Topic driven Applied Talent Training Model and Curriculum Practice: A Case Study of the "Higher Bridge Structure" Course

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Abstract: In view of the demand for high-level applied talents in the field of bridge engineering, this paper takes the course "Advanced Bridge Structure" of Civil Engineering and Water Conservancy of City College of Zhejiang University as an example, and discusses the training mode and course practice of applied talents driven by special topics. By analyzing the existing problems of bridge engineering education, such as lagging teaching content, single teaching mode and poor practical effect, this paper proposes a topic-driven teaching content reform scheme. Specific measures include reconstructing teaching content to ensure cutting-edge and advanced, introducing modern bridge technology, combining engineering examples and integrating interdisciplinary knowledge; Phased and multi-blended teaching methods, combined with online preview, classroom interaction, after-class research and practical operations, enhance students' learning interest and practical ability; and the assessment system based on "ability-oriented integration" to comprehensively evaluate students' knowledge mastery, practical ability and comprehensive quality. Taking the "Anti-collision Pier Topic" as an example, the teaching design process and implementation effect are elaborated in detail. The reform practice shows that the topic-driven teaching mode has effectively improved the teaching quality and talent training level of the course "Advanced Bridge Structure", and provided a useful reference for the modernization and transformation of bridge engineering education. In the future, we will continue to deepen the teaching reform, expand the curriculum content, strengthen school-enterprise cooperation, and use modern information technology to further improve the teaching effect and the quality of talent training.

Keywords: Professional Degree Graduates; Advanced Bridge Structures; Optimization of Teaching Content; Thematic Tasks for The Curriculum; Course Practice

1. Introduction

In recent years, with the acceleration of urbanization and the vigorous development of transportation infrastructure construction, the demand for professionals in the field of bridge engineering is increasing, and the quality requirements for talents are also increasing. In particular, with the continuous innovation of bridge design theory and the continuous progress of construction technology, the field of bridge engineering is undergoing a transformation from traditional design to intelligent and refined design. Over the past decades, China's bridge engineering field has gradually transitioned from relying on imported technology to independent innovation and world leadership, and the completion of a series of world-class bridge projects such as the Hong Kong-Zhuhai-Macao Bridge and Sutong Bridge has demonstrated the outstanding achievements of China's bridge engineers. However, in the face of the new trend of more intelligent and sustainable development in the global bridge engineering field, as well as the continuous emergence of new materials, new technologies, and new processes, bridge engineering education is faced with the

challenge of cultivating high-level applied talents with international competitiveness, innovative spirit and practical ability [1-2].

Driven by major national strategic needs and the continuous application of new technologies such as intelligent construction, big data, and artificial intelligence, it has become an inevitable trend to promote the transformation of bridge engineering education to a theme-driven application-oriented talent training model [3]. In this context, the bridge engineering major needs to be reformed and innovated in terms of curriculum system, teaching content, teaching methods, and practical teaching to meet the new requirements for bridge engineering talents in the new era [4-5].

At present, traditional bridge engineering education has problems such as lagging curriculum content, disconnection between theory and practice, and single teaching method, which is difficult to meet the urgent demand for compound and innovative talents in the field of bridge engineering in the new era [6]. In view of this, this paper takes the course "Advanced Bridge Structure" of Civil Engineering and Hydraulic Engineering of Zhejiang University City College as an example, and discusses how to reform and explore the teaching content and practical teaching mode of this course in the theme-driven teaching mode, in order to provide useful reference and reference for the modernization and transformation of bridge engineering education.

2. Analysis of the Current State of the Curriculum

As a local high-level university focusing on the cultivation of application-oriented talents, Zhejiang University City College is committed to cultivating high-quality talents with innovative spirit and practical ability. As an important part of the School of Engineering, the major of civil engineering and water conservancy is responsible for providing excellent bridge engineers to the society. However, with the rapid development of the field of bridge engineering and the continuous emergence of new technologies, some problems have gradually emerged in the teaching content and teaching mode of the course "Advanced Bridge Structures" [6-8].

