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Efficacy of BOPPPS teaching model in medical education: A systematic review and meta-analysis

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ADMINISTRATIVE INFORMATION

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Review Stage at time of this submission - Data analysis.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY2023100043

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 10 October 2023 and was last updated on 10 October 2023.

INTRODUCTION

Review question / Objective Clinical education is crucial for medical students to acquire practical skills and apply theoretical knowledge in patient care. Traditional pedagogical models, reliant on passive lectures, have limitations such as hindering active learning and practical application. To address these issues, the BOPPPS (bridge-in, objective, preassessment, participatory learning, post-assessment, and summary) teaching model has emerged as an innovative approach to medical education. BOPPPS method can effectively improve classroom teaching. However, its efficacy in the medical education remains unclear. Hence, the primary aim of this systematic review and meta-analysis is to examine the existing evidence and answer the pivotal question: Does the BOPPPS teaching model enhance undergraduate and postgraduate medical education? Are there specific contexts or subject areas in which the model is particularly effective? What are the limitations and areas for further research in this field? Through this inquiry, we aim to illuminate the path toward more engaging and effective medical instruction, reshaping the educational landscape for future medical professionals.

Condition being studied In this pursuit of innovation, the BOPPPS teaching model emerges as a compelling proposition. Grounded in constructionist theory and informed by the communicative approach, the BOPPPS model challenges the status quo by placing students at the forefront of their educational experience (Design courses based on BOPPPS teaching mode). BOPPPS strategically integrates teaching theory and practice, prioritizing the teaching process itself. Through its structured framework of

Bridge-in, Objective setting, Preassessment, Participatory learning, Post-assessment, and Summary, the BOPPPS model guides students to take an active role in their education, fostering a sense of ownership and enthusiasm for learning. Remarkably, this innovative approach has found application in various medical disciplines, including ophthalmology education, health services management , thoracic surgery education , physiology education, and Dental Materials Education, among others.

METHODS

Search strategy 1. Study Protocol

This study was conducted following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The systematic review and meta-analysis were conducted following a pre-defined protocol. The protocol was developed to outline the research questions, inclusion and exclusion criteria, search strategy, data extraction methods, and statistical analysis plan. The protocol was registered with [inplasy], and any deviations from the protocol were documented and justified in the final report.

2. Search Strategy

The literature search was conducted in the following databases: PubMed, EMBASE, Cochrane Library, Scopus, and Web of Science, spanning from any date to May 15th, 2023. The search strategy combined relevant keywords and Medical Subject Headings (MeSH) terms related to the BOPPPS teaching model and medical education. The search was not limited by language or publication status. Additionally, a manual search of reference lists of included studies and relevant systematic reviews was performed to identify additional articles.

3. Study Selection

Two independent reviewers conducted the initial screening of titles and abstracts to identify potentially eligible studies. Full-text articles of potentially eligible studies were then assessed for inclusion. Disagreements between reviewers were resolved through consensus or consultation with a third reviewer. Studies were included if they met the following criteria:

Inclusion Criteria: 1) Study Design: Randomized controlled trials (RCTs), semi-randomized experimental studies, experimental studies with pre-test and post-test control groups, and observational studies (cross-sectional, case-control). 2) Educational Intervention: Studies focusing on learning and teaching interventions that involved at least one type of BOPPPS educational intervention. 3) Participants: Studies involving undergraduate medical students as participants. 4) Outcome Assessment: Studies that objectively assessed the impact of the intervention(s) on students' knowledge, attitudes, skills, or behaviors using tests, questionnaires, or similar instruments. 5) Quality Assessment: Studies assigned "Medium" or "strong" scores in the quality assessment.

Exclusion Criteria: 1) Study Type: Descriptive or qualitative studies were excluded. 2) Publication Type: Study protocols, pilot studies, and conference papers were excluded. 3) Quality Assessment: Studies assigned "Weak" scores in the quality assessment were excluded.

This comprehensive set of inclusion and exclusion criteria ensured the selection of relevant and methodologically sound studies for the systematic review and meta-analysis.

4. Data Extraction

Data collection, extraction, and management were performed by two investigators using an electronic data abstraction form in Microsoft Excel software. The following information was collected: study characteristics (author, year of publication, study design), participant characteristics (sample size, demographic information), details of the BOPPPS intervention, comparison group details, and relevant outcome measures. Any discrepancies in data extraction were resolved through discussion or consultation with a third reviewer. For quality assessment, the two investigators independently summarized the quality indicators of each study. In case of disagreements, the corresponding author intervened and requested further details.

5. Quality Assessment

The quality of included studies was assessed using the Newcastle-Ottawa Scale (NOS) for Assessing the Quality of Nonrandomized Studies in Meta-Analysis. The NOS evaluates studies based on three key parameters:

Selection of the Study Population: Assessing whether the study adequately described the selection of participants and the representativeness of the exposed and non-exposed groups.

Comparability of Groups: Evaluating the comparability of groups on the basis of design or analysis, considering factors like age, gender, and other potential confounders.

Assessment of Exposure or Outcome of Interest: Examining how the exposure or outcome of interest was ascertained, including the use of valid and reliable measurements.

Each study was assigned a score ranging from 0 to 9, with higher scores indicating higher methodological quality. Articles scoring 7 or higher on the NOS were considered to be of high quality (See Supplementary Table 1).

This quality assessment approach allowed for the evaluation of the rigor and reliability of included nonrandomized studies, enhancing the overall robustness of the systematic review and meta-analysis.

