Diversified Curriculum Reform of Biopharmaceutics and Pharmacokinetics Driven by AI

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Abstract To address the challenges of Biopharmaceutics and Pharmacokinetics such as abstract theories and the difficulty of traditional teaching methods to intuitively present the dynamic behavior of drugs in the body, this paper proposes an AI-driven diversified curriculum reform model. Relying on tools such as Rain Classroom and Deepseek, the reform is carried out from four dimensions: theory, experiment, assessment, and faculty. Personalized teaching is achieved through knowledge graphs and AI learning companions. Practical skills are strengthened by introducing a pre-experiment mechanism and bilingual teaching. A diversified assessment system and an intelligent question bank have been established. A dual-qualified teacher team has been built while promoting industry-education integration. Practical feedback indicates that this model effectively lowers the learning barrier, improves students' academic performance and job adaptability, and enhances their recognition of AI tools, thereby providing an actionable pathway for the intelligent reform of the course.

Key words AI, Rain Classroom, Biopharmaceutics, Pharmacokinetics, Curriculum reform

1 Introduction

Biopharmaceutics and Pharmacokinetics is an emerging comprehensive discipline that integrates multiple interdisciplinary fields, including mathematics, medicinal chemistry, pharmacology, and physiology[1-2]. It is a compulsory course for students majoring in pharmacy, traditional Chinese pharmacy, and pharmaceutical engineering[3], and is also one of the mandatory subjects in the national licensed pharmacist examination. This course plays a vital role in guiding clinical medication and new drug research and development[4].

Biopharmaceutics and Pharmacokinetics is characterized by abstract theories and complex knowledge, demanding high levels of logical thinking and mathematical ability from students. Consequently, there are many challenges in teaching[5-6]. For instance, biopharmaceutics is to study the "dynamic process" of drugs within the body, while these processes occur *in vivo*, making them invisible and subject to individual variability. It is difficult for traditional teaching methods to present these processes intuitively, leading to a disconnect between theoretical knowledge and practical application. In addition, students often have difficulties in understanding the classification of compartment models and their applicable conditions, as well as the physical meanings of pharmacokinetic parameters, making it challenging for them to establish connections among these parameters. Traditional teaching methods frequently rely on text and formulas, are often one-way in nature, and lack integration with the latest advances in the field. As a result, students tend to receive knowledge passively, which leads to limited interactivity and few opportunities for active thinking and discussion[7]. The classification of compartment models is abstract, objective, and relative. Its classification basis and applicable conditions depend on the speed of drug distribution in the body, rather than on anatomical organs or tissues. Abstract modeling, mathematical derivation, and *in-vivo* dynamic processes can be combined by integrating artificial intelligence (AI) tools into this course, so as to deepen students' understanding of the relevant knowledge points.

With the continuous development of theories and technologies, the lagging updating of traditional teaching models has made it difficult to meet students' needs for cutting-edge knowledge. AI has shown great advantages and potential in the field of education and can be widely applied in teaching content, teaching methods, infrastructure, and resources, such as online library application, ideological and political case construction, virtual simulation promotion, and learning outcome assessment[8-9]. This course employs intelligent teaching tools such as Doubao, Deepseek, and Rain Classroom as carriers, and adopts interactive and visual approaches to make abstract concepts concrete, thereby achieving precise and individualized instruction. It accomplishes interactive deconstruction of formula derivation and real-time clinical correlation, and implements diversified reforms in theory, practice, and assessment. These efforts systematically improve teaching quality and promote the transformation of teaching models[10].

2 Optimization design of an AI-based diversified teaching model

2.1 Theoretical teaching One of the core difficulties in Biopharmaceutics and Pharmacokinetics is the dynamic nature of drug absorption, distribution, metabolism, and excretion in the body, as well as the abstract nature of pharmacokinetic models, which is difficult to be visually presented by traditional words or static pictures[11]. For example, augmented reality (AR) technology can be applied to display a 3D dynamic process of drug absorption in the intestine. Under the guidance by the teacher, AI tools can serve as "catalysts for learning". For instance, intelligent question-answering chatbots can be used to address students' questions

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regarding pharmacokinetic formulas.

