Ind. J. Pharm. Edu. Res., 2024; 58(2):411-416.
https://www.ijper.org

Original Article

Evaluation of Student Performance Based on Integrated Teaching Method in Pharmacology Curricula

Yulin Zhang[1,#], Jia Liu[1,#], Wei Xu[2,#], Qin Kong[1,*]

[1]Department of Pharmacology, School of Basic Medical Sciences, Anhui Medical University, Hefei, CHINA.
[2]Department of Resources and Environment, Anhui Vocational and Technical College of Forestry, Hefei, CHINA.
[#]These authors are equally contributed to this study.

Correspondence:
Dr. Qin Kong
Department of Pharmacology, School of Basic Medical Sciences, Anhui Medical University, 81# Meishan Road, Hefei-230032, CHINA.
Email: kongqin@ahmu.edu.cn (Q. Kong),

Received: 06-09-2023;
Revised: 15-11-2023;
Accepted: 19-01-2024.

ABSTRACT

Aim/Background: The transformation of the "new medical education" model imposes higher demands on universities and educators, representing the latest requirements for the development of medical education. In the past decade, continuous innovations in medicine, pharmaceuticals, and information technology have offered multiple convenient avenues for reform and advancement in medical education. To create "golden courses" that align with the demands of the new medical sciences, we are integrating mobile internet technology with conventional teaching methods to explore various aspects of pharmacology theory and experimental practices. **Materials and Methods:** A prospective cohort study of medical students enrolled in either conventional or integrated (plus application Moso Tech.) pharmacology curricula. Summative examination performance, job competence, and student self-rating of confidence were compared between the two groups. **Results and Discussion:** Throughout classroom instruction and practical teaching, over 80% of the students proactively participate in a broad spectrum of pedagogical approaches, resulting in noticeable improvements in their test scores. During the preparatory phase, we gain insights into the specific cognitive areas where students lack proficiency. This information empowers us to prioritize these aspects during instruction for a more targeted teaching approach. Simultaneously, we have received positive feedback, enabling us to enhance our teaching proficiency and student performance more effectively. Most importantly, this diversified teaching approach can augment student's learning enthusiasm. Various teaching methods can significantly boost students' comprehensive performance, confidence, and competency in future professional roles. These results highlight the need for potential amalgamation of instructional approaches to enhance the quality of education.

Keywords: New medical construction, Pharmacology education, Integrated teaching method, Medical education, Course reform.

INTRODUCTION

The emergence of the new medical sciences has been propelled by the strategic deployment of "Healthy China 2030" and the rapid advancement of mobile internet technology.[1] Innovating traditional medical education and cultivating multidimensional, high-level medical and health professionals to serve public health have become imperative considerations for every medical institution. As a fundamental discipline in medical education, pharmacology lays the groundwork in physiology, pathology, and biochemistry, offering essential knowledge and scientific methods for disease prevention, treatment, and rational drug use. The core task of discipline and specialty construction lays in curriculum development.[2] The competence of medical students, whether in clinical or related auxiliary work, is of utmost importance. Thus, exploring and establishing universally applicable and scientifically effective teaching and practical methods become paramount. Concurrently, the mobile internet era has arrived, with the rapid proliferation of smartphones and intelligent tablets providing great convenience for diversified teaching practices, including real-time updates of learning resources and clinical knowledge. Leveraging online course platforms, flipped classrooms, and micro-courses can establish innovative learning models and significantly enhance the interest and practicality of teaching.[3,4] This research employs the mobile teaching tool to explore a diversified teaching model for pharmacology (integrating experimental and class courses). The findings of this study hold significant implications for improving teaching effectiveness, guiding the reform of fundamental

DOI: 10.5530/ijper.58.2.46

medical courses, and accelerating the construction of first-class disciplines in China.

