Original Article

Application of the Case Teaching Method in a Pharmaceutical Analysis Online Course

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ABSTRACT
Objectives: To explore the teaching effect of integrating the case teaching method into an online course on pharmaceutical analysis. **Materials and Methods:** The case teaching method was adopted as the technique for delivering professional knowledge. The online course integrated knowledge teaching, practical ability, and value guidance. The effect of the case teaching method was evaluated by course assessment and a questionnaire. **Results:** After the reform, students' online course examination scores were greatly improved. The "excellent" or "good" rate increased from 7.7% to 53.8%, and 96.2% of students thought they had fully achieved their teaching objectives with high satisfaction. **Conclusion:** The integration of the case teaching method into the pharmaceutical analysis online course improved its teaching quality; therefore, it is worth promoting and applying in the future.

Keywords: Case teaching method, Drug analysis, Online courses.

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INTRODUCTION

When speaking at the National Education Conference on September 10, 2018, Xi Jinping stressed the importance of accelerating the modernization of education and transforming China into an educated country from higher historical, broader international, and deeper strategic perspectives.[1] This is a forward-looking and innovative principle and concept for developing higher education in the new era and introduces greater requirements for curriculum construction and talent training in colleges and universities.[2]

A drug analysis course is a professional pharmaceutical course to train students in the complete quality control of drugs,[3] develop their competence in drug research, production, supply, clinical analysis, and inspection,[4] and enable their ability to explore and solve drug quality problems.[5] Case teaching method has the characteristics of high degree of authenticity, clear pertinence, students' subjectivity, dynamic process and so on.[6] Case teaching method has successfully solved the problem of combining theory and practice in online classroom teaching with its successful practicality.[7] The teaching of pharmaceutical analysis should focus on integrating theoretical and practical content to strengthen students' innovative abilities.[8] In online teaching, case analyses can effectively engage students' learning interests.[9] To solve the problem that most traditional teaching methods mainly focus on teaching, the form is relatively simple, the scattered knowledge points and complex structure of the course are difficult to be transmitted systematically, and the teaching content lacks practicability.[10] In order to adapt to the new concept of building a powerful education country under the background of the new era,[11] the team members of the project may consider integrating case teaching into the class teaching of pharmaceutical analysis, so as to increase students' perceptual understanding of the course of pharmaceutical analysis.[12] This improves students' awareness of drug quality operations and allows them to adapt to the characteristics of our school as an application-oriented University.

MATERIALS AND METHODS

Case teaching method

In pharmaceutical analysis, the case teaching method involves students mastering basic knowledge and operations based on the teaching content plan in the form of case studies. These provide students with specific practice and guide them to develop independent thinking and the ability to diagnose, analyze, and solve problems.[13] In the online case teaching method, teachers undertake targeted topic selection and advance preparation according to specific teaching units.[14] Teachers operate the experimental process in the laboratory, simulate the operating

environment of students' offline experimental classes, and record videos. In the case teaching method,[15] students are assigned tasks via the learning platform. Students design and become familiar with experimental schemes according to basic theoretical knowledge and experimental PPT content, refer to relevant literature, summarize problems, and conduct video discussions and analyses of problems after watching videos. The teacher provides comments and summarizes the questions, highlights the key points and difficulties of each case, and answers the students' questions.[16]

Exploring case elements in the drug analysis course

To ensure the smooth implementation of case teaching in the online drug analysis course, we introduced case analysis teaching content into the course syllabus.[17] The specific design is shown in Table 1.

Implementing the online case teaching method for pharmaceutical analysis

The following section takes the content determination of drugs as an example and pharmaceutical Class 1 as the representative study group to briefly describe the online teaching process for pharmaceutical analysis using a case analysis approach.

All students (100%) provided informed consent prior to participation.

Pre-class preparation

One week before the class, the teacher formed five class study groups, each containing five or six students, a total of 26 people. All students were sent PPT, teaching materials, and a High-Performance Liquid Chromatography (HPLC) training video on the quality analysis of compound levonorgestrel tablets. The teacher asked each class to discuss the following questions

Table 1: The teaching contents of Drug Analysis and the roots of teaching cases.

Sl. No.	The teaching unit	The teaching content	Teaching cases and their roots
1	Drug standards	«Chinese Pharmacopoeia»,«Drug Standards»	«Chinese Pharmacopoeia» structure
2	Identification test of drugs	Identification test items, methods, conditions and method validation	Identification test of drugs
3	Inspection of drugs for impurities	Impurity and limit, impurity inspection method.	General impurity testing of drugs
4	Determination of drug content	Classification of quantitative analysis methods, validation of drug analysis methods, preparation of analytical samples	Quality analysis of compound Levonorgestrel tablets; Application of oxygen bottle combustion method in drug analysis
5	Analysis of aromatic acid non -steroidal anti-inflammatory drugs	Structure and properties, identification test, related substances and inspection, content determination	Quality analysis of aspirin and enteric-coated tablets
6	Analysis of phenylethylamine adrenergic drugs	Structure and properties, identification test, special impurities and inspection, content determination	Identification of epinephrine drugs
7	Analysis of local anesthetics of p-aminobenzoates and anilides	Structure and properties, identification test, special impurities and inspection, content determination	Quality analysis of procaine injection
8	Analysis of barbiturate and benzodiazepine sedative hypnotics	Structure and properties, identification test, special impurities and inspection, content determination	Dentification of benzodiazepines
9	Analysis of antibiotic drugs	Structure and properties, identification test, special impurities and inspection, content determination	Quality analysis of metronidazole apis and preparations
10	Analysis of vitamin drugs	Structure and properties, identification test, special impurities and inspection, content determination	Determination of vitamin A in vitamin AD capsule
11	Pharmaceutical analysis	Type of preparation and analysis method	Determination of menthol in balm by gas chromatography

Table 2: Online classroom teaching of case teaching method.

