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EDITED BY
Xingming Ma,
Xihua University, China

REVIEWED BY
Dennis Arias-Chávez,
Continental University, Peru
Goran Hauser,
University of Rijeka, Croatia

*CORRESPONDENCE
Jiaying Liu
✉ 1002162859@ucsiuniversity.edu.my

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BOPPPS model implementation and students' performance: a systematic literature review

Jiaying Liu[1,2]*, Siti Zobidah Omar[1], Yang Wang[1] and Yue Xiang[1]

[1]Faculty of Social Sciences and Liberal Arts, UCSI University, Kuala Lumpur, Malaysia, [2]Normal Education College, Longyan University, Longyan, Fujian, China

Applications of instructional models are among the key factors in enhancing student performance. While the BOPPPS model is widely implemented, a thorough and systematic evaluation of its impact on student performance remains absent. This systematic review synthesized findings from 19 studies to explore the relationship between the BOPPPS model and student performance. Using the PRISMA, Studies were analyzed for research characteristics, focusing on the use of BOPPPS model, learning subjects, student learning formats, and research theories to better analyze student performance. Specific student-related variables analyzed included academic performance, learning performance, skill tests performance, learning and cognitive ability performance, attendance performance, classroom performance, online performance, and other aspects. The results from the majority of the included studies consistently demonstrated a positive impact of the BOPPPS model on student performance across these diverse areas. To enhance understanding of the BOPPPS model's impact, future research could adopt longitudinal and mixed-method approaches, diversify and expand sample sizes, and explore cross-disciplinary and cross-cultural applications. Integrating new tools with the BOPPPS model is also recommended to further improve learner outcomes.

KEYWORDS

BOPPPS model, students' performance, learning outcomes, classroom participation, interaction

Introduction

The BOPPPS model (Bridge-in, Learning Objective, pre-assessment, Participatory Learning, post-assessment, and Summary) is a teaching approach (Chen et al., 2023; Hu et al., 2022). It was first established by Douglas Kerr's team at the University of British Columbia in 1978 (Wang, 2023). The BOPPPS model served as the initial theoretical framework for the Instructional Skills Workshop (ISW) in Canada (Hsu and Ou, 2022). The flexible, student-centered BOPPPPS model was designed to enhance classroom teaching efficiency and promote active learning (Guo, 2024). To help students better understand key educational concepts, teachers need to prepare content using the BOPPPS model before class and present it effectively during the lesson (Li et al., 2024). In addition to teaching academic knowledge, teachers could focus on students' personal experiences, emotions, and communication, etc. (McCloughen et al., 2020). Teacher-student interaction, identified as a crucial factor in classroom learning, directly influences student motivation and engagement (Wang et al., 2022; Amin et al., 2022). Therefore, it is important for teachers to encourage student learning and motivate student participation (Filgona et al., 2020). And the BOPPPS model can promote students' interaction and engagement, thus enhancing their performance and learning experience (Yu, 2023; Yang, 2019). This study offers a systematic examination of the BOPPPS model's impact on student performance. It delves into the themes, theories, and variables associated with the model, analyzing their interrelations in prior studies. This study aims to establish a foundation for future research, offering a clear roadmap and fostering innovative perspectives in the field.

In addition, this study provides a useful reference for instructors and helps educators better understand how to optimize classroom instructional strategies to promote students' performance.

Problem statement

The literature related to BOPPPS shows that there is more literature (Wang et al., 2022; Wei et al., 2023) on BOPPPS for science subjects compared to arts and social science subjects. Science courses tend to require more experimental, practiced, and technical instruction, which may lead teachers to focus more on skill training for their students.

An absence of connection or communication between teachers and students in class under traditional teaching methods (Al Rawashdeh et al., 2021). A decrease in student performance may result from low student engagement (Xu et al., 2020). Students are the main focus of the classroom but rarely participate in class. Instructors discuss the material they are teaching, but students are unable to concentrate. Students who don't make the adjustments to their learning may experience frustration and depression (Liang and Wu, 2021).

Participatory learning is one of the six components of the BOPPPS model (Chen et al., 2022; Xu et al., 2023). Accordingly, the researcher aims to use the BOPPPS model to improve teacher-student interaction and investigate the connection between students' performance and the model's application. However, few studies discussed the relationship between the BOPPPS model and students' performance (Ma et al., 2021).

Systematic review framework for BOPPPS model and students' performance

The central inquiry guiding this investigation revolves around the following: What are the prevailing themes, theories, and frameworks regarding the use of the BOPPPS Model in enhancing students' performance, and how do these elements interrelate within the corpus of prior research. This study was dedicated to exploring the factors associated with students' performance by exploring the previous theories, methods findings, etc. applied in the study of the BOPPPS model. Its principal aim is to undertake an exhaustive exploration and analysis of the implementation of the BOPPPS Model in educational settings, thereby fostering a nuanced comprehension of its impact on student performance.

Method

This study used Web of Science (WoS) and Scopus as the databases to be searched, and it used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The procedure for retrieval is shown in Figure 1.

Resources

The databases chosen for this study are WoS and Scopus. WoS is widely recognized for its extensive coverage of scholarly literature and its user-friendly interface, making it a preferred choice for most researchers. It crosses several academic domains, including the social sciences, engineering, natural sciences, humanities, and the arts. Within WoS, researchers can access a diverse range of literature types, including quantitative studies, qualitative research, and mixed-method approaches. The platform can be used in conjunction with a variety of literature management tools to enable notes-taking, citation tracking, bibliographic management, and other functions that promote the efficiency of literature review. Both WoS and Scopus boast broad coverage of scholarly journals and publishers worldwide, albeit accessible only through institutional subscriptions. Scopus covers a wide range of literature types and subject areas, and its advanced search capabilities facilitate systematic literature reviews. WoS is renowned for its high-quality scholarly literature, providing researchers with access to rigorously vetted publications and reliable citation metrics. Scopus boasts a broader coverage of journals and publishers. This study selects the use of both the Scopus and WoS databases, rather than solely depending on WoS. Because Scopus and WoS offer different academic resources and coverage. Scopus includes specific journals that are not covered by WoS. By leveraging the strengths of both databases, researchers can access a more comprehensive pool of literature.

