

# Research on the Application of AI-Empowered BOPPPS Teaching Model in the Course of First Aid Nursing Technology for Secondary Vocational Nursing Students

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**Abstract:** To explore the application effect of the AI-empowered BOPPPS teaching method in the secondary vocational course of First-aid Nursing Technology, this study selects Grade-2024 nursing students from a secondary vocational school as research subjects and conducts a controlled trial. Based on the six-phase BOPPPS model, an online-offline blended teaching mode is constructed by integrating technologies including AI virtual simulation, learning situation diagnosis and intelligent error-correction scoring for practical operations. After the course, theoretical and practical scores, critical thinking ability and academic self-efficacy of the two groups are compared. The results show that the experimental group achieves significantly higher scores in theoretical knowledge, practical skills, critical thinking and academic self-efficacy than the control group ( $P < 0.01$ ). This teaching mode can form a complete teaching closed loop, make up for the drawbacks of traditional practical training such as delayed feedback and disconnection between theory and practice, and improve students' comprehensive professional literacy. It can provide references for the curriculum reform of first-aid nursing in secondary vocational education.

**Keywords:** AI empowerment; BOPPPS teaching method; First aid nursing technology

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## 1. Introduction

First Aid Nursing Technology, a specialized extended course for secondary vocational nursing majors, covers pre-hospital rescue and transport, in-hospital emergency treatment, critical care monitoring, and common emergency and monitoring techniques<sup>[1]</sup>. Characterized by specialization, comprehensiveness and practicality, this course aims to cultivate students' autonomous learning ability, innovative thinking and comprehensive professional literacy. It enables students to proficiently master professional knowledge and operational skills for emergency and critical care<sup>[2]</sup>, and deliver holistic nursing for critically ill patients from physical and psychological dimensions.

Under the traditional teaching mode, there exists a disconnect between theoretical knowledge and skill transformation. The value guidance in practical training courses tends to be superficial with labeled implantation and mechanical integration<sup>[3]</sup>. Nursing students passively receive knowledge in class and fail to form in-depth integration of knowledge, skills and emotional cognition. Consequently, their clinical thinking cannot be fully developed, and they exhibit obvious deficiencies in clinical practice such as insufficient emergency thinking and weak emergency decision-making capacity<sup>[4-5]</sup>.

Proposed in the 1970s in the Instructional Skills Workshop (ISW) for teacher training in Canada, the BOPPPS model is goal-oriented and student-centered based on constructivist learning theory. It divides a complete teaching session into six progressive and recyclable modules to address the drawbacks of cramming teaching, insufficient feedback and passive learning in traditional classrooms, namely Bridge-in, Objective, Pre-assessment, Participatory Learning, Post-assessment and Summary<sup>[6-8]</sup>. With the rapid advancement of artificial intelligence (AI), educational AI technology has gained widespread recognition. AI can provide precise data support and intelligent teaching assistance through intelligent analysis of students' operation videos, virtual simulation training, and personalized learning path recommendation<sup>[9-10]</sup>. Against this backdrop, this study conducted a controlled trial on Grade 2024 nursing students of a secondary vocational school to analyze the teaching effects of the AI-empowered BOPPPS model in First Aid Nursing Technology.

## **2. Basic research information**

### **2.1. Curriculum construction**

First Aid Nursing Technology consists of 36 class hours, including 20 hours of theoretical teaching and 16 hours of practical training, for a total of 2 credits. This course adopts online-offline blended teaching and takes Critical and Emergency Nursing edited by Qiao Ping et al., published by China Science and Technology Press as the designated textbook. In accordance with the national teaching standards for secondary vocational nursing majors, the school cooperates with hospitals and emergency centers to construct a modular curriculum based on the whole emergency workflow, following the principle of systematic work process penetration. Three core modules are integrated: cardiac arrest rescue, trauma rescue, and injury & poisoning rescue. Each module contains four learning tasks: pre-hospital rescue, transfer and admission, ICU care, and comprehensive ability training and assessment. By analyzing typical cases of emergency and critical nursing and practicing common emergency operations, students master the complete rescue procedures for patients with cardiac arrest, trauma, injury and poisoning.

### **2.2. Research subjects**

The research subjects are Grade 2024 nursing students from a secondary vocational school. Class 1 and Class 2 serve as the control group receiving traditional teaching, while Class 3 and Class 4 constitute the experimental group adopting the AI-empowered BOPPPS teaching model.

