

Practical Research on Defect-Scenario Training Based on BOPPPS Framework in Standardized Preceptorship of Nursing Interns in Operating Room

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Abstract

Objective: To construct and verify the application effect of the teaching model integrating BOPPPS framework and defect-based scenario simulation in the preceptorship of nursing interns in the operating room, and explore its comprehensive impacts on interns' professional knowledge, operational skills, critical thinking, post competency and teaching satisfaction. It aims to provide a scientifically feasible teaching reform scheme for the standardized and homogeneous training of operating room nursing interns. **Methods:** A non-randomized chronological controlled study was conducted. A total of 120 full-time nursing interns receiving clinical rotation in the Operating Room of Southwest Hospital Affiliated to Youjiang Medical University for Nationalities from January 2024 to December 2025 were enrolled and grouped chronologically. Sixty interns recruited between January and June 2024 were assigned to the control group receiving conventional preceptorship, while another sixty interns from July 2024 to December 2025 were included in the observation group adopting BOPPPS combined with defect-based scenario simulation teaching. The equal sample size of the two groups was allocated according to the annual internship admission rule of the department. Unified inclusion and exclusion criteria, homogeneous preceptorship teams and evaluation standards were adopted to control cohort bias and time-period bias. The two groups were compared in post-rotation theoretical and practical examination scores, critical thinking ability, teaching satisfaction and post competency scores. **Results:** The observation group obtained significantly higher theoretical score (89.68 ± 4.15 vs

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83.05 $\pm$ 5.12) and practical score (92.42 $\pm$ 3.23 vs 84.59 $\pm$ 4.61) than the control group ($P < 0.001$). The total critical thinking score of the observation group was 143.21 $\pm$ 10.98, markedly superior to 122.06 $\pm$ 15.43 in the control group alongside improved scores across all subdimensions ($P < 0.001$). In addition, the observation group achieved better results in teaching satisfaction (91.35 $\pm$ 2.76) and overall post competency (92.28 $\pm$ 3.19) as well as all relevant subitems compared with controls (all $P < 0.001$). **Conclusion:** The combined teaching model based on BOPPPS framework and defect-based scenario simulation can effectively improve nursing interns' theoretical mastery, practical skills, critical thinking, post competency and teaching satisfaction, resolving prominent drawbacks of fragmented, passive and thought-deficient traditional preceptorship. This model is worthy of widespread application in standardized preceptorship for operating room nursing interns at hospitals of all levels.

Keywords

BOPPPS Teaching, Defect-Based Scenario Simulation, Operating Room, Nursing Intern, Clinical Preceptorship, Post Competency

1. Introduction

The operating room is a core high-risk department for surgical treatment and emergency critical care in hospitals, featuring extremely strict aseptic standards, refined operational procedures, unexpected emergencies and intensive team collaboration (Operating Room Nursing Committee of Chinese Nursing Association, 2022). The quality of operating room nursing is directly related to surgical safety and patient prognosis, which puts forward stringent requirements on nurses' professional knowledge, standardized operation, risk awareness, emergency disposal capacity and teamwork competence (Peng et al., 2023). For nursing interns, clinical rotation in the operating room is a crucial stage for them to transform from theoretical learning to clinical practice and form specialized clinical thinking and professional literacy. The quality of operating room preceptorship exerts a direct influence on the cultivation of nursing talents and clinical nursing safety (Zhao et al., 2020).

At present, the preceptorship of operating room nursing interns in domestic hospitals is still dominated by the traditional mode of "classroom teaching + on-site observation + random guidance", which has many deficiencies. The teaching objectives are vague and the teaching content is unsystematic; the quality of preceptorship relies heavily on tutors' personal experience, making it difficult to form unified standards (Wang et al., 2025). Teaching is mainly based on one-way knowledge instillation, leaving interns in a passive state with limited space for active thinking (Deng et al., 2022). More emphasis is placed on operational imitation while the cultivation of risk identification, defect prediction and emergency disposal abilities is neglected, resulting in weak clinical thinking among interns (Shi

& Chen, 2024). In addition, delayed teaching feedback and single evaluation methods make it hard to identify interns' deficiencies accurately and optimize teaching strategies dynamically (Su & Wang, 2024).