Identification of studies via databases and registers

Early in March 2024, the first phase in the systematic review process was completed to determine the keywords for information retrieval. The "BOPPPS Model and Student Performance" was thoroughly searched for using dictionaries, thesauruses, and synonyms that were suggested by databases. These terms are defined in Table 1. 98 articles from Scopus and 70 from WoS were found during the initial search. There were 138 genuine papers left after 29 duplicates were removed and 1 retracted document that had been detected as ineligible by automated tools was manually removed. Figure 1 in the text provides a visual representation of this procedural sequence.

Screening was done in the second stage of the systematic review process using predetermined inclusion and exclusion criteria (see Table 2). The search for this study was conducted in early March 2024, hence the decision to limit the search period to January 2019 through March 2024. The upward trend in both quantity of literature related to the BOPPPS model since 2019. Setting the cutoff point to March 2024 ensures that the study encompasses the most recent research findings while avoiding the issue of literature becoming outdated due to an excessively long time span. Then, only academic research publications published in journals were judged appropriate for inclusion; books, preprints, serials, theses, review pieces, and conference proceedings were not taken into account. The purpose of including only articles (research articles) in this study was to ensure the quality of the research literature.Selecting only articles only can reduce publication bias. Research Articles are rigorously peer-reviewed, helping to ensure the soundness of research methods and the validity of research findings. While gray literature can provide valuable insights, it is of variable quality and may bring publication

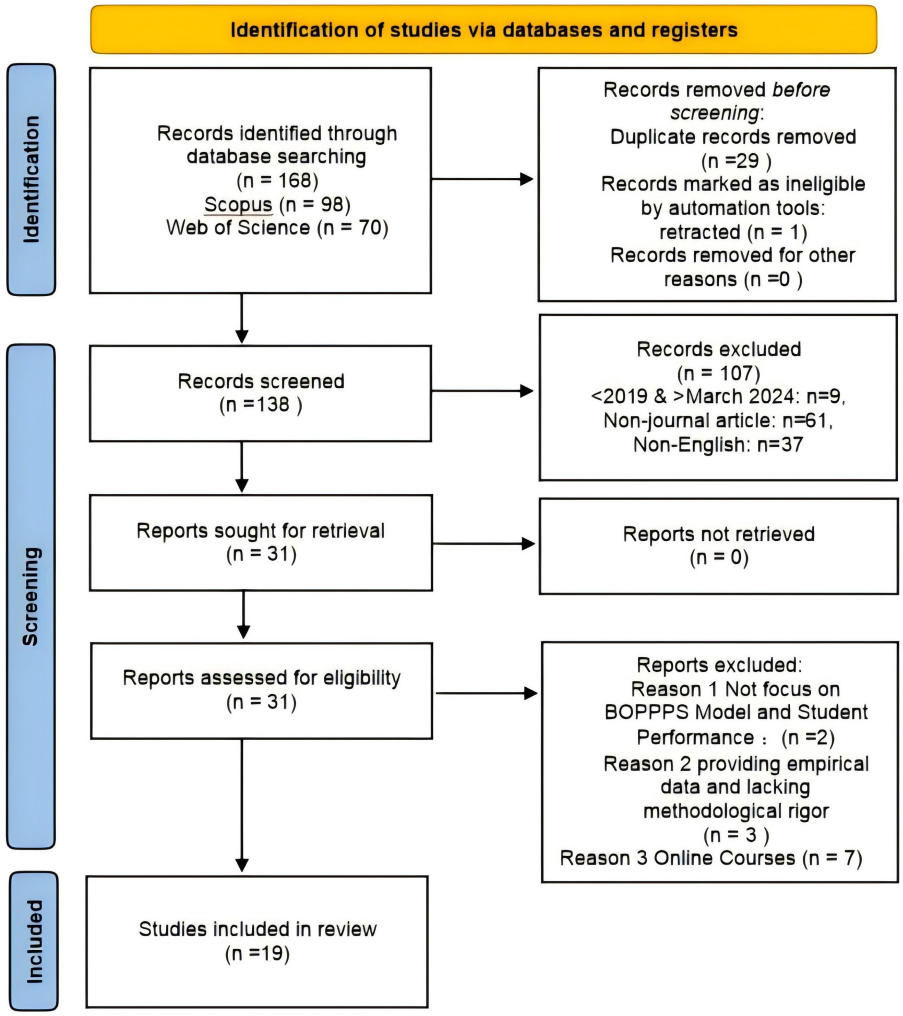

FIGURE 1
Flow diagram of this review study. Source: adapted from Page et al. (2021).

bias. Given the scope and objectives of this research, it was necessary to focus on articles that met high standards. The third factor was language selection, with a focus on including English publications to reduce language barriers and any translation distortions. Throughout the retrieval process, no reports that were unattainable were identified. Furthermore, during the assessment for eligibility, articles unrelated to the core focus of the study on the BOPPPS Model and Student Performance or those not centered on "students" as the subject of inquiry were excluded. Additionally, Reason 2 Articles were excluded due to their provision of empirical data and lack of methodological rigor. Lastly, for the research scope of this review, articles solely focusing on online courses were excluded, while those incorporating a hybrid of online and offline courses or offline courses were considered for inclusion. This choice was made in considering the significant variations in student performance between the online course and the other two types of teaching and assessment methods. This study focuses on the impact of offline teaching on students' performance, considering that online and offline teaching include offline teaching. Therefore, articles focusing on offline teaching and those combining online and offline teaching are more relevant to the review topic.

TABLE 1 Keywords and information search strategy.

Database	Keywords
Scopus	(TITLE-ABS-KEY ("BOPPPS" OR "BOPPPS model") AND TITLE-ABS-KEY ("Student*" OR "Student* Performance" OR "Student* Outcome*" OR "Achievement" OR "Academic Performance" OR "Learning Performance" OR "Learning Outcome*"))
WoS	TS=("BOPPPS" OR "BOPPPS model") AND ("Student*" OR "Student* Performance" OR "Student* Outcome*" OR "Student* Achievement" OR "Academic Performance" OR "Learning Performance")

TABLE 2 Inclusion and exclusion criteria.