Inclusion criteria: (1) full-time enrolled students; (2) good physical and mental health without relevant disorders during the research period; (3) voluntary participation in all questionnaires with signed informed consent. Exclusion criteria: (1) students who drop out or withdraw voluntarily during the research; (2) students experiencing severe psychological stress events that may interfere with research results.

## 2.3. Teaching staff allocation

The course adopts a person-in-charge responsibility system. All teachers in the teaching team are dual-qualified teachers with bachelor's degrees or above and secondary vocational teaching qualifications, with a student-teacher ratio of 1:16.

## 2.4. Resource allocation

Practical training facilities: A scenario-based simulated emergency nursing training center integrating out-of-hospital rescue, transfer, admission, ICU monitoring and simulated wards, equipped with complete emergency equipment, full-body simulation mannequins and various trauma care models. Teaching resources: Virtual simulation training platforms, micro-lessons, 3D animations, cloud classrooms, interactive software, and a standardized patient (SP) team with mature service systems.

## 3. Teaching methods

### 3.1. Control group

Before class, teachers push learning materials and preview quizzes via the Superstar Learning Platform to grasp students' learning status. In class, teachers deliver theoretical lectures, standard operation demonstrations, organize group discussions on emergency cases and conduct targeted error correction. After class, students finish online tests to consolidate knowledge and skills and use the open training room for independent practice to improve post-competency in emergency nursing operations.

### 3.2. Experimental group

The experimental group adopts the AI-empowered BOPPPS teaching model for First Aid Nursing Technology. Taking cardiac arrest training as an example, the detailed teaching arrangements are shown in **Table 1**.

**Table 1.** Teaching Arrangement of the AI-Empowered BOPPPS Model in First Aid Nursing Technology for Secondary Vocational Students

| Teaching Module | Core Teaching Content                                                                                                 | Teacher's Activities                                                                                                                                                                       | Students' Activities                                                                                                           | AI Empowerment Functions                                                                                                                                                                                                                        | Information Tools                                                                                             |
|-----------------|-----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| Bridge-in       | Out-of-hospital cardiac arrest cases, out-of-hospital CPR operation videos, AHA emergency guidelines, and task sheets | Upload case videos, PPT and graphic data to build teaching scenarios, raise guiding questions and integrate curriculum ideological and political elements to stimulate students' thinking. | Watch case videos, participate in class discussions, share personal insights and reflect on core issues in emergency scenarios | AI immersive virtual emergency scenario reconstruction, visualized clinical data display, and AI-generated interactive clinical scenarios matching students' weak knowledge points to enhance the sense of substitution and learning motivation | Superstar Learning Platform, multimedia teaching system, recording system, and AI virtual simulation platform |

| Teaching Module | Core Teaching Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Teacher's Activities                                                                                                                                                                             | Students' Activities                                                                                   | AI Empowerment Functions                                                                                                                                                                                                              | Information Tools                                                                                  |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| Objective       | <p>Knowledge Objectives: 1. Explain the etiology and pathogenesis of cardiac arrest; 2. List on-site assessment methods and clinical manifestations of cardiac arrest; 3. Describe the workflow and precautions of out-of-hospital cardiac arrest rescue. Ability Objective: Formulate and implement standardized out-of-hospital nursing plans for cardiac arrest patients. Literacy Objectives: 1. Foster emergency awareness that "time equals life"; 2. Cultivate rigorous and meticulous professional attitudes. Key points: Operation procedures for out-of-hospital cardiac arrest rescue. Difficult points: Formulating scientific out-of-hospital rescue plans for cardiac arrest patients</p> | <p>Clarify teaching objectives, key points, and difficult points via PPT and graphic materials, and explain the practical significance of objective achievement combined with clinical cases</p> | <p>Clarify personal learning objectives, make individual study plans and conduct targeted learning</p> | <p>Dynamic objective push by AI, differentiated hierarchical objectives delivered based on pre-assessment results to avoid one-size-fits-all teaching</p>                                                                             | <p>Multimedia teaching system, Superstar Learning Platform, AI learning status analysis system</p> |
| Pre-assessment  | <p>Online quizzes to test autonomous learning effects</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <p>Distribute test papers via Superstar Learning Platform</p>                                                                                                                                    | <p>Complete online tests</p>                                                                           | <p>Real-time learning status diagnosis by AI, scenario-based test items generated by AI question banks, and automatic class learning reports marking common error options and knowledge gaps to adjust teaching priorities timely</p> | <p>Online test module of the Superstar Learning Platform</p>                                       |

