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EDUCATION RESEARCH

Exploration of integrated experimental teaching reform based on task-oriented and micro-project mode

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[Abstract] An open design experiment was conducted based on the task-oriented and micro-project mode in pharmaceutical analysis to instruct students majoring in pharmaceutical drug analysis to integrate experimental resources, strengthen knowledge integration, improve students' ability to comprehensively utilize knowledge, discover problems, analyze and solve problems, and arouse students' enthusiasm for scientific experiments to the highest extent. Furthermore, to culture high-quality, innovative, and integrated pharmaceutical talents in the new century who are competent for drug inspection, have the concept of comprehensive control of drug quality, a solid foundation, and strong scientific research ability.
[Key words] Pharmaceutical analysis; Experimental teaching; Task-oriented; Micro-project; Integrate

1 Introduction

As China encourages pharmaceutical enterprises to conduct original research and development, and standardizes the management of drug production, the pharmaceutical industry has gradually shifted from the previous emphasis on sales with limited innovation to quality control and innovation[1]. Meanwhile, the requirements on the quality of pharmaceutical talents have also been improved continuously. As an essential part of the pharmaceutical discipline, pharmaceutical analysis is a "methodological discipline" for the research and development on drug quality control to culture the students' strong comprehensive concept of drug quality control, master the methods and skills of pharmaceutical analysis, be able to run pharmaceutical duties, possess good professionalism, and realistic scientific attitudes, possess independent mind and the ability to analyze and solve problems in the development of new drugs for comprehensive improvement of drug quality[2]. Pharmaceutical analysis has strong integrity, practicality, and application. Experimental education is an essential part of this course. This course has the traditional functions of strengthening students' theoretical knowledge and culturing students' practical ability, but is also an essential route to culture students' comprehensive use of knowledge and ability to analyze and solve

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practical problems. It also helps the students develop innovative thinking.

For a long time, due to the influence of traditional educational concepts, the issue of over-emphasizing theory rather than practice in the educational process of students majoring in pharmaceutical analysis has always been a problem. Additionally, in both theoretical and experimental teaching, due to class hour limitation, some experimental knowledge and principals involved in daily drug-testing duties are often taught or omitted by teachers during theoretical and experimental teaching processes, resulting in issues, such as the lack of real comprehension of basic drug-testing duties, slow on hand in practical work, and limited knowledge on the course of an issue[3-5]. How to make the undergraduates of drug analysis master the basic operational skills of pharmaceutical analysis and understand the concept of comprehensive drug quality control while learning the theory of pharmaceutical analysis during drug analyses experiments is an urgent problem to be solved[6]. Since 2015, based on the national pharmaceutical experimental teaching demonstration center, we have set the goal to groom intellectuals in pharmaceutical innovation, reform, and practice in experimental courses of pharmaceutical analysis in the construction of experimental teaching fundamentals, teaching contents, teaching modes, and teaching resource integration. It is clear that "ability first, emphasis on application, personality development" is the primary guide, and the talent cultural concept of "great moral character, strong foundation, emphasis on practice" followed by adjusting the structure of knowledge, ability, and quality of the starting point, to build an open design experimental teaching approach based on task-oriented and micro-project mode, construct "base-practice-innovation" stratified experimental teaching system, and diversified formative evaluation system. This teaching model has been applied in the experimental teaching of pharmaceutical analysis for undergraduates majoring in pharmaceutical analysis in our university. The course has comprehensively improved the students' innovative and practical abilities. Good results have been achieved as a result of the application of this teaching model and for this reason it can be used as a reference for grooming pharmaceutical talents.

2 Experimental teaching based on task-oriented and micro-project mode

Considering the enormous amount and longtime of analysis items, cumbersome instruments in pharmaceutical analysis and testing, the task-oriented design experiment was created[7-8]. Meanwhile, we opened the laboratory and micro-project the experimental content. Based on preliminary confirmative experimental learning, students completed the whole process of pharmaceutical testing using independent learning, self-management, and division of labor and cooperation, to culture the hands-on ability required by production practice. Through a problem-oriented theoretical exploration, experimental scheme design, group discussion, experimental operation, summary, report, sharing of results, exchange and evaluation, students are guided to put forward, discover, solve, and summarize problems in practice, to groom their innovative thinking abilities. In this teaching model, the teacher does not only teach but also serve as a helper. The preliminary design of the experiment provided students with theoretical guidance including how to write a plan for an experiment, correct and prepare reagents, etc. However, in the middle part of the experiment, students' problems should be discovered in time so as to guide them solve problems in the process of transforming theory into practice. At the late stage of the experiment, the teachers discussed the results and summarized the experiment with the students. In this way, students can become the leaders of the experiment using their subjective initiative.

Taking the "analysis of hawthorn" in the pharmaceutical analysis experiment as an example, the experiment content was developed as a micro-project, and the total tasks were divided into six parts according to the contents of the *Chinese Pharmacopoeia* (2020 edition), including identification, investigation and content determination (Table 1).