Database	Included	Excluded
Timeline	2019–March 2024	<2019 and > March 2024
Source type	Journals (research articles)	Journals (review papers), books, preprints, book chapters, series, theses, and conference proceedings
Language	English	Non-English
Teaching model	BOPPPS model	Other models
Course type	hybrid of online and offline Courses, offline courses	Online courses

Appraisal of quality

According to Stoll et al. (2019), to reduce bias, it is best to have more than one reviewer involved in the review process. This study use a data extraction sheet for recording and organizing key information extracted from each selected literature (Tian et al., 2017). The extraction process involves two reviewers to ensure the accuracy of the data and the quality of the articles. Disparities in the extraction phase are adjudicated by a consensus review of the full text by the two evaluators and a third evaluator, determining article retention or exclusion.

The articles were quality assessed using the PRISMA 2020 checklist, which covers basic reporting elements of a systematic evaluation, including title, abstract, and methods etc. (Page et al., 2021). Each article was divided into high, medium or low quality (Leadley et al., 2014). The review process focused on factors directly related to students' performance. The result are adequately supported by the article's data, and the reasoning process is sound. If the right steps have been taken and potential bias has been sufficiently taken into account. The results are reputable and trustworthy, and the conclusions are succinct and understandable. These 19 articles met at least a moderate standard of quality during the assessment process and were therefore retained.

Data analysis

This study organizes and identifies research characteristics and trends, exploring the application of the BOPPPS model, learning subjects, student learning formats, and research theories, all aimed at better analyzing student performance. It includes identifying variables related to student performance and discussing findings.

Results and discussion

Characteristics of the articles

Use of the BOPPPS model is summarized in three main categories (see Table 3), Category one, purely using the BOPPPS model (Guo, 2024; Xiong, 2023; Li P. et al., 2023; Hu et al., 2022; Zeng, 2023). The advantages of BOPPPS model are clear structure, step-by-step, and conducive to the organization and implementation of classroom teaching. Instructors can easily identify the impact of the BOPPPS model on students' performance. Category two, BOPPPS model used combined with another instructional model (Hu, 2024; Li Z. et al., 2023; Ma et al., 2021; Shih and Tsai, 2020; Wen et al., 2023; Liu et al., 2022; Yu, 2023; Chen et al., 2022; Xu et al., 2023; Wang, 2023; Li S. et al., 2023). BOPPPS can better suit the needs of specific courses and learners by combining other instructional models. However, the combination of models is more complicated and requires higher instructional design and organizational skills of teachers. Category three, the BOPPPS model combined with two or more instructional models (Chen et al., 2023; Dai et al., 2022). The combination of multiple instructional models can greatly increase the complexity of instruction. Teachers need to have a broader range of pedagogical knowledge and experience when applying multiple models, and it is more difficult to implement instruction and assess students' performance. The BOPPPS model can be used in combination with one or more models, showing that the model is highly flexible and applicable.

This study found three learning format in total: online, offline, online, and offline. Online has been excluded during the previous review process, review articles for types of courses see Table 3. The literature reviewed contained a total of seven offline (Chen et al., 2023; Hu et al., 2022; Li Z. et al., 2023; Shih and Tsai, 2020; Wen et al., 2023; Chen et al., 2022; Wang, 2023). Instructors can directly observe the students' learning status and performance in offline classes, and the teaching session can be well controlled. However, it is limited by classroom time and space. There are 12 online and offline papers (Guo, 2024; Hu, 2024; Xiong, 2023; Li P. et al., 2023; Dai et al., 2022; Ma et al., 2021; Zeng, 2023; Liu et al., 2022; Yu, 2023; Xu et al., 2023; Li S. et al., 2023; Hsu and Ou, 2022). A noteworthy point is that in most of these references, online and offline mainly refer to instructors uploading learning resources and tasks on online learning platforms for students to independently study relevant knowledge before class. As for offline teaching, some instructors also use the functions of online learning platforms, such as Rain Classroom, WeChat, QQ, etc., to post questions, implement classroom discussions, and collect feedback to help students participate in the classroom. Although the BOPPPS model is primarily implemented in offline settings, some instructors also leverage the functionalities of online learning platforms to enhance student engagement during classroom sessions. This blended approach, capitalizes on the strengths of different instructional phases, providing students with a diversified learning experience. These article features reveal the flexibility of the BOPPPS model to be used independently or in combination with other models, highlighting its broad applicability across disciplines. This versatility helps students be exposed to different forms of learning, which is beneficial for their educational experience. In addition, it provides a basis for current research that assesses students' performance.

The literature on BOPPPS indicates that, in comparison to arts and social science courses, there is a larger body of material on BOPPPS for science subjects. The medical category is the most widely used area for applying BOPPPS model in research, with a total of seven publications covering various aspects of Nursing, Surgery, Gynecology, etc. (Li P. et al., 2023; Hu et al., 2022; Li Z.

TABLE 3 Characteristics of the articles chosen for evaluation.

Use of BOPPPS model	Learning format	Subject	References
BOPPPS model	Online and offline	English	Guo, 2024
BOPPPS and flipped classrooms	Online and offline	English	Hu, 2024
BOPPPS model	Online and offline	Ideological and political education	Xiong, 2023
BOPPPS model	Online and offline	Medical	Li P. et al., 2023
BP-CM (BOPPPS, PAD, cyclic memory, memory system) teaching model	Offline	IoT hardware technology courses	Chen et al., 2023
BOPPPS model	Offline	Medical	Hu et al., 2022
BOPPPS and team-based learning (TBL)	Offline	Medical	Li Z. et al., 2023
BOPPPS and Blended learning	Online and offline	Health management	Ma et al., 2021
BOPPPS and Flipped classroom (FC)	Offline	Business Etiquette	Shih and Tsai, 2020
BOPPPS model and "Flipped classroom", "Rain Classroom", "presentation-assimilation-discussion (PAD)"	Online and offline	Animal medicine	Dai et al., 2022
BOPPPS model	Online and offline	Mathematics	Zeng, 2023
BOPPPS model and case-based learning (CBL)	Offline	Medical	Wen et al., 2023
BOPPPS and Hybrid teaching	Online and offline	Medical	Liu et al., 2022
BOPPPS and goal-problem oriented model	Online and offline	Financial	Yu, 2023
BOPPPS and case-based learning (CBL) model	Offline	Medical	Chen et al., 2022
BOPPPS and flipped classrooms	Online and offline	Medical	Xu et al., 2023
BOPPPS and interactive response system (IRS)	Offline	Management	Wang, 2023
Blended BOPPPS model	Online and offline	Fermentation engineering	Li S. et al., 2023
BOPPPS and design-based model	Online and offline	Architecture education	Hsu and Ou, 2022

