BOPPPS model via Chao Xing platform in medical cell biology experiments

Yang Jianguo[1, a*], Zhang Huiming[2, b], George Brown[3, c],

[1]Huazhong University of Science and Technology 13 Hang Kong Road, Qiao Kou District Wuhan, Hubei 430030, China
[2]XuetangX Ke Jian Building, Tsinghua Science Park Hai Dian District, Beijing 100084, China
[3]Rinri Therapeutics Ltd. 217 Portobello Sheffield, South Yorkshire S1 4DP United Kingdom
a.jianguo_yang0728@163.com,b.huiming_6489_zhang@gmail.com,c.george_53brown@outlook.com
***Corresponding Author**

Abstract: To address the issues of passive student engagement and a single-dimensional evaluation system in traditional experiment teaching, this study developed a blended online-offline teaching model for medical cell biology experiments that integrates the BOPPPS model with the Chao Xing Xue Xi tong platform. By reconstructing the instructional design framework, the six BOPPPS modules (Bridge-in, Objective, Pre-assessment, Participatory Learning, Post-assessment, Summary) were deeply integrated with experiment teaching procedures, while the Chao Xing Xue xi tong platform facilitated pre-class task distribution, real-time interaction, and multi-dimensional assessment. Questionnaire surveys revealed that 91.2% of students expressed high satisfaction with experiment project design, 92.7% reported significant improvement in hands-on ability, and 64.3% preferred the reformed teaching model. The multi-dimensional evaluation system effectively enhanced grade objectivity, with 89.2% of students expressing satisfaction. This teaching model highlights the vital role of student-centered interactive instruction in improving experiment teaching quality, offering a reference for experiment teaching reform in higher education institutions.

Keywords: BOPPPS teaching model, blended online-offline teaching model, experiment teaching, medical cell biology, teaching quality

1. Introduction

Medical cell biology is a core professional foundation course for clinical medicine, stomatology, and imaging medicine majors at Zunyi Medical University (hereinafter referred to as "our university"). The accompanying experiment teaching plays a pivotal role in cultivating students' clinical operation standards, teamwork capabilities, and scientific research thinking [1-2]. Experiment teaching differs substantially from theoretical teaching, as it requires students not only to master theoretical knowledge related to experimental projects, but also to become familiar with experimental principles and operational procedures, and to perform hands-on operations during class to develop their practical abilities and problem-solving skills [3]. Due to its relatively shorter development history compared to theoretical teaching, current experiment teaching concepts are somewhat outdated and teaching methods remain conventional, which is unfavorable for the sustainable development of experiment teaching. Traditional experiment teaching models typically involve instructors explaining experimental objectives, principles, and procedures, followed by student operations. While this model is classic, it is not conducive to achieving teaching objectives and desired outcomes [4]. Therefore, it is imperative to leverage advanced modern teaching methods to transform traditional experiment teaching models.

2. Problems in medical cell biology experiment teaching

Before the teaching reform, the experiment teaching of medical cell biology at our university adopted a traditional teaching model: students previewed before experiments; during class, instructors explained experimental principles, operational procedures, and precautions; students then followed the established procedures step-by-step to complete experiments under instructor supervision, obtaining predetermined

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results [4]. Although both teachers and students fulfilled their respective roles, the mutually reinforcing effect of teaching and learning was not adequately or concretely realized.

During experiment teaching, students passively received knowledge and mechanically completed experiments or simply copied demonstrations, leading to disinterest among some students and a lack of reflection on underlying concepts. The absence of independent thinking space prevented in-depth analysis of experimental results, hindering the cultivation of abilities to identify, analyze, and solve problems. Consequently, students demonstrated poor knowledge application skills, while their innovative spirit and research capabilities failed to be effectively developed [5].

Student operations lacked objective and fair evaluation; scoring relied solely on instructors' observations of classroom performance and presented results, failing to thoroughly and comprehensively assess students' actual hands-on abilities, collaborative skills, and problem-solving capabilities.

