

Exploration on Pharmacology Teaching Model and Practice Strategy Oriented Towards "Specialized Innovation Integration"

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ABSTRACT

Background: As an important discipline in medicine and pharmacy, pharmacology teaching needs constant improvement to adapt to social demands and technological developments. This study proposes suggestions based on "specialized innovation integration" to stimulate student interest and innovative thinking. **Materials and Methods:** This study utilized a control group (111 students, traditional teaching) and an observation group (110 students, specialized innovation integration model). Implementation included industry requirement integration, case teaching, mentorship, and diversified evaluation. Results were evaluated via a self-designed 4-Point Likert scale questionnaire across three dimensions: knowledge mastery, ability training, and value building. **Results:** The specialized innovation integration model received significantly higher evaluation scores and satisfaction rates compared to traditional methods ($p < 0.01$). It effectively improved learning initiative, knowledge acquisition, critical thinking, innovation, problem-solving, and teamwork. **Conclusion:** The teaching model based on specialized innovation integration contributes to cultivating self-learning and research thinking, greatly enhancing the quality and effectiveness of pharmacology education.

Keywords: Pharmacology, Practice strategy, Specialized innovation integration, Teaching model.

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INTRODUCTION

Pharmacology is a bridging discipline between basic medicine, clinical medicine, medicine and pharmacy, involving multiple aspects such as the action mechanism, pharmacodynamics, pharmacokinetics, drug interactions, and clinical applications of drugs (Engels, 2018). Under the theoretical guidance of pharmacological science, clinical practice is carried out to enrich pharmacological theory based on experimental research. Pharmacology teaching is currently facing significant challenges (Winquist, 2014). Firstly, updating teaching content lags the teaching needs. Pharmacology is a rapidly developing discipline, with new drugs constantly emerging and drug development techniques and treatment methods constantly being updated. However, the current pharmacology textbooks usually lag the development of the discipline and fail to reflect the latest scientific research achievements and clinical practices in a timely manner. Secondly, traditional and single teaching methods

on pharmacology lack diversity and flexibility. Traditional pharmacology teaching often adopts the approach of teacher lecturing and student listening, lacking interactivity and participation. This teaching method can easily lead to students passively receiving knowledge, lacking interest and initiative in learning. Additionally, there is a lack of practical teaching in pharmacology. Pharmacology is a highly practical discipline, but current teaching often focuses on imparting theoretical knowledge while neglecting the cultivation of practical abilities. Students lack practical operation and experimental experience, making it difficult to apply theoretical knowledge to solve practical problems. Thus, with the rapid development of pharmaceutical technology, the teaching content and model of pharmacology also need to be constantly updated and improved to adapt to new disciplinary developments and social demands (Vallance, 2006).

In response to above challenges faced, numerous pharmacology educators are constantly exploring various methods to improve teaching effectiveness. Firstly, update the teaching content. Teachers should pay timely attention to the latest developments in the field of pharmacology and incorporate the latest scientific research achievements and clinical practices into their teaching content (Fasinu, 2024). At the same time, textbook compilation should keep up with the pace of disciplinary development, regularly update and revise, and ensure the timeliness and accuracy



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of teaching content. Secondly, diverse teaching methods could be adopted to stimulate students' interest and initiative in learning, such as heuristic, exploratory, and discussion-based approaches. For example, students can actively participate in the teaching process and improve learning outcomes through case studies, group discussions, role-playing, and other methods (Yang, 2024; Colliver, 2000; Griffin, 2024). In addition, strengthening practical teaching and clinical internships could enhance the cultivation of practical abilities. Students can personally experience the process of drug preparation, testing, and clinical application by conducting experimental operations and simulating clinical scenarios, enhancing their practical and hands-on abilities (Brinkman, 2018). We should also pay attention to cultivating students' self-learning ability and scientific research spirit. Teachers should encourage students to learn independently and cultivate their abilities to search for literature, analyze data, and solve problems (Kaddoura, 2024). Also, students could be guided to participate in scientific research projects and exercise their innovative thinking and research abilities through scientific research practice.