Case study group			The teaching goal	
The problem	Presentation team	The review team	Knowledge of the target	Case objective and grounding point
1	1	4	Master the structure and composition of HPLC	Simulate laboratory operation to enhance students' perceptual understanding and master the structure of the instrument.
2	2	3	To master the applicability parameters of HPLC system	By watching the video recorded by the teacher, the students felt as if they were in the scene and were familiar with the significance and function of various parameters in the determination of content by HPLC.
3	3	2	Familiar with compound levonorgestrel tablet prescription composition	Through video playback, enhance students' intuitive feeling, familiar with the composition of tablet prescription.
4	4	1	Master the method of HPLC to calculate the content	Through practical operation, explain the meaning of each parameter in the content calculation formula while operation, enhance students' interest in learning.

based on the above three learning materials: (1) What is the structure and composition of HPLC? (2) What are the system applicability parameters of HPLC? (3) What are the main drugs in compound levonorgestrel tablets? (4) What is the standard external HPLC method for the determination of compound levonorgestrel tablets?

Classroom teaching

In class, the teacher played an operational video on compound levonorgestrel tablet quality analysis, which had been recorded previously in the laboratory. Groups one to five were instructed to state the answers to questions 1 to 4, respectively, and each group commented on the other groups' answers. The specific division of tasks is shown in Table 2. The teacher guided students to further discuss the situation and problems of the case and explained the relevant operational points whenever necessary.

For question 1, during the group presentation and following the discussion, the students suggested the structure of HPLC should be included in the analytical chemistry course. They said it was hard to remember. They used mind-mapping techniques to visualize the stationary phase, the liquid bottle, and the position and functions of the high-pressure pump. They felt enlightened after watching the teacher's operational video and better understood the HPLC and its working process, which is shown in Figure 1. This enhanced the students' interest in learning, prompting heated discussion and an active classroom atmosphere.

For question 2, both the presentation group and the commenting groups agreed that the parameters of HPLC were abstract, such

as the theoretical plate number, separation degree, and trailing factor. After watching the teacher's operational video, the students gained a certain degree of understanding that aided their memories.

For question 3, the groups agreed that the main drugs were levonorgestrel and ethinylestradiol, but that was insufficient. By watching the teacher's operational video, the students comprehended the relationship between the two main drugs and the reference substance, the injection sequence, the determination of retention time, the determination of peak area, and other contents. The classroom atmosphere was tense at this stage. In the experiment of determining retention time, students were confused. The experimental steps are as follows: Take levonorgestrel reference product, accurately weigh, add acetonitrile, ultrasonic treatment to dissolve, cooling, and quantitative dilution made into a solution containing levonorgestrel 75mg per 100mL, precision 2mL, placed in 100mL flask, acetonitrile-water (60:40) as the mobile phase, dilute to scale, shake well, high performance liquid chromatography for determination. Under this operation, the peak time obtained is the retention time of levonorgestrel. At this point, the video stops playing and the teacher explains its principle through a video link. The students suddenly understand the method to determine the retention time.

