

Exploration of Blended Online-Offline Teaching for Natural Medicines and Marine Medicines Directions in Pharmaceutical Science Major

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Abstract: Natural medicines and marine medicines are characteristic directions of the pharmaceutical science major, featuring a strong theoretical nature and practical application. At present, blended online-offline teaching for these directions faces problems such as poor adaptability of curriculum systems, disconnection between virtual and real practice teaching, unsatisfactory teacher-student interaction and learning supervision, as well as misalignment between assessment-evaluation approaches and teaching objectives. Starting from the above-mentioned dilemmas, this paper puts forward strategies including reconstructing a modular curriculum system, establishing a progressive practice-teaching system integrating virtuality and reality, building a multi-dimensional interaction mechanism oriented toward deep learning, constructing a three-dimensional online-resource library, and developing diversified process-oriented evaluation systems. It is expected to provide certain references for the blended-teaching reform of characteristic directions in the Pharmaceutical Science major.

Keywords: Pharmaceutical science major; Natural medicines; Marine medicines; Blended online-offline teaching; Teaching reform

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1. Problems existing in the application of blended online-offline teaching for natural medicines and marine medicines directions in the pharmaceutical science major

1.1. Insufficient adaptability of the curriculum system to the blended teaching mode

The curriculum content of the natural medicine and marine medicine directions features complex knowledge systems, strong interdisciplinary characteristics, and high theoretical abstraction. Natural Medicinal Chemistry covers structural elucidation, physicochemical properties, extraction and purification, and other topics. The complicated chemical structures involved pose difficulties for students' understanding. Nevertheless, existing curriculum systems mostly organize teaching content according to traditional disciplinary logic. Each chapter lacks flexible modular design and cannot be effectively decomposed into teaching units suitable for online

autonomous learning and offline in-depth seminars. Online teaching sessions are often simple replicas of offline classrooms and fail to fully utilize the role of online platforms in knowledge delivery; offline teaching sessions cannot provide precise and in-depth expansion targeted at problems emerging from online learning, resulting in disconnected and unintegrated online and offline arrangements ^[1]. In addition, this discipline involves numerous structural formulas, spectra, and bioactivity data that require intuitive presentation. Traditional linear curriculum frameworks can hardly be effectively integrated with blended teaching tools such as multimedia presentation and interactive learning, leading to inherent structural contradictions between curriculum systems and teaching modes.

1.2. Disconnection between virtual and real links in practice teaching

Practice teaching for the natural medicine and marine medicine directions includes experimental operations such as the extraction and separation of natural products, structural identification, activity screening, and the collection and treatment of marine biological samples. These operations set high requirements for students' hands-on abilities and experimental literacy. However, there is no systematic connection between online virtual simulation experiments and offline physical experiments. Online virtual experiments are mostly demonstrations and simulations of operating procedures and cannot adequately reproduce the operational feel, observation of phenomena, and handling of unexpected problems. Meanwhile, offline experimental teaching fails to make full use of online resources for preparatory knowledge learning and preview of operations. Consequently, students lack sufficient understanding of experimental principles, operational essentials, and precautions before entering laboratories. Such virtual–real disconnection reduces the efficiency of practice teaching, creates large cognitive gaps for students in the transition from virtual to physical operations, and prevents the formation of a continuous training chain for practical competencies ^[2].

1.3. Insufficient effectiveness of teacher-student interaction and learning supervision

In the blended teaching mode, students' online and offline learning activities are intertwined. Traditional face-to-face interaction is partially replaced by asynchronous communication, bringing new challenges to teacher–student interaction and learning supervision. In courses featuring high knowledge density and difficult comprehension, such as natural medicines and marine medicines, students require timely guidance and in-depth discussions when they encounter difficulties. However, online text-based communication can hardly achieve the immediacy and depth of face-to-face Q&A, which easily leads to the accumulation of learning confusion. Meanwhile, teachers have inherent limitations in monitoring online learning status. There are no effective supervisory means to verify whether students actually watch videos, truly understand knowledge points, and independently complete tasks ^[3]. Moreover, the learning content for these directions contains numerous terms, chemical structures, and reaction mechanisms that require memorization and comprehension. Without effective supervision, students' learning engagement and outcomes will be directly affected.