et al., 2023; Wen et al., 2023; Liu et al., 2022; Chen et al., 2022; Xu et al., 2023). Three studies in the management category applied the BOPPPS model, including (Ma et al., 2021; Shih and Tsai, 2020; Wang, 2023). There are two literatures in the engineering and technology category of research (Chen et al., 2023; Li S. et al., 2023). And two papers in the language category (Guo, 2024; Hu, 2024). Mathematics and Finance each have one related paper (Zeng, 2023; Yu, 2023). Finally, one article on the Architectural Design category (Hsu and Ou, 2022).

TABLE 4 Models and theories used in articles.

Theory	References	No.
Constructivist and Cognitive discovery theory	Guo, 2024	1
Constructivist and Communicative	Zeng, 2023	1
Information theory	Xiong, 2023	1
OBE (Outcome based education) concept	Li P. et al., 2023; Yu, 2023	2
Memory system	Chen et al., 2023	1
Team-based learning	Li Z. et al., 2023	1
Bloom's Taxonomy	Wen et al., 2023	1
Self-regulation theory	Wang, 2023	1
Design-Based Learning	Hsu and Ou, 2022	1
None	Hu, 2024; Hu et al., 2022; Ma et al., 2021; Shih and Tsai, 2020; Dai et al., 2022; Liu et al., 2022; Chen et al., 2022; Xu et al., 2023; Li S. et al., 2023	9

Theories

A variety of theories were involved in the literature related to the BOPPPS Model and students' performance (see Table 4). Nine had no theories and the remaining eleven had less literature using the same theories. These theories can be broadly categorized into the fields of psychology, information science, education, and cognitive science.

Two articles refer to the Constructivist theory (Guo, 2024; Zeng, 2023), and one article refer to Cognitive Discovery Theory (Guo, 2024). Several other theories are also employed across the selected articles, Information Theory (Xiong, 2023), OBE (Outcome-based Education) concept (Li P. et al., 2023; Yu, 2023), Memory System (Chen et al., 2023), Team-based Learning (Li Z. et al., 2023), Bloom's Taxonomy (Wen et al., 2023), Self-regulation Theory (Wang, 2023), and Design-Based Learning (Hsu and Ou, 2022). However, some articles (Hu, 2024; Hu et al., 2022; Ma et al., 2021; Shih and Tsai, 2020; Dai et al., 2022; Liu et al., 2022; Chen et al., 2022; Xu et al., 2023; Li S. et al., 2023) do not explicitly mention any specific theory.

Several theories shed light on the use of the BOPPPS Model and its impact on student performance. The Constructivist theory

and Cognitive Discovery theory (Guo, 2024) emphasize learners actively constructing knowledge through experiences, aligning with the participatory learning phase of BOPPPS. Leading American cognitive and educational psychologist Bruner held the view that learning should be oriented toward transforming a subject's fundamental structure into the cognitive structure of the student's mind through the process of discovery learning (Kirschner et al., 2006). The Constructivist and Communicative approaches (Zeng, 2023) underscore the value of interaction, supports an approach that is student-centered, echoing the interactive nature of BOPPPS. According to Anderson's and other experts' theories, remembering, comprehension, application, analysis, assessment, and production are among the academic behavior manifestations that people should be proficient in during their cognitive learning process (Feronica et al., 2021).

Information theory (Xiong, 2023) guides optimizing how information is presented and conveyed throughout the model. SPady proposed OBE, emphasizing student-centered, outcome-oriented, and continual improvement are essential principles (Sasipraba et al., 2020). The Outcome-based Education concept (Li P. et al., 2023; Yu, 2023) advocates defining clear learning outcomes, mirroring the objective-setting component of BOPPPS. Principles of Memory Systems (Chen et al., 2023) can enhance knowledge retention across the model's phases. Team-based Learning strategies (Li Z. et al., 2023) offer collaborative participatory activities. Both Team-based Learning and BOPPPS promote the promotion of student participation and interaction to improve the effectiveness of teaching and learning. Bloom's Taxonomy (Wen et al., 2023) aligns activities with progressive cognitive levels. Self-regulation Theory (Wang, 2023) highlights cultivating self-directed learners through BOPPPS. Moreover, Design-Based Learning (Hsu and Ou, 2022) mirrors the cyclical process of designing, implementing, and refining BOPPPS in real classroom contexts. These theories provide some guidance for understanding and optimizing the effectiveness of the BOPPPS model in promoting students' learning and improving their performance.

In these 19 papers, the use of theory involves a variety of different theoretical perspectives, providing a multifaceted interpretation of the BOPPPS model and its usefulness for students' performance. However, there are some shortcomings. Nine articles did not explicitly state the use of theories, accounting for nearly half of the reviewed literature, and the overall theoretical foundation is still weak, making it difficult to form a more systematic and in-depth theoretical analysis of the BOPPPS model. On the other hand, studies that do not mention theories may overlook the guiding of some other important theories. The existing literature needs to be strengthened in the use of theory. In the future, the theoretical basis of the BOPPPS model should be systematically examined and established in more empirical studies to provide solid theoretical support for the design and implementation of BOPPPS instruction.

