

Application Research on the Flipped Class Mode in the Course of ‘Principle and Technology of Early Warning Satellite’

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Abstract—Early warning satellites is one of the important detective equipment of anti-missile early warning system. Learning its basic principle and common technology is indispensable for training qualified people to meet the needs of future anti-missile early warning operations all over the world. Based on analyzing the advantages of the application of flipping classroom teaching mode and the breakthrough of traditional teaching mode, this paper explores the specific teaching implementation method of flipping classroom to the course of ‘Principle and Technology of Early Warning Satellite’, reflecting on the shortcomings, and proposing rationalization suggestions.

Keywords—Early warning satellite, Equipment teaching, flipping classroom

I. INTRODUCTION

Nowadays, early warning satellite is an important equipment in the anti-missile early warning system for all countries. Learning its basic principle and key technology is necessary for cultivating high-quality military talent which satisfies the requirements of future anti-missile early warning operations. Based on the early warning satellite systems of various countries especially the SBIRS[1-2] of American and our previous teaching experiences, there are still many problems needed to be solved in the current teaching of the principle and technology of early warning satellite.

II. TEACHING SITUATION ANALYSIS ON THE COURSE OF ‘THE PRINCIPLE AND TECHNOLOGY OF EARLY WARNING SATELLITE’

The combination of high participation, theoretical teaching and practical probation is the essential elements for constructing high-quality equipment principle and technical courses. However, those elements are very hard to achieve in recent classroom teaching.

Firstly, it is difficult to obtain the equipment performance, physical size and photos of national early warning satellites.

Secondly, it is difficult for students to understand while learning this course due to the ambiguous theories of the course which contains many interdisciplinary knowledge points as shown in Fig. 1.

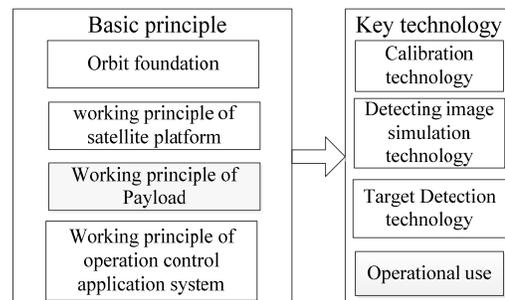


Fig. 1. The content of the course of ‘The principle and technology of early warning satellite’

Thirdly, the traditional classroom teaching environment is not flexible enough. So the teaching resources which can be shown in class are very limited.

As mentioned above, if the course of ‘Principle and Technology of Early Warning Satellite’ remains using the traditional teaching method of ‘face to face + board + multimedia + fixed time and location’, it will restrict the effect of classroom teaching. So, in view of the above problems, we consider introducing the ‘flip classroom’ teaching mode to enhance the classroom teaching effect and explore its demonstration effect.

III. RESEARCH ON THE TEACHING MODE OF "FLIPPING CLASSROOM"

A. The Connotation of the ‘Flip Classroom’ Teaching Model

The flipping classroom refers to re-adjusting the time inside and outside the classroom and transferring the decision-making power of learning from the teacher to the students. The main

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differences between the flipped classroom teaching mode and the traditional classroom teaching mode are shown in Table I [3-4]:

TABLE I. THE DIFFERENCE BETWEEN TRADITIONAL CLASSROOM AND FLIP CLASSROOM

	Traditional classroom	Flip classroom
Teacher	Knowledge transferor, classroom manager	Learning instructor, promoters, controller
Student	Recipient of knowledge	Investigator of knowledge
Teaching Form	Classroom explanation + after class homework	Learning before class + Classroom inquiry + After class practice
Classroom content	Knowledge explanation	Problem traction, collaborative inquiry
Technical application	PPT, video, voice	Internet, multi-functional teaching management platform, virtual reality, augmented reality, multimedia teaching equipment
Evaluation method	Traditional paper test	Multiple evaluation methods
Education resources	Paper teaching materials, question bank	Multimedia course, semi-physical simulation platform, video teaching materials, audio teaching materials.

B. Exploring the Role of 'Flipping Classroom' in the course of 'Principle and Technology of Early Warning Satellite'

After introducing the 'flipping classroom' to the course of 'Principle and Technology of Early Warning Satellite', there will be three good advantages shown as below:

The first advantage is to innovate traditional teaching concepts. In the teaching after applying 'flipping classroom', the teachers and students are all the main objects and the entire teaching process will show abundant of enthusiasm, initiative and creativity.

The second one is to introduce informational teaching equipment. The current classroom teaching has already subverted the traditional mode of 'a mouth', 'a blackboard' and 'a chalk'. Many informational teaching equipment can be used to improve the teaching quality, such as semi-physical simulation platform, teaching software system and many teaching videos.

