Research and Practice of the Hybrid Teaching Model Based on the BOPPPS Model in Electronic Technology Courses

Luya Zhang*, Jingna Cui[a], Dongqiu Xing[b], Jing Zhao[c], Shasha Wu[d]

Information Support Force Engineering University, Wuhan, Hubei, China

*zhangluya@gfkjdhsxtshysyxljd.onexmail.com, [a]8977317411@qq.com, [b]Angelaxing@126.com, [c]282986394@qq.com, [d]nancy-wsh@163.com

Abstract. Continuous innovation and reform in education and teaching are essential to address the evolving demands of development. To realize such innovation and reform, it is crucial to explore student-centered teaching models. This paper presents a study on the application of the BOPPPS teaching model in electrical engineering courses. Drawing on practical case studies and the unique characteristics of electronic technology courses, the author has conducted research and pilot programs exploring innovative applications of teaching methodologies, with the objective of enhancing students' knowledge acquisition while cultivating their critical thinking and practical competencies.

Keywords: BOPPPS teaching model, Online + Offline, electronic technique.

1 Introduction

The development of education determines the progress of science and technology and the quality of talent cultivation, serving as a crucial factor in the rise of a powerful nation. In 2025, the Central Committee of the Communist Party of China and the State Council issued the "Outline for the Construction of an Education Powerhouse (2024-2035)", clearly stating that "we should accelerate the establishment of a modern vocational education system, cultivating major artisans, skilled craftsmen and highly skilled talents", indicating a new path and direction for vocational education to serve the construction of an education powerhouse. [1]

To achieve these objectives and improve the quality of classroom instruction, it is essential to implement a well-structured pedagogical model. Amid the ongoing evolution of pedagogical approaches, the BOPPPS model has emerged as a leading instructional framework, distinguished by its rigorous alignment with and effective realization of the "student-centered" educational philosophy.

A. Y. M. A. Islam et al. (eds.), *Proceedings of the 2025 International Conference on Educational Technology and Management Information Systems (ETMIS 2025)*, Advances in Computer Science Research 129,
https://doi.org/10.2991/978-94-6239-630-2_2

1.1 Research Status at Home and Abroad

The BOPPPS teaching model is officially known as Bridge-in, Objective, Pre-assessment, Participatory Learning, Post-assessment, and Summary. To be precise, it is merely a framework for teaching design, originated from the teacher training program in British Columbia, Canada. [2] As one of the tools for education and teaching, the BOPPPS teaching model has also gained the favor of a large number of educators and administrators, particularly teachers in STEM disciplines, due to its prominent advantages such as clear objectives and student-centeredness. In recent years, it has been continuously promoted in the fields of higher education and vocational training in Europe and America, and has shown a diversified development trend. Foreign practitioners are attempting to combine BOPPPS with new paradigms such as blended learning and gamified teaching, and presenting them through Learning Analytics in a technologized and data-driven manner.

To gain insight into the research and application status of the BOPPPS teaching model in China, the author conducted a systematic search on the knowledge network using the following search criteria: "publication date: July 15, 2015 to July 15, 2025" and "topic: BOPPPS teaching model; application in instruction," resulting in a total of 15,487 relevant records. If the author replaced the search keywords with "BOPPPS teaching model; electronic techniques ," the results obtained were only 557 items. From this, it can be seen that although the growth rate of the number of published papers on the BOPPPS teaching model is considerable, the total amount of literature that uses electrical courses as practical examples is actually quite small. This also reflects that the research and application scope of this model in the teaching reform of electrical courses in our country is still limited, and there is still a lot of room for improvement. [3]