Pre-class analysis of the learning situation is conducted, and preview assignments are distributed online. During teaching, a "problem + case"-oriented approach is adopted, focusing on core concepts and classical formulas, integrating important parameters and clinical decision-making, and connecting with cutting-edge fields and industrial needs. Practical problems are embedded into all stages of teaching, and students are encouraged to think independently and engage in group discussions. During the discussion process, AI agents, AI instructions, AI-powered intelligent question-answering, and other scenarios can be adopted to facilitate learning. For example, when explaining "bioavailability", students are guided to use Deepseek to generate comparative cases of absorption curves for different dosage forms and discuss their clinical significance. Subsequently, different perspectives are collected via Rain Classroom bullet comments, and students are organized to compare various viewpoints and results, and carry out data correction and information integration, thereby cultivating their critical thinking and ability to solve complex problems.

After class, to facilitate effective student review, teachers with outstanding teaching ability and rich practical experience are organized to record breakthrough videos on key and difficult points, and a video library of key and difficult points is established for each chapter. Knowledge guides and lecture summaries are added through Rain Classroom, helping students identify and fill gaps according to their own needs after class. Students can also make full use of Rain Classroom's 24-h intelligent learning companion, which allows for precise configuration. By simply clicking the "I don't understand" button, they can call up the intelligent learning companion interface, which automatically answers questions and helps resolve problems in a timely manner.

2.2 Experimental teaching Biopharmaceutics and Pharmacokinetics is a highly practical discipline, the experimental teaching of which should focus on cultivating students' hands-on ability, independent thinking, and problem-solving skills[12-13]. Before conducting the experiment, teachers introduce it through a preliminary trial and fill out a pre-experiment card to verify the feasibility of the experimental protocol, and optimize the experimental design. Thus, key points and common error-prone steps in the experimental process can be identified, and problems can be detected early, reducing the risk during the formal experiment. After the pre-experiment is completed, preview courseware and videos are promptly distributed to help students become familiar with the procedures and steps in advance. For teachers, this approach helps cultivate a scientifically rigorous research mindset and the ability to anticipate problems. For students, it ensures that the experiment can be completed within the scheduled class hours.

During the experiment, teachers demonstrate standardized operation through experimental teaching, decompose key steps and preview common mistakes. Through "observation and demonstration", students translate abstract knowledge into reproducible actions, cultivate the practical ability of "hand-brain coordination", and achieve a shift from "knowledge memorization" to "capability generation". During the hands-on process, students are encouraged to think actively and understand the purpose and significance of each experimental operation.

The experimental items of this course cover professional experiments such as *in-vitro* dissolution testing, determination of drug plasma protein binding rate, *in-vitro* mucosal permeability experiment, and determination of *in-vivo* pharmacokinetic parameters in animals. Among these, the "determination of *in-vivo* pharmacokinetic parameters in animals" is selected for bilingual teaching to strengthen the English expression and application of core terms. Additionally, "English experimental group" activities are organized, encouraging students to discuss professional issues in English, such as the selection of pharmacokinetic models in experiments and the expression of pharmacokinetic parameters. This practice also helps improve the reading of English literature, enhances professional English communication skills, and lays a foundation for keeping up with international cutting-edge developments in the discipline.

2.3 Optimization of the assessment system Process-oriented evaluation is strengthened. For example, mid-term examinations and knowledge graph value-added assessments are added for longitudinal evaluation. Indicators such as classroom performance, assignment completion, and class participation are incorporated into the assessment system, establishing a diversified evaluation system that encompasses "process + outcome, theory + practice". Theoretical knowledge assessment addresses both depth and breadth, covering knowledge, experimental skills, and application ability across multiple dimensions. Experimental ability is mainly assessed through aspects such as laboratory discipline, experimental operation and safety, and the quality of lab report writing.

To more accurately track students' learning dynamics and reduce the weight of summative assessment, technology platforms are used to support process management. Tasks are released through Rain Classroom, allowing teachers to independently set grading rules, evaluation items, and indicators. The system intelligently grades subjective questions, automatically generating scores, comments, and annotations. Through assignment data (*e. g.*, types of errors in pharmacokinetic parameter calculations), teachers can promptly identify weak knowledge points and provide targeted reinforcement. Furthermore, based on the intelligent learning situation analysis module of Rain Classroom, the system automatically records students' classroom interaction data (such as correct answer rate and key words in questions asked) and generates personalized learning situation reports.