6. Data Synthesis and Meta-Analysis

Data from the included studies were synthesized using Microsoft Excel software. To quantitatively assess the impact of BOPPPS educational interventions on various educational outcomes, pooled effect sizes were calculated for relevant outcome measures. For continuous outcomes, standardized mean differences (SMD) with 95% confidence intervals (CIs) were calculated. For dichotomous outcomes, risk ratios (RR) with 95% CIs were computed. In cases of significant heterogeneity among studies, random-effects models were applied to account for potential variations in study design, participants, and interventions. Subgroup analyses were conducted based on factors such as study design, type of BOPPPS intervention, and outcome measures to explore potential sources of heterogeneity. Sensitivity analyses were performed to assess the robustness of the findings by excluding studies with lower quality scores or those at higher risk of bias. Statistical heterogeneity among studies was assessed using the I-squared (I^2).

7. Publication Bias

8. Ethical Considerations

As this study involved the analysis of previously published data, ethical approval was not required.

Participant or population 1) Study Design: Randomized controlled trials (RCTs), semi-randomized experimental studies, experimental studies with pre-test and post-test control groups, and observational studies (cross-sectional, case-control). 2) Educational Intervention: Studies focusing on learning and teaching interventions that involved at least one type of BOPPPS educational intervention. 3) Participants: Studies involving undergraduate medical students as participants. 4) Outcome Assessment: Studies that objectively assessed the impact of the intervention(s) on students' knowledge, attitudes, skills, or behaviors using tests, questionnaires, or similar instruments. 5) Quality Assessment: Studies assigned "Medium" or "strong" scores in the quality assessment.

Intervention Studies focusing on learning and teaching interventions that involved at least one type of BOPPPS educational intervention.boppps.

Comparator Traditional teaching.

Study designs to be included Randomized controlled trials (RCTs), semi-randomized experimental studies, experimental studies with pre-test and post-test control groups, and observational studies (cross-sectional, case-control).

Eligibility criteria 1) Study Design: Randomized controlled trials (RCTs), semi-randomized experimental studies, experimental studies with pre-test and post-test control groups, and observational studies (cross-sectional, case-control). 2) Educational Intervention: Studies focusing on learning and teaching interventions that involved at least one type of BOPPPS educational intervention. 3) Participants: Studies involving undergraduate medical students as participants. 4) Outcome Assessment: Studies that objectively assessed the impact of the intervention(s) on students' knowledge, attitudes, skills, or behaviors using tests, questionnaires, or similar instruments. 5) Quality Assessment: Studies assigned "Medium" or "strong" scores in the quality assessment.

Information sources PubMed, EMBASE, Cochrane Library, Scopus, and Web of Science.

Main outcome(s) A total of 15 studies with 2320 students were included. The pooled estimate showed that BOPPPS method could significantly improve the final examination scores (standard mean difference: 1.14; 95%CI: 0.84-1.43, I2 = 20%; PH < 0.001; P < 0.001) in medical education, compared to traditional teaching methods. Besides, the utilization of the BOPPPS was associated with improvement in students' satisfaction, classroom interaction, learning initiative, analytical ability, clinical thinking ability, and learning retention skill in medical education.

Quality assessment / Risk of bias analysis The quality of included studies was assessed using the Newcastle-Ottawa Scale (NOS) for Assessing the Quality of Nonrandomized Studies in Meta-Analysis. The NOS evaluates studies based on three key parameters:

Selection of the Study Population: Assessing whether the study adequately described the selection of participants and the representativeness of the exposed and non-exposed groups.

Comparability of Groups: Evaluating the comparability of groups on the basis of design or analysis, considering factors like age, gender, and other potential confounders.

Assessment of Exposure or Outcome of Interest: Examining how the exposure or outcome of

interest was ascertained, including the use of valid and reliable measurements.
Each study was assigned a score ranging from 0 to 9, with higher scores indicating higher methodological quality. Articles scoring 7 or higher on the NOS were considered to be of high quality (See Supplementary Table 1).
This quality assessment approach allowed for the evaluation of the rigor and reliability of included nonrandomized studies, enhancing the overall robustness of the systematic review and meta-analysis.

Strategy of data synthesis Data from the included studies were synthesized using Microsoft Excel software. To quantitatively assess the impact of BOPPPS educational interventions on various educational outcomes, pooled effect sizes were calculated for relevant outcome measures. For continuous outcomes, standardized mean differences (SMD) with 95% confidence intervals (CIs) were calculated. For dichotomous outcomes, risk ratios (RR) with 95% CIs were computed. In cases of significant heterogeneity among studies, random-effects models were applied to account for potential variations in study design, participants, and interventions. Subgroup analyses were conducted based on factors such as study design, type of BOPPPS intervention, and outcome measures to explore potential sources of heterogeneity. Sensitivity analyses were performed to assess the robustness of the findings by excluding studies with lower quality scores or those at higher risk of bias. Statistical heterogeneity among studies was assessed using the I-squared (I^2).

Subgroup analysis Subgroup analyses were conducted based on factors such as study design, type of BOPPPS intervention, and outcome measures to explore potential sources of heterogeneity.

Sensitivity analysis Funnel plots were constructed to visually inspect the symmetry of data points, with an asymmetric funnel indicating possible publicationbias.

Country(ies) involved China.

Keywords BOPPPS; Medical education; Traditional teaching; systematic review; meta-analysisBOPPPS, Medical education, Traditional teaching.

Contributions of each author
Jing Zhu and Hongtao Tie designed the study. Jing Zhu coordinated the study and the data acquisition. Xiaochuang Gan and Qitao Gou, performed the statistical analyses and interpreted the results. Jing Zhu and Hongtao Tie drafted the manuscript. All authors read and approved the final manuscript.

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