(1) The teaching content is lagging behind: Although the course of "Advanced Bridge Structure", as the core course of graduate students majoring in civil engineering and water conservancy, has covered the development status and trend of modern bridges, the analysis and design theory of concrete bridges, the analysis and design theory of steel bridges and composite structure bridges, and the analysis and design theory of long-span bridge structures, the update speed of the course content is relatively slow, and it is difficult to fully keep up with the development of new technologies, new materials and new processes in the field of bridge engineering. For example, the introduction of cutting-edge fields such as intelligent bridge monitoring and maintenance and new bridge structure systems is relatively limited, which makes it difficult for students to master the most cutting-edge professional knowledge.

(2) Single teaching mode: At present, the teaching mode of the course "Advanced Bridge Structure" is still mainly based on traditional classroom teaching, supplemented by a small number of case analysis and discussion. Although this model can help students master basic theoretical knowledge to a certain extent, it lacks sufficient interaction and practicality, and it is difficult to stimulate students' interest and enthusiasm in learning. In the context of informatization and intelligent education, it is difficult for a single classroom to meet students' needs for diversified and personalized learning methods.

(3) Poor practical effect: Due to the limitation of resources such as experimental equipment and venues, it is difficult for students to get sufficient practical opportunities in the course of "Advanced Bridge Structure". Most of the existing experimental projects focus on theoretical verification and simple application, while the practical links such as the analysis and solution of complex engineering problems, and the design and optimization of bridge structures are relatively weak. This leads to the lack of practical ability training of students, the disconnection between theory and practice, and the difficulty of effectively applying the knowledge they have learned to practical engineering. At the same time, due to the lack of practice bases and platforms for cooperation with enterprises, it is difficult for students to get in touch with real engineering

projects and working environments, which further limits the cultivation of their practical ability and innovative thinking.

Since then, the teaching team has carried out the research, training, targeting, relationship and derivation of the graduate course for applied talents, as shown in Figure 1, and carried out the comprehensive construction of this course.

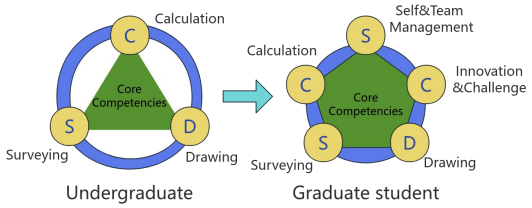

Figure 1. The Core Competence of Graduate Students of Applied Talents is Promoted

3. Topic-Driven Pedagogical Content Reform

3.1 Reconstruct the Teaching Content to Ensure That It Is Cutting-Edge and Advanced

In view of the lag of the course content of "Advanced Bridge Structure", this paper organically integrates and reconstructs the course content in an all-round way according to the development trend of civil engineering and hydraulic engineering and the needs of the industry, so as to ensure the cutting-edge and advanced nature of the teaching content. Specific measures include:

(1) Introduce modern bridge technology: Incorporate the latest research results of modern bridge design theory, application of new materials, and intelligent construction technology into the teaching content, such as the design and analysis of long-span bridges, bridge structural health monitoring technology, etc., so that students can master the latest bridge engineering technologies and methods.

(2) Combined with engineering examples: Combined with classic bridge engineering cases at home and abroad, such as Hong Kong-Zhuhai-Macao Bridge, Sutong Bridge, etc., analyze their design ideas, construction technologies and innovation points, and enhance students' understanding and ability to solve practical engineering problems.

(3) Integrate interdisciplinary knowledge: Strengthen the cross-integration of bridge engineering and civil engineering, materials science, computer science and other disciplines, and integrate the knowledge and technology of related disciplines into the teaching content, such as numerical simulation analysis of bridge structures, bridge health monitoring based on artificial intelligence, etc., so as to improve students' comprehensive quality and innovation ability.

Taking the "Special Topic of Anti-collision Pier" as an example, the teaching content not only covers the basic design principles and methods of anti-collision piers, but also introduces the latest materials and structural forms of anti-collision piers, such as high-performance composite anti-collision piers, deformable anti-collision piers, etc., and analyzes and discusses them in combination with actual engineering cases, so that students can fully understand and master the design and application of anti-collision piers.

