Research on the Teaching Method of Equipment Principles Course Based on the Integration of Principle Simulation and Actual Verification

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Abstract. In response to the obvious interdisciplinary intersection, multiple model derivations, and strong practical application background of the Equipment Principles course, this paper takes PID control principle as an example to specifically analyze the characteristics of teaching content, and studies the design and implementation effect evaluation of the teaching method of integrating principle simulation and practical verification. A design idea for the teaching method of Equipment Principles course based on the integration of principle simulation and practical verification is proposed, and an implementation effect evaluation index system is constructed. Comparative analysis of course teaching results data shows that the use of a teaching method based on the integration of principle simulation and practical verification in the equipment principle course can effectively improve the quality and efficiency of course teaching.

Keywords: PID control; Principle simulation; Actual equipment; verification

1 Introduction

In the information age, various types of information equipment and devices are widely used in various fields and have played an important role. Most information technology equipment has a one click operation function, which greatly improves the convenience of equipment operation and use. The equipment principle course aims to cultivate students' understanding and mastery of equipment principle technology, clarify the essence behind the "one click operation" of equipment, and enable them to better use and apply equipment[1]. Therefore, efficient teaching and learning of equipment principles and technology content is a common concern for teachers engaged in equipment principles course teaching and students majoring in equipment science.

S. Yang et al. (eds.), *Proceedings of the 2024 Seminar on Educational Technology and Management Information Systems (ETMIS 2024)*, Advances in Social Science, Education and Humanities Research 911,
https://doi.org/10.2991/978-94-6463-674-1_11

2 Analysis of Teaching Content Characteristics of Equipment Principles Course

2.1 Equipment Principles Course Teaching Content: Multidisciplinary and Clearly Interdisciplinary

For the field of weapons and equipment, whether it is vehicle mounted weapons, shipborne weapons, or airborne weapons, the effective performance of their combat effectiveness mainly depends on efficient firepower strikes. The implementation of firepower strikes requires accurate and reliable target detection, precise shooting element calculation or trajectory calculation, and fast and accurate weapon follow-up control as prerequisites[2]. For this purpose, the fire control systems of onboard weapons, shipborne weapons, and airborne weapons typically consist of target detection subsystems, weapon carrier positioning and navigation subsystems, weapon carrier attitude measurement subsystems, ballistic and meteorological measurement subsystems, fire control calculation subsystems, weapon tracking subsystems, communication subsystems, and power supply subsystems. The fire control system is based on its affiliated subsystems to complete the entire process of fire control, including information collection, element calculation, and shooting or firing control, in order to effectively carry out fire strikes on predetermined targets. Therefore, for the teaching of the equipment principle of fire control system, its content involves the integration and use of various basic theories and technologies such as ballistic theory and technology, measurement theory and technology, control theory and technology, computer technology, optoelectronic theory and technology, communication theory and technology, etc. Therefore, the interdisciplinary intersection of the teaching content of equipment principle course is more obvious.

2.2 Equipment Principles Course Teaching Content: Multiple Model Deductions

Equipment can effectively play its functional role, which is actually the transformation and implementation of the basic principles and technologies of various disciplines contained in it on the physical equipment. Taking the implementation and implementation of fire control in vehicle mounted weapons, shipborne weapons, and airborne weapon fire control systems as an example, the complex process of fire control can be highly summarized and abstracted as studying the motion characteristics of weapon vehicle mounted weapons, shipborne weapons, and airborne weapons, ammunition, and predetermined targets in space, establishing a mathematical model that is in line with reality, and then solving the data required for fire strikes. It is not difficult to find that the equipment principle course is based on theoretical analysis to derive mathematical models, and the teaching content is extensive, which needs to be emphasized and explained in depth during the implementation of the course.

2.3 The teaching content of Equipment Principles course has a strong background in practical application

The teaching and learning of equipment principle knowledge and technology may seem like a matter of understanding and mastering basic knowledge and technology, but in reality, at a deeper level, the realization of equipment function is based on the support and transformation of basic principles and technology[3]. It is not difficult to see that the teaching content of the Equipment Principles course has strong practicality and applicability, and it is necessary to attach great importance to and strengthen the practical teaching link in the teaching process of the Equipment Principles course.