2 Main Contents of the Study

2.1 BOPPPS Introduction

BOPPPS aims to achieve the core concept of "centering on student development", and divides the course teaching into six stages. The introduction (Bridge-in, B) aims to arouse interest and connect the past and the future. The learning objective (Objective, O) is followed by pre-assessment (Pre-assessment, P), which evaluates students' prior knowledge. Then comes participatory learning (Participatory Learning, P), where students are guided to actively participate in teaching to master knowledge and acquire skills. This is succeeded by post-assessment (Post-assessment, P), which tests the achievement of learning objectives, and finally concludes with a summary (Summary, S). [4] The most distinctive feature of the BOPPPS teaching model lies in its emphasis on teacher-student interaction and the importance placed on teaching feedback. This model is more conducive to stimulating students' enthusiasm, thereby ensuring the effective achievement of teaching objectives. [5]

2.2 Analysis of Learning Situation

Course Nature and Status. In November 2021, the General Secretary emphasized that talent serves as a pivotal factor in driving the high-quality development of our armed forces and constitutes a crucial support for securing the initiative in military competition and future warfare. The cultivation of military academy cadets, particularly the consolidation of their scientific theoretical foundation, represents a critical component in fostering high-caliber, professionalized new-type military personnel. [5] As the foundational underpinning of modern technology, electronic technology exhibits pervasive, driving, and innovative characteristics. In recent years, it has permeated various disciplinary domains, playing a pivotal role in information and communication systems, industrial control and automation, aerospace, power and energy, as well as artificial intelligence sectors. "Application of Electronic Technology" is a core course in the education of basic theory and skills related to electronic technology. It not only features rigorous theory, systematic structure, and comprehensive content but also possesses strong engineering relevance and practicality. Serving as a crucial bridge between foundational courses and specialized disciplines, it plays an indispensable role in cultivating students' engineering practice capabilities and fostering technological innovation competencies.

Current Situation Issue.

The Theory and Practice are not Closely Integrated. The discipline of electronic technology covers a wide range of knowledge, but the theoretical teaching is too fragmented and the practical aspects are too superficial. The technological development is relatively disconnected, and it lacks coverage of modern electronic technologies (such as PCB design and FPGA development), resulting in a certain gap from the engineering practice requirements.

The Specific Content is Abstract and Difficult to Understand. The concepts in the electronic technology course are abstract. Mathematical tools such as Fourier transform and Laplace transform are frequently applied, which requires a relatively high level of engineering mathematics. There are significant differences between ideal models and the characteristics of actual devices.

The Teaching Methodology is Characterized by a Lack of Diversity and Engagement. For a long time, the teaching methodology of electronic technology courses has relied on the single model of "lecturer instruction + experimental verification", resulting in low student engagement and delayed feedback on learning outcomes.

2.3 The Basic Idea of Topic Research

Currently, the commonly used hybrid teaching model that combines online and offline instruction can indeed compensate for the deficiencies of traditional teaching and online teaching. However, online teaching faces challenges in accounting for individual differences among students. Moreover, it requires students to have a certain level of self-learning and self-control abilities. Additionally, it fails to fully reflect students' participation and individuality. [2] To address the aforementioned issues, the research group has proposed a research and practice project on the application of the BOPPPS-based blended teaching model in electronic technology courses. Attempts are made to improve the teaching plan by leveraging information-based tools such as Rain Classroom. Preparations are underway to shift the teaching method from " one-way indoctrination" to " multi-dimensional interaction", upgrade the feedback mechanism from "lagging summary" to "dynamic closed-loop", and transform students from "passive recipients" into "active constructors".The specific research approach is shown in Figure 1:

