

A Study on Improving Classroom Heads-Up Rate of “Ship Structural Mechanics” Based on Multifactorial Influence

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Abstract: Traditional teaching methods have been unable to meet the basic requirements of teaching in the new situation, triggering the classroom phenomenon of low head-up rate. This paper starts from the fundamental, from the teaching mode to the treatment of teaching materials, and then from the cognitive process to the teaching process for a reasonable analysis. Taking "Principle of Force Method" as an example, it focuses on the theme of rationally simplifying the mechanics model and designing the optimal structure, combines forward case and reverse inquiry, and reasonably integrates the elements of ideological and political into it, and analyses the teaching design and teaching process on the basis of it, which enhances the attractiveness, interestingness, logic, vividness and memorability of the course, and increases the head-up rate of the students.

1. Introduction

With the constant change of teaching requirements in higher education, traditional teaching methods have been unable to meet the basic requirements of teaching in the new situation, which triggered a series of classroom phenomena such as playing mobile phones, sleeping, and low head-up rate^[1, 2]. In order to solve these problems, the reform of classroom teaching methods has been one of the hot issues of reform in teaching in colleges and universities. In view of the characteristics of engineering courses, more case-based^[3-5] teaching methods and inquiry-based^[6-8] teaching methods incorporating elements of ideological and political have appeared, and a large number of teaching practices have proved that these methods have a certain effect on improving the problem of low head-up rate in the classroom.

The head-up rate of students is an important criterion for measuring the quality of teaching. Improving the head-up rate of students can promote students' absorption of knowledge, thus improving the teaching quality of the school. The knowledge points of the course of Ship Structural Mechanics are both deep and difficult, and there are a lot of professional terms. This is the main reason for the low head-up rate. Identifying and studying the reasons behind the head-up rate aims to prescribe the right remedy to improve the head-up rate of students.

2. Teaching mode analysis

As a core course of ship and ocean engineering, the principles and methods involved in Ship Structural Mechanics are difficult, but it is a professional knowledge that students must master, and it is one of the core competitiveness of the students when they go to the workplace. Teaching through the traditional teaching methods, students accept the knowledge slower, difficult to learn and understand. The new teaching method should start from multiple factors: rational integration of book content, so that the teaching content modular; strengthen the link between the course and the course, to establish the relationship between the learned knowledge points and the knowledge points of the current course, to improve the professional knowledge system of the students; to strengthen the combination of theoretical and practical structure, so that students can understand what practical problems can be solved with the knowledge they have learnt. In this way, students are motivated to learn and improve their learning efficiency while exercising their professional skills.

3. Modular approach to teaching materials

After sorting out the knowledge points of the textbook, the content of the course is divided into "four methods and one theory", which are: Introduction, Initial Parameter Method, Force Method, Displacement Method and Energy Method, as shown in Figure 1. The introductory part incorporates the history of the development of ship structural mechanics and historical stories of educational significance, the initial parameter method, the force method and the displacement method, and the introduction of examples, such as the ship that is not designed according to the requirements of the ship, a serious marine accident; for typical marine accidents to be analysed with the learned methods, and what are the mechanical deficiencies, etc. The energy method is more difficult, combined with the finite element software, showing the beauty of mechanical analysis, the introduction of international cutting-edge information and technology, to stimulate students' feelings of scientific and technological strengthening of the country.