3 Design of Teaching Method Integrating Principle Simulation and Practical Verification

3.1 Analysis of Teaching Content Based on the Integration of Principle Simulation and Practical Verification

The teaching method of integrating principle simulation and practical verification is used to carry out course teaching. It is necessary to deeply analyze the teaching content, sort out the principle knowledge points that can intuitively simulate the equipment involved, and intuitively analyze the logical principles and implementation methods of the knowledge points, so as to promote students to intuitively and deeply understand the theoretical principles and technologies involved in the equipment, solve the problem of superficial understanding of principle knowledge and technology, and truly achieve the goal of knowing what the principle is and understanding why it is through principle simulation analysis[4]. On this basis, the simulation analysis results of the principle will be verified and integrated with the actual operation results of the equipment, further mastering the "how to use" of the principle and realizing the transformation and application of knowledge into ability. Taking PID control principle as an example, the teaching content analyzes the basic idea and control process of PID control, as shown in Figure 1. On this basis, the PID control principle in weapon follow-up control can be integrated with simulation analysis and practical verification.

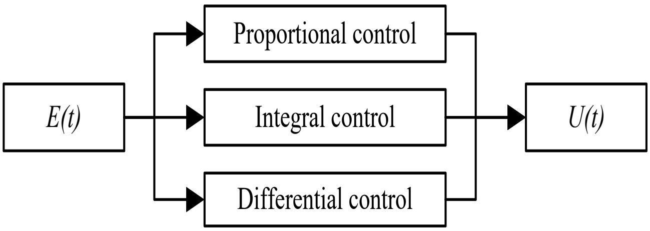

Fig. 1. The basic idea and control process of PID control (The figure is from the author's original work)

3.2 Design and Implementation of Equipment Principle Simulation Analysis Based on Teaching Content Analysis

After analyzing the basic ideas and process control of PID control principle in weapon follow-up control, it is necessary to use simulation software to lead students to carry out intuitive simulation of PID control principle, promoting students' profound understanding and mastery of teaching content. The specific method is to use a "building block" approach to construct a simulation model, and analyze the principles and processes of P, PI, and PD control in PID control through a "step-by-step" simulation, guiding students to analyze and summarize the characteristics of PID control. The simulation steps are designed as shown in Figure 2.

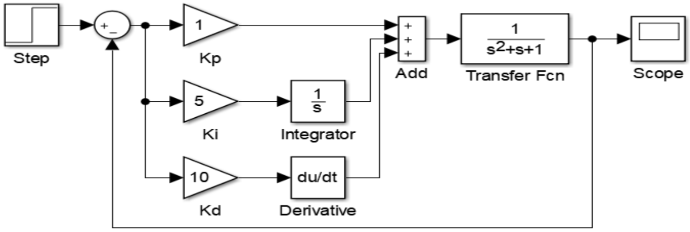

Fig. 2. Design of simulation analysis steps for PID control principle - PID control (The figure is from the author's original work)

3.3 Design and Implementation of Integration of Equipment Principle Simulation Analysis and Actual Equipment Verification

Equipment principle simulation analysis can visually demonstrate the implementation methods of principle knowledge and technology, but there are still doubts among students about whether the simulation analysis results are consistent with the actual equipment operating status. To this end, it is necessary to design a key link of verifying the principle simulation analysis results through actual equipment, in order to form a closed loop of teaching method implementation of "equipment principle teaching content analysis - equipment principle simulation analysis - actual equipment verification integration". Taking the pitch angle control of a certain artillery barrel as an example, both the PID control simulation conditions and the actual equipment follow-up control conditions are set to a control error of 300°[5]. The indicators for measuring control effectiveness are control process adjustment time t, steady-state error ΔC, and overshoot σ. The simulation results and the actual equipment follow-up control results are shown in Table 1.

Table 1. Comparison of PID Control Simulation and Actual Equipment Follow up Control Results Data (The Table is from the author's original work)

Project	Simulation result	Equipment operation results	Deviation amount
Adjust time(t /s)	2.7	2.6	0.1
Steady-state error (ΔC /°)	1.5	1.0	0.5
Overshoot σ /°	3.0	2.0	1.0

From the analysis of Table 1, it can be concluded that the actual operation results of PID control in the follow-up control of actual equipment are basically consistent with the simulation results of PID control of equipment, thus verifying the feasibility of the teaching method of "Analysis of Equipment Principles Teaching Content - Simulation Analysis of Equipment Principles - Integration of Actual Equipment Verification".

4 Evaluation of the Implementation Effect of the Course Teaching Method Integrating Three Principles Simulation and Real Implementation Verification

Evaluate the implementation effect of the equipment principle course teaching method based on the integration of principle simulation and practical verification, mainly focusing on talent cultivation goals, and set indicator systems from the dimensions of curriculum and students, as shown in Figure 3.

