Academic Education Publishing House
Higher Education and Practice Vol. 1 No. 4, 2024

Outcomes-based Teaching Reform of Introduction of Ships Based on Virtual Simulation Technology

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Abstract: The Introduction of Ships course is characterized by strong professionalism, perspective, and practicality, which is one of the core courses in the field of ship engineering. To solve the problem of poor teaching effect caused by the large amount of information and dispersion of the course, this paper proposes a reform plan for the education mode of Introduction of Ships based on the Outcomes-Based Education (OBE) concept and virtual simulation technology. Relying on the online virtual experiment platform, the course teaching resources are expanded and an integrated teaching model is constructed including pre-course, in-course, and post-course. The novel education mode is problem-oriented, closely integrates practical content with theoretical knowledge, and a customized teaching mode is realized through project-driven, case study, and comprehensive assessment and evaluation. A hybrid online and offline teaching channel is formed by synthesizing a variety of teaching strategies, so as to expand the flexibility of teaching activities. The proposed education mode can stimulate enthusiasm of students for active participation and independent learning, effectively achieve the student-centered teaching goal. Meanwhile, it has good expandability and can provide guidance and reference for the teaching of similar professional courses.

Keywords: Introduction of Ships; Education Mode Reform; Virtual Simulation Technology; OBE

1. Introduction

The Introduction to Ships course belongs to the core basic courses in the field of ship engineering, with distinctive professional features. It is one of the essential knowledge for practitioners in the fields of ship design, construction, inspection, maintenance, management, and other related fields. The scope of the course includes: ship structure, ship performance, ship equipment, ship construction process, ship design principles and so on. As a special means of transportation, the design, construction, and maintenance of ships are highly specialized and technically demanding [1]. Mistakes in any part of the process may lead to serious economic losses and even threaten the safety of the ship and its occupants. In view of the complexity and high risk of the ship engineering industry, it is crucial to strengthen the education of the Introduction to Ships course.

At present, the Introduction to Ships course is still dominated by the traditional teaching concept of knowledge irrigation and adopts the teaching form of “classroom face-to-face teaching”. Teachers and textbooks are the center, and the whole teaching process focuses on the teacher's own attention to the knowledge points. This teaching method lacks of interaction with students, which results in students receiving less personal attention. The results of course learning depend on motivation from students and discipline and encouragement from teachers, making it difficult to realize tailor-made teaching. Meanwhile, it is difficult to avoid the existence of a certain degree of “one-size-fits-all” phenomenon in the course assessment. Lack of differentiated assessment for students results in a lower sense of achievement of students. Therefore, in-depth reform of the existing education mode of the Introduction to Ships course to adapt to the needs of individualized teaching and differentiated assessment has become an urgent need to improve teaching effectiveness and learning experience of students [2].

2. Preliminaries

2.1 Outcome-based Education

Outcomes-Based Education (OBE) is an educational philosophy centered on expected learning outcomes [3,4]. It emphasizes the goal-oriented nature of instructional design and implementation process and takes the comprehensive development of knowledge, abilities, and qualities of students as a measure of educational quality. Under the guidance of this philosophy, educators need to clarify the objectives of the curriculum and design the teaching content, methods, and evaluation system according to these objectives to ensure that students achieve the established learning outcomes [5]. The education mode based on the OBE concept advocates a student-centered approach, focusing on personalized development and stimulating interest and motivation from students in learning. The mode emphasizes the competence-based approach, aiming to cultivate practical application abilities that are adapted to the needs of social development. Moreover, OBE education evaluation focuses on diversification, emphasizes the change of education and teaching concepts and practical innovation. It aims to effectively improve practical ability and innovation ability of students. Therefore, integrating the OBE concept into the Introduction to Ships course is an issue worthy of exploration and in-depth investigation.

2.2 Virtual Simulation Technology

Virtual simulation is an advanced computer simulation technology that simulates real-world systems, processes, or environments through computers [6-8]. It utilizes tools such as virtual reality, augmented reality, and simulation software to create high-fidelity virtual environments for experimentation, training, and design. Virtual simulation technology can model the behavior and performance of complex systems in the absence of physical prototypes or with real-world operation risks. Through virtual simulation, research and development costs can be significantly reduced, and training efficiency and safety can be improved. In addition, virtual simulation technology can provide an interactive learning experience that enhances the user's understanding of complex concepts, thereby effectively increasing motivation and learning outcomes.

The actual operation scenarios of ship engineering are complex and changeable, and the demand for practical teaching is extremely high. The core purpose of the course is to cultivate ship design, construction, and maintenance abilities of students, which cannot be improved without a real engineering environment. On-site teaching is an important means to improve practical ability of students. However, due to the constraints of space, equipment, safety, and other factors, it is difficult for all students to participate in on-site practice. Even if there are a small number of opportunities, most of them are based on observation, and students have fewer opportunities to operate in person. In view of this, the introduction of virtual simulation technology to empower the education of the Introduction to Ships course has become an effective solution [9]. This new education mode has become one of the important ways to realize the teaching mode of “technology + practice”, which is also the development trend of engineering education in the future.