3.2 Innovate Teaching Methods in a Multi-Faceted and Multi-Faceted Manner

In order to solve the problem of single traditional teaching mode and poor practical effect, this paper proposes a multi-stage and mixed teaching method, which includes:

(1) Pre-class stage: Use online teaching platforms (such as the teaching platform of the City Academy) to push teaching materials and MOOC videos, guide students to preview the course content, and put forward preview questions and feedback.

(2) In-class stage: Lectures, discussions, case studies and other teaching methods are used to stimulate students' interest and enthusiasm for learning by combining cases of major national bridge engineering projects. Through various interactive forms such as "teacher-student interaction", "student-student interaction" and "group discussion", students are guided to think actively and make the classroom more active.

(3) After-class stage: Assign self-directed learning tasks, such as reading the latest literature in the field of bridge engineering, analyzing actual bridge engineering cases, etc., to guide students to carry out in-depth discussions and research after class, and improve their ability to comprehensively analyze and solve complex engineering problems.

(4) Practical stage: Combined with the conditions of the laboratory and off-campus

practice base, a variety of practical tasks are designed, such as anti-collision pier design experiments, bridge structure health monitoring experiments, etc., so that students can operate by themselves and improve their practical ability and innovation ability.

In the "Anti-collision Pier Special Topic", the teaching methods include classroom lectures, case studies, group discussions and experimental operations. The special task assignment requires students to design a new type of anti-collision pier structure in groups, and carry out numerical simulation analysis and experimental verification. The comprehensive assessment methods include classroom performance, special essays, experimental reports and final reports, which comprehensively evaluate students' learning effectiveness and practical ability.

3.3 Based on the Assessment System of "Competency-Oriented Integration"

In order to solve the problem that the traditional assessment system has a weak educational effect, this paper proposes an assessment system based on "competency-oriented integration" [9], which organically combines process assessment and final assessment, and the specific measures include:

(1) Classroom performance assessment: Through class discussions, group assignments and other forms, students' classroom participation and cooperation ability are assessed, accounting for 20% of the total score.

(2) Special task assessment: Combined with the course content and students' interests, special tasks (such as anti-collision pier design tasks) are assigned, and the assessment is carried out through task completion, teamwork and innovation ability, accounting for 30% of the total score.

(3) Final examination assessment: Through closed-book or open-book examinations, students' mastery and application ability of the course content are assessed, accounting for 50% of the total score.

(4) Practical assessment: through the completion of practical tasks, experimental report writing, experimental operation skills and other aspects of the assessment, accounting for the total score of additional points.

This assessment system not only pays attention to students' knowledge mastery, but also pays more attention to the cultivation of students' practical ability, innovation ability and comprehensive quality, which can evaluate students' learning effect more comprehensively. At the same time, through student feedback and knowledge extension, we will continuously optimize the teaching content and methods to improve the teaching quality and talent training level [10].

4. Example of Special Teaching Design of Anti-Collision Pier

In order to solve the problems existing in the current situation of the course "Advanced Bridge Structure" and improve the teaching effect and talent training quality, this course introduces a topic-driven teaching content reform. The topic-driven teaching model aims to cultivate students' practical ability and innovative thinking through in-depth analysis of specific topics in the field of bridge engineering, closely combining theoretical knowledge with practical application. The following takes the "anti-collision pier topic" in the course syllabus as an example for special design.

4.1 Lecture Content Restructured

As an important part of the bridge structure, the reasonable design of the anti-collision pier is directly related to the safety and durability of the bridge. The teaching content of this topic will focus on the design principle, calculation method, material selection, structural details and engineering application of the anti-collision pier. By explaining the typical cases of anti-collision piers at home and abroad, and analyzing their mechanical performance and protection effects under different working conditions, students can deeply understand the design points and difficulties of anti-collision piers.

4.2 Choice of Teaching Method

This course adopts a variety of teaching methods, including classroom lectures, case analysis, group discussions, simulation design and other forms. In the classroom teaching session, the teacher will focus on explaining the basic theory and design methods of the anti-collision pier; In the case analysis session, through the analysis of real engineering cases,

students can understand the application of anti-collision piers in actual engineering; In the group discussion session, students are encouraged to conduct in-depth discussions on specific problems and put forward their own insights and solutions. In the simulation design session, students are asked to apply what they have learned to design a crash pier that meets specific requirements [11].