Pharmacology teaching in medical education holds significant importance in cultivating high-quality medical professionals.[5] Most medical courses, including pharmacology, rely on traditional classroom teaching. Students commonly express concerns about the abundance of knowledge to cover within limited class hours, leading to a fast-paced teaching approach by instructors, which can make the learning process more challenging for students. On the other hand, practical laboratory sessions demand a higher level of active thinking and hands-on skills. With a thorough understanding of the experimental principles, merely following the teacher's instructions during lab sessions may allow students to effectively reinforce the theoretical concepts learned in class. Adopting efficient teaching methods is particularly crucial for enhancing the talents of medical students. Traditional teaching tends to be "teacher-centered," numerous studies have indicated various drawbacks associated with conventional teaching methods, such as teachers delivering lectures and students passively receiving courses with limited feedback. Therefore, exploring and researching new teaching methods to address this challenge is necessary and crucial. In recent years, teaching methods emphasizing interaction and case-based learning have gained popularity over traditional teaching models. The flipped classroom approach has been widely adopted in medical education, where students prepare for classes by reading and watching pre-recorded information and lectures. We integrate traditional teaching methods with the flipped classroom model, providing students with opportunities for active learning to cultivate effective study habits.

The competency characteristics of general practitioners in China primarily encompass basic medical service abilities, public health service capabilities, and professional qualities.[6] These competencies require theoretical understanding, practical experience, and critical thinking. As China undergoes medical reform and transitions in healthcare service models, reforming medical student's teaching modes during their academic years becomes crucial for talent cultivation. This necessitates medical institutions to strengthen the transformation of teaching approaches throughout the entire education process, moving away from students solely preparing for examinations and fostering a "learning for application" mindset. The focus should be on guiding students towards future competency in their professional roles rather than merely mastering knowledge of pharmaceuticals. Generating these sparks of innovative thinking requires active guidance from teachers. However, pharmacology covers various subjects as an essential discipline bridging basic medical sciences and clinical medicine. In recent years, universities have utilized the internet for educational reform, employing Small Private Online Courses (SPOC), micro-courses, and scenario simulation. These teaching approaches can serve as positive supplements to traditional instruction.[7] However, online teaching methods have drawbacks, such as a lack of real-time interaction in Massive Open Online Courses (MOOC), leading to delayed problem-solving. Additionally, scenario simulation methods may only be suitable for large-scale teaching with a few students. On the other hand, experimental teaching serves as an extension and essential focus of theoretical instruction, playing a significant role in talent cultivation by fostering innovative thinking and problem-solving abilities.[8] However, current online courses cannot effectively complement traditional laboratory practices. Timely formative assessments are crucial to providing objective evaluations, understanding students learning outcomes and promptly adjusting teaching methods. Overall, the transformation in teaching approaches aims to enhance student's self-directed learning motivation and teacher's instructional capabilities. Therefore, the desired teaching model should supplement traditional instruction rather than a one-size-fits-all comprehensive teaching platform or other teaching methods.

We utilize a mobile internet-based real-time interactive teaching client accessible on smartphones and personal computers. The platform facilitates instant interaction, resource distribution, assignment of tasks, and fun quizzes between teachers and students, aiming to supplement the limitations of traditional teacher-centric lectures and passive listening. The platform comprehensively records teacher's classroom designs and student's learning processes. Teachers can employ incentive mechanisms and reward tests within the system to encourage active student engagement in the teaching process. Moreover, the substantial data generated from student behaviors, such as participation and responses, can assist teachers in educational research. The key features of this platform are its mobile-based nature, enabling projection through smartphones and smart tablets, as well as access through computer web browsers. Teachers can create classes, send notifications, distribute resources, and create engaging activities such as in-class quizzes, brainstorming sessions, and voting questionnaires based on instructional progress. We focus on utilizing the software as a complement and adjunct to classroom teaching, aiding student's growth and supporting teacher's pedagogy.

