

Reform of Teaching Mode of Ship Handling Practice Course under the TRIZ Theory

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Abstract: Ship handling course is one of the compulsory courses for the national first-class undergraduate majors (Navigation Technology). It has a certain theoretical depth and strong practicality. Due to the limitation of site, equipment and other conditions, the practice of the course is difficult to carry out, resulting in students' understanding of the course seriously restricted. MOOC is the product of "Internet+education", which has the characteristics of freedom, sharing and innovation. It can break through the limitation of vision and help to understand the concept and grasp the method. Through the combination of video, image and sound, it can stimulate students' senses, arouse their attention and interest, and improve their participation, initiative and creative learning ability. In order to achieve a good teaching effect, committed to the reform and innovation of the teaching mode of this course, the paper designed the "online offline on-site" three-dimensional teaching mode based on the TRIZ theory. Finally, it is verified that TRIZ theory is a good guide in the teaching reform of the course. Putting TRIZ theory into the teaching process will enable students to stimulate the innovation consciousness, enhance the learning enthusiasm of college students and cultivate the students' creative thinking.

Keywords: TRIZ Theory; Ship Handling; Reform of Teaching Mode; Practice of Teaching Mode

1. Introduction

The course is the core element of talent development. It is the course of study that is the most direct, central and visible aspect of the benefits that students derive from university.

The Ministry of Education has issued the Opinions on Accelerating the Construction of

High-level Undergraduate Education and Comprehensively Improving Talent Cultivation Capabilities, commonly known as the "40 Articles on Higher Education in the New Era".

The Ministry of Education, together with 14 central ministries and units, has jointly launched the "Six Excellence and One Top" programme. Not long ago, the Ministry of Education, the Ministry of Finance and the National Development and Reform Commission jointly issued the "Guiding Opinions on Accelerating the Construction of "Double First-Class" Higher Education Institutions", which explicitly put forward the strengthening of the core position of talent cultivation, and made it clear that the core of the construction of "Double First-Class" is talent cultivation. At the same time, the basic position of first-class undergraduate education in the construction of "double first-class" is made clear. The theme of the work conference on undergraduate education in higher education in the new era is to comprehensively revitalise China's undergraduate education, and to form an overwhelming momentum to make this matter take root and blossom in higher education institutions.

A three-year action plan will be used to make this matter really go into the hearts and minds of the people and every corner of the university, so that first-class undergraduate education and the training of first-class talents will become the fundamental tasks of institutions of higher education. To this end, the State has pointed out that "innovative teaching modes will be used to promote the popularisation of quality education, while teachers' application of information technology will be improved, teaching concepts will be updated, teaching methods will be improved, and teaching effectiveness will be enhanced."

Ship Handling is one of the compulsory courses for the national first-class

undergraduate programme of Maritime Technology, which is selected as one of the provincial first-class undergraduate programmes and the first national first-class undergraduate programmes in 2020, with a certain theoretical depth and strong practicability. Through the study of this course, students should be able to have the basic ability and quality of manoeuvring and emergency manoeuvring in special situations at sea; they should be able to pass the examination and assessment of ship manoeuvring related to the function of "Ship Navigation" stipulated by the national competent authority, and master certain knowledge and ability of management level.

In view of the strong practicality of this course, in order to achieve good teaching results, the TRIZ (Theory of Invention and Problem Solving) innovation method is integrated into the practical teaching process, and the "Yukun" ship, which is a specialised teaching internship ship of the university, is used as a platform to cultivate the comprehensive ability of students to solve complex problems and high-level thinking, so as to organically integrate the knowledge, ability and quality of the course. The organic integration of knowledge, ability and quality reflects the higher-order nature of the course; the large-scale ship manoeuvring simulator dedicated to the laboratory is used as a carrier to focus on the cutting-edge and modernity of the practical teaching content, enhance the interactivity of the students, and reflect the advancement of the teaching methodology; and the virtual simulation platform for ship manoeuvring is used as a tool to improve the participation of the students in the post-course learning, and to enhance the students' initiative and creativity in the learning ability. In this context, the paper reform and innovate the practical teaching mode of the Ship Manoeuvring course, design a three-dimensional teaching mode of "real ship-site-offline", enrich the teaching environment, establish a new assessment and evaluation system, and enhance the learning ability, innovation ability, and higher-order thinking ability of students. The programme is designed to enhance students' learning ability, innovation ability and higher-order thinking ability.