Among these strategies, specialized innovation integration aims to integrate professional education with innovation and entrepreneurship education, which is an effective way to improve and optimize the quality of university education. It can promote the transformation of university education from high-speed to high-quality development. The specialized innovation integration broadens the practical approaches and methods for cultivating students' professional abilities, so that the professional knowledge they learn meets their actual entrepreneurial needs. Strengthening students' internalization of knowledge, enhancing their abilities in entrepreneurial practice and innovation, provide a clear direction for the reform of pharmacy education, which cultivate a group of entrepreneurial talents with innovative spirit and creative consciousness.

MATERIALS AND METHODS

Research objects

In our university, 110 students with pharmacy major of 2020 grade in our university were selected as the observation group, specialized innovation integration were introduced into the teaching of pharmacology courses. 111 students with pharmacy major of 2019 grade were selected as the control group, and traditional teaching of pharmacology would be adopted. There was no statistically significant difference in gender and age between the two groups of students (Table 1). All students have completed the course content of pharmacology.

Methods

For control group, traditional teaching methods of pharmacology are mainly used, including two parts: theory education and practice education. The theory part explains professional

knowledge content around the teaching syllabus, while the practice part involves laboratory and clinical practice teaching, teacher demonstration teaching, and student imitation learning and practical exercises.

For observation group, specialized innovation integration was introduced into professional course teaching of pharmacology, utilizing information technology teaching platforms, adopting diversified teaching models based on basic theoretical knowledge. Relying on the research platforms and College Student Innovation and Entrepreneurship Training Program Project, students were given more opportunities to train their scientific research awareness and abilities. The specific implementation path included the following. (1) The industry requirements and disciplinary hotspots were integrated into the training process. To consolidate students' basic knowledge, strengthen students' professional skills, and lead students to understand the forefront, it needs to analyze the technical skills requirements, professional job abilities, and disciplinary development directions of pharmacology related field, and then introduce hot and difficult issues in pharmacology research. (2) Case teaching, problem driven, and practical training were integrated into course teaching. To training students in critical thinking, it needs to establish a pharmacology research case base to enhance students' learning outcomes through problem driven and practice-oriented approaches. (3) Mentor guidance, project application, and innovative consciousness were integrated into the entire teaching process. These measures could include implementing the undergraduate mentorship system, recruiting students into research teams, Cultivating-Appling-Constructing innovative training programs for college students to cultivate students' innovation awareness and enhance their research abilities. (4) Teacher evaluation, student self-evaluation, and student peer evaluation were integrated into curriculum assessment. It should increase process assessment to change the previous single teacher evaluation, and increase student evaluation to promote students' autonomous learning ability and critical thinking formation through self-evaluation and peer evaluation. The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Yanbian University. Informed consent was obtained from all participants.

Result evaluation

After the end of the course of pharmacology, two groups of students were investigated with a self-designed questionnaire on the cultivation effect of specialized innovation integration from three dimensions: knowledge mastery, ability training and value building. It includes learning initiative, knowledge acquisition ability, knowledge internalization ability, critical thinking ability, innovation ability, problem solving ability, team cooperation ability, and expression ability. Students were asked to make a self-evaluation according to the cultivation effect, using 4-Point Likert scale. In addition, taking the Likert score of the

questionnaire ≥ 3 as satisfaction, the students' satisfaction with the two teaching modes was counted.

Statistical Analysis

All data were expressed as Mean $\pm$ SD. The statistical analyses between groups were evaluated by *t*-test and χ^2 test, and performed by using GraphPad Prism 8.0 (GraphPad Software, San Diego, CA, United States). $p < 0.05$ was taken to show statistical significance.

RESULTS

A total of 221 questionnaires were collected, with a recovery rate of 100.0%, including 111 in the observation group and 110 in the control group. The results showed that the overall evaluation of the specialized innovation integration model in the observation group was significantly higher than that in the control group ($p < 0.01$). Compared with the control group, the observation group could effectively stimulate learning initiative, knowledge acquisition ability, knowledge internalization ability, critical thinking ability, innovation ability, problem-solving ability, team cooperation ability and expression ability ($p < 0.01$) (Table 2, Figure 1). The satisfaction of the observation group was significantly higher than that of the control group ($p < 0.05$, $p < 0.01$) (Table 3 and Figure 2).