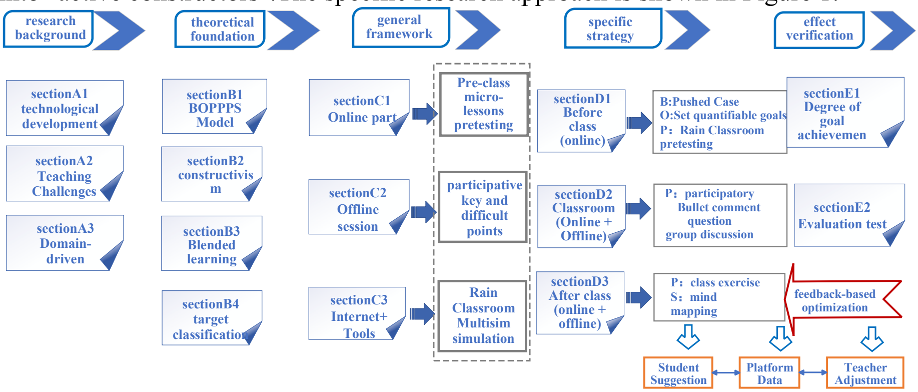

Fig. 1. Basic idea of research.

3 The Specific Implementation of the BOPPPS Blended Teaching Model

Taking the DC power supply module as an example and combining the "online + offline" model, a pilot class was selected from the current academic year to carry out the practical teaching of the BOPPPS blended teaching mode. It is systematically divided into pre-class, in-class, and post-class implementation phases [3]. During the in-class participatory teaching process, ideological education is appropriately integrated into the curriculum to achieve the unified teaching objective of "knowledge, ability, and values."The flowchart is shown in Figure 2:

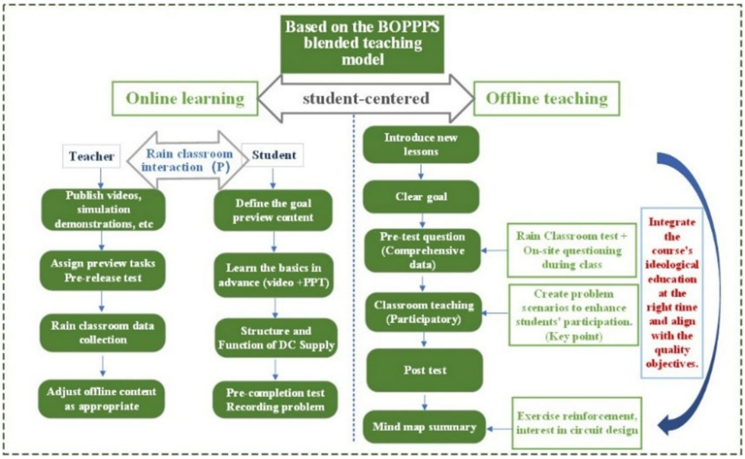

Fig. 2. A schematic diagram of the blended teaching design based on BOPPPS.

To grasp the effectiveness of BOPPPS in teaching, the author selected two classes, A and B, for comparison. Both classes are taught by the same instructor, covering identical instructional content (DC regulated power supply), with consistent implementation plans, teaching materials, and allocated class hours. Experimental Class A and Control Class B were parallel classes within the same academic year (both majoring in Communication Engineering), consisting of 41 and 45 students respectively. The class allocation was randomized based on the diagnostic examination conducted after student enrollment. Both classes exhibited no significant differences in gender composition (all-male classes) and average performance in prerequisite courses, thereby satisfying the comparability requirements. The trend of prerequisite course performance is illustrated in Figure 3.

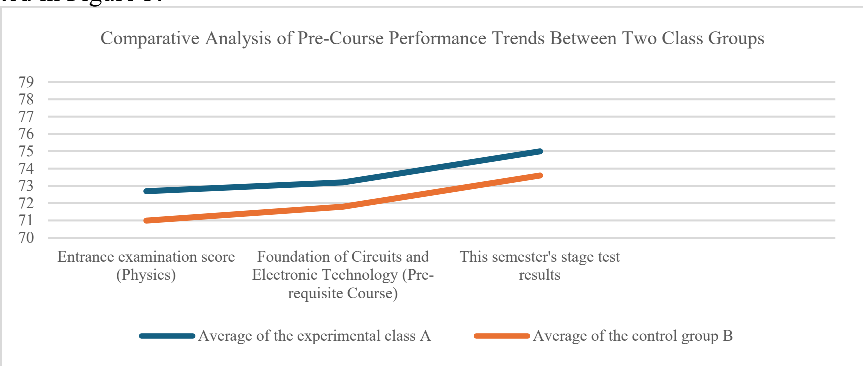

Fig. 3. Comparative Analysis of Pre-Course Academic Performance Trends.

