ISSN:3007-9640 DOI: https://doi.org/10.70114/acmsr.2025.2.1.P121

Exploration of the Application of Hybrid Teaching Mode Based on Virtual Simulation Experiment Teaching in the Experimental Teaching of Optoelectronic Sensors

Rongzhen Zhu [a] *, Jichao Wang [b], and Chenbin Wang [c]

[1] University of Aerospace Engineering, Beijing, 102249, China

[a] zhuyue1848610482@163.com, [b] wangjichao@buaa.edu.cn

Abstract. By combining modern information technology, blended learning models can break through the temporal and spatial limitations of traditional teaching methods, stimulate students' interest in learning, and improve their participation. In order to improve the teaching effectiveness of the photoelectric sensor experimental course, this article addresses the problems in traditional photoelectric sensor experimental course teaching and carries out a hybrid teaching reform of online and offline photoelectric sensor experimental courses. A hybrid teaching mode of online and offline+virtual simulation is constructed, and teaching links are carefully designed to optimize teaching methods and assessment methods, continuously improving students' learning initiative. Teaching practice has shown that through continuous improvement of the curriculum, student-centered classroom teaching has been achieved, improving teaching quality and achieving significant teaching effects.

Keywords: Hybrid teaching; virtual simulation; optoelectronic experiment.

1. Introduction

With the promotion of educational information technology, the teaching methods and models of experimental courses are constantly being reformed and innovated, and their educational and teaching platforms have also undergone new changes[1]. In the experimental teaching of optical courses, the use of the national virtual simulation experimental teaching project sharing service platform has transformed students' learning methods from single to diversified, enriched the course content, and provided students with an open and shared learning resource. Virtual simulation experiment teaching, as an important means of experimental teaching, is an important measure to promote the deep integration of modern information technology and experimental projects, expand the breadth and depth of experimental teaching content, extend the time and space of experimental teaching, and improve the quality and level of experimental teaching. In recent years, the school has vigorously promoted the construction of online teaching resources and encouraged teachers to build blended online and offline teaching courses based on online virtual simulation experiment platforms that are suitable for students' characteristics and training needs. The teaching team of the photoelectric sensor course keeps up with the pace of the times, meets the actual situation of our school's development, and adheres to the educational philosophy of "student-centered, output oriented, and continuous improvement" as the core. They have explored and practiced blended online and offline teaching for the photoelectric sensor course. Since 2020, we have carried out reforms in the blended online and offline teaching mode of photoelectric sensors, and also explored the blended online and offline experimental teaching mode[2, 3].

2. Current Situation of Experimental Teaching

The course of photoelectric sensors is a fundamental engineering course that closely integrates theory and practice, with strong practicality. One of the teaching objectives of the course is to enable students to learn the methods of commonly used photoelectric instrument detection, possess the preliminary ability of typical optical measurement circuit design, and apply photoelectric technology to engineering practice. The experimental teaching of photoelectric technology is an

ISSN:3007-9640 DOI: https://doi.org/10.70114/acmsr.2025.2.1.P121
important teaching link to cultivate these abilities. At present, the main characteristics of students are poor learning initiative, lack of enthusiasm and interest in learning, weak sense of teamwork, and insufficient emphasis on experiments in this course. They lack the ability to design experiments, operate experiments, obtain and process experimental data, and obtain reasonable and effective experimental conclusions. The specific manifestations are as follows: firstly, the level of attention is not enough, and most students lack sufficient pre class preparation, resulting in unfamiliarity with experimental content, unclear experimental steps, and insufficient understanding of experimental equipment and instruments. The second limitation is the teaching time of offline laboratory classes. Teachers usually only explain the experimental operations once, which makes it easy for students to make mistakes in actual experimental operations. The third issue is that the course assessment method is single, and students place too much emphasis on experimental results and reports. They do not pay enough attention to the standardization of the experimental process, and their ability to obtain reasonable and effective experimental conclusions is insufficient. As a result, the teaching effect is not ideal.

3. Construction and Implementation of a Hybrid Experimental Teaching Mode of Online and Offline+Virtual Simulation

3.1 Building a New Hybrid Teaching model of Online and Offline+Virtual Simulation

At present, the main force of college students has grown up in the online environment, with a strong desire for online learning. The new online education model represented by online teaching platforms provides unprecedented opportunities for them, and also provides a solid foundation for the smooth implementation of blended learning reform in this course. Referring to the teaching mode of optoelectronic sensor experimental courses in engineering majors at home and abroad, our course team has constructed a new teaching mode of optoelectronic sensor experimental online and offline+virtual simulation that is in line with the actual situation of local application-oriented colleges, with the teaching reform goal of "student-centered, ability centered", as shown in Figure 1.