DISCUSSION

Pharmacology is the core course of medicine and pharmacy. The reform of teaching mode of professional education and innovative education in pharmacology course focuses on the development of students' innovative ability, gives full play to the dominant position of students, and improves the quality of talent training (Herzig, 2002). Based on the reform and research of pharmacology

teaching, the goal of this study is to set up teaching content based on the "specialized innovation integration", combine professional education with innovation and entrepreneurship education, and learn from the successful experience of colleges and universities on the cultivation of college students' innovative ability, through systematic design and research, build an innovative practice teaching system, build an innovative practice platform, carry out innovative practice activities, and form a step-by-step, organic connection, and systematic and complete cultivation mode of innovative practice ability.

The questionnaire survey results showed that the overall evaluation score of the observation group was (3.52 $\pm$ 0.90), which was higher than that of the control group (3.11 $\pm$ 0.72) ($p < 0.01$); The satisfaction survey results showed that 88.3% of the students in the observation group were satisfied with the teaching reform mode of specialized innovation integration, compared with 73.6% of the students in the control group, suggesting that students' satisfaction with the teaching mode of specialized innovation integration is higher than that of the traditional teaching mode, which helps students improve their innovation ability. The results showed that 86.5%, 89.2% and 84.7% of the students in the observation group believed that the teaching mode of specialized innovation integration was helpful to improve students' critical thinking, innovative ability and problem solving ability, while only 68.2%, 73.6% and 70.0% of the students in the traditional teaching mode were satisfied, suggesting that the addition of innovative education reform in professional courses was helpful to improve students' innovative ability, critical thinking ability and application ability. In terms of autonomous learning initiative, knowledge acquisition ability, and knowledge internalization ability, 85.6%, 82.9% and 88.3% of the students in the observation group were satisfied, which were

Table 1: Comparison of Basic Information between Two Groups of Students.

Groups	n	Age	Men	Woman
control	111	21.3 $\pm$ 0.8	55	56
observation	110	20.5 $\pm$ 0.7	52	58

Table 2: Evaluation of different teaching models in two groups ($\bar{x} \pm s$).

Groups	Control group	Observation group	t	p
n	110	111	-	-
Overall evaluation	3.11 $\pm$ 0.72	3.52 $\pm$ 0.90	3.737	<0.01
Learning initiative	3.23 $\pm$ 0.81	3.49 $\pm$ 0.55	2.794	<0.01
Knowledge acquisition ability	3.09 $\pm$ 0.73	3.43 $\pm$ 0.62	3.733	<0.01
Knowledge internalization ability	3.06 $\pm$ 0.49	3.39 $\pm$ 0.63	4.344	<0.01
Critical thinking ability	3.02 $\pm$ 0.86	3.45 $\pm$ 0.68	4.125	<0.01
Innovation ability	3.07 $\pm$ 0.79	3.55 $\pm$ 0.57	5.183	<0.01
Problem solving ability	3.12 $\pm$ 0.61	3.48 $\pm$ 0.85	3.614	<0.01
Team cooperation ability	3.05 $\pm$ 0.83	3.42 $\pm$ 0.76	3.457	<0.01
Expression ability	3.05 $\pm$ 0.37	3.48 $\pm$ 0.56	6.728	<0.01

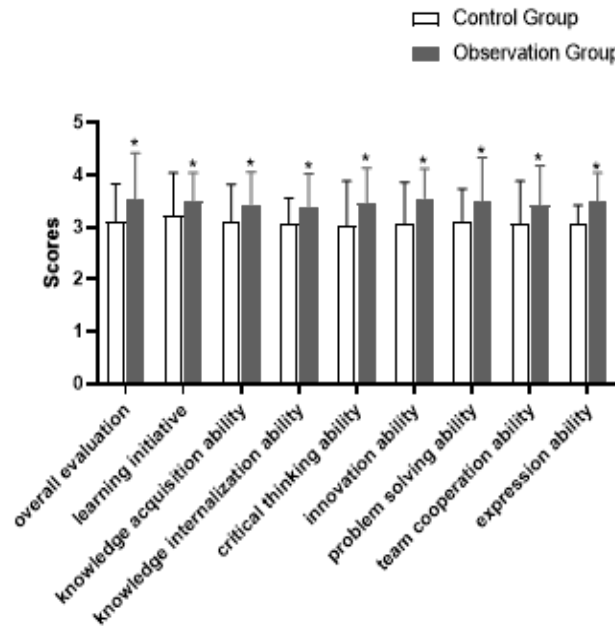


Figure 1: Evaluation of different teaching models in two groups.