The third one is to acquire expected excellence teaching performance. 'Flip classroom' can greatly enhance the enthusiasm of students to participate in teaching, and stimulate interest in learning, thus help students to overcome the fear of learning in the learning process and achieve relevant teaching goals.

IV. TEACHING PRACTICE OF 'FLIPPING CLASSROOM' IN THE COURSE OF 'PRINCIPLE AND TECHNOLOGY OF EARLY WARNING SATELLITE'

A. Advantage Analysis on Applying 'Flipping Classroom'

The flipping classroom divides the traditional classroom teaching into three parts such as pre-class preparation, in-class

guidance and after-school practice, emphasizing the learning subjectivity of the students. This kind of teaching model can solve many difficult problems to a certain extent and its advantages are shown in Table II:

TABLE II. THE ADVANTAGE OF FLIPPING CLASSROOM

Problems	Advantage analysis
It is hard for student to understand, because of the abstract concept and complex theoretical focus of the course.	Students can watch some teaching videos about the course to help them learn the relate knowledge, and bring questions to the classroom.
Difficult to see actual satellite equipment	We can introduce informational teaching equipment, such as build a semi-physical simulation platform of early warning satellite, to help the student understand the principle and technology of the equipment.

B. Teaching Organization of 'Flipping Classroom'

This section will focus on the problems in the teaching process of 'Principle and Technology of Early Warning Satellite', and design specific implementation methods and means.

1) *Building wealth teaching resources*: Explore the existing online teaching platforms such as MOOC: The existing online teaching platforms such as MOOC[5] are rich in aerospace and optical online course videos, such as, 'The Splendid Application Optics', 'Technology Optics', 'Aerospace Introduction', 'Rocket and Space Exploration and Discovery', 'Space Military Foundation' and 'Aerospace Equipment Decisive Space'. They are important platforms for students to supplement their learning in the aerospace and optical fields.

a) *Make use of existing software platforms*: The existing STK (Satellite Tool Kit) software[6] includes many modules of satellite orbit calculation, combat scene simulation, photoelectric detection imaging simulation and enrich demonstration resources to help carry out the teaching of the basic principles and key technologies of orbit and detecting image simulation.

b) *Build a semi-physical simulation platform and some software systems*: Only using the existing resources cannot fully meet the teaching requirement for the course, so it is necessary to build some special software and hardware facilities. Thus, we design and implement two semi-physical simulation platform and one special software system.

- Semi-physical simulation platform of payload detection

The semi-physical simulation is mainly composed of infrared dynamic scene detector, medium wave infrared lens, medium wave infrared camera, multi-dimensional parallel adjustment frame, electronic theodolite, small precision turntable, laser interferometer, etc., as shown in Fig. 2. It is used for simulating the detection modes of early warning

satellite and helping analyze the influence of satellite platform and motion detection mechanism jitter on imaging.

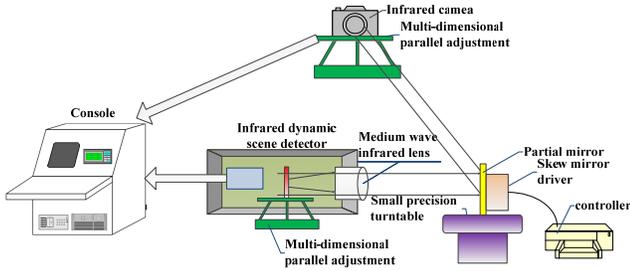


Fig. 2. Semi-physical simulation platform of payload detection

• Satellite simulator

The satellite simulation platform is consist of satellite motion simulator, ground measurement system, ground console and some matching software. The system block diagram is shown in Fig. 3. It is used to demonstrate satellite analog data link, telemetry remote control and attitude control.

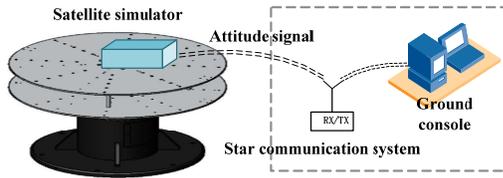


Fig. 3. Satellite simulation platform

• High-orbit satellite detection simulation software system

The software has the following three main functions:

First is to provide simulation and test experimental environment such as satellite scanning working mode, gaze working mode and cooperative working mode.

Second is to simulate the scheduling strategy of satellite resource.

Third is to implement the simulation of infrared target detecting and image compression processing.

The block diagram of system overall structure is shown as in Fig. 4.

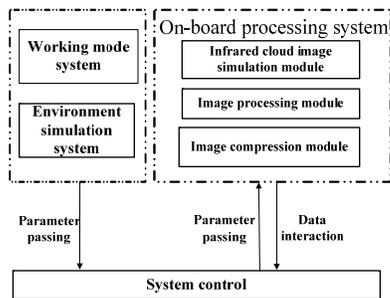


Fig. 4. The block diagram of system overall structure

c) Build a multi-functional teaching venue We also build a multimedia teaching place includes an array projection system, a multi-function platform, and many computer operating stations.