3. Application of the BOPPPS teaching model

3.1. Overview of the BOPPPS teaching model

The BOPPPS teaching model is a "guidance-interaction" model renowned for effective instruction, with teacher-student interaction at its core. It guides students to achieve learning objectives through participatory learning, reinforcing a student-centered teaching philosophy [6-7]. The BOPPPS teaching model comprises six modules: Bridge-in: serving as an introduction through questions, storytelling, short videos, and hot news to stimulate students' learning enthusiasm; Objective: designing scientific and reasonable learning goals to guide students in clarifying the knowledge, skills, and affective objectives to be acquired; Pre-assessment: assessing students' prior knowledge through question-and-answer sessions, quizzes, and questionnaires; Participatory Learning: enhancing teacher-student and peer interactions through problem guidance, group discussions, and experimental inquiry methods to unleash students' potential[1,6]; Post-assessment: evaluating whether learning objectives have been met through assignments and questionnaires, with instructors adjusting subsequent instructional design based on feedback; Summary: consolidating classroom content through student feedback, knowledge summaries, and peer evaluations within and between groups, helping students review and organize learned material while reflecting on learning outcomes. The BOPPPS teaching model emphasizes students' principal role in knowledge construction, following an instructional cycle that enables teachers to effectively organize teaching activities and make timely, appropriate adjustments through teaching-learning feedback. Meanwhile, students' comprehensive active participation enhances their learning motivation and abilities to analyze and solve problems [8-9].

3.2. Application value of BOPPPS in experiment teaching

Since the proposal of the BOPPPS teaching model, numerous universities at home and abroad have continuously implemented it in their teaching, achieving favorable outcomes. However, its application in experiment teaching remains limited [10-11]. Experiment courses are student-centered, cultivating practical and innovative abiliti

es through designated experimental content, emphasizing what students learn, do, and are capable of during the process, thus requiring organic integration of teaching and learning [12]. Therefore, to address deficiencies in previous experiment teaching, the authors integrated the Chao Xing Xue xi tong platform with the BOPPPS teaching model as the design philosophy, applying it to medical cell biology experiment teaching. This involved restructuring classroom organization methods, optimizing teaching approaches, and continuously improving experiment teaching effectiveness. The approach ensures that instructors' guiding role is fulfilled while students' principal status is manifested, fully stimulating students' interest in active learning, fostering innovative consciousness, enhancing instructors' teaching competence, promoting mutual improvement in teaching and learning, and ultimately improving experiment teaching outcomes.

4. Design of an online-offline integrated experiment teaching model

The traditional experiment teaching model fails to fully embody a student-centered teaching philosophy and reduces classroom teaching efficiency. Based on the "Two Properties and One Degree" teaching

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standards, this study achieves a closed-loop design encompassing pre-class, in-class, and post-class evaluation through the organic integration of online and offline components, comprehensively implementing the teaching philosophy of "student development as the center." A medical cell biology experiment teaching model supported by the Chao Xing Xue xi tong platform was constructed. Before class, students complete online learning of experimental objectives, principles, operational procedures, and precautions; they may also explore extended materials to gain cutting-edge knowledge, broaden their horizons, and enhance their interest in the subject. During class, instructors assess students' mastery of experimental content through pre-test questions, enabling targeted explanations and emphasis on weak knowledge points, thereby saving lecture time and improving classroom teaching efficiency. Students are selected to demonstrate error-prone experimental procedures on-site, with peers participating in evaluations, fully leveraging student-centered teaching characteristics and stimulating students' abilities to think actively and solve problems. The specific implementation process is shown in Figure 1.

