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A Preliminary Study on the Teaching Path of Pharmacy under the Concept of OBE Integrated into STEM Education for Pharmacy Interns

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Abstract: *The concept of outcome-based education (OBE) combined with STEM education methods can promote the transformation of pharmaceutical education from traditional knowledge transfer to ability training and knowledge application, and can guide teachers to establish a student-centered and ability-oriented education concept. In this study, 22 interns from the Department of Pharmacy of Zhuji People's Hospital from January 2022 to December 2023 were selected as the research subjects. They were divided into a control group and an observation group using a random number table method, with 11 people in each group. The control group adopted a simple pharmacy teaching model; the observation group consisted of 1 pharmacy teaching teacher and 1 clinical teaching teacher, and the pharmacy teaching path teaching method was introduced. The basic theoretical knowledge and practical skills assessment scores, teaching model scores and satisfaction of the two groups of interns were compared. The results showed that the scores of the interns in the observation group were (84.09±6.47) points for basic theoretical knowledge assessment and (89.91±1.47) points for practical skills assessment, which were higher than those in the control group [(77.27±7.56) points and (72.09±3.66) points, respectively], with statistically significant differences (P<0.05); the scores of the interns in the observation group in terms of learning interest, pharmacy professional quality, clinical thinking, pharmacy service ability, and teamwork awareness were higher than those in the control group, with statistically significant differences (P<0.05); the proportion of interns in the observation group who were very satisfied with the teaching methods was significantly higher than that in the control group, with statistically significant differences (P<0.05). Therefore, we can see that the pharmacy teaching path model based on OBE integrated with STEM education concepts is helpful to improve the assessment scores and pharmacy practice ability of interns, thereby improving the recognition and satisfaction of interns with teaching methods, and the teaching effect is significant.*

Keywords: *Outcome-Oriented Education; Pharmacy Teaching Path; Internship Teaching; Teaching Model; Education and Teaching Reform; Pharmaceutical Service*

1. Introduction

In the multidisciplinary diagnosis and treatment model of medicine and nursing, physicians are decision makers, pharmacists are participants, and nurses are executors. Close cooperation among the three can break down professional barriers and achieve a diagnosis and treatment effect of "1+1+1>3" [1]. However, pharmacists are in a clear disadvantage in the team. Most medical schools have not yet established clinical pharmacy majors. A large number of pharmacists who graduate with the "chemical pharmacy" training model have accumulated practical experience in pharmaceutical services through standardized clinical pharmacist training and gradually entered the role of hospital pharmacy work, resulting in a large waste of human and economic resources [2]. If a practical training plan that meets the actual situation of students can be formulated during the graduation internship to cultivate their good clinical thinking and professional pharmaceutical service awareness and improve their job adaptability, it will be more conducive to pharmacy graduates entering the hospital to meet the diversified needs of future jobs [3,4]. In response to this situation, this teaching and research section took pharmacy interns as the research object, used OBE to integrate STEM education concepts, adopted the pharmacy teaching path method [5], optimized the pharmacy internship teaching model, and provided a high-quality pharmaceutical service team required for the high-quality development of hospitals.

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2. Objects and Methods

2.1 Research subjects

A total of 22 interns working in the Pharmacy Department of Zhuji People's Hospital from January 2022 to December 2023 were selected as research subjects and divided into a control group and an observation group using a random number table method, with 11 people in each group.

2.2 Ethics approval and consent to participate

All participating students were informed about the research, signed informed consent forms, and there were no dropouts during the study, complying with ethical and regulatory requirements.

2.3 Research Methods

2.3.1 Curriculum design principles based on OBE integrated STEM education concept

Under the guidance of OBE teaching philosophy, this article integrates the connotation of STEM education, takes learning outcomes as the orientation, and carries out this teaching reform with clear goals, reverse thinking, step-by-step guidance, and ensuring achievement as the design principles.

2.3.2 Clarify the training objectives

Considering the future career development of pharmaceutical professionals and the transformation of pharmaceutical service models, the training objectives under the OBE integrated with STEM education concepts are to enable pharmaceutical graduates to master the operation mode of the pharmaceutical department and be familiar with the working mode of clinical pharmacists after the internship. Through the teaching method of "teaching them how to fish", interns can be guided to organically combine pharmaceutical professional knowledge and clinical practice within a relatively short internship period, so as to achieve a comprehensive improvement in comprehensive qualities such as pharmaceutical knowledge, clinical basis, and practical skills. See Figure 1 for details.

