Exploration of the Online and Offline Blended Teaching Model in Cell Biology Experiment Courses

Hongxia Li, Fang Zhao*, Yumei Qian, Chao Wu, Honghong Jiang
College of Biological and Food Engineering, Suzhou University, Suzhou, Jiangsu, China
**Corresponding Author.*

Abstract: The Cell Biology Experiment is a core professional course in the biotechnology program. In response to the reduced instructional hours under the new talent cultivation framework and the limitations of traditional teaching models, methodologies, content arrangements, and faculty allocation, we have implemented online-offline blended teaching reforms. The instructional system has been restructured into "four-tiered hierarchy and four modular components", complemented by multiple innovative measures: developing dedicated online course resource sections, creating novel teaching methods, adopting diversified assessment criteria, integrating ideological and political education elements, and enhancing student engagement through interactive teaching activities. These initiatives fully leverage the advantages of hybrid teaching. The results demonstrate effective guidance from instructors and significantly improved student learning autonomy. This model not only strengthens students' mastery of theoretical knowledge but also enhances practical operation skills, cultivates innovative thinking capabilities, fosters collaborative spirit, and develops comprehensive analytical abilities. Notably, students' learning interest in cell biology experiments has markedly increased. Additionally, both teachers' instructional competence and educational quality, as well as students' comprehensive literacy, have been substantially elevated.

Keywords: Online and Offline; Blended Teaching; Cell Biology Experiment; Teaching Reform; Exploration

1. Introduction

The course of Cell Biology Experiment is an important core course for biotechnology majors, as well as an experimental course. It is one of the main components of cell biology and plays an important role in deepening the understanding of theoretical knowledge, scientific research and innovation ability, and comprehensive ability cultivation of cell biology [1]. The main objective of this course is to enable students to understand and master the basic principles, methods, techniques, and skills of cell biology experiments, including the use and maintenance of optical microscopes and fluorescence microscopes, cell differentiation and cultivation, as well as related technologies such as cell nucleus extraction, cell fusion, and differential centrifugation. With the continuous updating of educational concepts and the deep application of information technology in the field of education, the teaching mode of universities is undergoing profound changes [2]. In recent years, with the rapid development of informatization and networking, high-quality network resources such as Smart Tree, Chinese University MOOCs, Learning Platform, and Xuetang Online Rain Classroom have gradually entered the classroom. Blended online and offline teaching has become an important direction for current university curriculum reform [3]. How to cultivate high-quality talents with solid professional knowledge, innovative thinking, and practical abilities in biotechnology education is one of the key issues in current education reform. The traditional teaching mode faces many challenges in the teaching of this course: due to the abstract, practical, and fast updating of course knowledge, traditional teaching is difficult to meet the increasingly diverse learning needs of students. The blended learning mode of online and offline combines the flexibility and resource richness of online teaching in time and space, as well as the advantages of face-to-face interaction and practical guidance in offline teaching, providing a new path to improve the teaching

quality of the "Cell Biology Experiment" course [4]. This study takes the experimental course of cell biology as an example and carries out blended teaching online and offline. The aim is to explore how to scientifically design and effectively implement this model, divide the teaching content into four levels, four modules, develop online course resource columns, innovate teaching methods, adopt diverse performance evaluations, integrate ideological and political concepts into the teaching content, stimulate student participation in teaching activities and teacher interaction, and fully leverage the advantages of blended teaching online and offline. Meanwhile, based on the different learning outcomes of students, this study aims to explore reform approaches from the perspective of experimental teaching, provide reference for improving the teaching quality of cell biology experimental courses in biotechnology majors, and accumulate experience for cultivating biotechnology talents with solid professional knowledge and practical hands-on abilities.