For question 4, students in all groups felt confused and gave inaccurate answers. Watching the teacher's operational video (When recording this part of the video, the teacher explained the calculation formula and the meaning of each parameter on the blackboard in black and white) helped them to master how to calculate the content of the peak area using the standard external
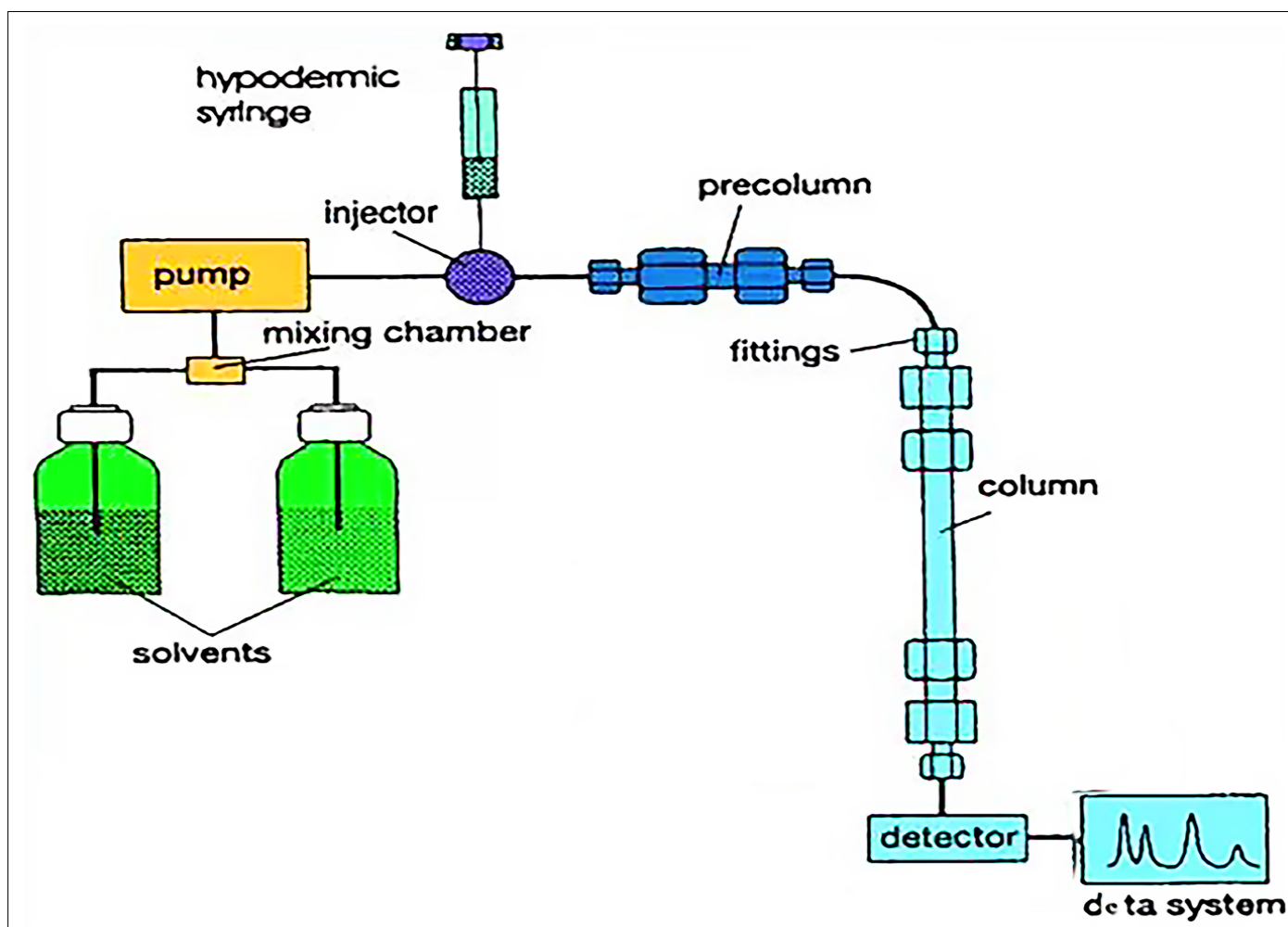
Figure 1: Working flow of HPLC.

method and learn the relevant data processing and analytical techniques.

With the four major problems and their sub-problems solved, students completed the section on drug content determination. The whole teaching process always followed the principles of case orientation, group cooperation, operation demonstration, student-guided learning, and teacher's explanation.

RESULTS

The effect of the online case teaching method for pharmaceutical analysis

The exploration and practice of case teaching in the online pharmaceutical analysis course was aimed fundamentally at enabling students to achieve the collaborative development of knowledge, ability, and quality in the post-epidemic era. To test the effectiveness of case teaching, this study selected two indicators: the academic performance of the course and the achievement of the case teaching objectives.

The content of pharmaceutical analysis is tedious; there are many knowledge points, and it is based on analytical chemistry, pharmaceutical chemistry, and organic chemistry. Instrumental analysis, in particular, is recognized as a difficult subject to learn. Through the introduction of the online case teaching method, students were instructed on group learning with questions, watching the teacher's practice video, and following the main learning route of structure, property, identity, inspection, and content determination. Students have the ability to deduce physical and chemical properties of drugs by observing and analyzing their chemical structures, and to deduce or design identification, inspection and content determination methods based on the physical and chemical properties.

The students' academic performance improved significantly, as shown in Figures 2 and 3. All students passed the examination, and 53.8% (up from 7.7% before the reform) were classed as "excellent" or "good".