3. Construction of Education Mode Based On OBE Concept and Virtual Simulation Technology

This paper describes the education mode of Introduction of Ships based on the OBE concept and virtual simulation technology from three aspects, namely, teaching model, teaching mode, and teaching channel, respectively.

3.1 Integrated Teaching Model

Following the student-centered teaching concept, an integrated teaching model is constructed as shown in Figure 1, which is divided into three parts: pre-course, in-course, and post-course.

The first part is pre-course study preparation. The teacher releases the syllabus, knowledge points of the course chapters, and course expansion learning resources before the course starts, so that students can view and pre-study anytime and anywhere before class. For the important and difficult content in the chapter, the teacher releases guiding questions on the online platform. Based on the guiding questions, the teacher guides students to utilize all teaching resources including search engines, generative AI, virtual simulation platforms, and other teaching resources to expand their learning. For the pre-study chapters,

corresponding quizzes are designed to consolidate the effect of pre-study.

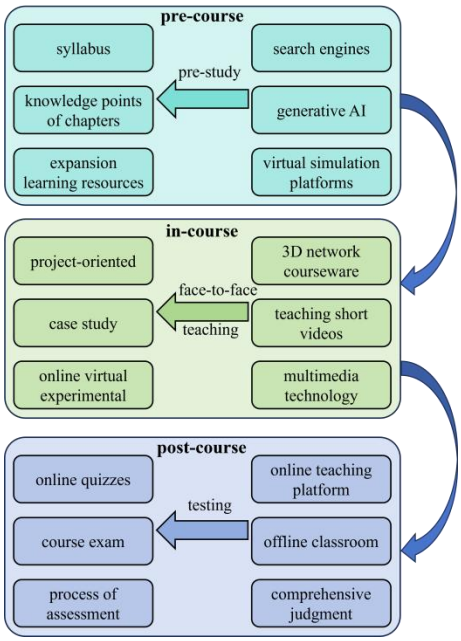

Figure 1. Integrated Teaching Model of OBE Concept Incorporating Virtual Simulation Technology

The next part is in-course implementation arrangement. The teacher conducts offline classroom face-to-face teaching with project-oriented teaching methods and case study teaching methods. Through three-dimensional network courseware, teaching short videos, multimedia technology, and other tools to visualize the course content [10]. Relying on the online virtual experimental platform, students are guided to actively participate in classroom discussions by completing projects on topics such as ship power systems, diesel engines, main propulsion devices, and ship auxiliary systems. Students are guided to practical engineering case studies through group reporting and interpretation to further form a correct outlook on life and values. Meanwhile, the research means of philosophy of science and technology is adopted to explore and solve the teaching problems in the Introduction to Ships course, to guide students to construct their ship electrical and electronic cognitive framework actively, and to improve the teaching effect.

The final part is post-course review assessment. After the class, the teacher will release online quizzes through the online teaching platform according to the schedule of the teaching calendar for the knowledge points of the course chapters. Students who are not advanced are contacted for interviews at the end of the class period to remediate weak points and improve their ability to reach them. The teacher uses timely communication tools to answer questions online, but also in the office or in the classroom face-to-face to answer questions and solve problems. At the end of the course, a comprehensive assessment is organized through the course exam. Through classroom performance, chapter unit test, experimental assessment, and final assessment of students to give comprehensive course grades, as the process of assessment of the comprehensive judgment basis. The multi-dimensional assessment method enables students to have a more comprehensive understanding and grasp of their course completion results, so that students can improve their personal understanding, enhance their professionalism, and become a seafaring talent with high-level professional practice ability.

3.2 Customized Teaching Mode

Grasping the teaching principle of being oriented to learning outputs of students, a customized teaching model is proposed as shown in Figure 2. It includes problem-oriented interactive teaching, project-driven blended teaching, and comprehensive assessment and evaluation with the OBE concept at the core, aiming to provide students with personalized and efficient learning experiences.

The first part is problem-oriented interactive teaching. Optimize and reform the traditional experimental practice teaching mode, which is mainly based on theory verification. With the help of virtual simulation technology into a problem-oriented, interactive teaching mode that combines theory and practice. The use of online virtual experiments to expand the traditional teaching methods, in the experimental time, duration, and form to give students greater autonomy. Through the high simulation effect of teaching for fun, students learn to master the knowledge in the near game and exercise the ability to solve complex engineering problems. Meanwhile, this teaching mode reduces the workload of instructors, saves laboratory resources, and improves the operational efficiency of the laboratory.