2) Organizing classroom teaching: The task-driven organizational implementation method is divided into three parts: pre-class preparation as shown in Table III, in-class guidance as shown in Table IV and after-school practice as shown in Table V.

a) pre-class preparation

TABLE III. TEACHING IMPLEMENTATION PROCESS

Teaching session	Instructor activity	Student activity	plan for design
The teacher releases the study guidance and the student preview.	Teachers upload pre-school teaching resources to relevant platforms, and review preview report, organize the preview question, update problem library.	Receive study guidance, learn related teaching resources according to plan, complete the pre-class preparation, and complete the pre-test at the same time.	Expand the learning time and space of the students, personalized and differentiated learning has been achieved.

• Information means and function

The preview notice is released through the online course platform, enabling teachers and students to communicate quickly and instantly, which can also improve the communication efficiency between teachers and students.

b) in-class guidance

TABLE IV. IMPLEMENTATION OF TEACHING PROCESS

Teaching session	Teacher activity	Student activity	plan for design
Teaching of payload working principle	Collect questions from students raised by self-study before class, lead classroom discussion	The students come to the stage and demonstrate the answer of the questions raised in the pre-class preparation, and to interact extensively with the instructors during the teaching process.	Let the learners understand the working mode of the payload.
Teaching of radiation calibration			Let the students experience the real laboratory calibration process and cultivate students' interest in learning.
Teaching of infrared image simulation			Let the trainees understand the principle of mastering the image simulation technology of the early warning satellite.

• Information means and function

Online teaching platform: Use it to send pre-study questions to the students and receive feedback from them.

Teaching video: Help students quickly build perceptual knowledge and learn the basic theoretical knowledge of satellite orbital, payload, image simulation and target detection technologies.

Matlab software platform: The Matlab software platform is used to virtualize the physical operation, allowing the students to program algorithms that implement key technologies such as radiometric calibration and target detection.

High-orbit satellite detecting software system: Adopt ‘High-Orbit Satellite Detection System’ software platform and its teaching demonstration module, to enable students to further understand the high-orbit satellite infrared detection image simulation technology through operating the system.

Array projection system: We can use it to project the common problems raised by the students, and it is convenient for the instructor to explain them to all the students.

Infrared camera: The device can help instruct the students to complete the single point, two-point non-uniformity correction and blind element compensation of the infrared camera, and can also help the student to understand the basic process of calibration of the infrared detector.

Turntable mechanism: We can use it as the physical display, which can also help students understand the working mode of the payload scanning camera and the gaze camera.

c) Combine with professional laboratories for after-school practice We will use professional laboratories to carry out after-school development which can help students carry out independent training and consolidate classroom learning results.

TABLE V. AFTER-SCHOOL PRACTICE

Teaching content	Practical content
Working principle of the payload	Simulating the working mode of early warning satellites, according to different combat missions
Key technology of radiation calibration	Implementing one-point correction, two-point correction and blind element compensation of the infrared camera
Key technology of detecting image simulation	Simulating the detection of early warning satellite for different operational scenarios

V. THE INSUFFICIENCY OF FLIPPING CLASSROOM MODE

Although the flipping classroom teaching mode can solve many difficult teaching problems of the course of ‘Principle and Technology of Early Warning Satellite’, it is impossible to cover all the knowledge points by the limitations of teaching resources and the faculties. Through the exploration of teaching practice and instructional design, the knowledge points that can realize the flipping classroom teaching mode are including the basic principle of payload, calibration

technology, image simulation technology and target detection technology.

VI. SUGGESTIONS FOR FLIPPING CLASSROOM APPLICATION

Firstly, flipping classroom model can really solve many problems in the teaching process, but it needs a lot of manpower, material and financial resources. Therefore, in the course of ‘Principle and Technology of Early Warning Satellite’, the application of flipping classrooms should consider the balance of the teaching benefit and the cost of preparing lessons in a reasonable interval.

Secondly, not all teaching knowledge points of the principle and technology of early warning satellite are suitable for flipping classrooms, so the selection of teaching knowledge points should try to meet the following requirements: 1) Reflecting the characteristics of the equipment. That is, it is necessary to select the principles or key technologies unique to the infrared warning satellite equipment. 2) Knowledge points should not be too difficult to students. 3) The cost-effectiveness of teaching should be as high as possible, and avoiding the lesson preparation is not proportional to the teaching effectiveness.

Third is to play the role of scientific research in teaching leadership and feedback. The flipping classroom has higher requirements for the overall ability of the instructors, because the infrared warning satellite is a highly sophisticated weapon and equipment. So we must continue to track its development, follow up and revise the teaching content, and ensure the advantages of the teaching content.

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