# Application of "Integration of Theory， Virtual and Practice" Teaching Mode in Radar Principle and Experiment

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**Abstract:** In order to improve the cadets' ability to understand the use of real equipment with theoretical knowledge and cultivate technical and skilled personnel to meet the needs of the army, this paper analyses the poor effect of the integration of theory and experiment in the previous course teaching process, combines with the cadets' characteristics, applies the "integration of theory, virtual and real" teaching mode to the course teaching, supplemented by information technology, summary and induction teaching methods. It reduces the difficulty of understanding, stimulates the students' interest in learning, and achieves a better teaching effect.

## 1 Introduction

Radar Principle and Experiment is not only a basic theory course for students to understand the use of equipment, but also a professional main course to understand the working mechanism of radar. How to make students understand the concepts and basic principles of radar subsystems in a relatively short period of time and lay a good foundation for later assembly and preparation is a problem that has been discussed in the teaching of radar principles. Literature [1-4] holds that the teaching mode of integration of theory, virtual and real is based on the principle of "learning by doing" and " doing by learning ", which can not only teach theoretical knowledge while operating, but also make theoretical knowledge have a foothold. It can also understand theoretical knowledge in practical operation, and can better couple theoretical teaching with practical teaching. Radar principle course is a general professional basic theory course for radar-related majors, which includes two parts of theory and practice. The application of the integrated teaching mode of theory, virtual and real in this course conforms to the idea of verifying theory by practice and guiding practice by theory. In this course, the main emphasis is on the students' understanding of radar theoretical knowledge, it also conforms to the cognitive law of students from practice to theory, from concrete to abstract [5]. This paper analyses the current situation of teaching, and proposes that the course should adopt the teaching mode of combining theory with practice, supplemented by information technology, summary and induction teaching methods, so that students can better understand the content of each principle knowledge point, and lay a good theoretical foundation for the later equipment practice course.

## 2 Analysis of teaching status

### 2.1 Trainee characteristics

The knowledge of radar principle is a course based on physics, mathematics, high-frequency electronic circuit and other basic courses, which requires high basic theoretical knowledge, and the theoretical knowledge of the course is obscure and difficult to understand, so students need to have certain abstract thinking ability when learning. However, the basic knowledge of cadets is relatively weak, and they generally have a certain fear of difficulties in learning, and most of them come from the army, pay more attention to hands-on operation, and generally do not pay enough attention to the study of theoretical knowledge. Therefore, the learning effect is not ideal.

### 2.2 Insufficient integration of theory and practice in teaching mode

This course is divided into two parts: principle and practice. The teaching of theoretical knowledge and the teaching of practical content can not be effectively integrated. The combination of theory and practice is not close enough. In the course of teaching, it is found that whether the students use the theory to guide the experiment or understand the theory in the experiment, the effect is not satisfactory, and the teaching effect of this way of disconnection between principle teaching and experiment is weak.

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## 3 The application of the teaching mode of the integration of theory and practice in the curriculum

### 3.1 The meaning of the integration of theory, virtual and real teaching

The teaching method of the integration of theory, virtual and real is the teaching method of the organic integration of theory, virtual and experiment (practice), which breaks through the phenomenon of the disconnection between theory and practice in the past teaching. In the whole teaching process, theory, virtual and practice can be carried out alternately. There is no fixed theory of virtual and real in the teaching process, but according to the needs of the course, there are virtual and real in theory, virtual in theory and virtual in reality. This kind of teaching mode solves the problem that the theory and the experiment are disjointed. At the same time, the virtual simulation technology simplifies and visualizes the knowledge in teaching, and effectively resolves the difficulties of principle knowledge.

### 3.2 The application of the integration of theory and practice in the teaching of this course

Radar Principle and Experiment is just in line with the teaching method of integration of theory, virtual and real, the design of the principle course into the experimental classroom, the course is divided into 80 modules, each module is a knowledge point. For each knowledge point, three links are adopted, namely, practical case, theoretical explanation and operation skill training, as shown in Figure 1.

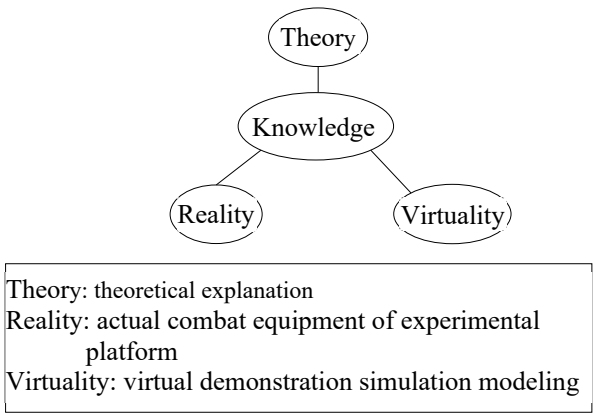


**Fig. 1** Schematic diagram of teaching mode of integration of theory, virtuality and reality

In order to illustrate the application of the teaching method of the integration of theory and virtual-reality in the teaching of this course, this paper takes the frequency synthesizer of radar transmitter in Radar Principle and Experiment as an example to explain the implementation process of the integration of theory and virtual-reality.