4.3 Thought-Provoking Questions

(1) Integration of bridge design and engineering practice: Discuss how to balance theoretical analysis and practical engineering needs in bridge design. Consider factors such as material selection, structural stability, economics, and environmental impacts, and analyze how these factors affect the final design of the bridge. At the same time, it explores how interdisciplinary knowledge, such as biomimicry and computer science, can be applied in the design process to promote innovative design.

(2) Bridge collision avoidance system and sustainable development: analyze the importance of bridge collision avoidance system in ensuring bridge safety and improving bridge service life. Discuss how to improve the impact resistance of bridges through design optimization and technological innovation. In addition, strategies for achieving sustainability in bridge engineering are discussed, including material recyclability, energy efficiency, and environmental impact.

(3) Social impact and ethical responsibility of bridge engineering: The impact of bridge engineering on local social and economic development is discussed, including traffic improvement, tourism development and regional tie strengthening. At the same time, the social responsibility and professional ethics that bridge engineers should assume in the design and construction process are discussed. By analyzing specific bridge engineering cases, we explore the reasons for successes and failures, as well as the lessons that can be learned from them.

4.4 Thematic Task Assignment

In order to deepen students' understanding and application ability of the topic of anti-collision piers, the following special tasks are assigned in this course:

(1) Collect typical anti-collision pier cases at home and abroad, and analyze their design characteristics, advantages and disadvantages.

(2) For a certain bridge, design an anti-collision pier that meets its requirements, and draw design drawings.

(3) Write a crash pier design report, detailing the design ideas, calculation process, material selection, structural details and other aspects.

4.5 Student Feedback and Knowledge Extension

At the end of the course, feedback from students was collected through questionnaires and interviews to understand students' acceptance and learning effectiveness of the topic-driven teaching model. At the same time, students are encouraged to participate in relevant scientific research projects or practical activities based on the knowledge they have learned in the course to further expand their knowledge and practical ability. For example, students can be organized to participate in the actual design project of bridge crash piers, or carry out related innovative experiments and research work, apply the knowledge they have learned to practical engineering, and cultivate students' practical ability and innovative thinking.

Through the topic-driven reform of teaching content, it can not only make the teaching content of "Advanced Bridge Structure" closer to the actual engineering practice, improve students' interest and enthusiasm in learning, but also cultivate students' practical ability and innovative thinking, and provide more high-quality bridge engineers for the society.

5. Prospect

In this paper, the cutting-edge, advanced and practical teaching content of the course "Advanced Bridge Structure" is successfully improved by carrying out a topic-driven teaching content reform. By reconstructing the teaching content and integrating modern bridge technology, engineering examples and interdisciplinary knowledge into the curriculum, students can not only grasp a solid theoretical foundation, but also understand the latest trends in the industry and improve their ability to solve practical engineering problems. At the same time, the phased and multi-mixed teaching method innovates the traditional teaching mode, enhances students' interest and participation in learning, and improves the

teaching effect. The assessment system based on "ability-oriented integration" comprehensively evaluates students' knowledge mastery, practical ability and comprehensive quality, and provides a strong guarantee for cultivating high-quality bridge engineering talents with innovative spirit and practical ability.

In addition, the teaching reform of the course "Advanced Bridge Structure" will continue to deepen and adapt to the new development and new requirements in the field of bridge engineering. First of all, the course content will be further expanded, and more of the latest bridge engineering technology and research results will be introduced, such as intelligent bridges, green bridges and other cutting-edge fields, so as to keep the course content advanced and forward-looking. Secondly, it will strengthen cooperation with industry enterprises, establish more off-campus internship bases, provide more practical opportunities for students, and enhance their ability to solve practical engineering problems. At the same time, modern information technology means, such as virtual reality (VR), augmented reality (AR), etc., will be used to enrich teaching methods and improve teaching effects.

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