The experimental group implemented a blended teaching approach based on the BOPPPS model, as illustrated in Figure 2. In contrast, the control group received conventional instruction, with both groups being evaluated using identical assessment criteria.

3.1 Before Class (Online)

Pre-class learning materials are disseminated via the Rain Classroom online teaching platform, contextualized within the framework of common AC-to-DC conversion scenarios in professional and daily life to stimulate student engagement. The experimental class conducted a questionnaire survey to explore students' learning intentions and used self-assessment questions to diagnose the difficulties in previewing, focusing on common problems (including the circuits that interested them the most and the ones they most wanted to explore), as shown in Table 1. Based on the learning situation focus points (rectification principle and filtering effect) revealed by the Rain Classroom survey, the goals are set at two levels: the first is the core goal (solving students' concerns): through simulation comparison of half-wave/full-wave rectification waveforms, to explore the influence of filter capacitors on ripple voltage, and to directly respond to the high-frequency questions raised in the pre-class survey. The secondary objective (stimulating innovative thinking) is: upon achieving the fundamental goals, to guide students to autonomously propose optimization solutions for filter circuits across diverse application scenarios, thereby transforming passive knowledge acquisition into active design thinking.

Table 1. Survey on the Willingness of Experimental Class Students to Implement BOPPPS Teaching Methodology.

options	subtotal	proportion
Interested (in the new model)	29	70.7%
Hesitant and indecisive (afraid of not adapting)	4	9.8%
Not very willing (worried about low efficiency)	5	12.2%
Doesn't want (which would increase the burden of study)	3	7.3%

3.2 During the Class (Both Online and Offline)

Class B employs conventional lecture-based instruction, whereas Class A adopts a participatory teaching methodology. The session commenced with a reiteration of the learning objectives, followed by a visualization of key knowledge points extracted from student questionnaires through a word cloud, thereby highlighting the focal areas of rectification and filtration as the primary challenges of the lecture. The core content was systematically structured into three integral components: the fundamental architecture of DC regulated power supplies, rectifier circuits, and filter circuits.

In the explanation of bridge rectifier circuits, scenario-based questions are formulated to embody participatory teaching methodology, as detailed below:

In the context of an electronic design competition, where several students from a class are required to independently design and construct a DC power supply for operational purposes, a team member successfully assembled the circuit and obtained the output waveform as illustrated in Figure 4: The upper waveform represents the secondary voltage of the transformer (rectifier input), while the lower waveform depicts the rectified output signal.

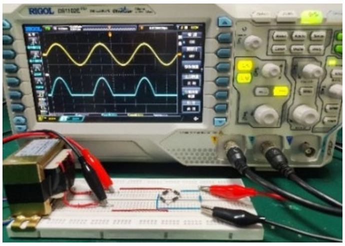

Fig. 4. Measured waveform diagram of the bridge rectifier circuit.

Participants are required to form groups of 2-3 individuals to conduct a collaborative analysis of potential failure points and their underlying causes. The teacher will subsequently randomly select group representatives to present their team's perspectives, followed by a comprehensive summary provided by the teacher.

The analysis reveals that the reverse connection of a diode during simulation merely results in half-wave rectification, posing no significant safety concerns. However, in practical applications, such a configuration can lead to diode burnout, potentially escalating to transformer damage, thereby jeopardizing the overall safety and stability of the circuit. Through group discussion and analysis, students not only consolidated their knowledge of circuit theory but also shared insights and proposed new ideological perspectives, transforming the ideological education component of the course from passive acceptance to active discovery. The implementation of participatory learning methodologies has significantly enhanced students' self-efficacy.