Student-related variables in BOPPPS model review

The researcher categorized and organized the factors related to students in the reviewed literature with a focus on identifying factors related to student performance (see Figure 2). Performance from academic performance, learning performance, skill tests, learning ability, cognitive ability, attendance, classroom performance, and classroom participation is categorized in several aspects, as well as online performance and some other factors. The organization and categorization are important for a better understanding of their interactions and impact on BOPPPS educational research, and the categorical organization in the table is based on theoretical foundations and practical considerations.

Academic performance are essential indicators of students' learning. These variables include regular coursework scores, exam or test scores, and formative assessments (see Table 5). These factors are important indicators of academic achievement in educational evaluation procedures. The evaluation of curriculum design, teaching methods, and other educational interventions on student learning Performance by their inclusion in studies. Regular coursework reflects students' ongoing grasp of material (Dai et al., 2022; Li P. et al., 2023; Ma et al., 2021; Liu et al., 2022). Examination and test scores provide an assessment of learning, and it is the factor that most researchers would choose to measure students' performance (Guo, 2024; Xiong, 2023; Li P. et al., 2023; Li Z. et al., 2023; Ma et al., 2021; Dai et al., 2022; Zeng, 2023; Wen et al., 2023; Liu et al., 2022; Chen et al., 2022; Li S. et al., 2023; Xu et al., 2023; Shih and Tsai, 2020). Coursework and examinations are used by most researchers to assess students' academic performance. Formative assessments allow monitoring of learning progress (Yu, 2023; Hsu and Ou, 2022). Teachers can use it to better understand how well their students are learning, where they might be having difficulty, and what instructional modifications could be necessary to meet their requirements.

Learning performance can be assessed through learning engagement (Yu, 2023) and achievement of learning goals (Li S. et al., 2023). Learning engagement reflects active involvement and participation in learning activities, which is crucial for students' deep understanding and knowledge retention. achievement of learning goals assessment can help students determine whether they are meeting their intended learning goals, and it can also help teachers evaluate the effectiveness of their teaching. Skill tests performance (Guo, 2024; Hu, 2024; Li P. et al., 2023; Chen et al., 2023; Hu et al., 2022; Ma et al., 2021; Wen et al., 2023; Chen et al., 2022; Xu et al., 2023; Hsu and Ou, 2022) evaluates specific competencies and practical abilities (see Table 5). Skills tests are more common in fields such as medicine, languages, and the arts, and usually involve hands-on exercises or demonstrations to assess a student's skills.

Learning ability variables encompass a wide range of factors that influence how students acquire, process, and apply knowledge. Learning ability variables (see Table 5) include memorization (Li P. et al., 2023), understanding (Li P. et al., 2023; Wen et al., 2023; Wang, 2023), knowledge acquisition (Li P. et al., 2023), learning awareness (Hsu and Ou, 2022), learning effectiveness (Li P. et al., 2023; Zeng, 2023; Liu et al., 2022), learning interest (Li P. et al., 2023; Wen et al., 2023), self-learning ability (Guo, 2024; Li S. et al., 2023; Li Z. et al., 2023; Li P. et al., 2023; Hu et al., 2022), learning initiative (Hu et al., 2022; Ma et al., 2021; Li S. et al., 2023; Liu et al., 2022), problem-solving skills (Chen et al., 2022; Hsu and Ou, 2022), and self-regulated learning (Wang, 2023). These factors reflect various cognitive processes in learning.

FIGURE 2
BOPPPS model and student-related variables.

Memorization of knowledge and concepts is deepened through repetition and consolidation. Students connect newly learned material to previous knowledge structures at the key learning stage of comprehension. Knowledge acquisition ability enables students to actively learn and acquire new knowledge and skills. Learning awareness, effectiveness, interest, and self-learning ability are important for lifelong learning. Learning initiative, Problem-solving skills and self-regulated learning enable students to navigate complex tasks and effectively manage their learning processes.

Learning ability performance emphasizes an individual's abilities and behaviors in the learning process. It focuses on how individuals approach learning tasks, adapt to the learning environment, and use resources and information for learning. Cognitive ability performance focuses on an individual's performance in cognitive activities. Attention is given to how individuals process information and understand concepts. Variables (see Table 5) reflecting cognitive abilities have critical thinking ability (Li Z. et al., 2023), students' perceptions (Shih and Tsai, 2020; Hsu and Ou, 2022), learning self-efficacy (Wang, 2023), academic self-efficacy (Wang, 2023), self-confidence (Wen et al., 2023), creative spirit and research awareness (Li P. et al., 2023), analysis ability (Hu et al., 2022; Li Z. et al., 2023; Chen et al., 2022).

Attendance performance (see Table 5) was measured in some studies (Ma et al., 2021; Li P. et al., 2023; Liu et al., 2022). Attendance records can contribute to the evaluation of a student's performance. Some classes may include attendance as part of the grade. Classroom performance factors (see Table 5) included interaction (Guo, 2024; Li P. et al., 2023; Hu et al., 2022; Wen et al., 2023), classroom attention (Guo, 2024), students' responses (Ma et al., 2021; Dai et al., 2022), answering questions (Ma et al., 2021; Li P. et al., 2023), discussion (Li P. et al., 2023), and classroom participation (Zeng, 2023; Li P. et al.,

TABLE 5 Analysis of variables related to students.