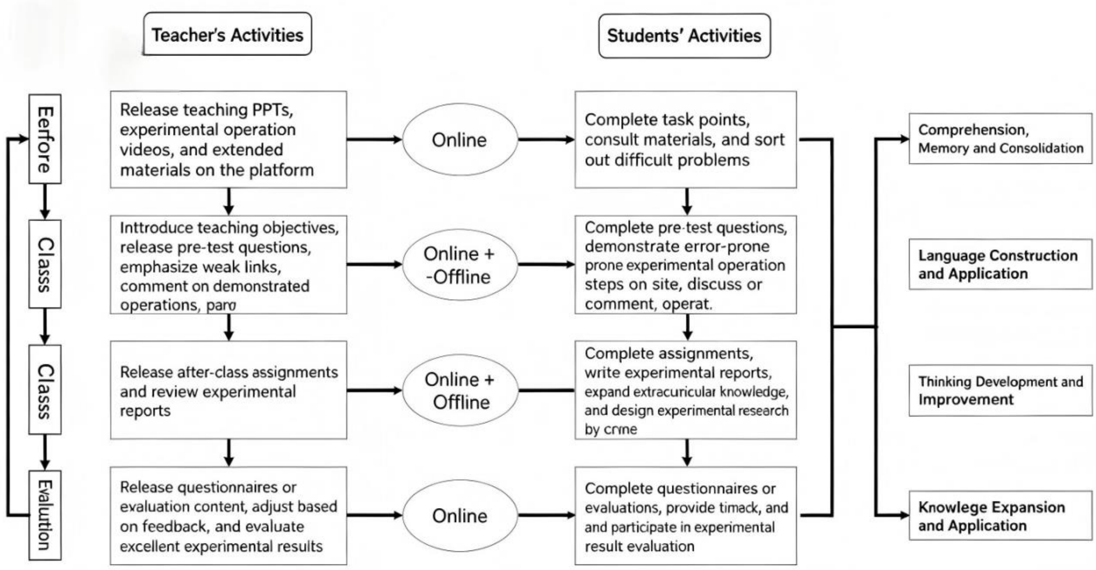

Figure 1 Implementation Process of Blended Online-Offline Teaching

4.1. Construction of the Chaoxing Xuexitong experiment teaching platform

An experiment teaching platform on the Chao Xing Xue xi tong platform was constructed by developing experiment teaching videos, micro-lectures, and test questions. Teaching videos present experimental procedures in an intuitive and vivid manner, facilitating students' comprehensive understanding of the experiment process. Micro-lectures were produced for difficult experimental operations to aid student comprehension and retention. Instrument and equipment operation procedures were recorded to ensure students fully understand specific usage methods. Micro-lectures demonstrating complete experimental workflows were employed, with emphasis on operational precautions to prevent poor experimental results caused by overlooked details. Additionally, other experiment-related video materials were uploaded to broaden students' knowledge and enhance their understanding of the applications and significance of experimental projects.

4.2. Teaching design based on the BOPPPS teaching model

Our university offers four offline experiments in medical cell biology: microscope usage and vital staining and observation of mitochondria; observation of rabbit erythrocyte membrane permeability and cell fusion; identification of living and dead cells, and isolation and identification of nuclei; and preparation and analysis of animal chromosome specimens. Instructional design was restructured according to the six elements of the BOPPPS teaching model; the design scheme is presented in Table 1.

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Table 1 Blended Teaching Design Based on Chao Xing Xue xi tong under the BOPPPS Model

Element	Time / min	Teacher Activities	Student Activities	Teaching Methods
Bridge-in	5	Present images, videos, or hot topics to introduce the experiment course and stimulate students' curiosity	Peer interaction, thinking and answering questions, etc.	PPT or video
Objective	2	Knowledge objective: consolidate relevant theoretical knowledge and expand the knowledge system Skill objective: complete experimental operations and analyze results	Understand learning objectives	PPT presentation
Pre-assess ment	20	Affective objective: such as animal welfare, humanistic care, social ethics, etc.1. Release pre-class task points: including micro-lectures, video materials, PPT, etc.2. Release test questions3. Select students to demonstrate or explain experimental procedures	Complete task points before class, familiarize with experimental content, and finish test questions	Xue xi tong interaction, random selection of students for operation demonstration
Participato ry Learning	90	Emphasize and demonstrate weak points, inspire student thinking. Set up experiment competitions to stimulate interest and motivation	Conduct experiments in groups, discuss between groups, and determine experimental protocols. Photograph experimental results	Multimedia courseware, on-site communication, inter-group discussion, inter-group scoring
Post-assess ment	10	Release test questions or questionnaires, question-and-answer rush. Adjust the next experiment teaching plan based on survey results	Complete tests or questionnaires, answer questions, and write experiment reports	Xue Xi tong interaction
Summary	8	Select excellent experimental results, summarize on-site, and invite students to share experiences of success and failure	Peer evaluation of experiment grades among groups	Teacher guidance, on-site communication, Xue Xi tong interaction