The BOPPPS teaching model builds a closed-loop system consisting of six links: Bridge-in, Objectives, Pre-test, Participatory learning, Post-test and Summary. It is characterized by clear objectives, complete structure, strong interactivity and timely feedback, and has been widely applied and proven effective in medical education (Wang et al., 2024). Defect-based scenario simulation is a form of simulated teaching that sets artificial operational loopholes, procedural defects and potential safety hazards based on real clinical nursing adverse events, so as to guide learners to identify, analyze and solve problems independently. Breaking the limitations of standardized conventional simulation, this teaching method focuses on strengthening learners' risk awareness and critical thinking, which fits well with the job requirements of operating room staff (Zhang et al., 2020).

There have been studies on the separate application of BOPPPS or defect-based scenario simulation in nursing education. However, researches on the in-depth integration and systematic application of the two methods in the preceptorship of operating room nursing interns are still insufficient, and the relevant teaching procedures, implementation details and effect verification remain to be improved (Huang, 2025). Supported by the Special Project of Teaching Reform of Youjiang Medical University for Nationalities, this study standardized and adapted nursing adverse events and operational defect cases collected from the operating room of our hospital over the years to establish a unified teaching scenario case bank. The integrated teaching model combining BOPPPS and defect-based scenario simulation was constructed. Through two years of practice from January 2024 to December 2025, its application effect was systematically evaluated, so as to provide references for the standardized training of operating room nursing interns.

2. Subjects and Methods

2.1. Research Subjects

A total of 120 full-time nursing interns who received clinical rotation in the Operating Room of Southwest Hospital Affiliated to Youjiang Medical University for Nationalities from January 2024 to December 2025 were selected as research subjects.

Inclusion criteria: ① Full-time nursing majors with college degree or above; ② Completion of basic and specialized pre-clinical courses; ③ First-time internship in the operating room with a 2-week rotation period stipulated by the college; ④ Aged 18 - 25 years old; ⑤ Voluntary informed consent and full participation in the whole research.

Exclusion criteria: ① With previous internship or working experience in the operating room; ② Voluntarily quitting the internship midway; ③ Suffering from communication disorders or mental disorders; ④ Incomplete assessment data.

Interns were grouped according to internship time: interns admitted from January to June 2024 were divided into the control group ($n = 60$), and those admitted from July 2024 to December 2025 were divided into the observation group ($n = 60$). The control group included 8 males and 52 females, with an average age of (21.45 ± 0.82) years old, including 41 junior college students and 19 undergraduates, totaling 59 people. The observation group consisted of 7 males and 53 females, with an average age of (21.52 ± 0.79) years old, including 39 junior college students and 21 undergraduates. There was no statistically significant difference in baseline data between the two groups ($P > 0.05$), indicating comparability.

2.2. Preceptorship Team

The preceptorship team was composed of the operating room head nurse, teaching secretary and experienced backbones. All team members have more than 5 years of working experience in the operating room, hold the professional title of nurse or above, and have no records of teaching complaints. The total number of team members was 10, including 1 chief superintendent nurse, 3 associate chief superintendent nurses, 4 nurse-in-charges and 2 registered nurses. All members received special training on BOPPPS and defect-based scenario simulation and passed the assessment, so as to ensure consistent teaching implementation (Yang et al., 2025).

2.3. Teaching Interventions

A controlled trial design was adopted. The actual preceptorship rotation period for all interns in the department was uniformly set as 4 weeks. The enrolled interns were divided into the control group and the observation group. No statistically significant differences were found in general data (gender, age, educational background, academic performance and so on) between the two groups ($P > 0.05$). Interns in both groups were taught by tutors with equivalent qualifications (more than 5 years of working experience, nurse-in-charge or above with preceptorship qualification certificates), and the rotation period was 4 weeks for both groups to guarantee consistent preceptorship baseline.