2. TRIZ Theory

2.1 The Main Elements of TRIZ Theory

TRIZ, or Theory of Inventive Problem Solving, is a set of theories and methods of technological innovation and a set of tools for solving all kinds of engineering and technical problems. It is centred on providing a very objective approach to innovation with rules to follow. It systematically summarises past human ideas in invention and innovation, and extracts a series of effective laws from them, which can be used to guide people to solve future problems in a systematic and efficient way[1]. The TRIZ method of innovation originated in the former Soviet Union, and was founded by a great engineer and inventor, Archie Schuler, and his colleagues, who analysed more than 2.5 million high-level patents around the world, and then summarised a set of theory and methodology in 1946, which is now known as "Theory of Inventive Problem Solving" (TIP). In 1946, they summarised a set of theories [2-4]. It is a brand-new innovation method, which can help people analyse problems systematically, quickly discover problems, essence and contradictions, accurately identify problems, explore directions, break thinking stereotypes, carry out logical and non-logical systematic thinking, predict future development trends according to the law of technological evolution, and help enterprises to develop competitive new products. TRIZ theory distills a set of solutions to complex technological issues. TRIZ theory is a set of systematic methods for solving complex technical problems, and its main purpose is to study the scientific principles and laws followed by human beings in the process of inventing and creating and solving technical problems.

TRIZ is not only a pure innovation theory, it is also a model that can help people form a more systematic and process-oriented thinking mode of innovation design, which helps people find innovative methods in what they are engaged in. After decades of development, TRIZ has entered a mature stage, and TRIZ theory has been accepted and applied all over the world [5]. Western developed European countries are in the world's leading position in the theory, technology and application research in the field of TRIZ. The introduction of TRIZ theory in China is relatively late, but in recent years

its theory has received attention from the academic community and the government, and is now being promoted and applied more and more deeply.

2.2 Problem-Solving Process Using TRIZ Theory

The general method of TRIZ to solve the problem of invention is: firstly, the special problem to be solved is defined and clarified; then, according to the method provided by TRIZ theory, the special problem to be solved is transformed into a similar standard problem, and a similar standard solution is summarised for the similar standard problem; and finally, based on the similar standard solution, the special problem to be solved by the user can be solved. The user's special problem can be solved based on the similar standard solution [6].

The problems we usually encounter are specific problems and the solutions sought are also specific solutions. The general approach adopted in the course of research is to quickly use one's experience to do a series of trials in an attempt to solve the problem as quickly as possible. However, contrary to expectations, this trial-and-error approach, while more effective on some simple problems, tends to take a long time to develop and consume more resources on some more difficult problems. As shown in Figure 1, the paper have improved it:

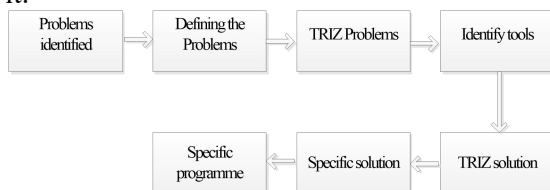


Figure 1. Problem-Solving Process Using TRIZ Theory

- (1) TRIZ theory first leads us to a very clear definition of the specific problem encountered, the clearer the definition of the problem, the greater the likelihood of solving the problem, if the problem has not been clarified, it is necessary to study the problem thoroughly before embarking on a solution;
- (2) Analyse the problem using causal and functional model analysis to find other alternative paths to break through the bottleneck of the problem, or to find the root cause of the problem, and then abstract this problem into a generalised problem;

(3) For this generalised problem, general solutions are found based on TRIZ tools such as standard solutions, principles of invention, scientific effect libraries, technological trends, etc., i.e. what are the general solutions to a similar problem.

(4) Bringing these generalised solutions into our specific projects translates into our own solutions.