MATERIALS AND METHODS

Participants and study design

The study was carried out with 245 students (n=121 enrolled in 2019, n=124 enrolled in 2020) at the AHMU. For the theoretical courses, we chose the chapters "Synthetic antibacterial drugs" and "Antituberculosis drugs" from the "Pharmacology (9th edition)" published by the People's Medical Publishing House. As for the experimental teaching, we selected 1 standard class (n=30) for the topic "The effect of furosemide on diuresis in rabbits" (Figure 1).

Planning teaching evaluation

The research methodology involved pre-publishing relevant course materials on the teaching platform (Moso Tech.). These materials included main lecture slides, online resources, study videos in both Chinese and English and some discussion questions. This approach encouraged students to preview the content, given them a better grasp of the subject matter and the opportunity to attend classes with questions in mind. During the lectures, the primary focus was delivering the content, with interspersed study videos. The teacher also addressed any questions that students might have had beforehand, enhancing their enthusiasm for learning. Following the lectures, interactive activities were conducted, including quizzes, brainstorming sessions, and voting questionnaires. Data from all activities were saved to facilitate teacher evaluation and summarization. We typically collect data after the conclusion of each class, but occasionally, we allow students to refine their responses after the teaching session. The assessment of performance (knowledge acquisition) involved conducting a final exam after confirming the comparability of the two groups in terms of their overall proficiency. The planning for the two teaching approaches was coordinated, and the goals were matched in both groups. Statistical differences were evaluated using a two-tailed unpaired Student *t* test for comparisons between two groups.

The main teaching processes

1. The teacher begins by having students answer previously posted questions on the platform and providing constructive feedback.

2. Students are encouraged to articulate their uncertainties, identifying areas where they find knowledge comprehension challenging and expressing enthusiasm for particularly engaging concepts.

3. Exploration of additional topics that students wish to delve into, related to the current chapter content.

4. The teacher delivers the course with targeted feedback tailored to address specific student concerns.

The primary approach involves implementing the teaching process across three phases: pre-class, in-class, and post-class, which ensures that students can preview topics of interest or areas of uncertainty before the lesson, providing timely feedback to the teacher. During the class, the teacher incorporates feedback into the teaching process, interspersing case studies and videos. After the class, the teacher promptly addresses student queries and administers brief quizzes to assess comprehension.

RESULTS

The results of learning pre-class resources

In the selected sections of "Synthetic antibacterial drugs" and "Antitubercular agents" four pilot resources have been distributed through the Moso platform. In the context of student learning facilitated under the teacher's guidance (with no obligatory mandate), the proportion of student engagement has consistently exceeded 50%, and the participation rate in laboratory sessions for small-group instruction has even reached an impressive 90% (Table 1). These metrics profoundly underscore the well-received nature of this pedagogical approach among most students. These data substantiate that students remain amenable to embracing novel instructional paradigms. Contrasted with conventional and monotonous pre-reading of textbooks, this methodology, characterized by using videos, images, and probing questions, introduces instructional processes that significantly pique students' interest.

The results of the course warm-up and questionnaire

Before commencing the course, instructors set up resources or questions closely related to the chapter for students to preview the theoretical and experimental courses. Questionnaires are commonly used to quickly gather student opinions, allowing us to understand their needs. For instance, in this survey, we included the question, "In experimental teaching, what do you think is the most effective teaching method for students?" Based on the questionnaire results, the top two methods were watching videos and explaining experimental slides, which align precisely with our school's established approach for experimental teaching, emphasizing explanation with supplementary visual aids to clarify instructions (Table 2). The activity ensures that students

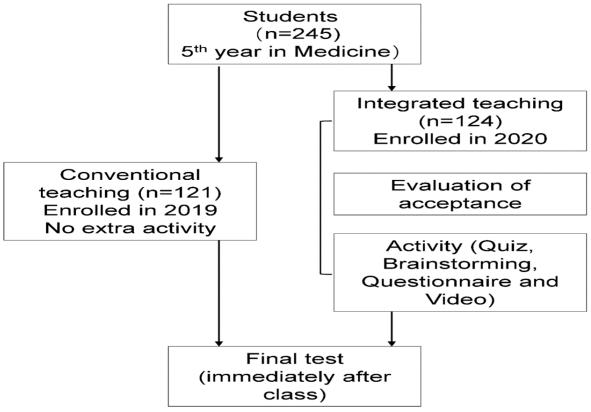

Figure 1: Flow chart of the study.