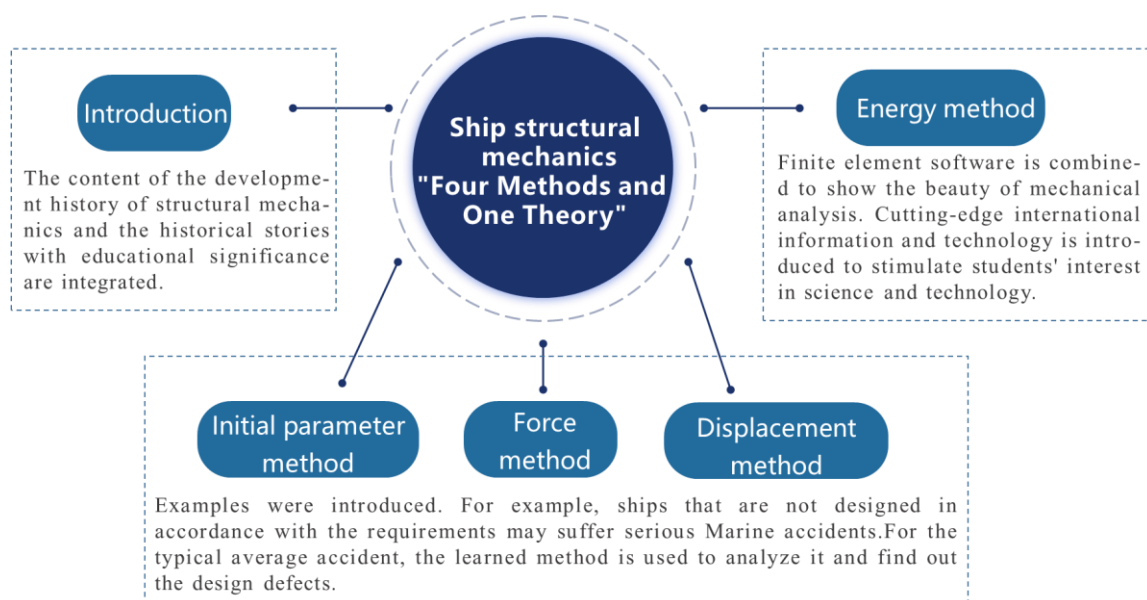


Figure 1: Knowledge point organisation of the teaching materials

4. Reasonable cognitive processes

From knowledge and skills, process and method, emotional attitude and values, the three dimensions of teaching objectives are integrated into the cognitive process, as shown in Figure 2. These three dimensions of teaching objectives are an organic whole, are reached in the cognitive process. Students experience the cognitive process of ship structural mechanics, recognise the inadequacy of the original knowledge structure in the face of difficulties, and cultivate interest and optimism in the process of solving difficulties; students learn to master the new knowledge and skills of ship structural mechanics, learn to use the corresponding mechanical methods, make scientific judgments on the conclusions obtained, and gradually form a scientific world view, outlook on life and values.

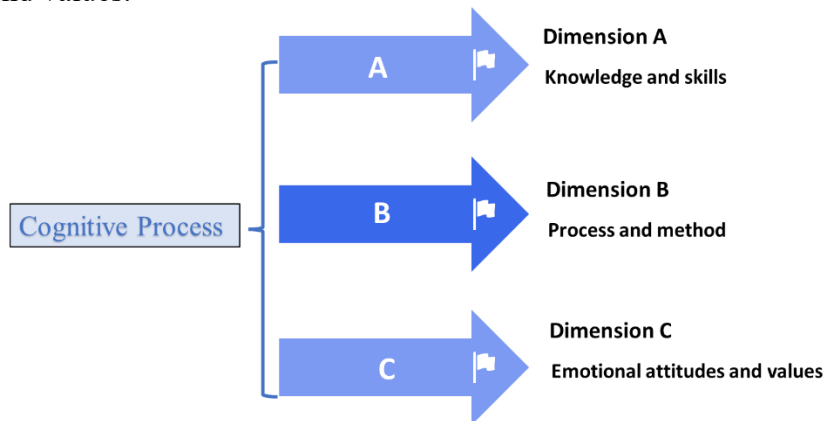


Figure 2: Cognitive process

5. Multiple forms of teaching and learning processes

The design of the teaching process reflects the cognitive process of mechanics, allowing students to experience the cognitive development process of practice-theory-practice spiral.