(1)The first part: actual installation case

Introduction of actual installation case: after a radar is started, the up-converter reports a red fault. The actual installation case is used to stimulate the students' interest in learning. The students can see from the fault point that it is the up-conversion fault. The input and output connection relationship of the up-conversion is shown in Figure 6. What causes the up-conversion failure? Why does the frequency synthesizer have no frequency output? Use practical cases to put forward theoretical knowledge needs, and link the second link-theoretical explanation.

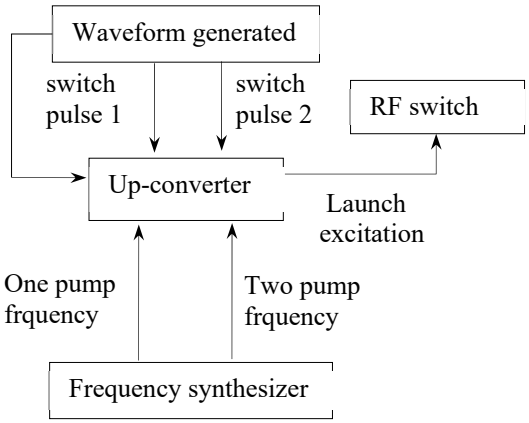


**Fig. 2** Connection of input and output signals of up-converter

(2) The second part: theoretical explanation

The explanation of theoretical knowledge points, the explanation of theoretical knowledge is explained in the way of theory and reality. This link first uses equipment examples to stimulate students' interest in learning, uses visual teaching methods to understand the difficulties of theory, and uses theory to solve practical problems. In the process of the integration of theory, virtual and real, it uses heuristic guidance, analogy and induction, information technology and other teaching methods to help students better understand knowledge points.

①First, guide the trainees to analyze the problem independently by using the frequency synthesis of the frequency source and excitation source of the radar, as shown in Figure 3, to determine which part of the frequency is completed.

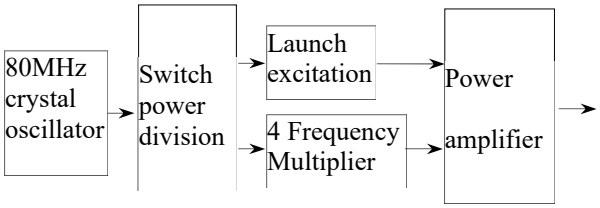


**Fig. 3** Principle block diagram of frequency source

② The natural transition from the problem in the real picture to the concept and principle of theoretical knowledge. In order to solve the difficulty of theoretical knowledge explanation-the concept of frequency synthesis, the visual teaching method is used to help students understand frequency synthesis, such as using the face value of paper money to simulate frequency synthesis and using the event of "bamboo blossom" to simulate frequency coherent understanding.

③ Use the principle knowledge to help the trainees solve the problems in the actual installation pictures, return to practice from theory, and solve the difficulties in understanding-the application of various frequency synthesis methods. After explaining the theory, the equipment examples are listed, and each frequency synthesis method is put on the case, so that the principle is organically combined with the actual equipment case, so that the theoretical knowledge is close to the actual combat, so that students know that the theoretical knowledge is no longer empty, but has a foothold, which can not only enhance the purpose and enthusiasm of students' learning, but also increase the sense of demand for theoretical knowledge. Take a certain type of equipment as an example to guide students to understand the application of frequency synthesis technology in equipment, as shown in Figure 4.

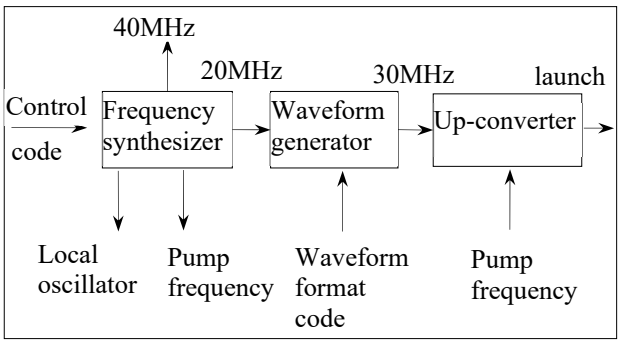


**Fig 4** Frequency synthesis block diagram of a radar

(3) The third link: operation skill training

The principle knowledge is used to guide the experiment to complete the skill training, and the skill training is completed by the way of experiment and practice. Operation skill training includes the completion of experimental content and the selection of appropriate instruments. In the process of operation skill training, the trainees should deepen their mastery of theoretical knowledge, be familiar with the standardization of operation, exercise their ability of maintenance style, and master the selection and use of instruments skillfully, so as to lay a good foundation for the later operation of equipment.