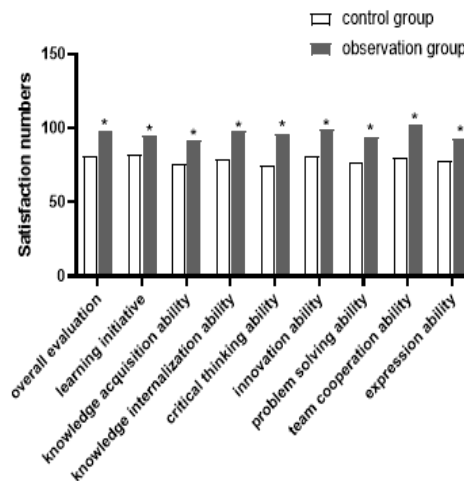


Figure 2: Satisfaction of different teaching models in two groups.

Table 3: Satisfaction with different teaching models in two groups (n%).

Groups	Control group	Observation group	χ^2	<i>p</i>
n	110	111	-	-
Overall evaluation	81(73.6)	98(88.3)	7.705	<0.01
Learning initiative	82(74.5)	95(85.6)	7.223	<0.05
Knowledge acquisition ability	76(69.1)	92(82.9)	5.765	<0.05
Knowledge internalization ability	79(71.8)	98(88.3)	9.399	<0.01
Critical thinking ability	75(68.2)	96(86.5)	10.57	<0.01
Innovation ability	81(73.6)	99(89.2)	8.844	<0.01
Problem solving ability	77(70.0)	94(84.7)	6.806	<0.01
Team cooperation ability	80(72.7)	102(91.9)	13.96	<0.01
Expression ability	78(70.9)	93(83.8)	5.231	<0.05

significantly higher than 74.5%, 69.1% and 71.8% in the control group ($p < 0.05$, $p < 0.01$), suggesting that students' integration of innovative education into the teaching of professional courses is helpful for students' mastery and application of professional knowledge. Team cooperation ability and expression ability are crucial to students' sustainable development. 102 of 111 students in the observation group believed that specialized innovation integration can effectively improve the cultivation of team cooperation ability, and 93 students' expression ability has been well improved in innovative education.

Pharmacology teaching is a complex and important task, which requires teachers to constantly update teaching content, adopt diversified teaching methods, strengthen practical teaching, and pay attention to cultivating students' self-learning ability and scientific research spirit (Zagaar, 2024). The implementation of these improvement strategies can effectively improve the quality of pharmacology teaching, stimulate students' learning interest and initiative, and cultivate their innovative thinking and practical ability. It is hoped that this study can provide a useful reference for the teaching and research of pharmacology.

CONCLUSION

This study is based on the reform of pharmacology teaching and the forefront of disciplinary development, taking the "specialized innovation integration" as the logical starting point, systematically reconstructing the curriculum teaching content system, and promoting the deep coupling of professional education and innovation and entrepreneurship education at the goals, content, and process. Based on the typical experience of cultivating innovative talents in domestic and foreign universities, relying on systematic research and top-level design, the study constructs an innovative practical teaching system and practical support platform. By designing a progressive teaching path and dynamic feedback mechanism, a spiral promotion, organic connection, and overall integration of innovative practice ability cultivation ecology is formed, ultimately achieving collaborative promotion of knowledge imparting, ability cultivation, and value shaping. The teaching model based on specialized innovation integration contributes to cultivating self-learning and research thinking, greatly enhancing the quality and effectiveness of pharmacology education.

ABBREVIATIONS

n: Number of participants; **SD**: Standard Deviation; **t**: Student's *t*-test statistic; **P**: Probability value; χ^2 : Chi-square test statistic.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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AUTHORS CONTRIBUTION

Yan-Ling Wu: Funding acquisition, Supervision, Resources, Investigation, Methodology, Writing-original draft, Writing-review and editing. **Zhen-Yu Cui**: Funding acquisition, Supervision, Writing-review and editing. All authors have read and agreed to the published version of the manuscript.

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