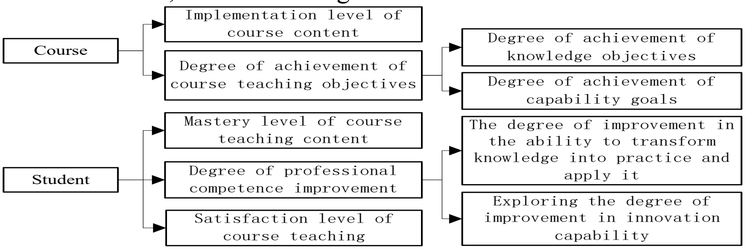

Fig. 3. Evaluation index system for course teaching methods integrating principle simulation and practical verification (The figure is from the author's original work)

Taking the teaching results data of PID control principle in 2023 (traditional teaching method) and 2024 (teaching method based on the integration of principle simulation and practical verification) as examples, the comparative analysis of the implementation effect of course teaching methods is shown in Figure 4 and Figure 5.

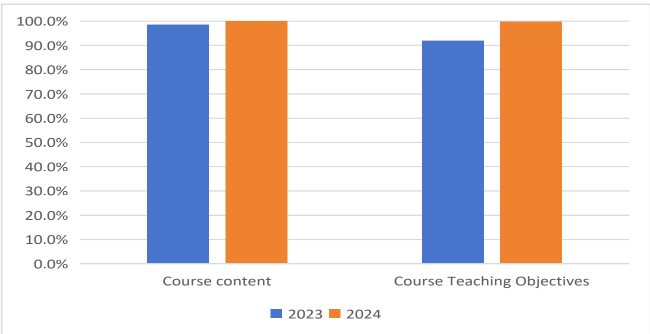

Fig. 4. Comparison of the degree of implementation of course content and the degree of achievement of course teaching objectives (The figure is from the author's original work)

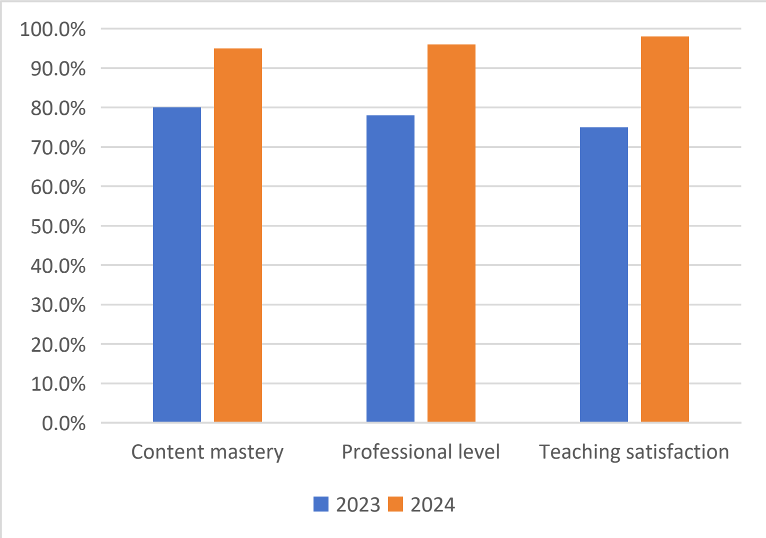

Fig. 5. Comparison of mastery level of course teaching content, improvement level of professional ability, and satisfaction level with course teaching (The figure is from the author's original work)

From the analysis of Figures 4 and 5, it can be concluded that the Equipment Principles course adopts a teaching method based on the integration of principle simulation and practical verification. The degree of achievement of course teaching objectives, students' mastery of course teaching content, satisfaction with course teaching, and the improvement of their own professional abilities have all been significantly improved, which effectively demonstrates the feasibility and effectiveness of implementing the teaching method based on the integration of principle simulation and practical verification in the Equipment Principles course.

5 Conclusions

Due to the obvious interdisciplinary intersection, multiple model derivations, and strong practical application background, the use of traditional lecture and demonstration teaching methods in the Equipment Principles course has certain limitations. Its intuitiveness is not strong, students' understanding and mastery are not deep, and the sense of learning acquisition is not good. The course teaching method based on the integration of principle simulation and practical verification is adopted to implement teaching, which can intuitively understand and analyze the principle knowledge and technology contained in the equipment, and flexibly transform the learned knowledge into practical application. The quality and efficiency of course teaching are significantly improved.

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