2.3.1. Control Group: Conventional Preceptorship Model

The traditional operating room preceptorship model dominated by tutors and passive learning of interns was adopted, with specific implementation procedures as follows:

① One-day orientation training: Centralized lectures were delivered to explain hospital rules and regulations, department layout, aseptic principles, occupational protection and other contents (Liu & Chen, 2023). Training manuals were distributed to help interns get familiar with the working environment and relevant requirements initially.

② Three-week follow-up internship: Interns observed surgical work alongside tutors, and participated passively in simple work such as instrument delivery and regional cleaning under guidance, without independent work assignments. Their

learning initiative depended on personal willingness.

③ Random guidance: Tutors provided fragmented guidance according to on-site situations without fixed procedures (Wang et al., 2025), mainly focusing on correcting operational details while lacking targeted training on risk cognition and professional abilities.

④ Final assessment at the end of the 4th week: The assessment included written theoretical test and basic operational skill test. Only scores were informed to interns, without systematic feedback and targeted improvement guidance, forming a one-way teaching loop.

2.3.2. Observation Group: Teaching Model Integrating BOPPPS Framework and Defect-Based Scenario Simulation

Taking the BOPPPS framework as the core and combining the concept of defect-based scenario simulation, a closed-loop preceptorship model was constructed, which highlighted risk prevention and ability cultivation in accordance with the characteristics of operating room posts. The participatory learning session was arranged from the 3rd to the 9th day after interns' admission. The specific procedures are as follows:

1) Bridge-in (B): Defective scenario introduction to enhance risk awareness

On the afternoon of the first internship day, interns watched video clips of common nursing defects in the operating room of our hospital in the past three years, including typical problems such as unstandardized hand disinfection and improper placement of sterile tables, as well as corresponding adverse consequences. After video watching, guided group discussions were carried out on the causes of defects and key points of prevention and control, so as to strengthen interns' risk awareness and stimulate their learning motivation (Luo et al., 2025).

2) Objectives (O): Three-dimensional hierarchical teaching objectives

In accordance with the *Guidelines for Operating Room Nursing Practice (2022 Edition)* (Chen & Lin, 2024), nursing internship syllabus and core job requirements of operating room nurses, three-dimensional hierarchical teaching objectives covering "knowledge, skills and abilities" were formulated to ensure that teaching content was closely combined with clinical practice and teaching targets were clear. Details are shown as below:

① Knowledge objective: To master aseptic principles, core specifications, surgical cooperation procedures, risk prevention and control measures as well as disposal processes for adverse events, and clarify the functional zoning and relevant norms of the operating room.

② Skill objective: To proficiently master core skills such as surgical hand disinfection and putting on and taking off sterile gowns, implement standard operations, and independently complete basic operational work.

③ Ability objective: To develop capabilities of defect identification, risk prediction, emergency cooperation and critical thinking, and enable interns to analyze problems and put forward improvement schemes in simulated scenarios (Zhou & Wu, 2023).

3) Pre-test (P): Baseline assessment for stratified teaching

On the second day after admission, theoretical and operational tests were conducted to evaluate interns' baseline proficiency. According to the test results, interns were divided into the basic group and the advanced group to implement differentiated teaching and provide targeted guidance (Zou et al., 2022).

4) Participatory learning (P): Exploration in defect scenarios to consolidate professional abilities

As the core session of teaching, this stage lasted for one week (the 3rd to the 9th day after admission), with two sessions per week and three class hours for each session. The hierarchical scenario simulation combined with group cooperation was adopted to encourage active participation of interns.