After the completion of the pharmaceutical analysis course, the students were asked to participate anonymously in a
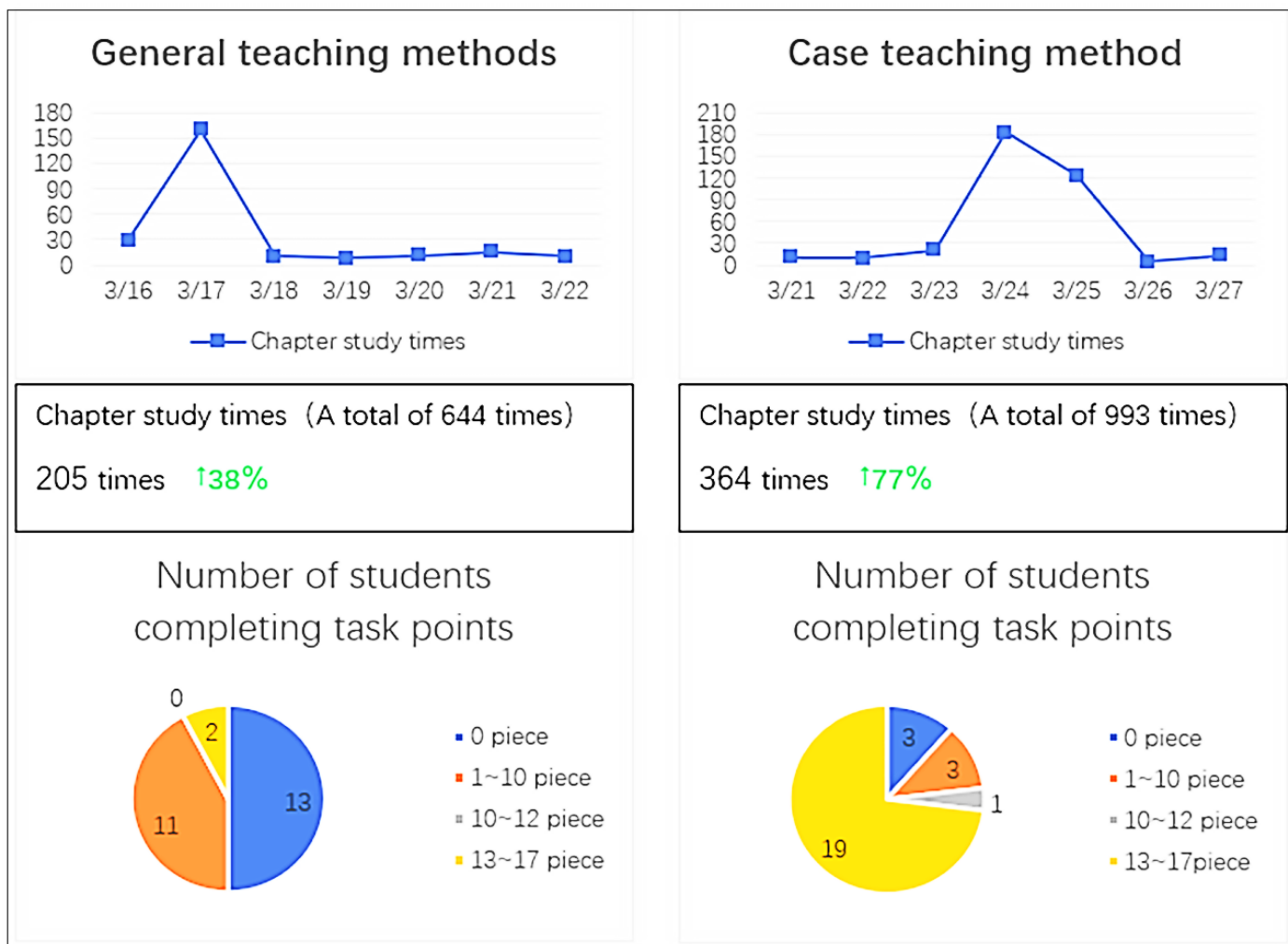
Figure 2: Learning effects of chapters and task points before and after case method teaching reform. (Left: Learning before reform; Right: Learning after reform)

questionnaire survey on the effect of the case teaching reform to investigate the degree of achievement of their individual objectives. The results showed that all students considered they had achieved the case teaching goal, and 96.2% thought they had achieved it completely. This indicated a high degree of teaching satisfaction, as shown in Figure 4. The seven quality objectives integrated into the case teaching of the online pharmaceutical analysis course were deeply popular and played good guidance/demonstration roles for students' future studies and work.

DISCUSSION

This was a bold attempt to embed the case teaching method for professional knowledge points in the pharmaceutical analysis course. During the pandemic, students were unable to complete the experimental course and could only watch online videos. This teaching reform, in which the students' own teacher demonstrates the practical operations in the students' familiar laboratory, enhances their affinity with learning the content and improves the combination of theory and practice to achieve teaching objectives.[18] It enables students to carry out group

learning by analyzing and solving case problems, naturally build their professional pharmaceutical knowledge, and cultivate their practical ability, The assessment results showed that the excellent rate increased from 7.7% to 53.8%, and 96.2% of the students believed that they had fully achieved the teaching goals. thereby solving the problem of teaching difficult, specialized, experimental courses in the post-epidemic era.