5.1. Cognitive conflicts lead to problems

Creating problematic scenarios, generating cognitive conflicts, eliciting problems, guiding students to explain with existing knowledge, and making students realise that they need to learn new knowledge and master new methods in order to solve the problems in front of them. Let the students appreciate that the theory of mechanics is developed in solving difficulties, and that they cannot retreat and avoid facing difficulties, but rather rise to the occasion.

5.2. Achieving knowledge system with lessons

The predecessor courses of Ship Structural Mechanics are Hull Structure and Hull Drawing. In the classroom, we help students to link the knowledge points of Hull Structure and Hull Drawing with Ship Structural Mechanics organically, not only explaining the mechanical model, but also completing the construction of the knowledge system from the actual structure of the ship (Hull Structure) to the ship's drawing (Hull Drawing) to the mechanical model (Ship Structural Mechanics), as shown in Figure 3. The complete knowledge system allows students to analyse the actual structure without knowing where to start, without the phenomenon that they can only solve the mechanical model but don't know how to simplify the mechanical model, so as to improve their practical ability.

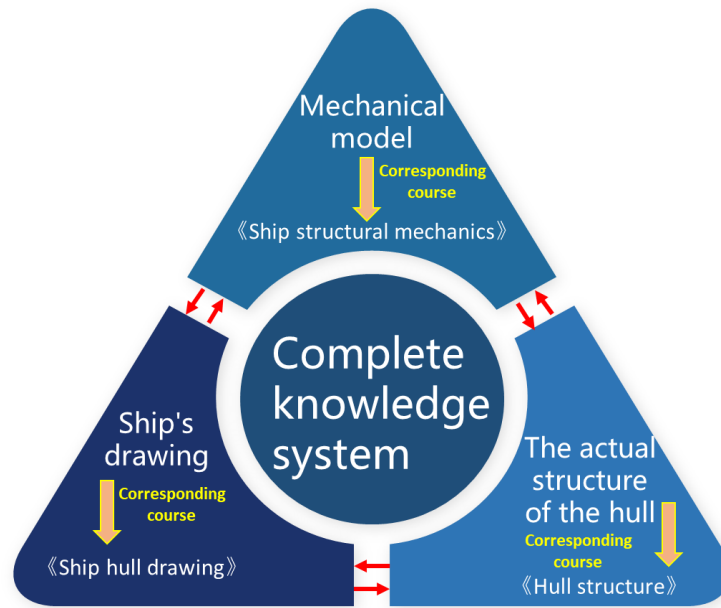


Figure 3: Knowledge system

5.3. Projects in the classroom, teaching in groups

The actual engineering drawings from the shipyard were distributed to each group of students and analysed using the methods learnt to calibrate the structural forces. Analyse the deficiencies in the structure and how to improve the defects in the structure. Not only can exercise students' ability to analyse and solve problems, but also improve their teamwork ability.

6. Multi-level case analysis

6.1. Design concepts for positive and negative cases

According to the teaching objectives, think about how to design case reflection questions from the perspective of improving students' practical application ability. Through the positive case guidance at the same time, the link to explore the root cause of the errors that exist in the reverse case, reflecting a certain level and comprehensiveness, from the positive and negative aspects of the complete mastery of the knowledge point, improve the application ability of the students. In the positive and negative problem design, the design of practical problems is particularly important, aimed at training students to solve practical problems according to the application of knowledge, you can let students simulate the role of the case, from the point of view of the role of the case to think about how to solve the problem in the situation in which they are located, which is more able to let the students produce a sense of immersion, so that the students in the case of teaching and learning to cultivate their own "practical" ability and enthusiasm to participate in the case. Positive case (correct case) through the teacher's guidance and explanation, play a role in demonstration, so that students understand the basic application of knowledge, and then through the exploration of the reverse case (wrong case), digging into the reasons for the error, to deepen the understanding of knowledge. To "Force Method" module in the knowledge of the principle of force method case teaching, for example, "positive case, linked to the reverse inquiry" design example shown in Figure 4 below.