Table 1: Number of students participating in integrated teaching.

Activity	Class teaching (Total, 124)	Practice teaching (Total, 30)
Quiz	73 (58.9%)	27 (90%)
Brainstorming	64 (51.6%)	28 (93.3%)
Questionnaire	89 (71.8%)	27 (90%)
Video	92(74.2%)	27 (90%)

can execute the experiment better during the subsequent practical operation phase.

During the theoretical teaching process, we can use questionnaires to gauge students' familiarity with the content and adjust the depth of teaching accordingly. For example, in the chapter "Synthetic Antibacterial Drugs," the instructor included questions like "Have you heard of this drug?" and "Do you know the main diseases it treats?" The results indicated that only 43.8% of the students knew that norfloxacin is primarily used to treat specific diseases (Table 3). This suggests that students must understand the drug pharmacologically to possess superficial knowledge. As a result, we should reinforce explanations regarding pharmacological mechanisms and clinical applications in subsequent theoretical lessons. This approach emphasizes student-centeredness, gathering student feedback, and tailoring the theoretical and experimental teaching processes based on their responses.

Table 2: Engagement results of course warm-up.

Activity	Class teaching (Total, 124)	Practice teaching (Total, 30)
Lecture	108 (87.1%)	19 (63.3%)
Video	101 (81.5%)	23 (76.7%)
Live presentation	/	17 (56.7%)
Postgraduate guidance	78(62.9%)	14 (46.7%)
Teach guidance	96 (77.4%)	15 (50%)

Table 3: Engagement results of theory course warm up.

Description	Class teaching (89 participate)
Do you know about quinolones?	
Yes	66 (74.2%)
No	23 (25.8%)
Do you know norfloxacin, ofloxacin or levofloxacin?	
Yes	75 (84.3%)
No	14 (15.7%)
Do you know what diseases norfloxacin, ofloxacin or levofloxacin are mainly used?	
Yes	39 (43.8%)
No	10 (11.2%)
Unsure	40 (45%)
Do you know which class of chemotherapy drugs were the first to be used in clinical treatment?	
Yes	53 (59.6%)
No	36 (40.4%)

Brainstorming and discussion

In the pedagogical research process of this segment, we employed impromptu brainstorming sessions during theoretical and laboratory classes to facilitate collective discussions. The aggregate participation statistics are presented in Table 4. Following the classes, instructors meticulously checked student responses, revealing the student's capacity for multifaceted discourse. Furthermore, deduced from the student analyses, the majority exhibited diligent contemplation during the lectures, steadily augmenting their foundational knowledge acquisition.

Final test

We proactively incorporated diagnostic questions addressing key instructional challenges and administered in-class quizzes to the students. This approach assessed students' learning outcomes and reflected the instructors' pedagogical efficacy, as depicted in Table 5. The amalgamation of diverse classroom instruction notably enhanced students' academic performance. Additionally, there was a pronounced increase in the number of individuals scoring above 80 points. However, it should be noted that approximately 40% of the students scored below 60. Post-inquiry discussions with these students revealed that the test duration could have been briefer, impeding comprehensive comprehension. This indirectly underscores students' challenges in digesting knowledge within a limited time. Through the comprehensive use of various teaching formats, we have observed a high level of student participation (Tables 1 and 2). Students are actively willing to respond to teachers' questions and provide feedback, which is crucial as it signifies proactive learning rather than passive knowledge acceptance. With platform support, students can access their learning traces and data anytime, motivating them to cultivate good study habits. Although specific parameters cannot be recorded in data, students often seek timely clarification on confusing concepts outside of class.

Table 4: Engagement summary of brainstorming in pharmacology course.