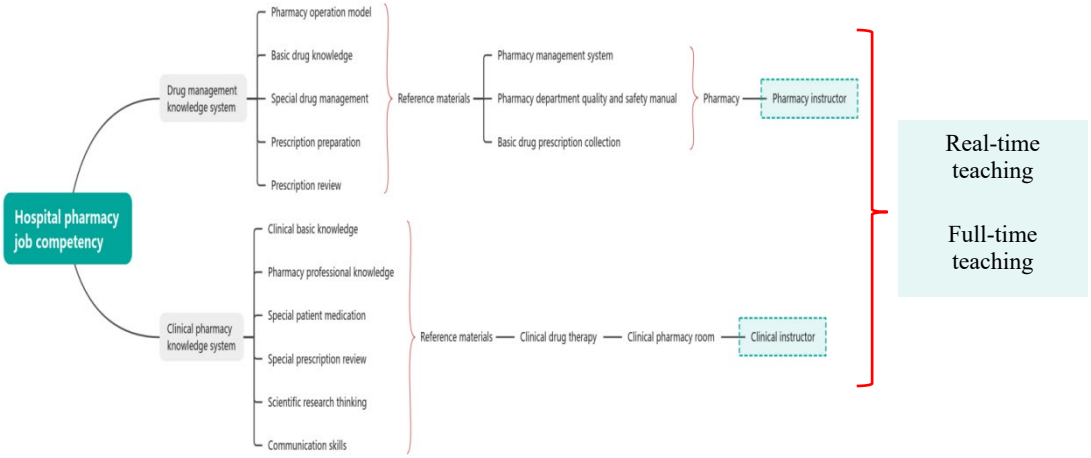

Figure 1 Training model based on OBE integrated with STEM education concept

2.3.3 Developing a pharmacy teaching pathway

Through the pharmacy teaching path method, we can improve the teaching objectives, sort out the process management, help the teaching teachers master the teaching rhythm, and guide the interns to carry out planned learning and arrangements. At the same time, it can maximize the learning interest of the interns and improve the learning quality while accumulating the basic knowledge of pharmacy in the early stage [6]. Combined with the previous experience of internship allocation of interns, this study set the internship time allocation ratio of interns in the pharmacy department and clinical pharmacy room at 2:3, which can ensure that the interns are familiar with the operation mode of the pharmacy department and master the basic drug knowledge, and ensure that the interns fully understand the working mode of clinical pharmacists, diagnosis and treatment routines, and specialty drugs. The specific time arrangements and internship goals of each department are shown in Table 1.

ISSN 2663-8169 Vol. 7, Issue 6: 1-9, DOI: 10.25236/IJNDE.2025.070601

Table 1 Distribution table of pharmacy teaching paths

stage	department	Internship Department	Time proportion of each stage	Internship Objectives
Phase 1	Department of Pharmacy (40% of the total duration)	pharmacy Drugstore Venous Configuration Center Hazardous Chemicals Pharmacy	60% 20% 10% 10%	Learn the working mode of pharmacy and master the basic knowledge of drugs Learn the working mode of the drug warehouse and master the basic classification of drugs Learn the working mode of the intravenous preparation center and master the basic knowledge of drug compatibility Learn the working mode of hazardous chemicals pharmacy and understand the types and management requirements of hazardous chemicals
Phase 2	Clinical Specialties (50% of the total time)	Respiratory Medicine Cardiovascular Medicine Medical Oncology Intensive Care Unit Gastroenterology	25% 25% 25% 25% 25%	Select 2-4 clinical departments for internship, familiarize yourself with the working mode, diagnosis and treatment routine, and specialty medication of clinical pharmacists, and complete internship assignments
Phase 3	Clinical Pharmacy Department (10% of total time)	Clinical Pharmacy Department	100%	Interspersed with Phase 2, students will go to the clinical pharmacy office on fixed days each week to report on the learning content of the week, check the completion of the learning assignments, and have the instructor answer practical questions

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2.3.4 Develop learning and teaching assessment paths

The control group adopted the traditional teaching model, with the teaching secretary rotating and arranging shifts according to the internship time. The internship location was mainly in the pharmacy, supplemented by the clinical pharmacy room. The teaching teachers were designated by the rotation department, and the teaching content was unified as online courses.