A knowledge graph database is established, interfacing with artificial intelligence and big data to make scattered knowledge points hierarchical and modular, forming a panoramic, interconnected "knowledge checklist". This helps students understand the logical chains between knowledge points and avoid rote memorization. Both teachers and students participate in building the course-specific knowledge base. Teachers lead the design by integrating information and concepts, setting nodes and keywords, establishing node relationships based on the logic of the teaching content, and indicating key and difficult points. Students collect and refine knowledge points, organize core knowledge points of the textbook according to daily teaching content, and construct their own knowledge graphs within the system. They can also mark points they do not understand, and review and fill gaps at any time. To ensure the scientific validity and accuracy of the knowledge graph content, student groups are organized to conduct cross-reviews, while teachers perform the final quality check. This process leads to the formation of a comprehensive knowledge system, which is progressively promoted and optimized in subsequent teaching. In addition, to make better use of the knowledge graph, dedicated supporting exercises tailored to the knowledge graph will be designed in the future.

The question bank serves as the core carrier for knowledge assessment, skill evaluation, and teaching feedback. The course team currently possesses an AI question bank, a self-built question bank, and a licensed pharmacist question bank, and has also purchased the People's Medical Publishing House (PMPH) test question bank. Teachers can intelligently compose tests on the PMPH web platform according to the requirements of the teaching syllabus, course progress, and key examination points. They can filter questions by difficulty level, question type, and knowledge area to rapidly generate unit quizzes, mid-term examination papers, and final examination papers. Students use the PMPH app for practice training. To continuously optimize the question bank content and management mechanism, regular maintenance and updating of questions are carried out to ensure the scientific validity, practicality, standardization, and long-term effectiveness of the question bank.

2.4 Faculty development Faculty development is a key pillar supporting teaching quality. Before instruction begins, the Rain Classroom intelligent lesson preparation assistant is used for collaborative lesson preparation. The content covers ideological and political education points, teaching interaction design, art-style image generation, *etc*. The preparation focuses on curriculum standards, student characteristics, and teaching progress, clarifying the core objectives of each chapter and concentrating on overcoming teaching difficulties. By gathering the team's wisdom and building consensus, a structured lesson preparation plan is formed, ensuring that team members share common goals and have clear divisions of labor, and an open, collaborative, and inquiry-based teaching research atmosphere is created.

To establish a linkage mechanism between classroom teaching and practical extension, teaching bases are jointly built with pharmaceutical enterprises and hospitals. Teachers engage in internships at enterprises or institutions both online and offline, participate in actual project operations, and strengthen the application of theory in practice. Practical problems from enterprises are brought into the classroom, achieving a dynamic coupling between teaching scenarios and industrial practice. Meanwhile, pharmacokinetic research data from enterprises and real-world therapeutic drug monitoring (TDM) cases from hospitals are introduced to enhance the practicality and authenticity of teaching. To convey the latest industry development trends, job market requirements, and professional standards to students, both corporate and academic mentors are appointed, and experienced corporate mentors are invited into the classroom. By sharing their industry experience, these mentors bring the latest technical methods and typical cases into the classroom, thereby enhancing students' professional identity and job adaptability.

3 Teaching reform effectiveness

To continuously optimize the course design, an anonymous questionnaire survey was conducted for students after the course ended, focusing on the aforementioned measures. This allowed timely identification of shortcomings and facilitated continuous improvement. A total of 561 valid questionnaires were collected. The feedback showed that 99% of the students considered the use of AI tools very important and believed it to be an essential skill for future pharmaceutical professionals, reflecting a high level of student recognition of the importance of AI skills. In addition, 95% of the students thought that AI tools were very helpful in understanding complex formulas and abstract knowledge points and indicated that they would continue to use them to enhance their learning, suggesting that AI can effectively lower the learning barrier. Furthermore, 93.5% of the students believed that using AI tools helped them complete assignments and projects more quickly, indicating that AI can provide a "burden-reducing and efficiency-enhancing" learning experience, effectively alleviate learning pressure, and stimulate active exploration. Finally, 96% of the students strongly supported the integration of AI into the teaching reform of Biopharmaceutics and Pharmacokinetics and hoped to extend this approach to more courses, fully demonstrating that the reform direction of integrating AI into teaching aligns with students' learning needs. Moreover, students suggested that future curriculum reforms should provide broader, interdisciplinary knowledge links and strengthen literature retrieval and summarization functions. In response to this suggestion, subsequent reforms will integrate disciplinary developments to achieve "tracing" and "tracking" of knowledge resources. In summary, the multidimensional incorporation of digital and intelligent teaching tools into Biopharmaceutics and Pharmacokinetics instruction can provide students with a more personalized and concrete learning experience.