Question	Answers
Do upper respiratory infections need antibiotics?	*n*=61
Yes	53 (86.9%)
No	0
Unsure	8 (13.1%)
Which drugs are ototoxic?	*n*=30
	aminoglycoside (28, 93.3%)
	Some diuretics (26, 86.7%)
	Some anticancer drugs (12, 40%)
	NSAIDs (10, 33.3%)

Table 5: Summary of random test performance by two groups.

	N	Min.	Max.	>80	AV	SD	*p* value
Conventional	121	18	96	9.9%	56	18.9	0.00218
Integrated	119	20	100	19.3%	64	17.6	

In summary, this real-time assessment strategy effectively mirrors the outcomes, resonates positively with students, and invigorates classroom dynamics. In response to student's responses, instructors also bestow appropriate recognition to foster an engaging classroom ambiance.

DISCUSSION

The rapid development of mobile internet has bestowed immense convenience across various sectors, enabling each industry to harness the advantages of technological advancements. The field of education is no exception, as the evolution of the mobile internet has injected new vitality into traditional teaching methods.[9] On one hand, this development revitalizes the conventional lecture format. On the other hand, as novel theories and pharmaceuticals continue to be researched and developed, alongside the emergence of new guidelines and expert consensus, the teaching methodologies in pharmaceutical education require timely updates. Given that the pace of textbook updates cannot keep up with the speed of new knowledge emergence, this presents a higher demand for the instructional prowess of frontline educators. Pre-class resources are of paramount importance, necessitating the integration of both knowledge and engagement to reflect teachers' comprehensive qualities and capabilities. It is about updating knowledge promptly and employing innovative teaching formats and models that make learning enjoyable and effortless for students.[10]

Furthermore, Moso necessitates seamless integration with campus networks. All our campus buildings have access to the campus network, significantly facilitating online resources and software deployment. The trends of informatization and modernization are the trajectory for the future. We must make efficient use of these tools, encouraging active student participation. Teachers should be facilitators, focusing on imparting effective learning methodologies, such as acquiring internet-based knowledge, rather than "feeding fish".

Simultaneously, we need to tailor resources according to distinct disciplines.[11] For instance; clinical and pharmaceutical fields might emphasize integrating clinical practice and drug usage. Basic subjects like biology should prioritize tracking the latest trends in drug development and understanding their mechanisms of action, laying a solid foundation for future pharmaceutical research. Moreover, diversifying teaching approaches is essential, as students tend to prefer varied modes of instruction, including competitions and interactive quizzes.

This study's major innovation lies in quantifying instructional assessment effects and encompasses students' recognition of teacher resources and teachers grasp of student autonomous learning. There needs to be reports on exploring this platform in integrated experimental and theoretical teaching. Concurrently, this research contributes to establishing a quality evaluation system for integrating theoretical and practical aspects in various medical courses. Compared to other platforms like micro-lectures, this platform features real-time interaction and a web version, making it better suited for large-screen teaching scenarios.[12] The central direction of this research lies in leveraging new teaching platforms to expand course knowledge, using direct and intuitive teaching materials to aid students in knowledge absorption.

In summary, this research aims to explore teaching reform through a novel instructional model, enhance teaching quality, cultivate adaptable medical students within the context of new medical backgrounds, and promote its usage across other institutions.

CONCLUSION

Various pedagogical strategies can substantially augment students' holistic academic achievements, bolster their self-assuredness, and cultivate their competence for prospective vocational endeavors. These findings underscore the imperative of contemplating the prospective integration of diverse instructional modalities to ameliorate the caliber of educational provision.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS CONTRIBUTION

Yulin Zhang: Investigation, Data curation, Writing-original draft. Jia Liu: Data curation, Writing-original draft. Wei Xu: Software, Investigation, Data curation. Qin Kong: Conceptualization, Supervision, Data curation, Writing-original draft, Writing-review and editing.