4.3. Practice of integrating BOPPPS teaching model with Chao Xing Xue Xi tong

Students were required to complete task points on the Chao Xing Xue Xi tong platform before class, which served as a component of their experiment grades. This requirement motivated students to preview online resources in advance, familiarize themselves with experimental principles and operational procedures, and learn about cutting-edge developments. At the beginning of class, pre-test questions were released to assess students' mastery of relevant knowledge points, enabling targeted explanations of weak areas and thorough emphasis on precautions. This approach effectively saved instructors' lecture time and improved experiment teaching efficiency. Post-test questions were released after experiments to evaluate students' understanding of relevant theoretical knowledge and their in-depth analysis of experimental results. During class, in-class exercises were used to encourage student participation in answering activities, with course points set as rewards to increase interaction with students and motivate active thinking and engagement. After the course, questionnaires were distributed through the Xue Xi tong platform to promptly obtain student feedback on experiment course design and teaching content, with adjustments made based on their suggestions. Additionally, homework was assigned to further deepen students' understanding and consolidation of experiment teaching content, promote more comprehensive and in-depth mastery of teaching material, enhance understanding and application of relevant theoretical knowledge, and prevent the disconnect between theory and practice.

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4.4. Multi-dimensional assessment with dual-feedback

Previously, experiment grades were solely composed of experimental operation and experiment report components, resulting in a simplistic grade structure lacking objectivity and fairness. After the reform, experiment grades comprise multiple components including attendance, discipline and hygiene, preview performance (including task points and preview report completion), question-and-answer participation, experimental operation, experiment report, and experiment assessment, truly achieving three-stage evaluation encompassing pre-class, in-class, and post-class phases. The online evaluation component includes task points, experiment result scoring, homework or quiz scores, and other reward mechanisms. The offline evaluation mainly comprises preview reports, experimental operation sessions, formative assessment, experiment reports, and point rewards for research interest groups. This diversified grade composition transformed the evaluation system from one dominated by subjective factors to one primarily based on objective factors (Figure 2), achieving whole-process assessment. Post-class research interest group projects were added to effectively motivate students to actively participate in scientific research experiments, cultivating their scientific thinking abilities and group collaboration capabilities.

4.5. Evaluation of teaching effectiveness after the reform

Six classes from the 2022 cohort at our university (including clinical medicine, imaging medicine, stomatology, and bioprocess majors) were randomly selected for instruction following the BOPPPS teaching model design. A questionnaire survey was administered after the course to assess students' recognition and satisfaction with the reformed teaching methods. Results indicated that teaching resources provided by the Chao Xing platform received overall high evaluations. The preview auxiliary function of experiment course PPTs was most prominent, with 76.5% of students rating it "very helpful" and only 1.8% considering it "not very helpful." Recognition of video materials and test questions was slightly lower than that of PPTs ("very helpful" rates of 69.6% and 77.0%, respectively), suggesting that digital resources played an important role in preview and knowledge consolidation, though the content depth or presentation format of video materials may require further optimization to enhance appeal. Students expressed high satisfaction with the current experiment project design, with 91.2% rating it "very satisfied" or "relatively satisfied." A total of 92.7% of students believed their hands-on abilities had "improved greatly" or "improved considerably," and 92.6% considered that experiment content stimulated their desire for knowledge exploration. The reformed teaching model received support from the majority of students, with 64.3% preferring the new model—significantly higher than the 33.9% favoring the traditional model. Among specific reform measures, pre-test questions' promotion of preview, deepening of process understanding, and stimulation of learning motivation all received high evaluations. However, approximately 30% of students considered these measures "moderately effective," and 1.6%–3.2% considered them "not very helpful," reflecting that the reform needs strengthening in differentiated teaching support and personalized learning pathway design. A total of 89.2% of students were satisfied with the reformed evaluation system, fully demonstrating its fairness, impartiality, and diversification.