3.3 After Class (Both Online and Offline)

Following the lecture, both classes were assigned identical test questions, accompanied by the simultaneous online distribution of experimental circuit design tasks. Students were encouraged to utilize the experimental platform for design verification purposes. In the design of the post-test questions, in addition to the basic question types, open-ended tasks were also added. For instance, analysis and design questions (such as "Design a filter circuit for the drone power supply with a ripple $\leq$ 5%, and explain the basis for parameter selection") were included.There are also fault diagnosis questions (such as "The output of a certain voltage stabilizing power supply fluctuates beyond the standard. Try to analyze the differences in fault characteristics between the damage of the rectifier tube and the failure of the capacitor"). This design of anchoring goals and promoting innovation through open-ended tasks enables teaching objectives to be both targeted and leave room for creativity, so as to assess the development of students' innovative thinking and practical application skills.

The application of mind mapping facilitates the systematic organization and summarization of key knowledge points, thereby providing essential data support for the subsequent generation of Large-scale data model and knowledge graphs. The detailed content design is illustrated in Figure 5 [6]:

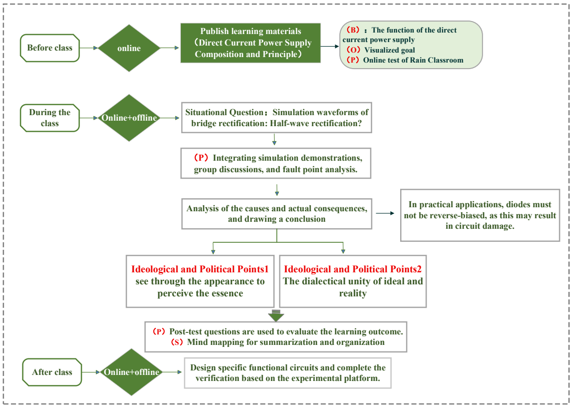

Fig. 5. Designing a DC Regulated Power Supply Using the BOPPPS Model.

4 Effect Verification Summary

4.1 Summary of the Main Situation

The author evaluates the effectiveness of the BOPPPS teaching model through quantitative data and qualitative feedback. A comparative analysis is conducted between two classes using standardized test questions, specifically including:

A comparative analysis of the willingness survey regarding the BOPPPS teaching model among experimental group students before and after the course (Figure 6). A comparative analysis of test completion rates between two classes before and after the instructional session (on the evening following the class) (Figure 7). Comparative Analysis of Post-Class Assignment Scores on the Rain Classroom Platform Across Two Classes (Figure 8) [7]. Statistical Survey Table on Learning Outcomes Across Various Dimensions in the Experimental Group (Table 2).

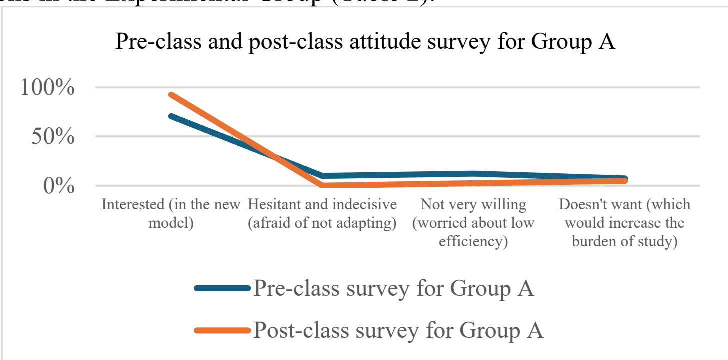

Fig. 6. Comparative Analysis of Pre- and Post-Class Attitudes Towards the BOPPPS Instructional Model in the Experimental Group.