Task-oriented teaching mode is divided into three levels: basic level, practice level, and innovation level. According to the knowledge learned in the theorical course, students put forward questions about the experiment, wrote and designed the experiment plan through independent learning,

Table 1 Hawthorn analysis of micro-project experiment content

Category	Tasks	Contents
Identification	Sub-task 1	Character and microscopic identification
	Sub-task 2	TLC identification
Investigation	Sub-task 3	Moisture determination
	Sub-task 4	Total ash content determination
Content determination	Sub-task 5	Extract content determination
	Sub-task 6	Total organic acid content determination

conducted the experiment, had a group discussion, and finally reported the results. Taking sub-task 2 TLC identification as an example, the specific implementation process is as follows (Fig. 1).

2.1 Basic level teaching

At this level, the main questions are raised. For example, the adsorbents commonly used in thin layer chromatography are silica gel, aluminum, etc. What are the selection principles of adsorbents in the analysis of traditional Chinese medicine? What is the contrast selection principle of TLC method? The students found the answers through independent learning and designed the experimental scheme simultaneously to include the specifications and models of experimental instruments, reagents, including drug preparation, and experimental time arrangement. The basic level was used to make early preparations for the development of the experiment and to groom the ability of students to plan and arrange work.

2.2 Practice level teaching

At this level, the students must master the pharmaceutical quality standard system, the basic theory, knowledge and experimental skills of pharmaceutical chromatography and chemical

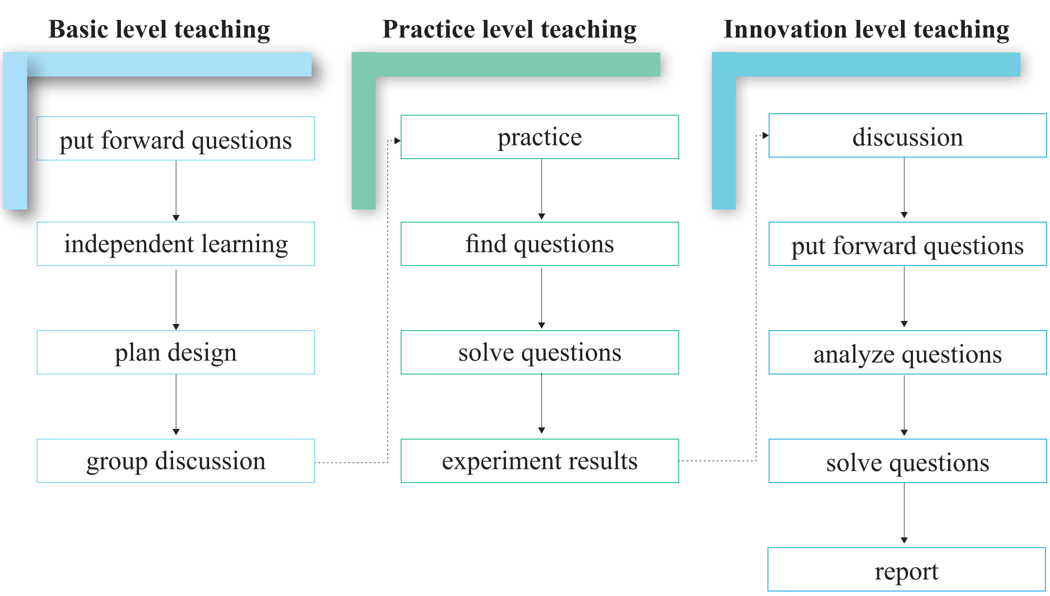

Fig.1 Task-oriented teaching mode

analysis to find and solve problems in the practice process, summarize the mistakes or noteworthy points in the experiment after the practice. For example, what is the difference between solvent vapor pre-balance and pre-saturation in thin layer chromatography as stipulated in the *Chinese Pharmacopoeia*? How to record the original record of TLC specification? Through practice level, students could complete the whole experimental process independently and be groomed in the practical ability of pharmaceutical analysis and testing.

2.3 Innovation level teaching

At this level, after completing the whole experimental process, students were asked to consider what methodological investigation data should be provided when establishing pharmaceutical quality standards? Identification methods require specificity and sensitivity, how can it be verified? If the reference substance used for content determination uses a non-legal reference substance, how can it be verified? At the innovation level, focus is placed on culturing the students' creative thinking abilities, carrying out innovative experiments and preliminary scientific research ability.

These three levels are progressing gradually, by completing all six sub-tasks of the micro-project, students could learn the whole process of analysis of traditional Chinese medicine. Meanwhile, each test item formed an independent sub-task, which could be performed independently or done as a team. Students could refine the operation process and share experimental data according to their understanding of the experiment. More importantly, after the training of the experimental mode, whether in the graduation thesis design period or into the relevant post-work, students can quickly adapt to the laboratory work requirements and the environment, attracting high praise from teachers and employers.