This teaching research can lay the foundation for the project of teaching method in the future.[19] This teaching reform takes task-based research method as the entry point, adopts the situational teaching model, supplemented by the comprehensive application method of discussion method and experiment method, and the final results are expressed in charts. The table uses the statistical method of hierarchical data to group discussion on the levels of properties and categories.[20] The chart uses the statistical data of Learning Pass, which is a platform for course learning, knowledge dissemination and management sharing based on micro-service architecture, with its own statistical data and statistical charts. The statistical data follows the principle
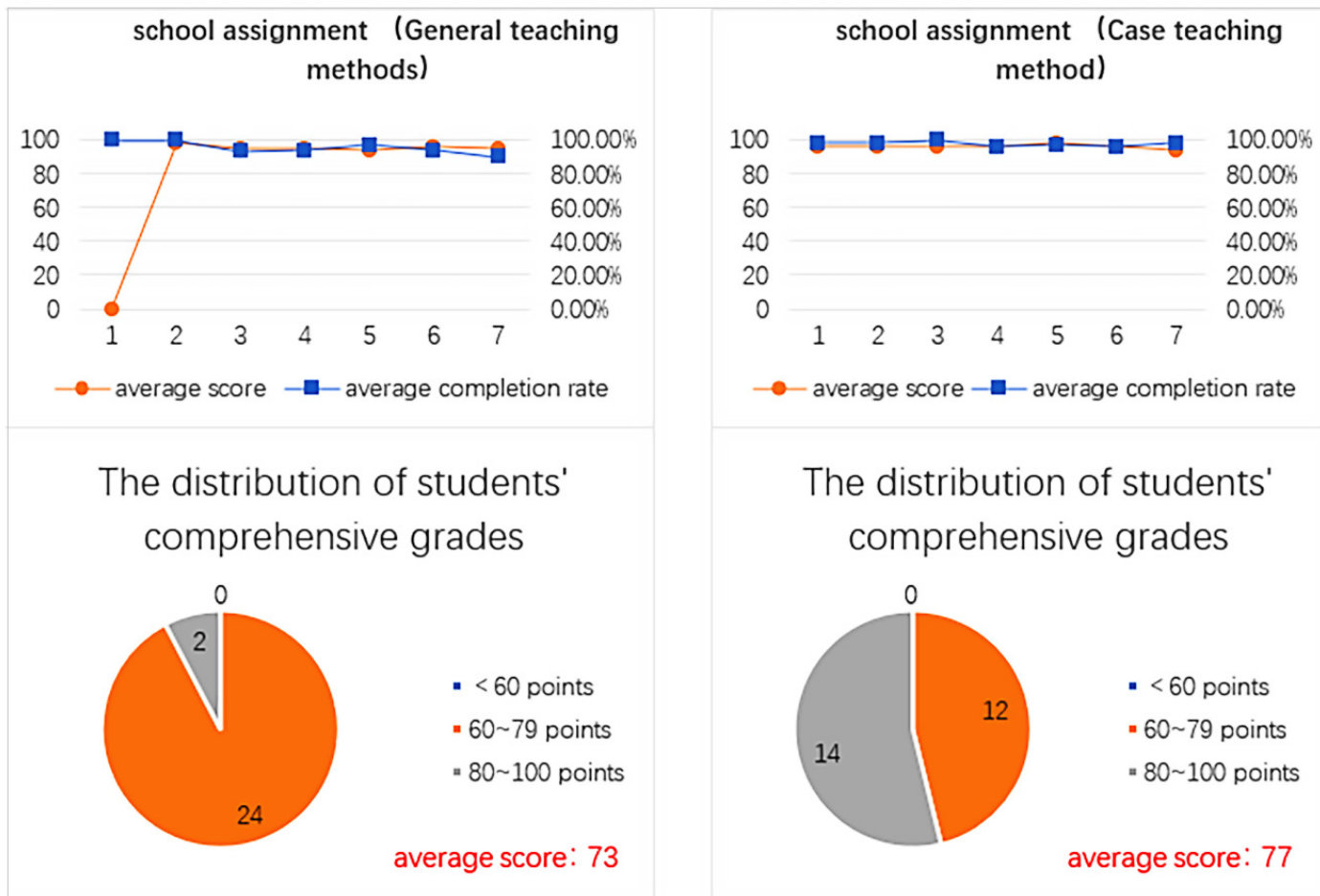
Figure 3: Learning effects of homework, discussion and comprehensive results before and after case method teaching reform. (Left: Learning before reform; Right: Learning after reform)
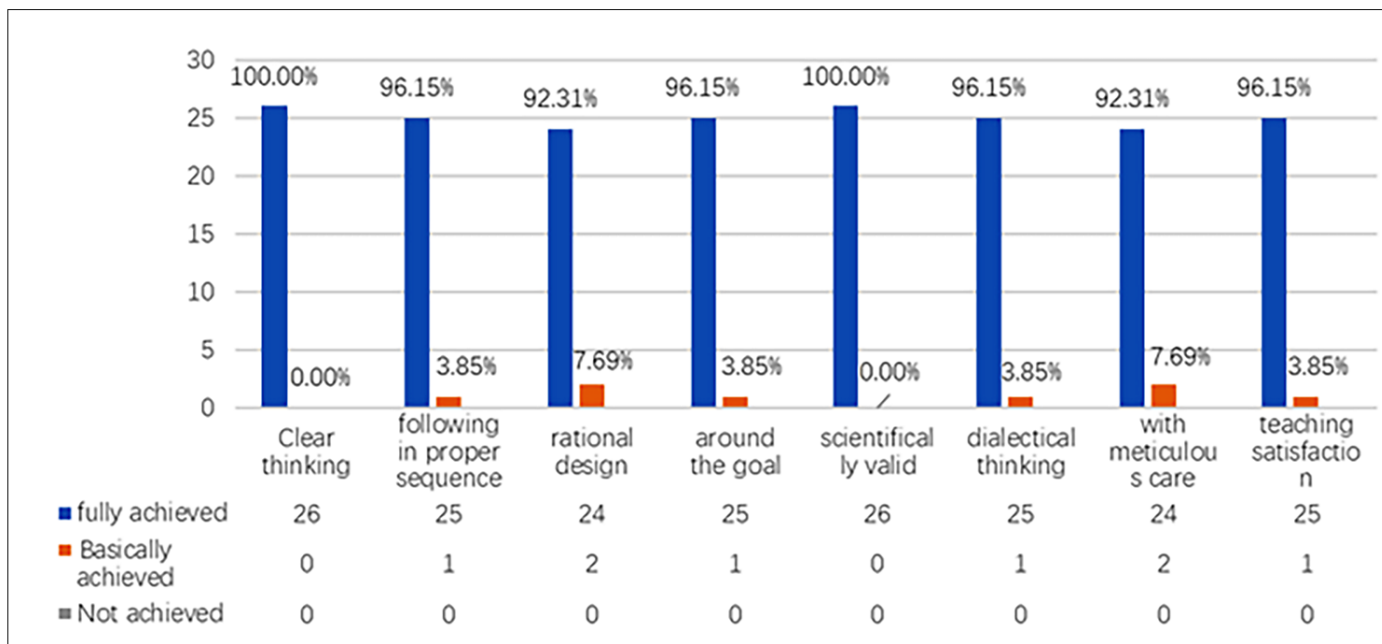