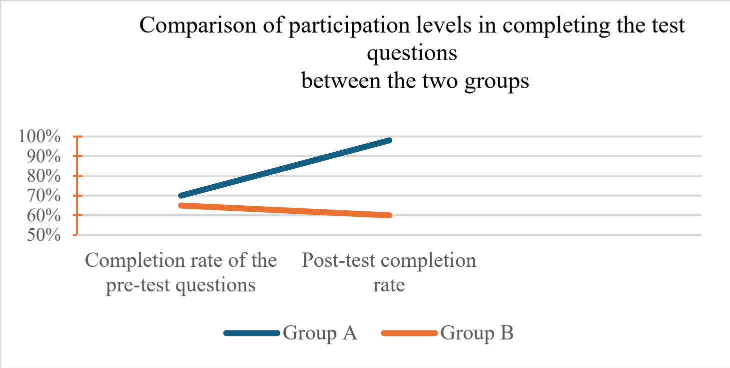

Fig. 7. Comparative analysis of the timely completion rates of pre- and post-test assessments across two classes.

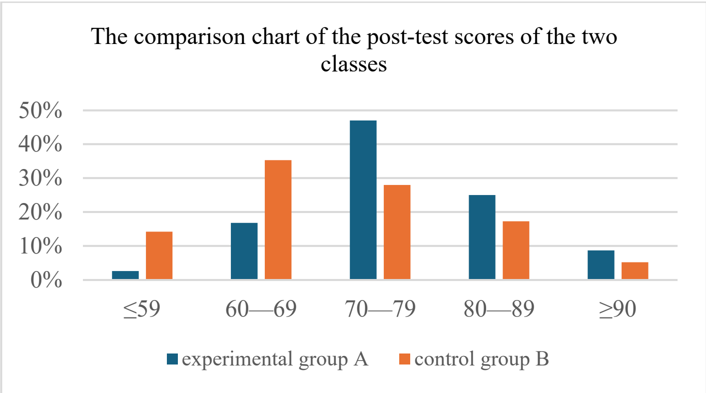

Fig. 8. Comparative Analysis of Post-Class Test Scores between Group A and Group B.

Table 2. Statistical Table of Learning Effects in More Dimensions for Group A

Through participatory learning	completely satisfy	Relatively satisfied	Generally satisfied	dissatisfy
Enhanced my ability to apply knowledge	43.90%	29.27%	21.95%	4.88%
This has enhanced my ability to learn independently.	46.34%	24.39%	19.51%	9.76%
Enhanced teamwork and communication skills	68.30%	14.63%	14.63%	2.44%
Expanded the breadth and depth of learning	73.17%	12.19%	7.32%	7.32%
Enhanced my innovation ability	75.61	14.63%	7.32%	2.44%
average	61.46%	19.02%	14.15%	5.37%

Furthermore, it was also learned that the students in the experimental group were more proactive and efficient when completing the electronic technology experiments.

4.2 Conclusion Analysis

The data highlights four key findings: First, experimental class students showed significantly higher acceptance of the BOPPPS model. Secondly, their post-class assessment completion rate reached 98%, a 38-point increase over the control group (60%), reflecting greater engagement and timely feedback. Thirdly, the experimental group exhibited a higher proportion of students scoring above 70 and 80 points in the post-class assessment compared to the control group, with an overall improvement in average scores. Fourthly, the experimental class demonstrated that 61.46% of students on average reported significant improvements in multidimensional competencies, including knowledge application and team collaboration, through participatory learning.

Quantitative and qualitative research findings collectively validate the efficacy of the BOPPPS model in electrical engineering curricula, demonstrating that this hybrid pedagogical approach integrates the dual advantages of behaviorist reinforcement and constructivist learning [8]. This not only provides empirical evidence for digital teaching reform but also achieves a win-win outcome for both instructors and students through the enhancement of teachers' curriculum design capabilities.