The observation group worked backwards from "professional competence" to determine the internship content, first clarifying the required abilities for the job, and then designing courses and practical training projects. The internship location is mainly in the clinical pharmacy room, supplemented by the pharmacy, and the time is allocated at a ratio of 2:3. The pharmacy teaching teacher pool is composed of pharmacists with more than 3 years of experience as chief pharmacists, and the clinical teaching teacher pool is composed of clinical pharmacists with clinical pharmacist certificates. The specific teaching teachers are uniformly designated by the Pharmacy Department. Unified teaching reference materials, such as the work system, basic drug prescription set, quality and safety manual, etc., formulated by the Pharmacy Department based on the actual situation of the hospital.

Table 2 Assessment path for the drug management knowledge system of pharmacy interns

Serial number	Task Items	Specific requirements
1	Familiar with the various work systems of the Pharmacy Department	Proficient in what you should know and do (online test ≥ 90 points)
2	Narcotic drug management	50 reviews of narcotic drug prescriptions
3	Prescription Management Measures	Completed 50 prescriptions (error rate <1%)
4	Sterile preparations	Complete 10 infusion preparations in accordance with regulations
5	Drug classification learning	Master the classification standards of the Chinese Pharmacopoeia (online test ≥ 90 points)
6	Pharmacological mechanism	Understand the drug's target (online test ≥ 90 points)
7	Prescription review points	Completed 20 virtual prescription reviews
8	Drug interactions	Memorize 50 groups of common compatibility taboos
9	Medication consultation	Simulated patient Q&A (100% accuracy)
10	Medication Error Management	Register 5 days of medication dispensing errors

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Table 3 Assessment path for clinical pharmacy knowledge system for pharmacy interns

Serial number	Teaching content	Mastery
1	Special review of antimicrobial drugs (2 copies)	X share
2	Preparation of parenteral nutrition solution plan (at least 5 copies)	X share
3	Special review on glucocorticoids (2 copies)	X share
4	Adverse drug reaction reports (5 cases)	X Example
5	Special review of Chinese medicine injection (2 copies)	X share
6	Special reviews of key monitored drugs (2 types)	X kind
7	Anesthesia prescriptions (at least 100)	X open
8	Special review on perioperative antimicrobial drugs (2 times)	X Second-rate
9	Medical records (at least 2 copies)	X share
10	Medication guidance for typical cases (at least 1 case)	X Example

During the teaching process, we clearly focus on common diseases and chronic diseases, and use clinical pharmacotherapy as the core teaching material to guide students to carry out rational clinical drug use. In the first phase, interns complete all online training courses. The course content mainly includes five major systems: antimicrobial drugs, respiratory system, digestive system, cardiovascular system, and tumors, laying a solid theoretical foundation for participating in prescription reviews, drug consultation, and other work. In the second phase, the teaching team formulates the learning outline of each specialty in advance, understands different clinical diagnosis and treatment knowledge, and allows interns to study clinical specialty knowledge in a systematic manner[7]. At the same time, the interns are trained to understand the consensus of various experts, treatment guidelines, and the latest progress in disease research, formulate the assessment standards for pharmacy interns (Table 2 and Table 3), laying a solid foundation for further improving their work ability[5].

2.4 Observation indicators

2.4.1 Evaluation of the final examination

The final assessment includes basic theoretical knowledge assessment and practical skills assessment. The basic theoretical knowledge assessment is all objective questions, with a full score of 100. Practical skills assessment: including system and process awareness rate (including drug management system, operating specifications and operating procedures) (0-30 points), medical order review ability (0-40 points), and comprehensive pharmaceutical service ability (0-30 points), with a full score of 100.

2.4.2 Questionnaire

The interns' evaluation of the teaching methods was collected. The evaluation items included scores on learning interest, pharmaceutical professional quality, clinical thinking, pharmaceutical service ability, teamwork awareness, etc., with each indicator being 10 points. The teaching teachers scored the interns in turn, taking the average score for each item, and comparing the different scores before and after the training based on the 5-item radar chart.

2.4.3 Satisfaction Survey

The interns rated the teaching model with a full score of 100, with a score of 85 or more indicating very satisfied, 71-84 indicating satisfied, 61-70 indicating average, and 60 or less indicating dissatisfied.

ISSN 2663-8169 Vol. 7, Issue 6: 1-9, DOI: 10.25236/IJNDE.2025.070601

2.4.4 Statistical analysis

The measurement data were expressed as (x±s) and the t test was used. The count data were expressed as n (%). The chi- square test was used for comparison among the groups. $P < 0.05$ was considered statistically significant.