TRIZ theory focuses more on problem analysis as well as borrowing from previous solutions and finding answers from similar problems in other fields. So the solutions obtained through TRIZ theory are usually proven usable, so they are highly reliable, easy to work with, and have less risk of project failure [7-9]. TRIZ theory is a very popular innovation designed theory and method, which has gradually got attention by many scientific research structures, companies and experts[10-13].

3. Practical Teaching Reform of Ship Handling Course by Incorporating TRIZ

3.1 Reform of the Teaching Model

Establishment of a shipboard teaching mode using the Yukun ship as a platform and TRIZ theory to concretise problems. "Yukun" is China's first specialised teaching ship for students majoring in seafaring (Figure 2), which can sail along the coasts of China and major ports around the world, and belongs to ocean-going ships with unlimited navigational zones, exporting a large number of high-end talents in shipping for China. In order to promote the in-depth integration of information technology related to ship manoeuvring and the teaching of navigation, the paper have designed a three-dimensional teaching mode combining "online-site-actual ship" with online resources such as catechism classes as the carrier and with students as the center.



Figure 2. Teaching Practice Vessel "Yukun"

(1) Before the class, online teaching is the main carrier, using teaching videos and interesting guiding questions to awaken the mind and stimulate students' curiosity, and students complete the questions set by the teacher in the process of independent learning by using catechism to achieve the knowledge and memory of the course content.

(2) On the scene, the teacher adopts a group learning mode, such as Figure 3, so that students can change from passive learning to active learning, actively share their learning achievements, and become the dominant player in the classroom, so as to realise that they can learn from teaching and learn to teach, and stimulate students' interest in participating in the learning process. For the key and difficult content, the teacher assists in explaining and simplifies the problems by using the hydrodynamic experimental platform and teaching video; for the application-oriented content, focus on combining information technology teaching, introduce the large ship manoeuvring simulator (Figure 4), ship collision avoidance manoeuvring simulator (Figure 5), stand-alone simulators, the ship force analysis system, and VR panoramic system into the classroom, so that the students can achieve the knowledge directly in the classroom, and apply in the application of Learning knowledge, reflecting on knowledge in application, and innovating knowledge in application. The focus of teaching is gradually changing from "explaining" to "promoting application".

(3) Based on the feedback from the pre-course and on-site teaching as well as the problems left behind by the students, the paper will focus on solving them during the teaching on the "Yukun" ship. In the course of "Ship Manoeuvring", ship berthing and de-berthing manoeuvring (Figure 6), ship mooring manoeuvring (Figure 7), ship manoeuvring experiments and so on belong to the key contents, and through the explanation on the real ship, students can understand these contents more intuitively, so as to lay a solid foundation for their future work in ship transport.

3.2 Reform of Teaching Resources

In traditional mathematics, the textbook is the main resource and is relatively single. With the development of the Internet and big data,

digital course learning resources are becoming an important supplement to traditional course learning resources, and the construction of three-dimensional course teaching resources for "Ship Manoeuvring", which integrates digital learning resources and traditional course resources, has become the mainstream trend of course construction.

A series of teaching resources, such as the virtual simulation platform of Ship Manoeuvring and Collision Avoidance, as shown in Figure 8; VR panoramic video system, as shown in Figure 9; stand-alone ship-manoevring simulator, as shown in Figure 10; and teaching resources of the "Yukun" ship, have formed a complete three-dimensional resource.