Figure 4: Analysis on the achievement of case teaching objectives and teaching satisfaction.

of repeatability, randomization and regional organization. It is a teaching platform widely used in Medical Colleges and Universities.

The discipline characteristic of drug analysis is practical science, the process of drug quality establishment, confirmation and inspection are all separated. Do not open experimental operation. Pharmaceutical education has been disrupted in many countries by the Novel Coronavirus pandemic, with face-to-face lectures being replaced by pre-recorded videos. However, drug analysis skills training cannot easily be replaced by video because of the high level of teacher-student interaction required. Therefore, we developed a new web-based drug analysis skills learning course.[21] Online teaching adopts case teaching method. First of all, it puts forward higher requirements for teachers. Teachers need to visit the laboratory in person, fully familiarize themselves with each experiment, explain key and difficult contents, as well as possible experimental phenomena, analyze experimental results, and organically combine theory with practice.[22] Secondly, teachers need to set reasonable questions, skillfully guide the discussion process in class, and fully mobilize the enthusiasm of students. If necessary, control the pace of the discussion and explain difficult points and key points. Teachers should have flexible adaptability and strong organizational management ability, and need to invest more time and energy. Finally, because they are accustomed to the traditional passive teaching mode, some students do not adapt to the teaching method of combining questions with discussion, and they are not active in group discussion, but appear psychological pressure. More guidance and encouragement from teachers and help from peers are needed to make students quickly integrate into and master the new learning mode.[23-26] This study started from September 2019. The subjects were undergraduate students in the School of Pharmacy for three consecutive years, with a total of more than 600 students. The same research method and project were applied. Online case teaching experiment content mainly choose the representative instrument analysis experiment part, the analysis process of the part is used for characterization of drugs, especially the fast, cheap, non-invasive, non-destructive and be applied to the ideal of offline and online, online features, substance was isolated from the surrounding matrix analysis for trace analysis of preliminary steps. Spectral chromatography contains a large profile of information that can be used beneficially by using multivariate mathematical and statistical (stoichiometric) techniques to discuss a comprehensive exploration of collected data and experimental results established for quantitative (calibration) and qualitative purposes.[27] Novel "green" analysis methods (keeping the requirements of green pharmaceutical analytical chemistry) are introduced to achieve effective, economic and environmental experimental goals,[28] so as to stimulate students to explore the subjective initiative of knowledge. The effect of online case teaching adopts two evaluation indexes, which are subjective and objective. In the subjective aspect, questionnaire survey is used, while in the objective aspect, homework and examination are used. Scientific performance statistics are carried out through the learning platform, and the two methods show the learning effect intuitively and objectively in the form of charts. To compare the influence of online case learning and traditional teaching mode on the learning outcomes of pharmacy students.[15] The desired effect is achieved. Through tracking the follow-up learning process of students, it is found that they have enhanced their independent thinking, method selection, analysis and problem-solving abilities, and demonstrated keen thinking and hands-on ability in the follow-up comprehensive experiment design and experimental discussion.[29] We have the confidence to carry on the case teaching method.

Due to the COVID-19 pandemic, faculty members of the School of Pharmacy are working hard to transform the campus curriculum into a linear one Type. A few years ago, we moved our undergraduate and graduate drug analysis courses from in-class to completely online. The course is content intensive and has a relatively high enrolment rate. Since the transition, we have identified this challenge and gathered a wide range of student feedback that has guided substantial improvements to our online courses.[30] In this paper, the focus is on how online teaching approaches focus on the basic pillars of pharmaceutical analysis: organization, course content delivery, communication, and evaluation. High yield improvement cases of enhanced learning are provided.[31] Identify the factors that influence student satisfaction and performance with online courses during this period and establish relationships between these variables. The study was quantitative, with data collected from three consecutive undergraduate students majoring in pharmacy, pharmaceutical engineering, and pharmaceutical preparations.[32] The results show that four factors, including teaching quality, course design, timely feedback and students' expectation, have a positive impact on students' satisfaction.[33]

The findings from this study are limited because the study was conducted at only one pharmaceutical course, which may prevent generalization of our findings to other pharmaceutical disciplines students. In addition, the same homework and statistical goals were used every year, with students from different grades telling each other. Also, it was not possible to determine whether students watched the video experiment section in their entirety, This limits the integrity of the test results. In addition, since there is no blinding in our study, some analytical bias is inevitable.[34] Given that the nature of the program prevents counselors from blindly guiding students, we acknowledge that their assessments of student leadership traits may be influenced by subjective factors, including perceptions and interpersonal relationships that improve over time.[35] Therefore, the content of satisfaction survey may favor online case teaching before and after the reform.