| Teaching Module        | Core Teaching Content                                                                                                                                                                                                                                      | Teacher's Activities                                                                                                                                                                       | Students' Activities                                                                                                                                                                                                                                                | AI Empowerment Functions                                                                                                                                                                                                                                                                               | Information Tools                                                                                                                                                           |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Participatory Learning | Scene identification—activate emergency response—patient positioning—chest compression—airway opening—artificial ventilation—AED operation                                                                                                                 | 1. Organize group case discussions; 2. Arrange repeated operational training via interactive software; 3. Guide students to complete out-of-hospital CPR under changing clinical scenarios | 1. Discuss cases in groups and draft emergency rescue plans; 2. Refer to loose-leaf textbooks and practice out-of-hospital cardiac arrest rescue procedures repeatedly via interactive software; 3. Complete out-of-hospital CPR under variable emergency scenarios | Dynamic courseware demonstration, virtual simulation training, real-time operation error correction and intelligent data collection by an AI interactive feedback system that marks wrong steps and pops up optimization hints to form a closed-loop learning mode of “operation-feedback-improvement” | High-fidelity simulation mannequins, virtual simulation platform, multimedia teaching system, recording system, Superstar Learning Platform, AI intelligent feedback system |
| Post-assessment        | 1. Knowledge evaluation: Online theoretical test covering the out-of-hospital cardiac arrest rescue workflow 2. Skill evaluation: Operational assessment via interactive software 3. Value-added evaluation: Operational data analysis by an AI system     | 1. Release online theoretical tests; 2. Organize operational assessment via interactive software                                                                                           | 1. Finish theoretical tests online; 2. Complete operational assessment of out-of-hospital cardiac arrest rescue on interactive software and upload scores                                                                                                           | Intelligent AI scoring for practical operations, multi-dimensional academic data analysis, and individual ability mapping generated by AI to objectively and visually evaluate students' proficiency and identify common learning problems                                                             | Online test module of the Superstar Learning Platform, AI intelligent scoring system, high-fidelity simulation mannequins, and a recording system                           |
| Summary                | Systematically sort out knowledge points, operational essentials, and clinical thinking logic of this class, reinforce key content, reflect on teaching deficiencies, assign after-class homework and preview tasks to guide autonomous follow-up learning | 1. Analyze common and individual operational errors in interactive software training; 2. Demonstrate error-prone operation steps; 3. Conduct standard operational demonstrations.          | 1. Listen to teachers' analysis of operational defects; 2. Watch teachers' demonstration of standardized out-of-hospital cardiac arrest rescue procedures via interactive software; 3. Record key operational points in loose-leaf textbooks                        | AI-generated class learning summary reports, visualized knowledge graphs, hierarchical homework distribution, personalized student learning archives, and targeted recommendations for review resources and preview priorities                                                                         | Multimedia teaching system, Superstar Learning Platform, AI knowledge graph generation system                                                                               |

### 3.3. Evaluation methods

After the course, students were evaluated on four dimensions: theoretical knowledge, practical skills, critical thinking disposition and academic self-efficacy.

(1) Academic assessment: Both groups completed identical written theoretical examinations and uniform practical skill tests at the OCEC examination center.

(2) Critical thinking disposition: The Chinese Version of Critical Thinking Disposition Inventory (CT-DI-CV) was adopted, with the test-retest reliability coefficient of the full scale as 0.77. The scale includes 7 dimensions with a Likert 6-point scale, with item scores ranging from 10 to 60 and total scores ranging from 70 to 420<sup>[11]</sup>.

(3) Academic self-efficacy: The Academic Self-Efficacy Scale compiled by Liang Yusong (2000) was used,

with Cronbach's  $\alpha$  coefficient of the full scale as 0.817. This scale contains 22 items divided into 2 dimensions with a Likert 5-point scale; total scores range from 22 to 110, and higher total scores indicate stronger overall academic self-efficacy<sup>[12]</sup>.

### 3.4. Statistical analysis

SPSS 28.0 statistical software was adopted for data analysis, with the test level  $\alpha$  set at 0.05. Count data were described by case number and constituent ration (%), and inter-group comparisons were performed via the Chi-square test. Measurement data conforming to normal distribution were expressed as mean  $\pm$  standard deviation (SD), and independent samples t-test was used for between-group comparisons.