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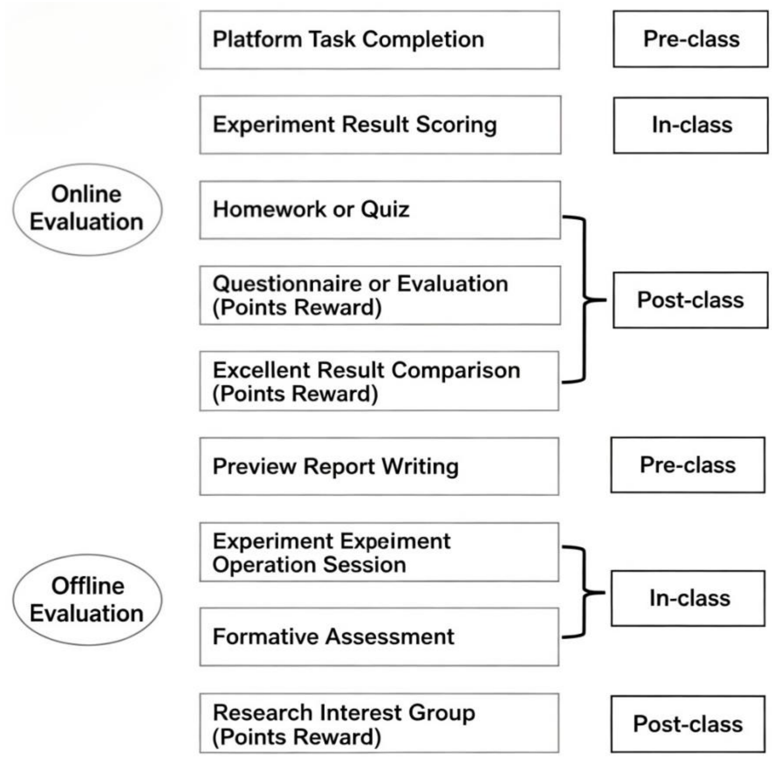

Figure 2 Construction of a Diversified Experiment Achievement Evaluation System

5. BOPPPS model in experiment teaching reform

5.1. Traditional experiment teaching challenges and BOPPPS introduction

The BOPPPS teaching model, as an advanced educational concept and instructional strategy, has been increasingly applied in the global education field, demonstrating significant advantages and effectiveness. Its core lies in being student-centered, emphasizing student participation and interaction, stimulating student potential through diverse teaching methods, and guiding students to think actively, thereby achieving effective teaching [10]. Experiment teaching, as an important component of higher education, plays an irreplaceable role in cultivating students' practical skills, scientific research literacy, and innovative thinking [13]. However, the traditional experiment teaching model has gradually revealed some urgent problems in long-term practice, restricting the improvement of experiment teaching effectiveness. In terms of teaching content, some experiment courses still focus primarily on verification experiments, with outdated and monotonous content that fails to stimulate students' learning interest and innovative thinking. For example, some medical cell biology experiment courses are limited to repetitive verification of classical theories, lacking integration with frontier scientific research, preventing students from accessing the latest experimental techniques and research methods. In terms of teaching methods, traditional experiment teaching is mostly teacher-centered, with students passively receiving knowledge and lacking opportunities for independent exploration and critical thinking. This "spoon-feeding" teaching approach leads students to mechanically follow steps during experiments, lacking in-depth understanding of experimental principles and critical analysis of experimental results [14-15].

5.2. Advantages and practice of the BOPPPS model in experiment teaching

In response to the aforementioned issues, the BOPPPS teaching model offers novel insights and methods for experiment teaching reform. In experiment teaching, the BOPPPS model effectively integrates abundant teaching resources through blended online-offline instructional design, breaking through the temporal and spatial constraints of traditional experiment teaching. Taking medical morphology experiment teaching as an example, instructors distribute experiment-related videos, cases, and other materials through online

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platforms before class to guide students in autonomous preview, laying the foundation for in-class experimental operations. During class, instructors employ diverse teaching methods such as problem guidance and group discussions to stimulate students' active learning awareness, enabling students to fully exercise subjective initiative throughout the experiment process. After class, instructors utilize online platforms to assign homework and organize discussions, helping students consolidate learned knowledge and expand their thinking [16]. Meanwhile, the BOPPPS model emphasizes a student-centered teaching philosophy, focusing on student participation and interaction, thereby providing students with more opportunities for autonomous exploration and innovation. In the "Tumor Cell Biology" experiment, students independently designed experimental protocols and selected experimental materials and methods, thereby not only mastering experimental operation skills but also cultivating scientific thinking and innovative capabilities [14]. Furthermore, the application of the BOPPPS model in experiment teaching is also reflected in its comprehensive evaluation of teaching effectiveness. Through pre-assessment and post-assessment components, instructors can promptly understand students' learning progress and existing problems, enabling targeted adjustments to teaching strategies and ensuring the achievement of teaching objectives.