Going forward, improvements to online case course will be made. A few students expressed anxiety and stress over having

to complete the question modules. To address this concern, the online case course could be made available earlier, it could be earlier at the beginning of the semester.[36] Additionally, assessment questions must be updated regularly to maintain the integrity of the evaluation and early identification process, as overseen by the senior education specialist. Because the modules in the online case course are obligatory in scope, the needed content knowledge does not change from year to year. Therefore, the modules do not need to be substantially modified each year. Instead, new questions are constructed that align with module content, it is a new direction to further improve the teaching effect.

CONCLUSION

The online teaching of drug analysis was conducted using the case teaching method with teachers' practical experiments. Representative experiments were selected for each section. Through the learning platform, students focused on the online classroom, which increased their participation and interactivity and cultivated their professional competence. The assessment showed that results classed as "excellent" or "good" increased from 7.7% to 53.8%; a total of 96.2% of the students thought they had fully achieved the teaching objectives, and the teaching effect was significantly improved. Based on the school-running characteristics of "putting ethics first, paying attention to humanity, strengthening practice and serving the grassroots", and aiming at cultivating the practical ability of application-oriented undergraduate students with characteristics, In future teaching processes, the case teaching mode can be integrated into more courses to cultivate excellent pharmaceutical students.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

PPT: Power Point; **HPLC:** High-Performance Liquid Chromatography.

SUMMARY

The online teaching of drug analysis was conducted using the case teaching method with teachers' practical experiments. Representative experiments were selected for each section. Through the learning platform, students focused on the online classroom, which increased their participation and interactivity and cultivated their professional competence. In future teaching processes, the case teaching mode can be integrated into more courses to cultivate excellent pharmaceutical student.

REFERENCES

1. Chen M. Three same and three forces. To promote the ideological and political curriculum in colleges and universities and the combination of curriculum ideological and political analysis. Ideol Educ Res. 2021(5):122-6.

2. Qiujuan MA, Mingxia WU, Juan Z, *et al*. China education technology and equipment. 2019;19:110-24.

3. Penghua S, Na SUN, Fugang X, Juntao SUN, *et al*. The application of Aalborg PBL model in curriculum ideological and political teaching: A case study of Drug Analysis. Chin J Pharm. 2021;35(11):1322-6.

4. Wenchao LI, Qichao L, Lihong G, *et al*. Orthogonal study on optimal extraction technology of total alkaloids from the roots of *Arundo arundinacea*. China Mod Chin Mater Med. 2018;20(5):620-4.

5. Alsunni AA, Rafique N. Effectiveness of case-based teaching of cardiovascular physiology in clinical pharmacy students. J Taibah Univ Med Sci. 2021;16(1):22-8. doi: 10.1016/j.jtumed.2020.11.009, PMID 33603628.

6. Rajiah K, Maharajan MK, Maricar FMAB. Students as Partners: How the Student-centred Active Learning Concept May Help Indian Pharmacy Education. Ind J Pharm Edu Res. 2022;56(4s):s620-6. doi: 10.5530/ijper.56.4s.209.

7. Yinan W, Dongzhi Y, Fei H, Ziming Z, Aixia H, Dong G. Exploration of student-oriented online display teaching. Pharm Educ. 2020;38(03):34.

8. Hasamnis AA, Arya A, Patil SS. Case-based learning: Our experience in Clinical Pharmacology teaching. J Pharm Bioallied Sci. 2019;11(2):187-9. doi: 10.4103/jpbs. JPBS_135_18, PMID 31148897.

9. Jagsi R, Griffith KA, Moran JM, Ficaro E, Marsh R, Dess RT, *et al*. A randomized comparison of radiation therapy techniques in the management of node-positive breast cancer: Primary outcomes analysis. Int J Radiat Oncol Biol Phys. 2018;101(5):1149-58. doi: 10.1016/j.ijrobp.2018.04.075, PMID 30012527.

10. 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.

11. Boura F, Awaisu A, ElGeed H, Katoue M, Kheir N. Pharmaceutical care education at pharmacy colleges in the Middle East and North Africa region: A systematic review. J Clin Pharm Ther. 2022;47(8):1134-48. doi: 10.1111/jcpt.13674, PMID 35509234.

12. O'Dwyer PJ, Box KJ, Dressman J, Griffin BT, Henze LJ, Litou C, *et al*. Oral biopharmaceutics tools: Recent progress from partnership through the Pharmaceutical Education and Research with Regulatory Links collaboration. J Pharm Pharmacol. 2021;73(4):437-46. doi: 10.1093/jpp/rgaa055, PMID 33793836.

13. Brubacher MS, Lauer Z, Eck LM, Lowry B. Teaching root cause analysis through a collaborative case-based method. Med Educ. 2019;53(11):1135-6. doi: 10.1111/medu.13981, PMID 31650605.

14. Aluko A, Rana J, Burgin S. Teaching and Learning Tips 9: Case-based teaching with patients. Int J Dermatol. 2018;57(7):858-61. doi: 10.1111/ijd.13781, PMID 29878314.

