



## Based on the BOPPPS Model of Online Teaching for Undergraduate Nursing Education: A Meta-Analysis

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### Abstract

The goal of nursing education is to cultivate nursing professionals with professional knowledge, skills, and core competencies. Traditional teaching models limit the development of students' initiative and critical thinking skills. The BOPPPS teaching model, as a student-centered teaching method, effectively addresses the limitations of online learning. This meta-analysis aims to explore the differences in teaching effects between online teaching strategies based on the BOPPPS teaching model and traditional teaching methods in undergraduate nursing education in Chinese higher education, with a particular focus on their impact on final exam scores. The research design follows the Cochrane Systematic Review Handbook and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Literature searches cover databases such as PubMed and Web of Science, with a search period from January 2021 to October 2024. Studies were selected according to the PICO principle, excluding those that could not obtain full text, non-Chinese and English, conference papers, reviews, etc. Two researchers used the Cochrane Bias Risk Assessment Tool to assess the quality of included studies. Statistical analysis was conducted using Review Manager 5.2, with standardized mean difference (MD) and corresponding 95% confidence intervals (CI) used to estimate the effect size. A preliminary search identified 99 articles, with 7 articles ultimately included in the meta-analysis. The results show that online teaching methods using the BOPPPS model have a significant advantage over traditional teaching methods in improving the final exam scores of undergraduate nursing students.

**Keywords:** BOPPPS, Nursing Education, Online Teaching, Meta-Analysis

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### Introduction

Nursing is a key component of healthcare and plays a crucial role in safeguarding patient health. Therefore, it is the goal of nursing education to cultivate skilled clinical professionals, enabling nursing students to possess the necessary professional knowledge, skills, and core competencies <sup>[1]</sup>. Although traditional lecture-based learning (LBL) is the most common method in nursing education and has the advantage of disseminating core theoretical knowledge to a large number of students, the traditional teaching approach is teacher-centered, with students in a passive position, limiting students' practice of practical skills and the development of critical thinking abilities, thereby reducing student enthusiasm <sup>[2, 3]</sup>. Currently, nursing undergraduates have fewer practical courses in school, and after entering clinical practice, there are issues such as poor operational skills and a disconnect between theory and practice. The teacher-oriented nature of LBL cannot effectively transform knowledge into students' understanding and may weaken students' interest, which is not conducive to cultivating clinical practice abilities in nursing undergraduates. Innovative teaching strategies are needed to better meet their needs.

During the COVID-19 pandemic, most global schools have adopted hybrid teaching, with students' learning shifting from the lecture hall to an online environment. A large number of technological tools have been rapidly integrated, including web-based technologies, mobile applications, conference platforms, telemedicine learning platforms, note-taking software, on-demand video libraries for standardized exams, and social media, promoting autonomous, personalized, and didactic education <sup>[4, 5]</sup>.

However, many participants in digital courses have expressed that online learning is difficult to maintain focus and can lead to mental fatigue [6]. The BOPPPS teaching model, also known as Guided Learning Interaction plus Education, is a new student-centered teaching model oriented towards educational goals, divided into six basic steps: Bridge, Objective, Pre-Assessment, Participatory Learning, Post-Assessment, and Summary. Studies have shown that combining digital education with the BOPPPS teaching model and optimizing each component can effectively address the limitations of online learning and is an efficient teaching model [7].

To date, the application of BOPPPS in university teaching is very common, but information on the combined use of digital education and BOPPPS teaching is still scarce. Therefore, this meta-analysis aims to evaluate the impact of online teaching based on the BOPPPS model compared to traditional teaching models on the teaching effects of undergraduate nursing courses in Chinese universities, including final exam scores.

### Study Design

This systematic review was conducted according to the Cochrane Systematic Review Handbook and the PRISMA guidelines.

### Literature inclusion and exclusion criteria

This study determined the inclusion criteria according to the PICO's principle. 1. P Population: Nursing undergraduates in school; I Intervention: BOPPPS model combined with online teaching; C Comparison: Traditional teaching model or online teaching; O Outcome: Final exam scores; S Study Design: Randomized trials

**Exclusion criteria:** Unable to obtain full text; Non-Chinese and English;

Conference papers, reviews; Duplicate studies or overlapping subjects; No clear indicators for pre-post comparison

### Search Strategy

This study searched PubMed, Web of Science, and Chinese

online databases such as CNKI, Wanfang, VIP, and China National Knowledge Infrastructure. The search period was from January 2021 to October 2024. English keywords included "baccalaureate nursing education," "BOPPPS," "e-learning/online," and Chinese search terms were BOPPPS, digitalization, nursing training. MeSH search terms were used for English database searches, and subject terms were used for Chinese database searches.

### Quality Assessment

Two researchers used the Cochrane Bias Risk (RoB 1) tool to assess the quality of included studies. The evaluation criteria included the randomization process, deviations from the expected intervention, missing outcome data, outcome measurement, and selection of reported results. When disagreements occurred, a third senior researcher assessed the study.