2. Characteristics of Blended Online and Offline Teaching

Blended online and offline teaching is an emerging teaching model that combines online and offline teaching through the release of preview materials using modern information technology [5]. The hybrid teaching mode includes two aspects. In the online teaching stage, students can make full use of the advantages of the Internet, including PPT courseware, virtual experiment, animation demonstration, frontier of discipline development, homework, etc., and upload them to the network platform. Students can flexibly plan their own learning time and progress, which is very convenient. Rich and colorful online resources can stimulate students' passion for learning and ignite their interest in learning; During the offline teaching period, teachers have face-to-face communication with students in the laboratory. Through on-site demonstrations, guidance, and teacher-student interaction, teaching strategies are adjusted in a timely manner according to students' learning status in the classroom, such as grouping (2-3 people) for experiments, discussions, and result analysis, to help students understand theoretical knowledge and cultivate their practical operation ability and teamwork spirit. Using multimedia, video and other means to improve teaching effectiveness. Meanwhile, offline teaching emphasizes face-to-face interaction and practical guidance, and teachers can complement each other's advantages by combining online and offline blended learning. Online resource learning provides convenience, diversity, and specificity for students' self-directed learning. Offline teaching strengthens classroom interaction and practical training, constructing a more efficient and comprehensive teaching mode. This model not only enhances the teaching effectiveness of cell biology experimental courses, but also opens up new avenues for the knowledge and ability development of biotechnology students.

3. Basic Information of the Course

3.1 Course Offering Status

This course is a core course for biotechnology majors and plays a very important role in undergraduate teaching of life sciences. It plays an important role in cultivating high-level applied biological talents in our school. The undergraduate biotechnology course was first introduced in 2005. Since then, the cell biology laboratory course has undergone four adjustments. In 2005, cell biology experiments were integrated into the biotechnology laboratory. After 2016, a separate 18 experimental hours were set up for cell biology experiments, and comprehensive experimental projects were added. After 2019, 32 experimental hours were set up for cell biology experiments, and design based experimental projects were added. In 2024, the number of experimental hours for cell biology experiments was adjusted to 24. The learning of subsequent courses is crucial, such as cell engineering, molecular biology and experiments, genetic engineering, etc. The construction of this course plays an important role in cultivating high-quality talents in the field of biotechnology.

3.2 Teaching Status

There are some problems with the traditional teaching mode of cell biology experimental

courses, such as outdated experimental teaching content and relatively single types of experimental projects; The teaching process is rigid and rigid [6]. The teaching methods and tools are too traditional, lacking discussions and interactions between students and teachers; The form of teaching assessment is not objective and comprehensive enough. Traditional teaching methods result in students' low enthusiasm for learning, weak participation, lack of innovative consciousness, uneven hands-on skills, and poor experimental teaching effectiveness.

3.3 Teaching Team and Teaching Resources

The teaching team structure of this course needs further improvement. Some team members and teachers have been teaching this course for a long time, and their teaching methods have become almost fixed, lacking innovation and making it difficult to fully mobilize students' learning enthusiasm. Although there are teaching resources in the library, they are outdated and there are not many materials available in recent years, mainly textbooks. The new materials available for students to expand their learning are limited. Lack of online teaching resources, selecting high-quality resources for this course requires a lot of teachers' energy and time. Some of the laboratory equipment is outdated and limited in quantity, making it difficult to meet students' learning needs for cutting-edge experimental techniques. For example, in animal cell culture and passage, due to the limitations of cell culture rooms, workstations, and incubators, it is not possible for every student to operate hands-on. Therefore, groups can only be formed and representatives can be selected from each group for operation. This makes it difficult to improve the hands-on ability of each student.