15. Duan Y, Li Z, Wang X, Gao Z, Zhang H. Application of online case-based learning in the teaching of clinical anesthesia for residents during the COVID-19 epidemic. BMC Med Educ. 2021;21(1):609. doi: 10.1186/s12909-021-03047-2, PMID 34886875.

16. Zeng J, Liu L, Tong X, Gao L, Zhou L, Guo A, *et al*. Application of blended teaching model based on SPOC and TBL in dermatology and venereology. BMC Med Educ. 2021;21(1):606. doi: 10.1186/s12909-021-03042-7, PMID 34879860.

17. Beccaria M, Cabooter D. Current developments in LC-MS for pharmaceutical analysis. Analyst. 2020;145(4):1129-57. doi: 10.1039/c9an02145k, PMID 31971527.

18. Ying LIU, Dart Z, Lili W, *et al*. Hybrid "Golden Lesson" teaching based on flipped Classroom and PBL--taking "Drug Analysis" as an example. J Chem Educ. 2020;41(20):92-7.

19. Persky AM, Medina MS, Castleberry AN. Developing critical thinking skills in pharmacy students. Am J Pharm Educ. 2019;83(2):7033. doi: 10.5688/ajpe7033, PMID 30962645.

20. Fernandes JPS. The importance of medicinal chemistry knowledge in the clinical pharmacist's education. Am J Pharm Educ. 2018;82(2):6083. doi: 10.5688/ajpe6083, PMID 29606703.

21. Michael company, Patrick Ho–Yu Chung, Ken Terman zhu COVID 19 during a pandemic to medical students online teach basic surgical skills: Case-control study. Today Surfing. In. 2021;51(8):1404-9.

22. Epifano F, Genovese S. Recent developments in pharmaceutical analysis–RDPA 2019. J Pharm Biomed Anal. 2020;189:113454. doi: 10.1016/j.jpba.2020.113454.

23. Qixi L, Chenju Z, Jinqing W. Meta-analysis of the application effect of problem-oriented teaching method in surgical nursing teaching. Gen Nurs. 2018;16(29):3692-5.

24. Songlin H, Jinhua W. Discuss the problems and countermeasures of PBL teaching method in the application of oral preventive medicine. Education and teaching forum. 2018;10(43):160-1.

25. Zhen-WeiLan, Lyu-Hong Wang, Qi-Ting Li, Shu-Mei Wang, Jiang Meng. Analysis of volatile oil components of different species of Curcumae Rhizoma based on GC-MS and chemometrics. Zhongguo Zhong Yao Za Zhi. 2021;46(14):3614-24.

26. Xin G, Hongjie L, Yunhua S, *et al*. Thinking and discussion of PBL teaching mode in critical medicine teaching. Contin Med Educ China. 2018;10(35):16-8.

27. Xue Y, Guowei L. The effect of TBL combined with PBL in clinical practice of respiratory medicine. Contin Med Educ China. 2020;12(21):32-3.

28. Tabani H, Nojavan S, Alexovič M, Sabo J. Recent developments in green membrane-based extraction techniques for pharmaceutical and biomedical analysis. J Pharm Biomed Anal. 2018;160:244-67. doi: 10.1016/j.jpba.2018.08.002, PMID 30110661.

29. Bovill C. A framework to explore roles within student-staff partnerships in higher education: Which students are partners, when, and in what ways? IJSaP. 2017;1(1). doi: 10.15173/ijsap.v1i1.3062.

30. Margaret B, Michael RG loch. Will your transition to the online course: High yield change of success. Curr Pharm to teach. 2021;13(9):1099-101.

31. Gopal R, Varsa Singh, Arun Agarwal. Impact of online courses on student satisfaction and performance during the COVID-19 pandemic. Educ Inf Technol. 2021;26(6):6923-47.

32. Hadjeris F. Revisiting sustainable development Goal 4 in the context of COVID-19 Pandemic: A case study of online teaching in Algerian higher education institutions. Hum Behav Emerg Technol. 2021;3(1):160-8. doi: 10.1002/hbe2.245, PMID 33821243.

33. Jiang Z, Wu H, Cheng H, Wang W, Xie A, Fitzgerald SR. Twelve tips for teaching medical students online under COVID-19. Med Educ Online. 2021;26(1):1854066. doi: 10.1080/10872981.2020.1854066. PMID 33280546.

34. Villano R, Harrison S, Lynch G, Chen G. Linking early alert systems and student retention: A survival analysis approach. High Educ. 2018;76(5):903-20. doi: 10.1007/s10734-018-0249-y.

35. Martens SE, Spruijt A, Wolfhagen IHAP, Whittingham JRD, Dolmans DHJM. A students' take on student-staff partnerships: Experiences and preferences. Assess Eval Higher Educ. 2019;44(6):910-9. doi: 10.1080/02602938.2018.1546374.

36. Zhao W, He L, Deng W, Zhu J, Su A, Zhang Y. The effectiveness of the combined Problem-Based Learning (PBL) and Case-Based Learning (CBL) teaching method in the clinical practical teaching of thyroid disease. BMC Med Educ. 2020;20(1):381. doi: 10.1186/s12909-020-02306-y, PMID 33092583.