Type of variable	References	No.
Performance		
1. Academic performance		
•Regular coursework score	Dai et al., 2022; Li P. et al., 2023; Ma et al., 2021; Liu et al., 2022	4
•Examination/Test score	Guo, 2024; Xiong, 2023; Li P. et al., 2023; Li Z. et al., 2023; Ma et al., 2021; Dai et al., 2022; Zeng, 2023; Wen et al., 2023; Liu et al., 2022; Chen et al., 2022; Li S. et al., 2023; Xu et al., 2023; Shih and Tsai, 2020	12
•Formative assessment	Yu, 2023; Hsu and Ou, 2022	2
2. Learning performance		
•Learning engagement	Yu, 2023	1
•Achievement of learning goals	Li S. et al., 2023	1
3. Skill tests performance	Guo, 2024; Hu, 2024; Li P. et al., 2023; Chen et al., 2023; Hu et al., 2022; Ma et al., 2021; Wen et al., 2023; Chen et al., 2022; Xu et al., 2023; Hsu and Ou, 2022	10
4. Learning ability performance		
•Memorization	Li P. et al., 2023	1
•Understanding	Li P. et al., 2023; Wen et al., 2023; Wang, 2023	3
•Knowledge acquisition	Li P. et al., 2023	1
•Learning awareness	Hsu and Ou, 2022	1
•Learning effectiveness	Li P. et al., 2023; Zeng, 2023; Liu et al., 2022	3
•Learning interest	Li P. et al., 2023; Wen et al., 2023	2
•Self-learning ability	Guo, 2024; Li S. et al., 2023; Li Z. et al., 2023; Li P. et al., 2023; Hu et al., 2022	6
•Learning initiative	Hu et al., 2022; Ma et al., 2021; Li S. et al., 2023; Liu et al., 2022	4
•Problem-solving skills	Chen et al., 2022; Hsu and Ou, 2022	2
•Self-regulated learning	Wang, 2023	1
5. Cognitive ability performance		
•Critical thinking ability	Li Z. et al., 2023	1
•Students' perception	Shih and Tsai, 2020; Hsu and Ou, 2022	2
•Learning self-efficacy	Wang, 2023	1
•Academic self-efficacy	Wang, 2023	1
•Self-confidence	Wen et al., 2023	1
•Creative spirit and awareness of research	Li P. et al., 2023	1
•Analysis ability	Hu et al., 2022; Li Z. et al., 2023; Chen et al., 2022	4
6. Attendance performance	Ma et al., 2021; Li P. et al., 2023; Liu et al., 2022	3
7. Classroom performance		
•Interaction	Guo, 2024; Li P. et al., 2023; Hu et al., 2022; Wen et al., 2023	4
•Classroom attention	Guo, 2024	1
•Students' responses	Ma et al., 2021; Dai et al., 2022	2
•Answering questions	Ma et al., 2021; Li P. et al., 2023	2
•Discussion	Li P. et al., 2023	1
•Classroom participation	Zeng, 2023; Li P. et al., 2023	2
8.Online performance	Li P. et al., 2023; Zeng, 2023; Liu et al., 2022	3
Other		
1. Satisfaction		
•Learning satisfaction	Hsu and Ou, 2022; Li S. et al., 2023	2
•Course satisfaction	Hu et al., 2022; Chen et al., 2022; Li S. et al., 2023	3
•Student satisfaction	Zeng, 2023; Liu et al., 2022; Li P. et al., 2023	3
•Teaching satisfaction	Wen et al., 2023; Xu et al., 2023	2
2. Other aspects		
•Intercultural communication competence	Hu, 2024	1
•Student learning style expectation	Xiong, 2023	1
•Teaching feedback	Chen et al., 2023	1
•Students' choices about teaching method in the future	Liu et al., 2022	1
•Moral concepts and professionalism	Li S. et al., 2023	1
•Affective commitment	Yu, 2023	1
•Motivation	Guo, 2024; Ma et al., 2021; Chen et al., 2022	3
•Self-improvement	Chen et al., 2023	1

2023). Classroom performance is directly related to classroom efficiency and is a crucial element in the success of the BOPPPS model implementation. Classroom interaction and classroom participation promotes communication among students and between students and teachers. students' active participation in the classroom can reflect their learning attitudes, and students who actively participate in classroom activities are usually more likely to achieve good grades. Students' concentration in class determines their understanding and absorption of the content. Students' responses, including answering questions and discussion, are also part of the teacher-student interaction. Teachers can assess the effectiveness of teaching and learning by the extent to which students respond or answer questions and make adjustments based on students' feedback. Teachers can assess the effectiveness of teaching through the degree of students' responses or answers to questions and make adjustments according to students' feedback. A good classroom discussion environment can promote the exchange of ideas and knowledge sharing among students.

Online student performance (see Table 5) was not the center of this study, and several of the 11 combined online and offline BOPPPS instructional literatures considered the factors of online student performance (Li P. et al., 2023; Zeng, 2023; Liu et al., 2022), it captures student engagement in online learning contexts. Satisfaction belongs to multiple dimensions of evaluation Satisfaction variables encompass learning satisfaction (Hsu and Ou, 2022; Li S. et al., 2023), course satisfaction (Hu et al., 2022; Chen et al., 2022; Li S. et al., 2023), student satisfaction (Zeng, 2023; Liu et al., 2022; Li P. et al., 2023), and teaching satisfaction (Wen et al., 2023; Xu et al., 2023). These variables provide insights into students' affective experiences and attitudes toward various aspects of the educational process.

Finally, there are a number of other factors that are relevant to students, but not to students' performance (see Table 5). Other variables explored include intercultural communication competence (Hu, 2024), student learning style expectation (Xiong, 2023), teaching feedback (Chen et al., 2023), students' choices about future teaching methods (Liu et al., 2022), moral concepts and professionalism (Li S. et al., 2023), affective commitment (Yu, 2023), motivation (Guo, 2024; Ma et al., 2021; Chen et al., 2022), and self-improvement (Chen et al., 2023).

From the review, it can be seen that there are many factors associated with students' performance in studies using the BOPPPS model, and researchers can choose aspects of interest or less researched elements to explore based on the categorization.

Review of literature research design, type, and instruments

Research examining the impact of the BOPPPS model on student performance has employed diverse research designs and instruments to comprehensively assess various aspects of student outcomes. Four studies adopted a mixed-methods approach, combining quantitative and qualitative data collection BOPPPS to holistically evaluate the model's effects on students' performance (Guo, 2024; Shih and Tsai, 2020; Li Z. et al., 2023; Hsu and Ou, 2022). These four mixed-methods studies implemented experimental or quasi-experimental designs and utilized interviews or semi-structured interviews to delve into student performance. Quantitative methods were widely embraced and used. In addition to the quantitative components within the 4 mixed-methods studies, 15 articles employed purely quantitative methods (Table 6). Furthermore, most quantitative studies incorporated two or three instruments among tests, scales, or questionnaires to assess students' performance.