### 3.5. Research results

**Table 2.** Comparison of Assessment Indicators Between the Two Groups

| Group              | Total Number | Male (n/%) | Female (n/%) | Theoretical Score | Practical Skill Score | Critical Thinking Score | Academic Self-Efficacy Score |
|--------------------|--------------|------------|--------------|-------------------|-----------------------|-------------------------|------------------------------|
| Experimental Group | 76           | 9/11.8%    | 67/88.15%    | 87.96 $\pm$ 11.94 | 90.96 $\pm$ 7.77      | 314.39 $\pm$ 52.36      | 82.57 $\pm$ 7.25             |
| Control Group      | 79           | 11/13.9%   | 68/86.07%    | 76.43 $\pm$ 17.17 | 79.46 $\pm$ 13.66     | 277.62 $\pm$ 52.81      | 75.91 $\pm$ 14.46            |
| t-value            | —            | —          | —            | -4.8699           | -6.4761               | 4.482                   | 3.815                        |
| P-value            | —            | —          | —            | <0.01             | <0.01                 | <0.01                   | <0.01                        |

Independent samples t-test results showed that the experimental group achieved significantly higher scores in theoretical knowledge (87.96  $\pm$  11.94), practical skills (90.96  $\pm$  7.77), critical thinking disposition (314.39  $\pm$  52.36), and academic self-efficacy (82.57  $\pm$  7.25) than the control group (76.43  $\pm$  17.17, 79.46  $\pm$  13.66, 277.62  $\pm$  52.81, 75.91  $\pm$  14.46 respectively), with t values of -4.8699, -6.4761, 4.482 and 3.815, all  $P < 0.001$ .

## 4. Discussion

### 4.1. AI-empowered BOPPPS model resolves practical training difficulties and forms closed-loop teaching

Traditional teaching of First Aid Nursing Technology for secondary vocational students is plagued by insufficient individual guidance, delayed learning feedback, inadequate simulated training equipment and separation of theory and practice. The six-stage AI-empowered BOPPPS model can introduce emergency knowledge via 3D rescue scenes and operation videos to stimulate learning motivation. Teachers can design hierarchical teaching arrangements based on AI-generated learning status data. Intelligent pre-assessment accurately identifies students' knowledge deficiencies. During practical training, AI vision recognition technology detects non-standard operations such as improper compression depth and frequency in real time, forming a closed training loop of "operation-error correction-repeated practice". The system automatically completes post-class ability assessment, and targeted review resources are provided in the summary stage. This model effectively addresses long-standing challenges in differentiated teaching and real-time training feedback, and remarkably improves practical training efficiency.

## **4.2. AI-empowered BOPPPS improves comprehensive literacy of nursing students and matches post-competency requirements**

Research results demonstrated that students receiving the AI+BOPPPS teaching model obtained superior performance in theoretical mastery, operational proficiency, academic self-efficacy and critical thinking disposition, which is consistent with the conclusions of existing domestic research on nursing teaching reform [13-14]. Real-time AI error correction avoids the accumulation of incorrect operational habits and standardizes students' emergency procedures. Simulated clinical scenarios combined with group training enhance students' clinical judgment and emergency response capacity. Continuous data feedback throughout the whole training process provides positive learning stimulation and reduces learning burnout. Meanwhile, ideological and political elements regarding life values, professional responsibility, and teamwork are integrated into teaching via AI platforms, realizing the integration of technical training and professional literacy cultivation, which conforms to the training objectives of secondary vocational nursing talents.

## **4.3. Limitations of the AI-empowered BOPPPS model and corresponding improvement strategies**

The current teaching model has three major limitations. First, AI evaluation standards only quantify standardized operational skills, while humanistic literacy such as doctor-patient communication and ethical judgment cannot be digitally measured, which requires supplementary offline explanation by teachers. Second, existing teaching materials are mainly limited to videos and test questions, lacking interactive role-play modules that may reduce students' learning interest. Third, some schools lack sufficient training resources, and teachers are insufficiently proficient in digital teaching tools, leading to loose integration of teaching and practical training and ambiguous group learning tasks. Corresponding improvement strategies are proposed: incorporate humanistic communication training into simulation modules; design hierarchical and interesting teaching materials supported by AI; carry out thematic teaching research to extend after-class practice via online platforms; conduct long-term follow-up surveys on students' internship performance to form replicable curriculum reform schemes.

## **5. Conclusion**

This study reformed the First Aid Nursing Technology curriculum for secondary vocational students by integrating AI technology into the six-stage BOPPPS teaching framework. The model guides students to establish positive learning attitudes and professional cognition, sets hierarchical learning objectives and realizes personalized teaching through pre-class learning diagnosis [15]. Multiple interactive activities replace one-way lecture-based teaching, highlight students' dominant position in class, facilitate knowledge absorption, and simultaneously promote the all-round development of students' operational skills, clinical thinking and learning confidence, providing solid support for the long-term career development of nursing practitioners.

## **Disclosure statement**

The author declares no conflict of interest.

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