3. Research results

Table 4 Teaching effect of pharmacy interns

	Control group	Observation Group	t-value	P-value
Total number of people (N)	11	11		
Male (F)	2 (18.18%)	1 (9%)		
Age (years)	22.18±0.75	21.73±1.00	1.20	>0.05
Entrance Examination (points)	70.73±7.47	68.73±5.90	0.70	>0.05
Exit examination (points)				
Basic theory test results	77.27±7.56	84.09±6.47	2.27	<0.05
Practical skills assessment results	72.09±3.66	89.91±1.47	4.51	<0.001
Teaching method evaluation				
Study interests	5.45±1.51	7.73±1.35	3.73	<0.05
Pharmacy professional quality	4.45±1.29	7.45±1.13	5.80	<0.001
Clinical Thinking	4.64±1.03	7.09±0.70	6.55	<0.001
Pharmaceutical service capabilities	4.827±0.98	7.55±0.52	8.14	<0.001
Teamwork awareness	5.00±1.34	8.09±0.70	6.77	<0.001

The 22 interns in the pharmacy department were divided into a control group and an observation group by random number table method, with 11 in each group. There was no statistically significant difference in gender, age and entrance examination scores between the two groups ($P>0.05$), which was comparable; in the exit examination scores, the basic theoretical knowledge assessment and practical skills assessment scores of the observation group were higher than those of the control group ($P<0.05$). In the evaluation of teaching methods, the scores of the interns in the observation group in learning interest, pharmaceutical professional quality, clinical thinking, pharmaceutical service ability, and teamwork awareness were higher than those of the control group, and the differences were statistically significant ($P<0.05$), as shown in Table 4. At the same time, it can be seen from the radar chart that after the training, the average scores of the five dimensions increased significantly compared with those before the training, as shown in Figure 2.

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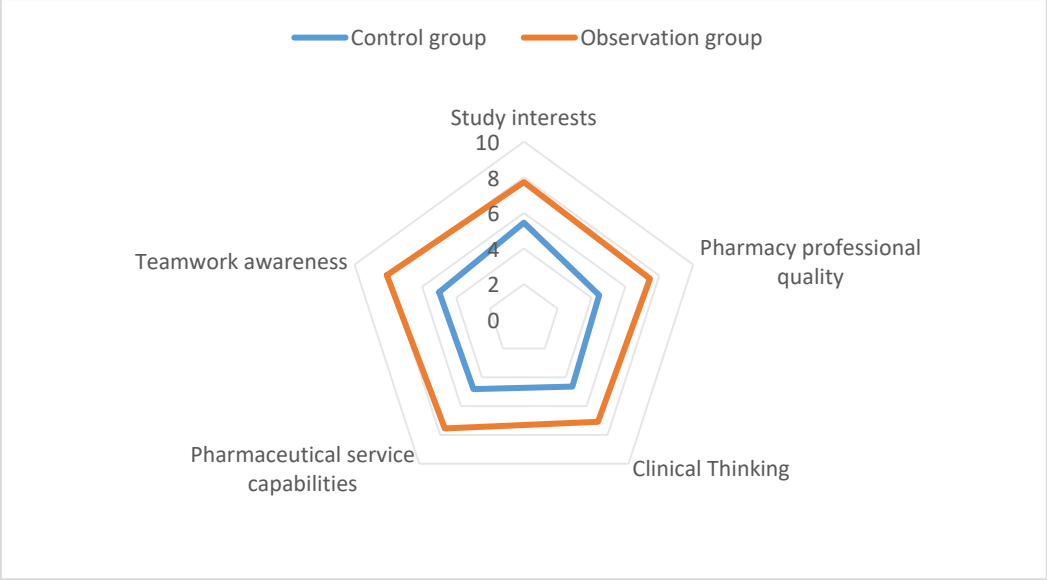

Figure 2 Radar chart of self-evaluation of learning outcomes of the two groups of interns before and after training

A total of 22 questionnaires were distributed and all were collected, with a recovery rate of 100%. The proportion of the observation group who were very satisfied with the teaching method was significantly higher than that of the control group, and the difference was statistically significant ($P < 0.05$), as shown in Table 5.