ACKNOWLEDGEMENT

This work was supported by the Teaching Quality Improvement Project of Anhui Medical University (2021xjkc08) and the Anhui Provincial College Natural Science Project (2023AH050670). We thank all the students who participated in the study and the Experimental Teaching Center of Basic Medicine (Anhui Medical University).

ABBREVIATIONS

SPOC: Small private online courses; **MOOC:** Massive open online courses; **SD:** Standard deviation; **NSAIDs:** Nonsteroidal anti-inflammatory drugs.

SUMMARY

This study aims to investigate whether various teaching methods can enhance student's overall performance and teacher's educational levels. The research findings indicate that adopting integrated teaching methods can significantly increase student's interest in learning and overall performance, which is highly beneficial for promoting educational development. These teaching strategies can be robust supplements to conventional education, enhancing both student and teacher's overall competence levels.

REFERENCES

1. Tan X, Liu X, Shao H. Healthy China 2030: a vision for health care. Value Health Reg Issues. 2017; 12: 112-4. doi: 10.1016/j.vhri.2017.04.001, PMID 28648308.
2. Wen J, Lu W, Chen Z. Innovation and construction of examination database of pharmacology. Indian J Pharm Educ Res. 2020; 54(2): 279-83. doi: 10.5530/ijper.54.2.32.
3. Engels F. Pharmacology education: reflections and challenges. Eur J Pharmacol. 2018; 833: 392-5. doi: 10.1016/j.ejphar.2018.06.032, PMID 29935169.
4. Liu L, Du X, Zhang Z, Zhou J. Effect of problem-based learning in pharmacology education: A meta-analysis. Stud Educ Eval. 2019; 60: 43-58. doi: 10.1016/j.stueduc.2018.11.004.
5. Guilding C, White PJ, Cunningham M, Kelly-Laubscher R, Koenig J, Babey AM, *et al.* Defining and unpacking the core concepts of pharmacology: a global initiative. Br J Pharmacol. 2023. doi: 10.1111/bph.16222, PMID 37605852.
6. Chen S, Sam XH, Soong A, Car LT, Lian S, Smith HE. Recruitment of general practitioners in China: a scoping review of strategies and challenges. BMC Prim Care. 2022; 23(1): 249. doi: 10.1186/s12875-022-01854-0, PMID 36162977.
7. YU Y, SHEN B-z. Application of SPOC flip classroom based on WeChat platform in clinical pharmacology teaching. Basic Clin Med. 2020;40(7):1015.
8. Lawson R, Leymarie S, Nikitopoulos C, Humeau A, Bouchenaki H, Duroux JL, *et al.* Alternative to animal experimentation in pharmacology teaching: development and validation of an equivalent digital learning tool. Pharmacol Res Perspect. 2022; 10(1): e00908. doi: 10.1002/prp2.908, PMID 35147294.
9. Noori A, Kouti L, Akbari F, Assarian M, Rakhshan A, Eslami K. A review on different virtual learning methods in pharmacy education. J Pharm Care. 2014: 77-82.
10. Jovanovic J, Mirriahi N, Gašević D, Dawson S, Pardo A. Predictive power of regularity of pre-class activities in a flipped classroom. Comput Educ. 2019; 134: 156-68. doi: 10.1016/j.compedu.2019.02.011.
11. Coyne L, Merritt TA, Parmentier BL, Sharpton RA, Takemoto JK. The past, present, and future of virtual reality in pharmacy education. Am J Pharm Educ. 2019; 83(3): 7456. doi: 10.5688/ajpe7456, PMID 31065173.
12. Wang K, Zhu C, Tondeur J. Using micro-lectures in small private online courses: what do we learn from students' behavioural intentions? Technol Pedagog Educ. 2021; 30(3): 427-41. doi: 10.1080/1475939X.2020.1832565.

Cite this article: Zhang Y, Liu J, Xu W, Kong Q. Evaluation of Student Performance Based on Integrated Teaching Method in Pharmacology Curricula. Indian J of Pharmaceutical Education and Research. 2024;58(2):411-6.