Regarding research designs, mixed-methods and quantitative methods garnered substantial attention and application. The mixed-methods, integrating quantitative and qualitative data collection techniques, enabled comprehensive evaluations of the BOPPPS model's impact on students' performance. The universal adoption of quantitative methods signifies researchers' inclination toward objective data and statistical analyses when assessing the model's effects on students' performance. The mixed-methods research offers a more holistic assessment by combining the reliable statistical support of quantitative data with the in-depth exploration of students' subjective experiences and perspectives through qualitative data.

Concerning research instruments, questionnaires, tests, and scales were the most commonly employed data collection tools. Additionally, interviews and semi-structured interviews were utilized for qualitative data collection, complementing quantitative data and providing deeper insights into students' learning experiences and perceptions. Overall, these studies encompassed diverse research designs and data collection tools, scientifically examining the BOPPPS model's influence on learners from multiple angles, thereby furnishing more reliable evidence to support BOPPPS educational practices.

Research finding

Several studies reported that the BOPPPS model and its variations effectively enhanced students' engagement, participation, interest, and motivation in learning (Guo, 2024; Ma et al., 2021; Shih and Tsai, 2020; Zeng, 2023; Wang, 2023; Hsu and Ou, 2022). Specifically, Guo (2024) and Shih and Tsai (2020) found that the BOPPPS approach increased classroom participation and interactions, and fostered a lively and enjoyable learning environment, leading to improved overall learning outcomes. Ma et al. (2021) highlighted the model's ability to stimulate enthusiasm and initiative, while Zeng (2023) observed heightened learning passion and Wang (2023) found that self-efficacy improved. Li S. et al. (2023) found increased student initiative and Hsu and Ou (2022) also noted increased interest and motivation among students.

Several studies have shown how the BOPPPS model and its improved learning abilities and skills, such as critical thinking, problem-solving, analytical skills, and self-directed learning (Li Z. et al., 2023; Ma et al., 2021; Chen et al., 2022; Wen et al., 2023). and Li Z. et al. (2023) proposed the BOPPPS model to improve students' autonomous learning competencies and critical thinking abilities. Ma et al. (2021) and Chen et al. (2022) found that

TABLE 6 Research design, type, instruments, and findings.

References	Design and type	Instruments	Finding
Guo (2024)	Mixed methods (experimental)	Test, scale, interview	It can effectively increase students' classroom participation and effectiveness in teaching, improving their overall English language skills and independent English learning abilities.
Hu (2024)	Quantitative (experimental)	Test, questionnaire	A 10-week experiment was set up with two courses. The average score for experimental class performance was much greater than that of the control class.
Xiong (2023)	Quantitative (experimental)	Test, questionnaire	The teaching effectiveness of the BOPPPS teaching mode with online and offline integration is greater than the "online resources + offline classroom teaching" mode, which is greater than the BOPPPS teaching mode, which is greater than the traditional teaching mode.
Li P. et al. (2023)	Quantitative (experimental)	Test, questionnaire	More than 95% of students are satisfied with the teaching model, which has increased their participation in class and clinical reasoning skills.
Chen et al. (2023)	Quantitative (experimental)	Test, questionnaire	The BP-CM model has a good impact on students' initiative and memory. Teachers can receive quick feedback, which greatly increases students' knowledge and ability degrees. It improves the teaching quality of IoT hardware technology classes and helps students develop long-term learning capacities.
Hu et al. (2022)	Quantitative (experimental)	Test, scale	The BOPPPS model can better inspire clinical medical students' enthusiasm for thoracic surgery and enhance the students' comprehensive ability.
Li Z. et al. (2023)	Mixed methods (quasi-experimental)	Test, semi-structured interview	The combination of BOPPPS and TBL positively impacted nursing students by improving their autonomous learning competencies and critical thinking ability.
Ma et al. (2021)	Quantitative (quasi-experimental)	Test, scale	The BL-BOPPPS model has increased health students' enthusiasm and interest, strengthened their abilities, initiative, and motivation in learning, and improved self-directed learning capacity, academic performance, and quality of teaching.
Shih and Tsai (2020)	Mixed methods (quasi-experimental)	Questionnaire, semi-structured interview	Students in the BOPPPS group performed better than the traditional group. The experimental group students were very pleased with the BOPPPS teaching method because it produced more teacher-student interactions, making the class lively and fun, which significantly improved their learning outcomes.
Dai et al. (2022)	Quantitative	Test, questionnaire	The BL-BOPPPS teaching model is feasible and effective in veterinary infectious disease course. By establishing a diverse teaching assessment and evaluation system, emphasizing students' participatory learning and learning initiative, their independent learning, thinking, and creativity abilities will be enhanced.
Zeng (2023)	Quantitative (experimental)	Test, questionnaire	The BOPPPS teaching approach can considerably raise the number of students who achieve high scores, improve the learning effect, decrease failure rates, and boost students' learning passion and ability to absorb knowledge.
Wen et al. (2023)	Quantitative (experimental)	Test, questionnaire	The BOPPPS-CBL model significantly improved nursing students' abilities in ECG interpretation. It's an effective approach to improving students' attitudes toward teaching and learning.
Liu et al. (2022)	Quantitative (experimental)	Test, questionnaire	HBOPPPS can improve the effectiveness of Physiology teaching. It is due to greater repeatability and flexibility and also improved learning initiatives.
Yu (2023)	Quantitative	Questionnaire	BL classes based on the GPOB model positively affect students' learning engagement and performance and activate their affective commitment to career development.
Chen et al. (2022)	Quantitative (experimental)	Test, questionnaire	The BOPPPS-CBL group showed a significant increase in motivation and learning effect. This model increases students' enthusiasm for learning and assists them to develop their analytical and problem-solving skills without raising learning pressure.
Xu et al. (2023)	Quantitative (experimental)	Test, questionnaire	The hybrid BOPPPS teaching method improves trainee doctors' learning environments, stimulates their interest and initiative in learning, improves their clinical practice skills, and increases their satisfaction.
Wang (2023)	Quantitative (experimental)	questionnaire	When teachers used the BOPPPS model and the interactive response system tool, students who participated in the classroom showed high levels of learning and academic self-efficacy in the classroom.
Li S. et al. (2023)	Quantitative (experimental)	Test, questionnaire	The "B + BOPPPS" teaching model may increase students' interest in studying and boost their subjective initiative. It also increased the student's capacity to gain and apply knowledge, which benefited the theoretical teaching quality of the Fermentation Engineering course.
Hsu and Ou (2022)	Mixed methods (experimental)	Test, questionnaire and interview	It helps students learn more effectively. The analysis of learning satisfaction indicates that it increases students' interest and motivation to learn.

the model enhanced self-directed learning capacity and problem-solving skills, respectively.