Table 5 Comparison of satisfaction [n (%)]

Group	Very satisfied	satisfy	generally	Dissatisfied
Control group (n=11)	1 (9.09)	3 (27.27)	5 (45.45)	2 (18.18)
Observation group (n=11)	4 (36.36)	7 (63.64)	0	0
$\chi 2$ value	10.40			
P-value	<0.05			

4. Discussion

In 1981, Spady et al. proposed a clear definition of the OBE education concept: clearly focusing and organizing the education system to ensure that students gain "successful experience" in their future life. Outcome-based education (OBE) is student-centered, learning outcome-oriented, and focused on continuous improvement. It is conducive to improving the quality of talent training and comprehensive quality. It is a more practical teaching concept that is closer to student needs [8-11]. The OBE education concept requires the use of reverse thinking to set up the curriculum system. First, we need to determine what students need and what effect they want to achieve after learning (determine the teaching objectives),then determine the teaching process (select the teaching method), and finally evaluate the teaching. The STEM education concept is a new teaching model that combines teaching with autonomous learning. Its core is practicality, and it has an interdisciplinary, cross-cutting, and exploratory collaborative education method. The integration of the outcome-oriented OBE education method with the STEM teaching concept aims to explore teaching methods that improve theoretical level and master practical skills. In addition, through the pharmaceutical teaching path, the teaching content is broken down into quantifiable task modules to ensure that different teaching teachers implement unified standards and improve the level of teaching homogeneity.

The results of this study showed that the basic theoretical knowledge assessment scores and practical

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assessment scores of the observation group interns were higher than those of the control group, and the difference was statistically significant ($P < 0.05$) . The reason for this was that the pharmacy teaching path model made the teaching process planned, purposeful, and step-by-step. At the same time, it enabled interns to maximize their interest in learning after accumulating a certain amount of previous knowledge, thereby improving the learning effect of interns [12-13]. Under the guidance of the instructor, a systematic knowledge system was established, focusing on the cultivation and strengthening of practical ability. The thinking-practice-learning model enabled interns to have a comprehensive and systematic understanding of the basic knowledge and practical skills of pharmacy, making it easier to master and improve their pharmaceutical service level. In addition, by explaining relevant theoretical knowledge and demonstrating practical skills through homogeneous online courses , the teaching content can be presented intuitively and vividly, which is easier for interns to accept, thereby ensuring the effectiveness of practical teaching.

The results of this study showed that the scores of the interns in the observation group were higher than those in the control group in terms of stimulating learning interest and enthusiasm, building clinical thinking, improving the ability to analyze and solve practical problems, improving clinical comprehensive practice ability, and enhancing teamwork awareness. The difference was statistically significant ($P < 0.001$), indicating that the pharmacy teaching path of OBE integrated into the STEM education concept can effectively improve the interns' comprehensive pharmacy practice ability. The reason for the analysis is that this teaching model is more conducive to the interns' integration of professional knowledge into clinical practice skills during the application process, thereby cultivating the interns' ability to solve clinical problems, stimulating and cultivating their clinical dialectical thinking ability, and building a complete clinical thinking system in continuous practical application and continuous summary and accumulation, thereby improving the interns' comprehensive clinical practice ability; at the same time, due to the improvement of their own comprehensive ability, it can reversely promote the improvement of interns' learning interest, thereby achieving two-way promotion and a virtuous circle.

Compared the evaluation of the teaching model by two groups of interns through a satisfaction questionnaire , which can reflect the interns' recognition of different teaching methods and teaching results. The results showed that the proportion of interns in the observation group who were very satisfied with the teaching method was higher than that in the control group, and the difference was statistically significant ($P < 0.05$). This suggests that applying the pharmacy teaching path model under the OBE STEM education concept to pharmacy internship teaching can effectively improve the teaching satisfaction of interns and is easy to be accepted and recognized by interns.

5. Conclusions

The pharmacy teaching pathway model based on OBE integrated into the STEM education concept can effectively solve the outstanding problems of pharmacy interns' lack of learning interest and weak ability to solve practical problems. It can improve the interns' basic theoretical knowledge assessment scores and practical assessment scores, help stimulate their learning interest and enthusiasm, thereby improving their clinical thinking ability and pharmacy practice ability, and can effectively promote the improvement of the quality of pharmacy practice teaching.

Acknowledgements

OBE: Outcome-based education

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This study was approved by the Medical Ethics Committee of Zhuji People’s Hospital, 2022 Medical Ethics No. (0112).

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Not applicable.

The authors declare that they have no competing interests.

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