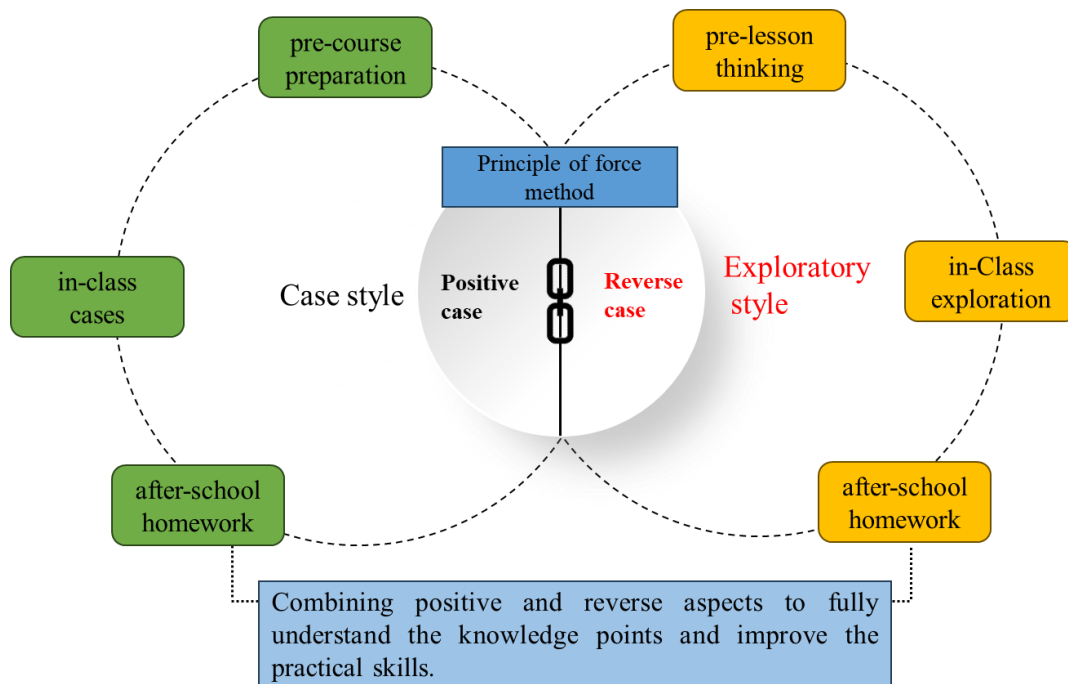


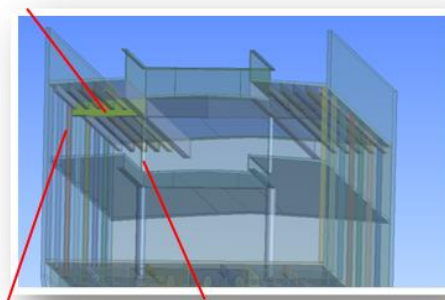
Figure 4: Combining positive and negative cases

6.2. Taking the principle of force method as an example

The actual structure is simplified into a reasonable mechanical calculation model through the learned mechanical theory, and then the strength calibration is carried out, or the structural dimensions are designed in reverse. For students, the transition from the actual structure to the mechanics model is difficult, the new teaching method should enhance the connection between the actual structure and the mechanics model obtained by simplifying according to the learned Structural Mechanics of Ships, and strengthen the students' comprehension on the basis of the actual structure, and the layer-by-layer analysis of the application examples is precisely as a bridge for the students to understand the relationship between the mechanics model and the actual structure. To a certain extent, it can improve the phenomenon that students can only do problems but can't solve the actual engineering problems.

For example, for the actual ship segment structure, as shown in Figure 5, what kind of constraint form is simplified for the tween deck frame as deck beams.