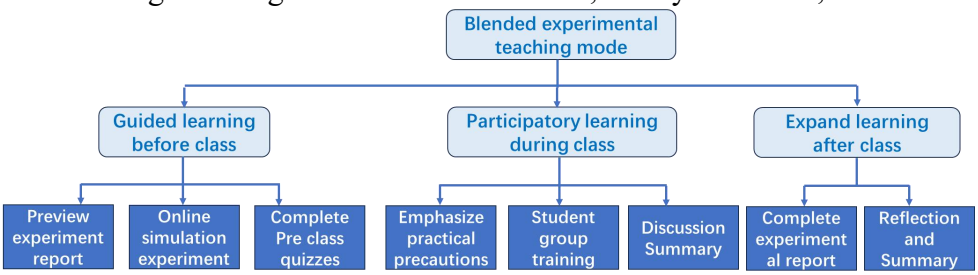

Fig. 1 Blended online and offline experimental teaching mode

3.2 Implementation of a Hybrid Teaching mode of Online and Offline+Virtual Simulation

3.2.1 Self directed learning on the front line of class

In order to cultivate students' conscious and proactive learning abilities and create a self-directed learning environment that is in line with the characteristics of the information technology era, our course group has carried out online teaching resource construction on the Rain Classroom platform, and reformed the experimental teaching mode with the help of the national virtual simulation experiment platform and class WeChat group. Before class, teachers release teaching materials such as electronic experiment guides, experimental outlines, courseware, videos, and experimental preview requirements to students in advance. Students can use fragmented time to preview and understand the experimental content and requirements, experimental steps and methods, and experimental data that need to be recorded. The learning tasks in the pre class stage are shown in Figure 2.

ISSN:3007-9640 DOI: https://doi.org/10.70114/acmsr.2025.2.1.P121

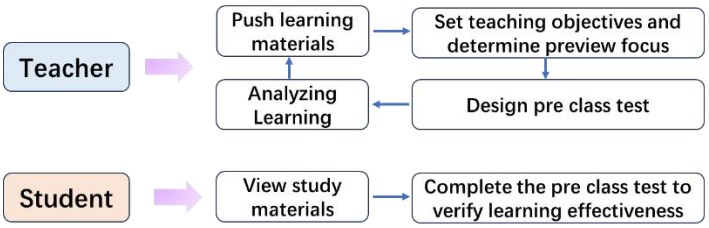

Fig.2 Pre class learning stage

3.2.2 Offline participatory learning during class

Through pre class preparation and virtual simulation experiments, students have gained a preliminary understanding of the experimental content, steps, instruments, etc. During the preparation process, they may have questions and bring them into the offline classroom. Teachers can then explain the experiments with different focuses based on students' questions. Classroom practice follows the following teaching activities: 1. Before the experiment begins, the teacher provides guided answers to the questions raised by students based on their pre class preparation, with the aim of guiding students to explore the answers to the questions during the experiment. 2. Students are divided into groups for experiments, where they discuss the experimental plan and their respective responsibilities. They follow the experimental steps to build and test the experimental circuit, select suitable experimental equipment for observing experimental data, and take photos to record the data during the experiment for subsequent analysis and processing. Teachers will conduct mobile inspections to standardize students' operations and answer new questions that arise during the practical process. 3. After each experiment, the teacher checks the integrity of the experiment and discusses experimental data with the students. The last task for the students before the experiment is to put the experimental instruments, equipment, tables, chairs, and notebooks back in place, further cultivating their experimental literacy[4, 5].

3.2.3 Online extended learning after class

In order to further cultivate students' ability to analyze, solve, and summarize problems, it is essential to summarize the experimental activities after class. Students write experimental reports, organize, analyze, and process experimental data, summarize experiments and their experiences and insights. Teachers review experimental reports to understand students' mastery of the experiment, providing a foundation for further experimental expansion and continuous teaching reform. The learning tasks for the after-school stage are shown in Figure 3.