Figure 3. In-Class Group Discussions

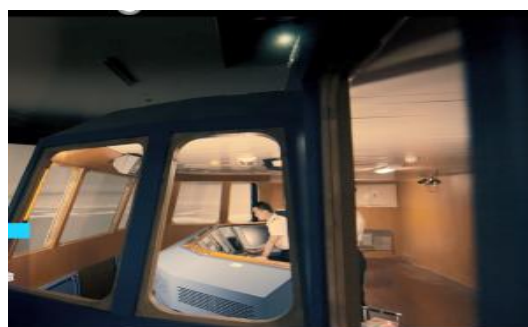


Figure 4. Large Ship Manoeuvring Simulator



Figure 5. Ship Manoeuvring and Collision Avoidance Simulator



Figure 6. Ship Berthing On-Site Teaching



Figure 7. Ship Mooring On-Site Teaching



Figure 8. Ship Manoeuvring Virtual Simulation Platform

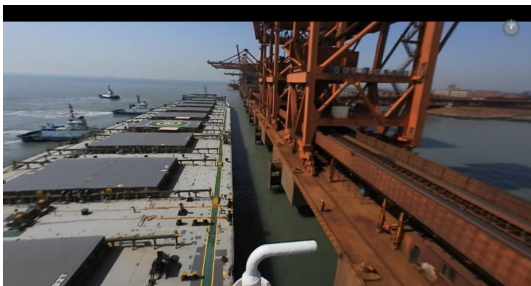


Figure 9. VR Panoramic Video System

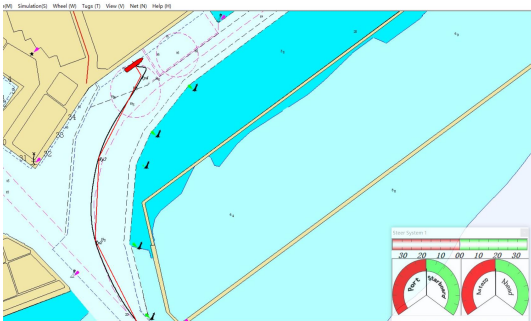


Figure 10. Stand-Alone Ship Manoeuvring Simulator

3.3 Reform of the Appraisal System

In line with the reform of the teaching mode, the construction of a three-dimensional

assessment system combining "process evaluation" and "summative evaluation" can not only effectively check the effectiveness of the teaching at all stages, but also judge the overall quality of the students' knowledge, ability and vocational qualities, so as to achieve objective evaluation of the level of personnel training.

3.4 Objectives of the Reform

(1) Based on TRIZ theory and using the Yukun ship as a platform, focusing on the cutting-edge information of different types of ships, familiarising ourselves with and mastering different ship manoeuvring methods, and fully integrating all kinds of informatisation resources with teaching resources, the papaer carry out student-centred blended teaching with a "degree of challenge"; (2) Reversing the situation of passive learning and passive acceptance by students, allowing students to create independently and openly, extending in the direction of "problem discovery" and "independent innovation", and stimulating students' creative vigour and motivation.

(3) The establishment of a sound new assessment and evaluation system will reflect the "student-centred" teaching objectives, paying more attention to students' practical ability, creativity and higher-order thinking ability; it will give a more realistic response to the weaknesses in teaching, so that teachers will be able to make timely improvements in response to shortcomings; and it will reflect the comprehensive quality of the students, rather than a single test of the students' ability to memorise knowledge.

3.5 Effectiveness of the Reform

(1) By reasonably applying the TRIZ theory to the theory of ship manoeuvring, students have a firmer grasp of the basic theoretical knowledge, and their innovation ability is significantly enhanced; the interaction between teachers and students in the classroom has been greatly improved, and the attendance rate of students is as high as 99%;

(2) Through the reformed practical teaching, students can firmly grasp the ship manoeuvring methods in all kinds of complex situations, and their practical manoeuvring ability is significantly improved;

(3) The resources for practical teaching have

been greatly enriched, and the motivation as well as convenience of students to learn online and offline has been greatly improved.

(4) The experts of the university supervisory team thought that the lecturers' theoretical teaching was rich in levels, the teaching design and methodology were advanced, and the characteristics and innovations of the course were remarkable, and they gave a good evaluation to the teaching of this course.

4. Conclusions

TRIZ theory is introduced into the practical teaching of the course "Ship Manoeuvring", and a three-dimensional teaching mode of "on-line, on-site and on-board" is designed with students as the centre. Through the reform of teaching mode, teaching resources and assessment system, students' understanding and knowledge of basic knowledge can be improved; practical ability can be strengthened, and students can firmly grasp the methods of ship manoeuvring in all kinds of complex situations. In the era of big data, teachers should take advantage of the Internet technology to reform the teaching mode, adopt scientific teaching design and various teaching methods, so as to improve the quality of classroom teaching and satisfy the students' personalised learning in a multimodal environment, and further promote the teaching of ship manoeuvring courses to a new level.

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