4. Construction and Implementation of Blended Online and Offline Teaching

4.1 Construction of Blended Online and Offline Teaching Mode and Arrangement of Teaching Content

Place Due to the strong practicality and difficulty of cell biology experiments, the teaching content has been modularized and reconstructed based on the characteristics of online and offline teaching and the needs of biotechnology majors. The experimental content mainly includes dedifferentiation and redifferentiation of plant cells, cell membrane permeability, mitochondrial hyperactive staining and observation, display and study of cell cytoskeleton, isolation and preparation of organelles, and animal cell fusion technology. Through experiments, students not only deepen their understanding and certification of theoretical knowledge in cell biology, but also gain sensory knowledge about cell life activities through observation and hands-on operation of cell life phenomena. This effectively improves the teaching effectiveness of theoretical courses, and enables students to master the basic principles, methods, and skills of cell biology experiments, cultivate and improve their ability to design and apply various experimental techniques, cultivate and train their innovative consciousness and ability, cultivate rigorous scientific attitude and pragmatic style, improve their ability to discover, analyze, and solve problems, lay a solid foundation for independent teaching or scientific research in the future, enhance their hands-on innovation ability and sense of social responsibility. This course is completed in the fourth semester of university. According to the characteristics of the course "Cell Biology Experiment", it can be divided into "four levels and four modules", specifically: four levels, first mastering basic operational techniques and experimental skills. ① Construction and usage of inverted and fluorescence microscopes; ② Cell culture techniques; ③ Principles and methods of extracting submicroscopic substances; Secondly, master the research methods of animal and plant cells, including aseptic operation techniques; ④ Microscopic observation of cellular submicroscopic structure; ⑤ Fusion technology of animal cells. The third is to master the principles and ideas of designing and innovating comprehensive experiments, as well as the permeability of cell membranes. Dedifferentiation of plant cells.

Fourthly, students can choose their own experimental content and materials according to their hobbies, design their own experimental plans and steps, and use their spare time to complete experimental creations outside of the course in an open laboratory. Four modules: a. Basic experiments (preparation and

observation of mitochondria and vacuole systems) b. Professional experiments (animal and plant cell culture techniques) c. Innovative experiments (open design and comprehensive experiments) d. Expanded experiments (experiments combining microbiology and biochemistry)

4.2 Creation of Online Course Resources

Including Collect online resources such as excellent cell biology experimental course websites and online videos from well-known universities at home and abroad, and screen teaching videos, exercises, etc. closely related to biotechnology majors to integrate into our university's course teaching platform. The teaching team brainstormed and collaborated to create high-quality experimental teaching courseware, question banks, and other resources, and uploaded them to the platform for sharing. Fully utilize laboratory resources offline, optimize experimental instrument configuration, and ensure smooth implementation of experimental teaching. At the same time, utilizing course internships and collaborating with enterprises to establish internship and training bases, providing students with more practical opportunities and expanding teaching resources.

4.3 Innovations in Teaching Methods

Teachers use online teaching platforms to provide students with rich learning resources, and students can freely arrange their own learning time (including key and difficult knowledge content). By logging into the resource platform, students can intuitively and clearly understand the experimental principles and precautions of different experimental modules.

At the same time, teachers actively participate and interact with students. In offline teaching, students start preparing for experiments and participate in them. Some experimental plans and steps guide students to use books as references and existing laboratory instruments as conditions to try to develop new experimental plans and cultivate their ability to solve practical problems. By establishing close, approachable, and encouraging interactive mechanisms, actively giving students affirmation and motivation [7].

4.4 Integration of Ideological and Political Education into Various Aspects of Blended Learning Courses

We must adhere to taking the cultivation of moral character as the central link, integrate ideological and political work throughout the entire process of education and teaching, and achieve Full process and all-round education, striving to create a new situation for the development of higher education in China [8]. Therefore, in the teaching process, it is necessary to deeply explore the ideological and political elements in the curriculum, naturally integrate them into the classroom content, and integrate teaching into learning. For example, rare endangered species are preserved through tissue culture, emphasizing the care of endangered plants. Organizational training involves continuous succession and transfer, with a heavy workload that inevitably leads to student complaints. It teaches students to persevere in their work and not be afraid of hardship. The contaminated culture medium can only be washed off after sterilization to prevent bacterial contamination. At the same time, the culture medium after subculture cannot be directly poured into the trash can. It must be placed in a garbage bag before being placed in the trash can, paying attention to laboratory safety and environmental hygiene. By introducing touching stories of scientists' explorations, such as Jenner's invention of the cowpox vaccine and Chinese scientist Tang Feifan's outstanding contributions to the fight against highly infectious diseases, students' spirit of scientific exploration and innovative consciousness are stimulated [9].