Deck beam



Tween deck frame Pillar

Figure 5: Segment structure of the actual ship

Firstly, the deck beam and the tween deck frame are selected as the research object, and according to the actual deformation characteristics and force conditions, the simplified mechanical calculation model is the rigid frame structure shown in Figure 6. Nodes 1, 2, 3 are all without displacement and there are corners. And the water pressure of the wave on the deck is simplified as a uniform load acting on the deck beams, while the tween deck frame is not stressed.

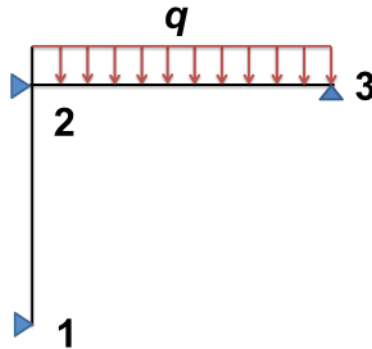


Figure 6: Simplified mechanical model

What kind of constraints are needed to simplify the tween deck frame if only the deck beams are to be analysed for forces? Since beam 1-2 (the tween deck frame) is not subjected to force, based on this characteristic and applying the principle of force method, the tween deck frame can be simplified to the elastic fixed end of the deck beam, and the coefficient of elasticity can be obtained from the equation 1, i.e. $\alpha = \frac{l_1}{3EI_1}$.

$$\alpha M = \frac{l_1}{3EI_1} M = \theta_{21} \quad (1)$$

Next, students are guided by inquiry to consider why the unstressed tween deck frame are simplified to the elastically fixed end of the deck beam, as shown in Figure 7, and why they cannot be simplified to a rigid fixing or rigid support.

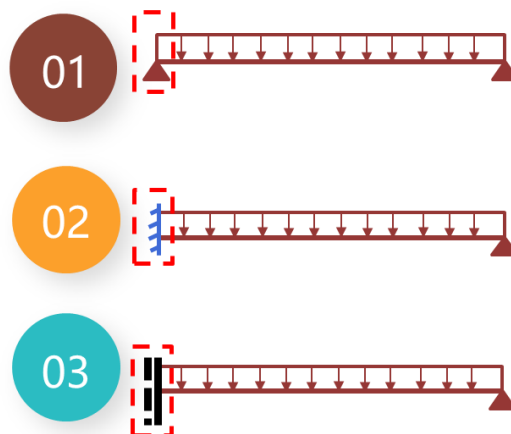


Figure 7: Different forms of constraints

If simplified to a rigid support in the first case, it results in too small a cross-section, too small a flexural modulus and insufficient strength. If simplified to the second case of rigid fixing, it will result in a cross-section that is too large, a flexural modulus that is too large, strength that is overfilled, weight that is increased, cost that is increased, and load capacity that is reduced. Only the

third case of elastic fixed end has a moderate cross-section size and reasonable strength. Therefore, it is most reasonable to simplify the elastic fixed end, which is why it cannot be simplified to rigid support and rigid fixed end.

6.3. Curriculum ideology and politics

Integrating the elements of ideology and politics in case-based and inquiry-based cases, if you want to design a reasonable structure, you have to go through a comprehensive consideration of multiple factors and have a scientific spirit of hard work. If the design of the structure is not reasonable, it may cause loss of economic benefits in the light of the situation, or cause safety accidents in the heavy.

7. Conclusions

This paper analyses the teaching mode, textbook processing, cognitive process, teaching process reasonably, and takes "Principle of force Theod" as an example, focuses on the theme of reasonable simplification of mechanics model, designing the optimal structure, and analyses the teaching design and teaching process by combining the forward case-based and reverse inquiry-based teaching methods and reasonably integrating the elements of ideology and politics, which enhanced the attractiveness, interestingness, logic, vividness and memorability of the course, and improved the head-up rate of the students with a good effect.

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