6. Conclusion

In conclusion, the BOPPPS teaching model can effectively address numerous problems existing in traditional experiment teaching, enhance experiment teaching quality, cultivate students' comprehensive literacy and innovative capabilities, and provide robust support for experiment teaching reform in higher education. However, certain drawbacks also exist, such as increased screen time for students, making it difficult to distinguish whether students are genuinely learning while using their phones [17]; additionally, effective supervision of whether students have earnestly completed the viewing of relevant operation videos during pre-class preview remains challenging. Therefore, how to effectively achieve deep integration of experiment course teaching with modern technological methods, and explore teaching models better suited to the contemporary context and actual student needs, merits in-depth exploration by educators in higher education institutions.

7. References

[1] Wang C, Zhuo SY. Exploration of BOPPPS combined with PAD class in biochemistry experiments for traditional Chinese medicine majors[J]. Basic Medical Education, 2019, 21(11): 869-871.

[2] Zhang P, Qin MJ, Zheng YL, et al. Ideological and political construction of cell biology experiment curriculum oriented toward competency cultivation[J]. Research and Exploration in Laboratory, 2023, 42(2): 226-230.

[3] He ZQ, Tan J, Zhou Y, et al. Practice of flipped classroom in medical morphology experiment teaching[J]. Research and Exploration in Laboratory, 2019, 38(2): 189-191.

[4] Liu X, Hao Y, Xia CL, et al. Instructional design of "Medical Cell Biology Experiment" based on flipped classroom: Taking cell fusion experiment as an example[J]. Journal of Higher Education, 2020(25): 81-83.

[5] Liu JJ, Liang BR, Li JN, et al. Instructional design and practice of comprehensive experiments in environmental engineering under BOPPPS teaching model[J]. Research and Exploration in Laboratory, 2025, 44(2): 95-100.

[6] Jia RH, Wei XX, Li YT. Practice of blended teaching model based on Chao Xing Xue Xi tong platform under BOPPPS model: Taking organic chemistry experiment "Distillation and Boiling Point Determination" as an example[J]. Guangdong Chemical Industry, 2020, 47(18): 279-280.

[7] Wang YH, Ning G, Wu YH. Exploration of BOPPPS combined with mind mapping teaching method in protein and enzyme engineering course[J]. Education Modernization, 2020, 7(45): 61-63.

[8] Zou XX, Zhang Q, Xu C, et al. Application of BOPPPS combined with AI teaching model in breast X-ray imaging diagnosis teaching[J]. Journal of Clinical Radiology, 2025, 44(3): 570-572.

https://doi.org/10.62852/csa/2026/263

[9] Luo JJ, Huang J, Cen WJ. Online-offline blended teaching practice of genetics based on BOPPPS model: Taking "Plant Male Sterility" as an example[J]. Genomics and Applied Biology, 2025, 44(2): 201-206.
[10] Ling MY, Hu Y, Zhang L, et al. Practice of a new teaching model combining Rain Classroom and BOPPPS model in biochemistry experiments[J]. Research and Exploration in Laboratory, 2024, 43(7): 206-210.
[11] Gao YH, Wang HD, Zhang MY, et al. Instructional design and practice of comprehensive experiments in metallurgical engineering under BOPPPS teaching model[J]. Research and Exploration in Laboratory, 2024, 43(2): 110-114.
[12] Chen HY, Xu JR. Application of BOPPPS model in natural medicinal chemistry experiment teaching[J]. Higher Education Research (Southwest University of Science and Technology), 2020, 36(3): 53-59.
[13] Su Y, Li R, Jiang B. Exploration of ideological and political teaching practice in pathogenic biology and immunology course based on SPOC and BOPPPS teaching model[J]. Chinese Journal of Immunology, 2023, 39(6): 1225-1229.
[14] He MN, Zhang T. Exploration of open teaching in medical cell biology experiments based on interdisciplinary integration[J]. Basic Medical Education, 2025, 27(1): 43-48.
[15] Gao FR, Li J, Xu J, et al. Design and practice of exploratory medical cell biology experiments[J]. Research and Exploration in Laboratory, 2022, 41(10): 236-241.
[16] Qiu YY, Fan JY, Xia Q, et al. Exploration and practice of blended morphology experiment teaching integrated with BOPPPS[J]. Research and Exploration in Laboratory, 2025, 44(1): 136-140.
[17] Le L, Rao XC, Zhou J, et al. Design and application of BOPPPS teaching model based on Rain Classroom and micro-lectures in medical microbiology course[J]. Microbiology China, 2024, 51(12): 5240-5248.

https://doi.org/10.62852/csa/2026/263