design of teaching contents and ways of realization; thirdly, teachers provide corrections when students deviate from the presupposed goals. Fourthly, new services for innovative activities are derived from the service for teaching activities to expand the depth and breadth of teaching. The service-oriented teaching of engineering training conforms to the concept of OBE engineering education. The realization of OBE concept can not be separated from the assistance of service-oriented, and the development of service-oriented can not be separated from the support of OBE. The two interact, influence and promote each

other, forming a common development and benign interaction relationship.

The service-oriented reform of engineering training is to change the current convergence of teaching content and evaluation methods, the "teacher-centered" teaching process, and the inadequate cultivation of practical and innovative ability in engineering training. At the same time, combining the three elements of OBE concept, we should integrate its contents into the service-oriented reform, promote the transformation of engineering training to the way of attaching importance to the cultivation of students' interest and innovation ability, and promote the transformation of engineering education personnel training to the direction of high-quality, strong ability, broad vision and attach important to responsibility.

### III. SERVICIZING REFORM OF ENGINEERING TRAINING TEACHING UNDER THE CONCEPT OF OBE

#### A. Establishment of Expected Learning Outcomes and Service-oriented Approaches

Intended learning outcomes (ILO) is an important manifestation of OBE's emphasis on practice orientation and ability enhancement. To formulate the intended learning results of engineering training courses, the following aspects should be considered: First, the intended learning outcomes should meet the requirements of five indicators: student development, professional training objectives, graduation requirements, career requirements, and continuous improvement. These five indicators basically cover the engineering education professional certification standards stipulated in the "Engineering Education Professional Certification Standards (Trial Implementation)". (See Table 1 for details).

TABLE I. EXPECTED LEARNING OUTCOMES INDICATORS AND CONTENT DESCRIPTIONS

Indicator	Description
Student development	The cultivation and improvement of students' abilities of autonomous learning, problem discovery, problem analysis, innovative thinking, team spirit, communication skills and project management in the process of learning
Goal for major	The goal of major should be consistent with the direction of social and economic development, and conform to the orientation and mission of the school and the needs of professional stakeholders
Graduation requirements	Graduation requirements are educational objectives based on the level of cultural quality of engineering students and the characteristics of professional development.
Career requirements	In order for students to integrate into the workplace more smoothly, besides mastering the preliminary engineering skills, they should gradually cultivate the ability to analyze and solve complex engineering problems, mainly including original design, data analysis, debugging and operation, program optimization and so on.
Continuous improvement	Fostering the eyesight of student's development and the ability of solving engineering problems. Make students have critical thinking initially, support and encourage students to improve and improve existing programs, technologies and processes

Secondly, the intended learning outcomes should be "student-centered" and ensure the success of students of different majors and levels. The results of engineering training must show that students can really acquire certain abilities or enhance certain abilities through learning. Teachers can only help students achieve results by assistance. Therefore, the

intended learning results must embody the core idea of "student-centered". On the other hand, the level of students' ability development, analysis and understanding are not the same. The intended learning outcomes of "student-centered" are bound to be diverse. Teachers should formulate learning outcomes suitable for students at different levels, and they need

to ensure that students can achieve their learning outcomes ultimately through differentiated learning practices. Thirdly, the intended learning outcomes should be easy to quantify. Quantitative intended learning outcomes can not only help students evaluate their learning situation at any time, correct errors in time according to the deviations in learning, but also serve as important reference data for teachers to further improve teaching quality.

The process of service-oriented development of expected learning outcomes is actually a process of putting forward practical implementation strategies and methods. If there is no service-oriented process, the intended learning results are just a piece of paper, and there is no basis for implementation. Firstly, according to the specific conditions of different majors, we should further refine the intended learning achievement indicators to cover the technical knowledge and practical skills that the majors must master. We should also face the future development and strengthen the practice of teamwork, engineering management, component analysis, scheme demonstration and so on. Secondly, according to the requirement of differentiated development, we should modularize and fragment the detailed expected learning results, so that students can freely choose and combine the intended learning results modules according to their abilities and future development orientation. Finally, a teaching module is designed to meet the requirements of modular expected learning results. The process of students' learning is transformed into a process of combination and matching between modules, which not only meets the needs of differentiated and individualized learning, but also enables teachers' guidance work to follow a regular pattern, and ensures that the expected results can be achieved smoothly within the control of teachers.