The next part is project-driven blended

teaching. The traditional teaching mode of the course adopts a teaching method that separates "principle-application" and "project-practice". This mode has a large time span, poor knowledge continuity, poor student initiative, and low motivation for independent learning. In view of this, a new blended teaching mode is proposed, in which project tasks are integrated into online teaching resources. In-depth theoretical teaching in the form of modularized sub-projects encourages students to explore the answers through simulation and experimentation. Meanwhile, the proposed teaching mode is committed to cultivating national sentiment and innovative thinking of students and realizing the comprehensive cultivation of knowledge, ability, and literacy.

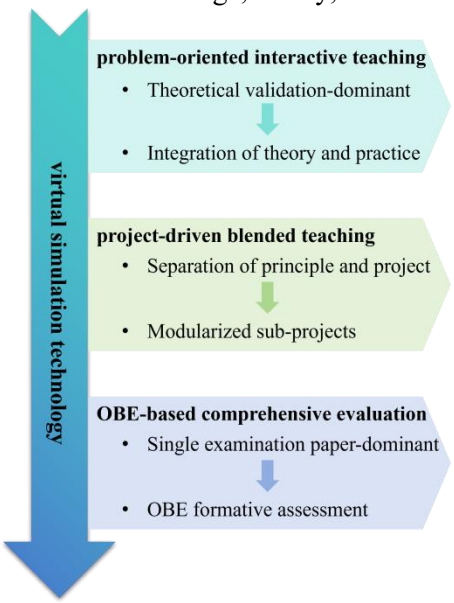

Figure 2. Customized Teaching Mode of OBE Concept Incorporating Virtual Simulation Technology

The final part is the comprehensive assessment and evaluation centered on the OBE concept. The traditional course assessment method of "one single examination paper determines the grade" is completely changed. OBE formative assessment reform for students is carried out through reasonably evaluated the achievement of students' abilities. Knowledge quizzes, situational judgment quizzes, and multi-subject evaluations are adopted to comprehensively assess knowledge acquisition and changes of students in behavioral habits. In the assessment criteria, quantitative indicators including students' classroom participation and scores on relevant tests, and qualitative indicators including changes in behavior and the use of information technology are introduced for comprehensive assessment.

3.3 Blended Learning Channels

Developing a teaching environment supported by virtual simulation technology, online and offline hybrid teaching channels are designed as shown in Figure 3. Through the deep integration of multiple teaching strategies, combine experimental operation with virtual simulation to realize the further expansion of theoretical teaching.

The first part is the construction and utilization of the online teaching platform. As the main carrier of teaching, the online teaching platform integrates rich teaching resources, including electronic teaching materials, video lectures, interactive discussion forums, and online tests. The teacher releases learning tasks through the platform, while students can independently arrange their study time to complete pre-study, study, and review. The online platform not only provides flexible learning modes but also tracks students' learning progress through data analysis, providing support for personalized teaching.

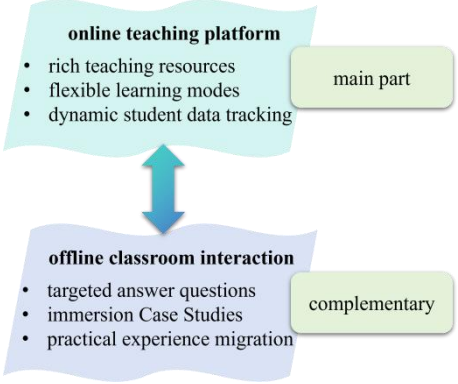

Figure 3. Blended Teaching Channels of OBE Concept Incorporating Virtual Simulation Technology

The next part is offline classroom interaction and practical operation. The offline classroom can be seen as a supplement to online learning. The teacher can target and answer the problems encountered by students in online learning. By organizing interactive activities such as group discussions and case studies, participation and learning effects of students are enhanced. In addition, students can enhance their practical experience in the offline classroom based on the knowledge accumulated on the online simulation experiment platform to improve their practical

ability.

4. Conclusions

The main goal of Introduction of Ships education is to cultivate seafaring talents with a high level of professional practice ability. The teaching of Introduction of Ships should follow the actual engineering background and ability development needs of students. Moreover, it is necessary to build a contextualized learning environment for students to promote the close integration of theory and practice. This paper takes virtual simulation technology as the support and constructs the education mode of Introduction of Ships based on the OBE concept and virtual simulation technology from three aspects: teaching model, teaching mode, and teaching channel, aiming to provide students with a customized and interactive learning space. This educational model has good operability, which is beneficial to improve the quality of education and teaching in the field of marine electrics. Meanwhile, it can be further extended to the training of marine electro technical officers and promote the goal of cultivating excellent engineers in the information age.

Acknowledgements

This work was supported by the grant Development of liquid cargo and electromechanical simulation operation system for LNG ship CBG3N21-3-3 and the University-level Teaching Reform Project of Dalian Maritime University No. BJG-C2024076.

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