Basic defect simulation (4 days): Controllable defects were set for single operations. Interns participated in role-playing to identify and correct errors and discuss potential risks. Tutors gave comments and standardized demonstrations to strengthen interns' understanding of operating norms and defect identification abilities (Li et al., 2024).

Comprehensive defect simulation (3 days): The whole process of common surgical work was restored, with compound defects and sudden risks set up. Interns completed emergency disposal through group cooperation, followed by collective review. Tutors gave comments and optimization suggestions to enhance interns' emergency response capacity and critical thinking (Ma et al., 2024).

During the whole learning period, tutors tracked interns' learning status, recorded their weak points and adjusted teaching focuses dynamically.

5) Post-test (P): Comprehensive assessment to inspect teaching outcomes

After the participatory learning stage, a three-dimensional assessment covering theoretical knowledge, operational skills and scenario disposal was carried out, with higher difficulty than the pre-test. One-on-one feedback and personalized improvement guidance were provided after assessment to consolidate learning achievements (Li & Zhao, 2024b).

6) Summary (S): Multiple reviews for continuous improvement

After the completion of the whole teaching cycle, a collective review meeting was held. Combined with interns' self-evaluation, group mutual evaluation and tutors' overall summary, key and difficult points of learning as well as existing deficiencies in teaching were sorted out, so as to optimize subsequent teaching schemes and realize continuous improvement (Qiang et al., 2026).

2.4. Observation Indicators

All indicators were assessed at two time points: on admission (before intervention, baseline) and at the end of rotation (after intervention). Specialized staff were responsible for data collection and sorting to ensure the authenticity and integrity of data. Specific indicators are as follows:

2.4.1. Theoretical and Operational Scores

The written test papers and operational assessment checklists were compiled uniformly by the operating room teaching team of our hospital in combination with the internship syllabus. The same scoring criteria and assessment scales were applied to both groups. Four core operational skills were selected for assessment. Two tutors who were blinded to the grouping information scored independently, and the average score was taken as the final result. The full score for both theoretical and operational assessment was 100 points, and a higher score represented better proficiency (Liu & Chen, 2023). Only the post-intervention assessment results of this indicator were statistically analyzed.

2.4.2. Critical Thinking Ability

The simplified Critical Thinking Scale compiled by Yu Binbin and colleagues was adopted for evaluation. The scale consists of 31 items divided into six dimensions, with a scoring range of 1 - 6 points for each item. The total score ranges from 31 to 186 points, and a higher score indicates stronger critical thinking (Yu et al., 2021). The Cronbach's α coefficient of the scale was 0.804, which reflected good reliability.

2.4.3. Teaching Satisfaction

A self-designed teaching satisfaction questionnaire was used, which contained 20 items in five dimensions with a scoring range of 1 - 5 points. The total score ranges from 20 to 100 points (Zhang & Liu, 2022). Pre-survey results showed that the questionnaire had good reliability and validity (Cronbach's $\alpha = 0.826$, content validity index = 0.913).

2.4.4. Post Competency

A self-developed post competency scale was formulated referring to relevant guidelines. The scale includes 25 items in four dimensions, scored from 1 to 4 points, with a total score ranging from 25 to 100 points (Li et al., 2024). Pre-survey results verified its good reliability and validity (Cronbach's $\alpha = 0.838$, content validity index = 0.907).

2.5. Statistical Analysis

SPSS 30.0 statistical software was used for data analysis. Measurement data that conformed to normal distribution were expressed as mean $\pm$ standard deviation ($\bar{x} \pm s$). Independent sample t -test was used for inter-group comparison, and paired sample t -test was used for intra-group comparison. Enumeration data were presented as case number and percentage, and analyzed by Chi-square test. A two-tailed $P < 0.05$ was considered statistically significant. All data were double-checked to ensure accuracy. In view of the deviation of t -values in the original manuscript, all statistical values were recalculated and revised.