Improved academic performance and learning effectiveness were also observed in multiple studies (Hu, 2024; Li P. et al., 2023; Ma et al., 2021; Shih and Tsai, 2020; Dai et al., 2022; Zeng, 2023; Chen et al., 2022). Hu (2024) reported higher average scores in the BOPPPS class, while Shih and Tsai (2020) noted better learning outcomes and Li P. et al. (2023) find that improved clinical reasoning skills. Ma et al. (2021) and Zeng (2023) observed enhanced academic performance and knowledge absorption, respectively. Dai et al. (2022) and Chen et al. (2022) highlighted the model's effectiveness in improving learning effects.

Numerous research also emphasized how the BOPPPS model, improves learning environments, student satisfaction, and teaching quality (Chen et al., 2023; Hu et al., 2022; Xu et al., 2023; Wen et al., 2023; Liu et al., 2022). Chen et al. (2023) found that the model improved teaching quality and facilitated long-term learning capacities, while Hu et al. (2022) and Xu et al. (2023) reported increased student satisfaction and improved learning environments. Wen et al. (2023) and Liu et al. (2022) noted the model's effectiveness in enhancing teaching and learning.

These research findings point to the possibility that the BOPPPS teaching model can improve student engagement, motivation, skills development, academic performance, and overall quality of teaching and learning. The BOPPPS model emphasizes student engagement throughout the learning process, effectively stimulating their interest and motivation, thereby enhancing learning outcomes. By providing clear learning objectives, the model helps students strengthen their learning focus and improve efficiency. The pre-assessment and post-assessment components enable students to promptly evaluate their learning progress. Additionally, the BOPPPS model offers students a well-structured learning framework, helping them focus more effectively on mastering knowledge and skills.

Limitations and recommendations

It ought to be considered to recognize that there were certain limitations to the method. Several research projects only used questionnaires or interviews, which might not give researchers a complete picture of the efficacy of the BOPPPS model because of biases or incomplete viewpoints. Additionally, the relatively small sample sizes in some research may have had an impact on how broadly applicable the results are. Even though the majority of research presented positive findings, there was no discussion of the accuracy, accessibility, or comprehensiveness of the data gathered. Variables like response rates, incomplete data, or measurement mistakes may affect how valid and reliable the findings remain.

Limitations of external and internal validity

The fact that the research was carried out across various academic fields and environments may have limited the findings' applicability to different student demographics or scenarios. The efficacy of the BOPPPS paradigm and its modifications may be impacted by subject matter changes, institutional considerations, or cultural differences. There were few talks about possible confounding variables or internal biases that could affect the outcomes, and few research used experimental designs. The observed results could have been affected by variables like student prior knowledge, teacher effectiveness, or the atmosphere of the classroom. A few of the studies mentioned that there were time or resource limits, which could have affected the research's breadth, length, or depth.

Some methodological advice for the future

Studies should think about using more reliable research designs, including mixed-methods approaches or longitudinal studies, to capture the long-term effects of the BOPPPS model and triangulate results from various data sources. Greater diversity and larger sample sizes may also improve the results' generalizability. A review reveals fewer qualitative studies. Qualitative research might be done to learn more about the experiences, opinions, and difficulties that instructors and students have when putting the BOPPPS model into practice. These revelations may help develop strategies for successful execution and remove any obstacles.

Researchers could investigate how well the BOPPPS model and blended BOPPPS model work in other cultural contexts, topic areas, or educational levels (e.g., primary, secondary, or higher education). This would enable a more comprehensive grasp of the model's application by highlighting its adaptability and possible adjustments for particular circumstances. Researchers could investigate how to combine new technologies with the BOPPPS model to improve learning outcomes and offer individualized help as educational technology advances. Finally, future research can contribute to more thorough, constraints, and practices for implementing the BOPPPS teaching model across a variety of educational situations by resolving these limitations and recommendations.

Conclusion

The study conducted a comprehensive examination of 19 articles using the PRISMA systematic review methodology, with a focus on the characteristics of the articles chosen for evaluation (such as the use of the BOPPPS model, course type, and subject), the application of theory, the variables related to students in the use of the BOPPPS model, research methods, and finding analysis. In the article, student-related variables are categorized into types, including academic performance, learning performance, skill tests performance, learning ability performance, cognitive ability performance, attendance performance, classroom performance, online performance, and other aspects. The key factors associated with students' performance and use of the BOPPPS model included students' classroom participation, interaction, learning engagement, etc. Participatory learning is a crucial component emphasized by the BOPPPS model. Participation and classroom engagement encourage students to communicate with peers and with teachers and participate in interactions. Students' engagement in the classroom is a reflection of their learning

attitudes, and actively participating in class activities usually obtains better performance.

Some suggestions for methodology for the future. First, to capture the long-term effects of the BOPPPS model, employ mixed-methods approaches or longitudinal research. Second, to improve the ability to apply of findings, include more diversity and larger sample sizes in investigations. Third, find out how well the BOPPPS model works in various educational settings, subject areas, and cultural contexts. Fourth, as educational technology develops, investigate whether new tools might be added to the BOPPPS model to boost student performance and offer created assistance.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

JL: Formal analysis, Software, Writing – original draft. SO: Supervision, Writing – review & editing. YW: Resources, Validation, Visualization, Writing – original draft. YX: Resources, Software, Validation, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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