4 Conclusions

The implementation of AI-assisted teaching in Biopharmaceutics and Pharmacokinetics is an inevitable choice for disciplinary teaching reform in the era of educational informatization. Through the integrated application of technological means such as virtual simulation, intelligent planning, and data analysis, many limitations of traditional practical teaching are overcome. Through various measures including "using theory as the foundation, practice as the bridge, and intelligent tools as the guide", and visualizing abstract theories, providing personalized and precise instruction, optimizing experiments with intelligence, implementing dynamic competency assessment, and linking to cutting-edge content, the course directly addresses core difficulties such as "abstract concepts that are difficult to understand, large differences in student learning status, and incomplete assessment". This approach helps students establish a complete cognitive chain, cultivates the ability to solve practical problems, and lays a solid foundation for future work in clinical pharmacy, formulation development, and related fields. In the future, as AI technology continues to evolve, the application scenarios of AI in teaching will continue to expand, injecting lasting momentum into the creation of more innovative and effective talent cultivation models.

References

[1] REN JG, ZHANG ZQ, TAO HZ, *et al.* Application of excel software in case-based teaching of biopharmaceutics and pharmacokinetics[J]. Pharmaceutical Education, 2023, 39(6): 83 – 87. (in Chinese).

[2] PENG W, MEI QX, LI N. Research progress on teaching reform methods of biopharmaceutics and pharmacokinetics in recent years[J]. Journal of Li-Shizhen Traditional Chinese Medicine, 2023, 34(5): 1236 – 1239. (in Chinese).

[3] ZHENG HS, CHENG BX, PIAO JG, *et al.* Exploration of ideological and political elements based on the course knowledge chains of biopharmaceutics and pharmacokinetics[J]. Pharmaceutical Education, 2023, 39(1): 26 – 30. (in Chinese).

[4] SUN L. Curriculum design and research of biopharmaceutics and pharmacokinetics under the background of pharmaceutical industry innovation [J]. Guangdong Chemical Industry, 2024, 51(14): 192 – 194. (in Chinese).

[5] GE SS, HUANG SX, ZHOU L, *et al.* Research on the application of PAD class combined with case method in Biopharmaceutics and Pharmacokinetics course based on "high-level, innovation-oriented and challenging"[J]. Health Vocational Education, 2025, 43(14): 51 – 54. (in Chinese).

[6] XU LY, HE LQ, SHI SJ, *et al.* Construction of innovative classrooms in biopharmaceuticals and pharmacokinetics[J]. Pharmaceutical Education, 2022, 38(2): 57 – 61. (in Chinese).

[7] PENG W, LI N, MEI QX. Exploration of teaching reform of biopharmaceutics and pharmacokinetics combined with clinical pharmacy of Chinese materia medica in Chinese medicine colleges and universities[J]. Journal of Li-Shizhen Traditional Chinese Medicine, 2021, 32(12): 2993 – 2995. (in Chinese).

[8] CHEN L, JIANG YF. Exploration of 5G + AI technology empowering medical undergraduate teaching reform[J]. Clinical Research and Practice, 2024, 9(11): 168 – 171, 189. (in Chinese).

[9] LI RM, SHI XZ, LI S, *et al.* Evaluation on the effectiveness of AI-empowered ideological and political cases in the teaching of medical curricula[J]. Journal of Shenyang Medical College, 2025, 27(6): 659 – 662, 672. (in Chinese).

[10] ZHANG TT, MA QM. The application of "Internet +" blended teaching mode in Biopharmaceutics and Pharmacokinetics Course[J]. Chinese Medicine Modern Distance Education of China, 2022, 20(20): 15 – 17. (in Chinese).

[11] WANG Q, CHU XQ, CHEN J, *et al.* Reflections on the MOOC construction of biopharmaceutics and pharmacokinetics under the standard of "Golden Course"[J]. Journal of Traditional Chinese Medicine Management, 2023, 31(13): 10 – 13. (in Chinese).

[12] WU L, BI XL, CHEN ZP. Exploration and innovation in the specialized course construction of pharmaceutical majors based on OBE educational idea: Taking the biopharmaceutics and pharmacokinetics curriculum as an example[J]. Education and Teaching Forum, 2025(28): 99 – 102. (in Chinese).

[13] LI LH, ZHANG SP, ZHU L, *et al.* Design and application of online and offline mixed teaching in experimental teaching of "Biopharmaceutics and Pharmacokinetics"[J]. Journal of Tonghua Normal University, 2021, 42(4): 132 – 137. (in Chinese).