#### *B. Realization of intended learning achievements and service-oriented approaches*

Achievement of results is the core link of putting OBE concept into practice, and it is also the decisive factor to achieve the teaching goal of engineering training. The intended achievement of learning depends largely on the design of teaching content. Generally speaking, the systematic, comprehensive, practical and innovative teaching content of engineering training should be highlighted according to the detailed indicators in the designated stage of the results and the training objectives and characteristics of the specialty. In terms of teaching methods, the main forms of teaching methods are "situational orientation", "problem orientation", "product orientation" and "case orientation". Combined with modern teaching techniques such as information technology, network technology and real-time communication technology, the software and hardware support is provided for students to devote themselves wholeheartedly to engineering training. To stimulate students' learning initiative, arouse students' desire to explore the unknown world, improve the quality of engineering training teaching, and ensure the realization of expected learning results. The service-oriented approach to the achievement process can be summarized as the following three points:

Firstly, the training module is designed carefully according to the expected results. The teaching module should not only embody the universality, practicability and convenience of teaching operation, but also highlight the personality, reflecting the difference of "student-centered" teaching. The supporting system of teaching module can also be combined with other modules to form a more comprehensive module, so as to cover all expected results, and ensure that the results can be achieved through the efforts of students.

Secondly, using VR technology to create engineering scenarios. The hardware environment of engineering training in domestic colleges and universities has been greatly improved, but some hardware lacks corresponding technical guidance in teaching practice, the utilization rate is not high, and the teaching effect is difficult to guarantee. In addition, in the mechanical processing of various equipment and accessories, such as: machine tools, cutting tools, etc., in the case of operational errors will cause unbearable safety accidents. High input, high hidden danger and low output are the main contradictions that restrict the realization of OBE achievements. VR technology is an effective means to alleviate this contradiction. VR can present engineering scenarios for students in a new way, and let students "immerse" in the virtual environment of "real" practice. It not only reduces the potential safety hazards in engineering training, but also provides a new mode for students to actively and efficiently expand practical skills.

Thirdly, we should construct a "micro-classroom" that links the interaction between teachers and students. Under the traditional engineering training mode, the interaction between teachers and students is limited by time and space. The communication between teachers and students is limited to the classroom, resulting in the estrangement between students and teachers. The students' doubts encountered in the training can't be answered in time by teachers and gradually lose their motivation and interest in learning. With the application of modern education methods such as "micro-classroom", "rain classroom" and SPOC based on network and real-time communication technology to engineering training teaching, the time and space limitations are gradually broken. From pre-class preparation, classroom practice to after-class review, teachers and students can maintain a good state of interaction.

#### *C. Evaluation of learning outcomes and service-oriented approaches*

Unlike theoretical classroom teaching, engineering training generally requires the completion of a complete project in a limited time and place. The course time is short and the teaching task is heavy. Students need to complete all the training modules in a few weeks, and have access to knowledge of different disciplines and different types of work. In addition, the serious imbalance of teacher-student ratio is a prominent problem that puzzles engineering training teaching. Therefore, teachers are often unable to evaluate each student objectively and impartially. In view of this, it is suggested that the service-oriented measures of learning outcomes evaluation should start from the following aspects:

First, establish a three-level linkage teaching evaluation system. The quality control of curriculum teaching is carried out at three different levels: school, engineering training center and training department. At the school level, the office of academic affairs takes the lead and designs the top-level evaluation system of engineering practice teaching in conjunction with colleges; the engineering training center is responsible for the formulation and revision of evaluation rules; and the training department is responsible for the specific implementation.

Secondly, relying on "micro-classroom" technology, we can alleviate the contradiction between the imbalance of teacher-student ratio. Restricted by space-time conditions, teachers often fail to make an objective and impartial evaluation of students' training situation in time and accurately. Short video push function in "micro classroom" can effectively alleviate this contradiction. Students make short video of training results and push it to teachers' clients. Even if teachers are not online for a while, it will not affect the objectivity of evaluation.

Thirdly, we should establish a student evaluation system based on "human-oriented". Students are the producers of learning outcomes and the objects of teaching activities. All teaching activities of teachers are based on students' learning outcomes, which is the embodiment of "people-oriented". Therefore, students' evaluation has important reference significance for improving teachers' teaching methods, promoting curriculum reform and improving the coverage of teaching content.

#### IV. CONCLUSION

Based on the concept of OBE engineering education, the service-oriented teaching reform of engineering training and the establishment of a service-oriented engineering training teaching system are not only the needs of engineering and technical personnel training in colleges and universities, but also the needs of engineering education reform. According to the three elements of the OBE model, the service-oriented reform of the traditional engineering training mode is put forward, which provides a new reference mode for the teaching reform of engineering training course. It will help students lay a solid foundation in the cultivation stage of engineering quality, such as knowledge, ability, innovation consciousness, team spirit and social responsibility.

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