3. Results

3.1. Theoretical and Practical Examination Scores

The theoretical and operational scores of the observation group were significantly

higher than those of the control group ($P < 0.001$), as shown in **Table 1**. The average theoretical score of the observation group was 6.63 points higher, and the average operational score was 7.83 points higher than the control group, which indicated that interns in the observation group had a better grasp of professional knowledge and more standardized operational behaviors.

Table 1. Intergroup comparison of theoretical and practical scores ($\bar{x} \pm s$, point).

Group	<i>n</i>	Theoretical Score	Practical Score
Observation	60	89.68 $\pm$ 4.15	92.42 $\pm$ 3.23
Control	60	83.05 $\pm$ 5.12	84.59 $\pm$ 4.61
<i>t</i> value	-	7.935	10.802
<i>P</i> value	-	<0.001	<0.001

3.2. Critical Thinking Assessment

All subdimension and total critical thinking scores of observation group were statistically higher than control group ($P < 0.001$), with most prominent improvements in analytic ability and systematic reasoning (**Table 2**).

Table 2. Intergroup critical thinking scores ($\bar{x} \pm s$, point)

Dimension	Observation (<i>n</i> = 60)	Control (<i>n</i> = 60)	<i>t</i> value	<i>P</i>
Truth-seeking	24.15 $\pm$ 2.03	20.08 $\pm$ 2.57	9.601	<0.001
Analytical ability	23.87 $\pm$ 1.96	19.76 $\pm$ 2.43	10.157	<0.001
Systematicity	23.52 $\pm$ 2.11	19.45 $\pm$ 2.62	9.563	<0.001
Self-confidence	23.91 $\pm$ 2.05	19.82 $\pm$ 2.51	9.872	<0.001
Inquisitiveness	24.03 $\pm$ 1.98	20.11 $\pm$ 2.45	9.435	<0.001
Cognitive maturity	23.73 $\pm$ 2.09	19.64 $\pm$ 2.58	9.786	<0.001
Total score	143.21 $\pm$ 10.98	122.06 $\pm$ 15.43	8.654	<0.001

3.3. Teaching Satisfaction and Post Competency

The observation group outperformed controls in overall satisfaction and all subitems of post competency (all $P < 0.001$). Average satisfaction was elevated by 8.88 points and total competency improved by 14.69 points (**Table 3**, **Table 4**).

Table 3. Intergroup teaching satisfaction ($\bar{x} \pm s$, point).

Group	<i>n</i>	Satisfaction Score
Observation	60	91.35 $\pm$ 2.76
Control	60	82.47 $\pm$ 4.42
<i>t</i> value	-	13.205
<i>P</i>	-	<0.001

Table 4. Intergroup post competency scores ($\bar{x} \pm s$, point).

Group	<i>n</i>	Aseptic Practice	Risk Identification	Emergency Management	Teamwork	Total Score
Observation	60	23.45 $\pm$ 1.12	22.98 $\pm$ 1.21	22.75 $\pm$ 1.15	23.09 $\pm$ 1.08	92.28 $\pm$ 3.19
Control	60	20.12 $\pm$ 1.37	18.85 $\pm$ 1.52	19.21 $\pm$ 1.33	19.40 $\pm$ 1.29	77.59 $\pm$ 4.38
<i>t</i>	-	14.412	16.635	15.928	16.017	18.763
<i>P</i>	-	<0.001	<0.001	<0.001	<0.001	<0.001

4. Discussion

The preceptorship of operating room nursing interns is a key link in the cultivation of nursing talents. The traditional preceptorship model has drawbacks such as ambiguous objectives, fragmented procedures, passive learning status of interns, insufficient critical thinking and delayed feedback, which can no longer meet the requirements of modern nursing talent cultivation (Wang et al., 2025; Deng et al., 2022; Shi & Chen, 2024; Su & Wang, 2024). The integrated teaching model constructed in this study takes closed-loop teaching as the foundation and defect exploration as the core, and has achieved prominent teaching effects after two years of clinical practice.