### Statistical Analysis

Heterogeneity statistical analysis and meta-analysis of effectiveness outcomes were conducted using Review Manager 5.2. For continuous data, final exam scores were used to estimate the effect size with standardized mean difference (MD) and corresponding 95% confidence intervals (CI). Heterogeneity tests were performed for each study result. If  $I^2 < 25\%$ , it indicates low heterogeneity;  $I^2 = 25\text{--}75\%$ , it indicates moderate heterogeneity; if  $I^2 > 75\%$ , it indicates high heterogeneity. If  $I^2 < 50\%$ , the fixed-effect model was used for analysis, indicating low to moderate heterogeneity or no statistical heterogeneity in the studies. If  $I^2 \geq 50\%$ , the random-effects model was used for analysis.

### Results

#### Search Results

According to the search strategy, 99 articles were initially identified, with 47 duplicates removed, 3 irrelevant to the topic, 11 with inaccurate study subjects or vocational nursing students, and articles types such as reviews and conferences excluded. After carefully reading the full text, 7 articles were included in our meta-analysis based on the inclusion and exclusion criteria (Figure 1).

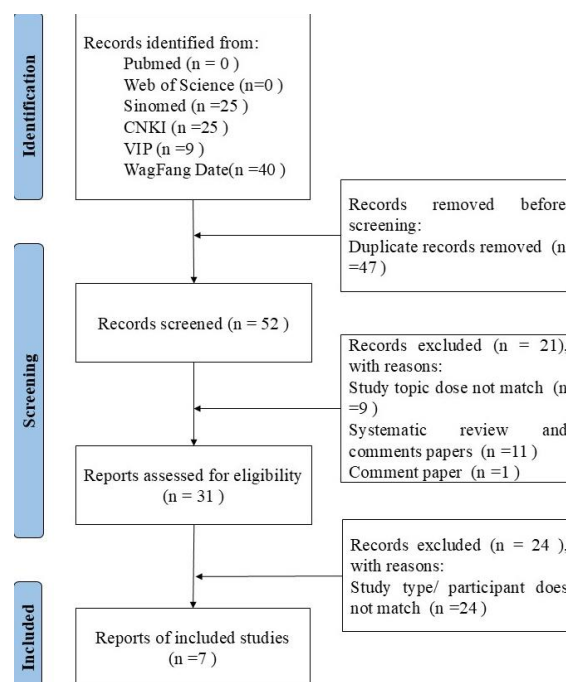


Fig 1: PRISMA flow chart of study selection

**Study Characteristics**

Table 1 lists the characteristics of the 7 included studies published between 2021 and 2024. In this study, the intervention group sample size ranged from 14 to 381 cases, and the control group ranged from 14 to 376 cases, with a total sample size of 1598 cases, including 749 cases in both the intervention and control groups. The subjects in the

intervention group received BOPPPS-based online blended teaching, while the subjects in the control group received traditional teaching or online teaching, etc. The most common outcome was the objective evaluation, i.e., the final total score, used to assess students' mastery of related professional knowledge. All articles in the analysis were published in Chinese.

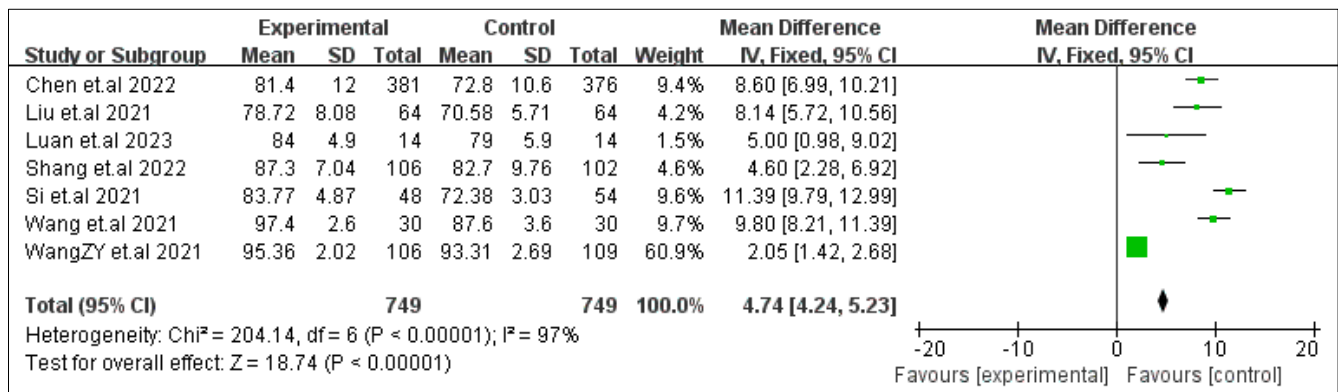
**Table 1:** General characteristics of the included studies (n = 7)