4.3 Limitations and Improvement Directions

The current research has not adequately accounted for the impact of individual student differences on instructional outcomes. Future studies may necessitate the implementation of stratified instructional activity designs and extended longitudinal tracking periods to assess long-term efficacy.Instructional practices should be enhanced with personalized tutoring, while optimizing time allocation across all BOPPPS components (e.g., reducing pre-assessment duration and increasing practical discussions).

5 Conclusion

The application of the BOPPPS instructional model in electrical engineering courses demonstrates significant advantages, as its structured design and interactive features effectively address the pain points inherent in traditional teaching methodologies. The integration of a blended instructional approach based on the BOPPPS teaching model in classroom design significantly enhances student engagement and self-directed learning, thereby facilitating knowledge assimilation and improving overall teaching efficacy. [9] [10]

References

1. zhongyan, Shen., dan Sun: The "six characteristics" for building an educational powerhouse. The practical path for provincial modern vocational education system construction. Education and vocation178(6), 14–22 (2025). doi: 10.13615/j.cnki.1004-3985.2025.06.001

2. Al Rawashdeh, A. Z., Mohammed, E. Y., Al Arab, A. R., Alara, M., Al-Rawashdeh, B: Advantages and disadvantages of using e-learning in university education: analyzing students' perspectives. Elect. J. E-Learn (19), 107–117(2021). doi: 10.34190/ejel.19.3.2168
3. jie, Cheng., weigang, Qin., xin, Ma: The Application of BOPPPS Model in Electrical Engineering Experiment Teaching.Laboratory Research and Exploration43(9):129- 134(2024). doi: 10.19927/j.cnki.syyt.2024.09.024
4. chen, Wang., chengsong, Hu., lijia, Chen., yue,Wu., qihong, Ban: Exploration and Practice of the BOPPPS Teaching Model Based on the OBE Concept in Computer Science Education. Electronic components and information technology. 8(10), 57–59 (2024). doi: 10.19772/j.cnki.2096-4455.2024.10.018
5. hongcheng, Fan., zisen, Qi., liangsi, Zhou: The Exploration and Practice of the BOPPPS Teaching Model in Communication Courses. Science Teaching Journal3 57–60 (2024).doi: 10.16400/j.cnki.kjdk.2024.3.019
6. xin,Lv: Research on the Ideological and Political Teaching Reform of the "Circuit and Electronic Technology" Course. Scientific consultation, 6: 187–190. (2024). https://fx.gfkd.chaoxing.com/jour/detail_38502727e7500f26ef05ce1c291a3e951e09ca7c622447771921b0a3ea255101fc1cf1fbb4666ae6c1af0344e3f606cff0c6ca5b4807e3f403766e49f332c4a039bd194604fc3f9ab5dbc8d3ff33159f
7. fengjiao, Li., xueting, Li: Research on Online-Offline Hybrid Teaching Based on Rain Classroom and "BOPPPS Teaching Model" —— Taking "Electronic Technology" as an Example. Industry and Technology Forum22(8), 126–127 (2023). doi: 10.3969/j.issn.1673-5641.2023.08.053
8. Yaron, Schur.,Ainat, Guberman: Conceptual Change of ‘Teaching’ among Experienced Teachers after Studying Attentive Teaching: Education Sciences3(14), 231 (2024). doi:10.3390/educsci14030231
9. liang, Zhang., xiangyu, Du., dexin, Li., xiaoji, Song: First-Class Course Teaching Design and Practice Based on the BOPPPS Model - Taking the Fundamentals of Electronic Technology Course as an Example. Higher Education Journal9(21), 95–98 (2023).doi:10.19980/j.CN23-1593/G4.2023.21.023
10. xiaoyun, Peng., shijie,Yan: Curriculum Reform of "Principles and Interface Technology of Single-Chip Microcomputers" Based on OBE Concept and BOPPPS Model. Technological Innovation Trends (17),81-84(2025). doi: 10.19392/j.cnki.1671-7341.202517027