3.3 Building Student-Centered Online and Offline Teaching Processes

Although online short video playback and virtual simulation have broken the limitations of time and space, making learning more convenient for students, there are significant differences in students' self-learning abilities. Some students lack practical awareness of theoretical exercises, especially in experimental teaching. Some students are not familiar with the use of experimental equipment, and some students' experimental operations are not standardized enough, resulting in increased difficulty in obtaining experimental results. This requires mathematics teachers to carefully design mathematical activities in the teaching process, organically integrate the design intention of the teaching process before, during, and after class with the application of blended learning mode, and establish teaching objectives. In pre class preview teaching activities, teachers can use online teaching platforms to publish course announcements to students in advance, or use WeChat groups to push practical teaching content and course announcements to students before the start of classes. In offline classroom teaching activities, teachers provide targeted explanations for difficult problems that arise during pre class preparation, guide students to practice with questions, explore the answers to problems in experiments, record experimental data in a standardized manner, master standardized experimental operation steps, and cultivate good experimental literacy. In post class summary teaching activities, students are required to learn how to organize, analyze, and

ISSN:3007-9640 DOI: https://doi.org/10.70114/acmsr.2025.2.1.P121
process experimental data, and be able to conduct theoretical analysis and experimental summary of experimental results. The mathematics section designed in this way allows students to know their learning objectives in advance and enter the classroom with questions. The implementation of virtual simulation experiments makes the experiments more intuitive, visual, and practical, which helps to improve the effectiveness of practical teaching in class. After class, there is reflection, and students' learning efficiency is further improved.

4. Establishment of Online and Offline+Virtual Simulation Teaching Assessment and Evaluation System

The course assessment method is an important part of course construction, an important means to test students' learning effectiveness, and also an important basis for evaluating the quality of classroom teaching. In order to objectively evaluate the effectiveness of experimental teaching, a digital electronic technology experimental assessment and evaluation system with a blended learning mode has been constructed, as shown in Table 1. The assessment content consists of three parts: pre class experiment preview, in class hands-on practice, and post class experiment summary. Each part has different assessment content and proportions, and evaluates students' learning process and learning ability from multiple dimensions. The evaluation of grades is more reasonable and objective.

Table 1. Design of Assessment and Evaluation System for Digital Electronic Technology Experiments

Teaching link	Assessment content	Assessment ability dimension	Assessment ratio
Before Class	Theoretical learning	Self directed learningIndependent thinking	20%
	Simulation experiment optical path design		
	Test		
In class	Normative	Basic experimental literacy	50%
	Troubleshooting	Experimental operationability	
	Group discussion	Ability to analyze and discuss	
After class	Data analysis and processing	Induction and summarization ability	30%
	Test report		

5. Summary

This article explores the reform and implementation of online and offline hybrid digital electronic technology experimental teaching from the perspectives of the current situation of photoelectric sensor course experimental teaching, the construction of hybrid teaching mode, and the design of evaluation system. An in-depth analysis was conducted on the innovation of the blended teaching mode of online and offline+virtual simulation, online self-learning, offline classroom practice, post class summary teaching, and assessment and evaluation methods. In the process of teaching implementation, a blended learning model with continuous improvement has been formed, and a complete online and offline cross guidance learning mechanism has been created, focusing on the cultivation of students' experimental literacy. Through teaching reform, the educational philosophy of the teaching staff has been updated, which has stimulated students' interest in learning, improved their ability to learn independently, promoted the enhancement of teamwork awareness, and achieved good teaching results. At the same time, it has also promoted

ISSN:3007-9640 DOI: https://doi.org/10.70114/acmsr.2025.2.1.P121
the improvement of the quality of talent cultivation in this major, and provided new ideas for the cultivation of innovative and applied talents.

References

[1] Zheng Xudong. Smart Education 2.0: A New Education Ecology from the Perspective of Educational Informatization 2.0- Interpretation of the Action Plan for Educational Informatization 2.0 [J]. Distance Education Journal, 2018, 36 (4): 9.

[2] Wang Rong, Wei Qingmin, Qin Liqin, et al. Application of blended online and offline teaching mode based on virtual simulation technology in inorganic chemistry experiments [J]. Chemical Design Communication, 2021, 047 (011): 112-113

[3] Deng Yiyu, Zhao Zhifang. Research and Innovation of Blended Online and Offline Teaching Mode - Taking the Course of "Human Computer Interaction Design" as an Example [J]. Journal of Beijing Institute of Printing and Technology, 2021 (11): 103-106

[4] Wang Wei, Lv Dongyu, Dong Lijun, et al. Exploration and Application of Blended Teaching Mode in Chemical Laboratory Safety Course [J]. University Chemistry, 2021, 36 (2): 143-149.

[5] Ouyang Jianming, Peng Gang, Luo Jian, et al. Teaching Reform and Practice of "College Physics Experiment" Combining Virtual and Reality, and Mixing Online and Offline [J]. Journal of Higher Education Research, 2021 (3): 58-62