Author (Year)	Sample size		Mode of teaching		vFinal test result		
	Intervention group	Control group	Intervention group	Control group	Intervention group	Control group	
Chen et.al 2022 <sup>[8]</sup>	381	376	Blended Teaching Method Based on the BOPPPS Model		Traditional teaching method	81.4±12.0	72.8±10.6
Liu et.al 2021 <sup>[9]</sup>	64	64	Online BOPPPS Teaching Method		Routine teaching method	78.72±8.08	70.58±5.71
Luan et.al 2023 <sup>[10]</sup>	14	14	"BOPPPS Integrated with ChaoXing Learning Platform"		Online teaching	84.0±4.90	79.0±5.90
Shang et.al 2022 <sup>[11]</sup>	106	102	BOPPPS Teaching Model Based on the ChaoXing Learning Platform		Online teaching	87.3±7.04	82.7±9.76
Si et.al 2021 <sup>[12]</sup>	48	54	BOPPPS model + blended learning in online and offline teaching		Traditional teaching method	83.77±4.87	72.38±3.03
Wang et.al 2021 <sup>[13]</sup>	30	30	Blended Learning Constructed with the BOPPPS Teaching Model Based on Internet Technology		Online teaching	97.4±2.60	87.6±3.60
Wang et.al 2021 <sup>[14]</sup>	106	109	Constructing a Blended Learning Environment with the BOPPPS Teaching Model		Routine teaching method	95.36±2.02	93.31±2.69

**Risk of bias in the included studies**

The bias risk of RCTs was assessed using the Cochrane tool (Figure 2). In all included studies, 2 studies did not specify the randomization method and were assessed as "unclear." During the teaching activities, teachers generally issued

homework or post-class tests to the intervention group through online or learning platforms, which was not the case for the control group. Therefore, blinding of educators and learners was essentially impossible, resulting in a high-risk assessment.



**Fig 2:** Risk of bias of included RCTs with the Cochrane RoB2 tool

**Meta-analysis results**

A total of 7 relevant studies were included (Figure 3). The objective outcome was mainly exam scores, with most studies showing that the scores of participants in the intervention group were higher than those in the control group. The meta-analysis of BOPPPS-based offline teaching

compared to conventional teaching or single online teaching showed a statistically significant difference in scores between the two groups (MD=4.74, 95%CI:4.24-5.23, Z=18.74, p<0.00001). Due to significant statistical heterogeneity among the studies (p<0.00001, I<sup>2</sup> = 97% > 70%), a random-effects model was used for analysis.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Chen et.al 2022	?	?	+	-	+	+	+
Liu et.al 2021	+	?	-	-	+	+	+
Luan et.al 2023	+	?	-	-	+	+	+
Shang et.al 2022	+	?	-	-	+	+	+
Si et.al 2021	?	?	-	-	+	+	+
Wang et.al 2021	+	-	-	-	+	+	+
WangZY et.al 2021	+	?	-	-	+	+	+

**Fig 3:** Forest plot of theoretical score for Online teaching based on the BOPPPS model compared with the traditional teaching group

## Discussion

Digital education is a convenient and adaptable learning tool accessible anytime, anywhere through digital technology, which can promote continuous professional development and enhance the capabilities of healthcare personnel [15]. By integrating digital education into the six modules of Bridge, Objective, Pre-Assessment, Participatory Learning, Post-Assessment, and Summary, the distance between teachers and students is shortened, fostering a student-centered educational philosophy. This helps students to consolidate classroom knowledge at any time, transforming passive learning into active learning, and improving students' initiative and interest. The BOPPPS-based online teaching model uses multimedia methods in the teaching process, which helps to create a positive learning atmosphere and enhance learning comprehension and practical abilities [16]. In China, almost all nursing students take final exams at the end of the term to assess their learning ability and knowledge mastery [7]. The included studies show that compared to the control group, BOPPPS-based online teaching significantly improved the final exam scores of undergraduate nursing students. Among them, the students in the experimental group had a significantly higher satisfaction with teaching than the control group [11, 12, 13], and their autonomous learning abilities were greatly improved [8, 14].

Although the final exams in the included literature all indicated that the experimental group's scores were higher than the control group, the meta-analysis results showed high heterogeneity, which can be analyzed for the following reasons. First, China has traditionally educated students in a teacher-centered manner, and most lack proactive thinking. Although the BOPPPS teaching strategy is widely applied in schools around the world, its implementation in China is still

in its infancy. Second, due to the use of electronic products, most students are easily distracted by other factors during online learning, leading to a lack of focus. Third, only seven articles were included, with participants being only Chinese students, and some studies had a small sample size, which may reduce the representativeness and generalizability of the results. Fourth, to minimize the impact of experimental implementation bias and scientifically measure the impact of teaching models on student learning outcomes, blinding of teachers and students involved in the experiment should be practiced. However, due to the adoption of the BOPPPS teaching model, double-blinding is not possible. Fifth, before implementing the plan, researchers did not assess students' learning abilities, knowledge mastery, and autonomous learning abilities.

Overall, although the number of studies on the effectiveness of BOPPPS-based online teaching is limited and lacks broad empirical support, randomized controlled trials, as the highest form of evidence, show a positive trend in the included studies regarding the effectiveness of BOPPPS-based online teaching strategies in improving the effectiveness of undergraduate nursing education.

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