4.1. The Integrated Teaching Mode Remedies Core Drawbacks of Conventional Preceptorship

Traditional preceptorship relies heavily on tutors' personal experience and lacks systematic design. Interns passively receive knowledge with insufficient active thinking, resulting in weak clinical adaptability (Wang et al., 2025). The six links of BOPPPS form a complete closed-loop teaching system. With progressive arrangements from introduction to summary, it clarifies teaching objectives and standardizes teaching procedures, thus solving the problem of fragmented teaching (Wang et al., 2024). Defect-based scenario simulation transforms passive observation into active exploration, guiding interns to identify defects, analyze causes and formulate countermeasures independently, which stimulates their learning initiative and changes the passive learning state. The combination of pre-test, post-test and summary forms a two-way feedback mechanism, which helps tutors find out interns' deficiencies accurately and optimize teaching dynamically, making up for the shortcomings of delayed feedback and single evaluation in traditional teaching (Li & Zhao, 2024b).

4.2. Comprehensive Promotion of Interns' Multi-Dimensional Abilities

The significant improvement of theoretical and operational scores in the observation group is attributed to the targeted teaching which clarifies learning priorities, stratified teaching adapting to individual differences, and error-correction training strengthening the understanding of operational norms, so as to avoid mechanical imitation (Zou et al., 2022; Li et al., 2024). Repeated defect exploration and

collaborative problem-solving in scenario training effectively exercise interns' ability to analyze problems and judge risks, thus enhancing their logical thinking and overall critical thinking (Yu et al., 2021). The novel student-centered teaching form and timely personalized feedback bring a good learning experience to interns and improve teaching satisfaction (Zhang & Liu, 2022). The all-round training on aseptic norms, risk judgment, emergency disposal and teamwork is highly consistent with the core requirements of operating room posts, which shortens interns' clinical adaptation cycle and greatly improves their overall post competency (Li & Zhang, 2024a).

4.3. High Clinical Adaptability and Popularization Prospect of the Model

This teaching model makes use of the existing resources of the operating room, without the need for high-end equipment. It features low investment and easy implementation, and is suitable for promotion in hospitals at all levels, especially primary medical institutions (Yang et al., 2025). All defective scenarios are derived from real clinical cases, so the teaching content is highly practical and closely connected with actual job demands (Chen & Lin, 2024; Zhou & Wu, 2023). The two-year practical application and reliable data results provide empirical references for the teaching reform of operating room nursing education (Huang, 2025).

4.4. Research Limitations and Future Prospects

This study is a single-center research with samples limited to interns in our hospital. Multi-center researches can be carried out in the follow-up to verify the general applicability of the model. This study only conducted follow-up until the end of internship, and the long-term application effect remains to be further explored. The defect scenario case bank can be enriched by adding rare and complex clinical scenarios to improve the hierarchical simulation training system.

4.5. Practical Enlightenment for Clinical Preceptorship

The traditional indoctrination-based preceptorship mode for operating room interns should be abandoned. It is necessary to build a teaching system with clear objectives, closed-loop procedures, practical training and thinking guidance. The BOPPPS model combined with defect-based scenario simulation focuses on students and emphasizes exploratory learning. It can comprehensively improve the overall abilities of nursing interns and provide a feasible optimization scheme for clinical nursing talent cultivation.

5. Conclusion

The teaching model integrating BOPPPS framework and defect-based scenario simulation can significantly improve the theoretical knowledge, operational skills, critical thinking, post competency and teaching satisfaction of operating room nursing interns. It effectively overcomes various deficiencies of traditional pre-

ceptorship, conforms to the requirements of specialized teaching. With low cost and easy operation, this model is worthy of wide application in the preceptorship of nursing interns in operating rooms of hospitals at all levels.

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Conflicts of Interest

The authors declare that there is no commercial conflict of interest in this study, and all research data and conclusions are authentic and objective.

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