① Use the training platform to complete the frequency measurement and frequency synthesis measurement process, and use the principle knowledge to guide the trainees to understand the frequency synthesis mode of the launch platform, and complete the output from experiment to theory.

② The theoretical knowledge is used to solve the frequency measurement and instrument selection in the real equipment picture, which not only completes the test of skill training, but also realizes the output from experimental theory to real equipment case.

### 3.3 Application of teaching methods and means

In the teaching mode of the course, appropriate teaching methods are adopted for the corresponding knowledge points, which can not only mobilize the enthusiasm of the students, but also simplify and popularize the knowledge, reduce the learning difficulty of the students and improve their interest in learning.

(1) Application of information technology

In the course, information technology is used to construct virtual simulation model, simulate the internal structure of the main components of the transmitter, model and animate the invisible structure and obscure principle knowledge, simplify, visualize and visualize the obscure knowledge, It display various practical circuit applications, and explain the process of knowledge pushing vividly, and simplify, visualize and visualize the obscure knowledge, so that students can easily accept and deepen their impression[6]. The application of information technology in this part is just equivalent to "tickling". It solves the difficulties and pain points when teachers explain and students understand the principles. Just as PPT was introduced into classroom teaching in that year, the appropriate addition of information technology to classroom teaching can not only improve the teaching efficiency of teachers, but also improve the learning effect of students.

(2) Summary and induction

For the working principles that are difficult to understand in the course, observe the phenomena first, and then summarize the conclusions. For sergeant cadets, they need to know what it is and understand the general principles, so they can draw conclusions intuitively by using the summary induction method. The way from phenomenon to conclusion avoids the process of analyzing principles, draws conclusions directly, and then simply analyzes the reasons according to the conclusions to resolve the difficulties in the course.

(3) Analogy method

There are also some unknown contents that are not easy to understand in the course, which have many similarities with common phenomena or principles in life. For the explanation of this part of the content, we can use the analogy method. For example, in the article, we use the "bamboo blossom" event to compare the frequency. Bamboo blossoms in different places at the same time, revealing the same root and same sex. The frequency coherence is also due to the frequency from the same source, so there is coherence between the frequencies. The use of analogy not only helps students to understand and master the teaching content smoothly, but also improves their ability to learn to use analogy to analyze problems, and improves their interest in learning and deepens their understanding and memory.

(4) Problem chain

In view of the teaching content, the general teaching task is disassembled into several key problems linked by the chain of problems, and the teaching content is concretized to reduce the students' fear of difficulties and advance layer by layer until the core of the problem. For example, when explaining noise and noise figure, break the content down into a chain of questions: "What is noise?" "Where is the noise coming from?" "How to characterize the noise figure?" "Is the real equipment also characterized in this way?" and other interlocking problems. Part of the teaching process is shown as follows: the instructor shows the signal and background noise

displayed in the filter, inspires the students to think, and obtains the characteristics of the noise, such as tiny, messy and voltage signals; once again, the students are inspired to think about where the noise comes from? Students can conclude from their experience that the noise is external, but the teacher gives different answers: noise is divided into internal noise and external noise, and answers the internal noise. As shown above, use each question in the question chain to inspire students to think, guide students to solve problems, attract students' attention and promote in-depth learning through constant "doubt-explain-solve".

In addition, in the teaching, we also use the heuristic guidance, reverse teaching method [7], visualization teaching method, analogy and so on. These methods complement each other, promote each other, complement each other and effectively promote the reform of the teaching mode of the integration of theory, virtual and real.

## 4 Analysis of teaching application effect

The 201022 class has implemented the teaching mode of integration of theory, virtual and real, while the 201021 class has not implemented the teaching mode of integration of theory, virtual and real. The result of the comparison between the two classes shows that the 201022 class is better as a whole:

①Through the students' classroom reaction in class, the students' acceptance of the content in this class is higher than that in the other class;

② The students in this class were better than those in the other class;

③ There are more students asking questions during the break, and some students ask deeper questions;

④ The quality of homework in this class is also high.

## 5 Concluding remarks

According to the cadets' characteristics and the course content, this paper adopts the teaching mode of integrating theory with reality. The design is not a simple teaching mode that is theory + virtual + experiment (example), nor is necessarily carried out in order, but it should be adapted to the characteristics of each chapter, The teaching mode should be closely combined, different teaching methods should be flexibly used, so the teaching advantages of the integration can be brought into fully, so that students can learn more knowledge. It is worth noting that in the process of carrying out the teaching method, teachers need to explore the appropriate time to intersperse experiments in theory, put forward theory from experiments, and compile applicable and readable teaching materials. In the future, they will actively practice and explore in the direction of the teaching method, hoping to integrate theory, reality and reality more appropriately and achieve better teaching results. In this course, it is the first time to apply the teaching mode of integrating theory with practice in teaching activities, which not only greatly s the students' interest, but also improves the students' ability to guide practice with theory, realizes the deep coupling between teaching and weaponry, and lays a good foundation for the improvement of equipment courses and professional ability in the later stage.

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