3 Diversified formative evaluation

The formative evaluation should reflect the evaluation of the students' abilities, and its specific quantitative assessment methods and detailed rules should be able to promote and stimulate the students' learning enthusiasm, guide their independent learning, and make the learning process of experimental class to become the grooming and training process of the students' experimental ability. The evaluation results could reflect the teaching effects and the contents that are still needed to improve the teaching process, to achieve improvement in teaching quality[10]. In the total experimental score of 100 points, the basic level accounts for 30%, the practice level accounts for 50%, and the innovation level accounts for 20%. Under the overall condition of the three levels jointly constituted in the experiment, a diversified way of jointly scoring by teachers and students was formed.

3.1 Student mutual evaluation

The basic level is the preliminary preparation of the experiment, including combining of the knowledge learned in the theoretical class, literature review, and the design of the experimental scheme. This part takes the form of mutual evaluation of students, namely, the students assessed each other’s scores according to the content of the experiment preparation (20 points) and the feasibility of the experimental scheme (10 points).

3.2 Teacher evaluation

The practice level is the main part of the experiment, including the preparation of experimental drugs, reagents and instruments, the specific steps of the experiment, the detailed record of the experimental operation process, and the experimental report’s formation. Practice level takes the form of teacher evaluation. The teacher grades students according to the preparation of the experiment (10 points), the details of the experiment operation (20 points), the standardization of the report record (10 points), and the completeness of the experiment reported (10 points).

3.3 Student self-evaluation

The innovation level is an extension of the experiment to further deepen the understanding of drug pharmaceutical quality further. This part was in the form of students' self-evaluation. Students scored themselves according to their extracurricular learning (20 points), including literature reading and whether they had solved the newly proposed difficult problems.

The diversified formative evaluation of pharmaceutical analysis based on task-oriented and micro-project experimental teaching was formulated from three aspects, namely, the basic level, the practice level, and the innovation level, each layer corresponds to an evaluation method: the basic level is the foundation of the experiment, and it is the knowledge point that every student needs to master skillfully. Therefore, the mutual evaluation of students is from the perspective of students themselves, which can objectively reflect students' understanding of the basic knowledge; the practice level is built on the completion degree of the whole process of the inspection experiment, students can't evaluate their shortcomings, so they need the teacher's knowledge and experience to aid them; the innovation level is based on grooming the innovative thinking of students. To a large extent, this course covers the parts beyond experimental operation, including the development status of new methods at home and abroad and the development trend of new technologies. Different students have significant differences in learning motivation and learning ability, so students evaluate through their gains. This kind of diversified formative evaluation system, which breaks the traditional single teacher evaluation, achieves teachers' and students' participation, combines the innermost and outmost part of the experiment, and has more reference values.

4 Conclusion

Pharmaceutical analysis experiments based on task-oriented and micro-project mode are more independent and flexible in time and space,. Students can maximize the subjective initiative develop global consciousness. This kind of exercise could greatly improve the overall arrangement in the future. In this experiment, concepts including the task-oriented method, the problem-guided method, and the group discussion method were introduced into the experimental teaching of pharmaceutical analysis and detection methods, breaking the original setting of experimental teaching contents based on drug structure as a unit and building a task-oriented experimental teaching mode. The experimental teaching content is designed according to the main requirements corresponding to the basic working procedures of pharmaceutical testing. The teaching is organized with typical pharmaceutical substances using carrier and conventional detection technology as the focus, combined with the current new technology and new method of drug testing, giving full play to the leading role of students, and providing certain guarantees for pharmaceutical enterprises to groom talents. This experiment mode will also be used in other experiments of pharmaceutical analysis in the later stage, including "Determination of related substances and contents of Cefalexin Capsules by HPLC," "Quality control of vitamin C and its preparations," etc. Meanwhile, the construction of experimental teaching mode plays an important role in the promotion of increasing investment in teaching funds, strengthening the construction of teaching laboratory and teaching team construction, and reforming teaching management. Nearly three years students' employment and employers' surveys have been collected. According to the data, students' satisfaction was higher by employers, especially in the moral character and personal qualities and skills. Therefore, it is worth popularizing the experimental teaching of other majors.

Presently, with the rapid development of science, technology, and the medicine industry, new technologies and new knowledge have emerged in an endless stream. More and more scholars have proposed the concept, reformed ideas, and design of integrated pharmacy. In such an era, teachers need to change their teaching concepts, take grooming, innovative, integrated, and applied talents as the goal, and pay attention to grooming students' innovative abilities rather than just inculcating knowledge. Teachers are also required to adjust their teaching methods and contents to keep pace with the times, actively make use of modern teaching technology and network resources to build up virtual simulation laboratories[11] and adopt the PBL + LBL teaching mode[12-13] for improving students' learning enthusiasm, culturing students' innovative thinking ability, hands-on ability, and the capacity to comprehensively use knowledge to solve problems. In the process of practical development for the experimental teaching system based on task-oriented and micro-project mode, we should also actively find problems, summarize experience, timely reform teaching methods and teaching contents, strive for the best practical teaching effect, and culture more high-quality integrated pharmaceutical prodigies for China's pharmaceutical industry.

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