4.5 Encourage Students to Participate in Innovative Activities and Subject Competitions

In order to cultivate students' innovative experimental ability, the previous confirmatory experiments have been changed to design experiments. Encourage students to carefully review literature and materials during the experimental design process, make design plans and steps, and have the teacher provide feasible suggestions. Finally, allow students to complete the experiment independently or through teamwork [10]. By encouraging students to participate in a series of activities such as college students' life science competition, innovation and entrepreneurship training plan, "Internet plus", Challenge Cup

competition, etc., we provide students with all-round support services, including guidance for college students to apply for scientific research projects and write scientific research papers. By participating in these innovative activities, students' innovation ability, teamwork, and practical hands-on ability have all been improved.

4.6 Establishment of Blended Learning Course Assessment System

To adapt to the characteristics of blended learning, establish a diversified teaching assessment system. Online learning evaluation includes multiple aspects such as learning duration, participation in discussions, completion of online assignments, and online testing, accounting for 20% of the total score. Offline evaluation includes pre class participation, in class experimental operations, which account for 60% of the total grade, and course report and paper writing, which account for 20% of the total grade.

5. Conclusion

Cell biology is a highly experimental discipline, and the progress of life sciences is accompanied by technological innovation and scientific research in cell biology experiments. Discovery is inseparable. The combination of online and offline teaching methods has achieved good results in the course of "Cell Biology Experiment" in the biotechnology major. This teaching model has reformed the online and offline educational resources, teaching methods, and performance evaluation, mobilized students' learning enthusiasm, and cultivated their self-learning ability, collaborative ability, and innovative thinking ability. At the same time, this model also provides teachers with greater space for teaching innovation and promotes the comprehensive improvement of teaching abilities.

Blended online and offline teaching fully combines the flexibility and convenience of online teaching with the interactive practicality of offline teaching. With students as the main body, teachers play an inspiring role, allowing students to actively participate in the construction and learning of the knowledge system, cultivating their interest and ability for self-directed learning, and improving their professional level and academic performance. Against the backdrop of continuous development in education and teaching, the blended learning model of online and offline will undoubtedly unleash greater potential, injecting new vitality into biology education and cultivating more high-quality biotechnology professionals who meet the needs of society.

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References

[1] H X Li, M Li, Q Wang, et al., Teaching Reform and Practice of Cell Biology Experiment Based on Curriculum Ideology and Politics. Journal of Minzu Normal University of Xingyi, 2022, 4:64-67.

[2] C Y Han, J B Wen, Q Q Li, Exploration of blended online and offline teaching mode in the course of "Microbiology and Immunology" in pharmacy major. Modern Horticulture, 2024, 24: 811-185.

[3] S Y Liu, Y Ding, Y H Zhu, Wait The blended online and offline teaching mode of histology and embryologyRetrospective Study and Evaluation of Teaching Effectiveness. Anatomy Research, 2025, 47(1): 82-86.

[4] X Mei, J C Xia, L Feng, Microbiology and Immunology Course Based on Blended Online and Offline Teaching Exploration and Practice of Cheng Sizheng. Chinese Journal of Immunology, 2024, 40(05): 1114-1116.

[5] Z Hou, Exploration and Practice of Blended Online and Offline Teaching in Landscape Planning and Design Courses. Modern Horticulture, 2021, 44(19): 172-173.

[6] K K Li, X J Chen, W T Li, et al., Exploration of Online and Offline Mixed Teaching Mode of Pharmacy Experiment Based on Applied Talent Training, Chinese Medicine Modern Distance Education of China, 2024, 22(24): 20-23.

[7] W W Lu, Y Xu, J M Chen, Exploration of Ideological and Political Elements in Cell Biology Experiment Course. Education and Teaching Forum, 2024, 31: 33-36.
[8] M A Qi, Design and Construction of Experimental Teaching for Cell Biology
Based on Innovation Ability Orienta. Journal of Changchun University, 2023, 33(12): 97-100.
[9] S H Yang, Exploration of fragmented teaching design in educational psychology courses. Education Informatization Forum, 2024(05): 33-35.
[10] Z L Xu, Y G Lv, H Mei, et al., Application of the "semi flipped classroom+semi self-designed" teaching model in cell biology experimental teaching. Experimental Technology and Management, 2021, 38 (1): 191-194.