1.4. Misalignment between assessment-evaluation approaches and teaching objectives

Blended teaching emphasizes autonomy, cooperation, and deep learning. Its teaching objectives include not only knowledge mastery but also competence cultivation and the development of professional literacy. Nevertheless, current assessments for the natural medicine and marine medicine directions still mainly adopt closed-book final examinations, focusing on the memorization and reproduction of knowledge points. Evaluation approaches for online-learning participation, discussion quality, collaboration skills, and problem-

solving abilities in practical operations are insufficient. As a result, students focus on examination-oriented strategies for coping with final exams rather than on genuine exploration and thinking. Process-oriented online-learning data are not fully incorporated into evaluation systems, and evaluations of offline practical-session performance mostly remain formal, without systematic criteria and recording mechanisms.

2. Blended online-offline teaching strategies for natural medicines and marine medicines directions in the pharmaceutical science major

2.1. Reconstruct a modular curriculum system oriented toward blended teaching

To address the insufficient adaptability of curriculum systems, the curriculum content for the natural medicine and marine medicine directions should be modularly reorganized according to knowledge logic and learning rules. It should be divided into online and offline modules, with explicit clarification of their distinct teaching functions, learning modes, and complementary relationships ^[4].

Online modules focus on knowledge delivery. Core knowledge points, such as the structural characteristics of chemical constituents in natural medicines, key aspects of spectral elucidation, extraction and separation technologies, and the unique bioactivity mechanisms of marine medicines, are prioritized and organized into several online learning units with the attributes of being fundamental, closed-ended, and deterministic. Micro-lectures are produced for the core and difficult knowledge points of each unit. The micro-lectures should be concise, highlight key points, and adopt a four-dimensional framework of “knowledge point + ideological and political education + frontier progress + industrial application” for content design. While explaining basic theories, ideological and political elements such as scientific spirit and cultural confidence are integrated; the latest scientific research achievements and pharmaceutical industry application cases are adopted as supplementary materials, enabling students to independently complete both systematic and fragmented knowledge input. Offline modules emphasize competence internalization. In-depth learning content, including comprehensive structural elucidation of complex natural products, comparative demonstration of multi-scheme extraction processes, and decision-making on practical problems in marine medicine R&D, is designed as seminar themes and practical tasks. Basic content covered in micro-lectures will not be repeated. Based on the difficulties and discussion topics generated from micro-lecture learning, case seminars, problem-oriented learning, and group collaboration are adopted to help students achieve knowledge transfer, integration, and application through in-depth face-to-face interaction ^[5]. Online and offline modules are organically connected through the “pre-test–feedback–post-expansion” mechanism. Online-learning data provide accurate references for the starting points of offline teaching, while new questions arising from offline sessions further extend to subsequent online learning.

2.2. Construct a progressive practice-teaching system integrating virtuality and reality

To solve the disconnection between virtual and real practice teaching, a progressive practice-teaching system consisting of three parts—online virtual simulation, offline basic experiments, and comprehensive exploratory practice—should be established. At the first level, students preview and simulate experimental operations via the online virtual-simulation experimental platform, mastering experimental procedures, instrument operation, and safety specifications. At the second level, students carry out basic verification experiments in laboratories, transforming the operational knowledge acquired online into hands-on abilities. At the third level, students conduct comprehensive and exploratory practical projects in groups. Teaching cases are embedded throughout

these three levels. Three types of cases—classic scientific research cases, cutting-edge research translation cases, and industrial application cases—are selected and integrated into practice teaching at each level. Classic scientific research cases, such as the discovery and R&D of paclitaxel and the development of trabectedin, an anti-tumor drug of marine origin, can reflect the basic paradigms and scientific thinking of natural medicine research. Cutting-edge research translation cases, such as the screening and structural optimization of bioactive secondary metabolites from marine microorganisms, reflect disciplinary frontiers. Industrial application cases, such as industrial-scale extraction processes for active ingredients of natural medicines, enable students to understand how theoretical knowledge is transformed into practical products and services ^[6].

2.3. Establish a deep-learning-oriented multi-dimensional interaction mechanism

To improve the effectiveness of teacher–student interaction and learning supervision, a comprehensive interaction system covering the pre-class, in-class, and after-class phases should be built. In the pre-class online-learning phase, teachers release learning-guidance tasks and thought-provoking questions on platforms, guiding students to watch micro-lectures and read literature with questions in mind. Asynchronous discussions are carried out via forums or instant-messaging tools. Teachers reply to questions on a regular basis and summarize common problems. In offline classroom sessions, teachers launch in-depth discussions targeting common problems from online learning. Flipped classrooms, group debates, and case analysis are adopted to transform one-way knowledge imparting into multi-directional exchange of ideas. In the after-class expansion phase, teachers assign open-ended and comprehensive tasks on platforms to promote students’ knowledge transfer and application. The core of the multi-dimensional interaction mechanism lies in expanding interaction from the single mode of “teacher questioning, student answering” into diversified modes including teacher–student interaction, student–student interaction, and learner–resource interaction ^[7]. Online-platform learning-behavior data, including micro-lecture-viewing progress, forum-participation frequency, and online-quiz scores, can serve as the basis for learning supervision. Teachers can timely identify students with learning difficulties and deliver precise interventions, ensuring learning engagement and facilitating deep learning.

2.4. Build a three-dimensional online-teaching resource library

The online-teaching resource library serves as the fundamental guarantee for effective blended teaching. An integrated resource library with rich categories, multi-level contents, and extensive applications should be built according to the teaching requirements of the natural medicine and marine medicine directions. The content system of the resource library should include micro-lecture-video resources (interpretation of core knowledge points for each module), teaching-case resources (classified compilation of classic research cases, cutting-edge research translation cases, and industrial application cases), virtual-simulation-experimental resources (experimental modules for extraction and separation, spectral elucidation, and activity screening), literature resources (classic disciplinary papers and frontier reviews), and test-question-bank resources (formative-test items for each knowledge point) ^[8]. Organic links and indices should be established among various resources for convenient retrieval and application by teachers and students. Micro-lecture videos should elaborate on key contents such as difficulties in structural elucidation and processes for discovering unique drug targets, with emphasis on visual and situational presentation. Case resources should be tagged by type, applicable curriculum modules, and difficulty levels so that teachers can freely select them in each phase of practice teaching. A continuous-update mechanism should be established for the resource library to incorporate cutting-edge disciplinary achievements and the latest industrial developments in a timely manner and to guarantee the

timeliness of resources. In addition, the resource library should support teachers' personalized reorganization according to actual teaching needs and allow students to select content based on their own learning progress, so as to achieve mutual promotion of teaching and learning ^[9].

2.5. Improve the diversified process-oriented evaluation system

To eliminate the disconnection between assessment/evaluation and teaching objectives, a diversified process-oriented evaluation system covering the whole learning process and the objectives of knowledge, competence, and literacy should be constructed. The evaluation system should transform from a single final summative assessment into a diversified combination of online process evaluation, offline-performance evaluation, and comprehensive final assessment. Online process-evaluation indicators include the completion of micro-lecture learning, online-quiz scores, forum-discussion quality, and contribution to collaborative tasks, which are objectively recorded and quantitatively analyzed by means of platform-data-collection functions. Offline-performance evaluation covers classroom participation, group-seminar performance, standardization of experimental operations, and quality of experimental reports, assessed through a combination of teacher observation, peer evaluation, and self-evaluation ^[10]. The comprehensive final examination emphasizes students' systematic understanding of core knowledge systems and their comprehensive application abilities, reduces the proportion of mechanical memorization, and increases examinations of knowledge transfer, case analysis, and problem-solving abilities. When formulating evaluation criteria, explicit evaluation rubrics should be defined for different learning tasks, so that students can understand the evaluation dimensions and expected standards, and allow the evaluation to play its guiding and motivating functions for students' learning.

3. Conclusion

Blended online–offline teaching brings new opportunities for the teaching reform of the natural medicine and marine medicine directions in the pharmaceutical science major, and meanwhile puts forward systematic reform requirements for curriculum systems, practice teaching, interaction mechanisms, resource construction, and evaluation approaches. Practical dilemmas including insufficient curriculum-system adaptability, virtual–real disconnection in practice teaching, inadequate teacher–student interaction and supervision, and misalignment between assessment/evaluation and teaching objectives need to be addressed through comprehensive measures: modular curriculum reconstruction, construction of practice-teaching systems integrating virtuality and reality, establishment of multi-dimensional interaction mechanisms, building of three-dimensional resource libraries, and improvement of diversified process-oriented evaluation systems. With the development of educational technologies and the continuous renewal of teaching concepts, further research is required for blended teaching in the natural medicine and marine medicine directions in areas such as intelligent-learning analytics, personalized-learning-path recommendation, and in-depth industry–education integration, so as to support the cultivation of innovative pharmaceutical talents better.

Disclosure statement

The author declares no conflict of interest.

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