BMC Medical Education

RESEARCH

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Evaluation of the BOPPPS model on otolaryngologic education for five-year undergraduates

Dachuan Fan[1†], Chao Wang[2†], Xiumei Qin[1†], Shiyu Qiu[1†], Yan Xu[1], Yatang Wang[1] and Jinxiao Hou[3*]

Abstract

Background This study aimed to assess the effectiveness of the BOPPPS model (bridge-in, learning objective, pre-test, participatory learning, post-test, and summary) in otolaryngology education for five-year undergraduate students.

Methods A non-randomized controlled trial was conducted with 167 five-year undergraduate students from Anhui Medical University, who were allocated to an experimental group and a control group. The experimental group received instruction using the BOPPPS model, while the control group underwent traditional teaching methods. The evaluation of the teaching effectiveness was performed through an anonymous questionnaire based on the course evaluation questionnaire. Students' perspectives and self-evaluations were quantified using a five-point Likert scale. Furthermore, students' comprehension of the course content was measured through a comprehensive final examination at the end of the semester.

Results Students in the experimental group reported significantly higher scores in various competencies compared to the control group: planning work (4.27 ± 0.676 vs. 4.03 ± 0.581, $P < 0.05$), problem-solving skills (4.31 ± 0.624 vs. 4.03 ± 0.559, $P < 0.01$), teamwork abilities (4.19 ± 0.704 vs. 3.87 ± 0.758, $P < 0.05$), and analytical skills (4.31 ± 0.719 vs. 4.05 ± 0.622, $P < 0.05$). They also reported higher motivation for learning (4.48 ± 0.618 vs. 4.09 ± 0.582, $P < 0.01$). Additionally, students in the experimental group felt more confident tackling unfamiliar problems (4.21 ± 0.743 vs. 3.95 ± 0.636, $P < 0.05$), had a clearer understanding of teachers' expectations (4.31 ± 0.552 vs. 4.08 ± 0.555, $P < 0.05$), and perceived more effort from teachers to understand their difficulties (4.42 ± 0.577 vs. 4.13 ± 0.59, $P < 0.01$). They emphasized comprehension over memorization (3.65 ± 1.176 vs. 3.18 ± 1.065, $P < 0.05$) and received more helpful feedback (4.40 ± 0.574 vs. 4.08 ± 0.585, $P < 0.01$). Lecturers were rated better at explaining concepts (4.42 ± 0.539 vs. 4.08 ± 0.619, $P < 0.01$) and making subjects interesting (4.50 ± 0.546 vs. 4.08 ± 0.632, $P < 0.01$). Overall, the experimental group expressed higher course satisfaction (4.56 ± 0.542 vs. 4.34 ± 0.641, $P < 0.05$). In terms of examination performance, the experimental group scored higher on the final examination (87.7 ± 6.7 vs. 84.0 ± 7.7, $P < 0.01$) and in noun-interpretation (27.0 ± 1.6 vs. 26.1 ± 2.4, $P < 0.01$).

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Conclusion The BOPPPS model emerged as an effective and innovative teaching method, particularly in enhancing students' competencies in otolaryngology education. Based on the findings of this study, educators and institutions were encouraged to consider incorporating the BOPPPS model into their curricula to enhance the learning experiences and outcomes of students.

Keywords BOPPPS model, Otolaryngology education, Five-year undergraduates, Competency-based education

Introduction

Otolaryngology is a distinctive clinical discipline characterized by its unique professional attributes that focus on the diagnosis and treatment of disorders affecting the ears, nose, throat, head and neck regions. Otolaryngologists frequently encounter various clinical manifestations associated with systemic diseases, requiring advanced clinical reasoning and complex problem-solving abilities [1]. Undergraduate otolaryngology education encompasses a wide range of knowledge areas and emphasizes the integration of theory and practice to train a highly qualified cadre of doctors [2]. The challenge of this specialized education lies in providing effective teaching modalities that ensure competency in the diagnosis and management of otolaryngologic disorders within a standardized framework [2–4].

In medical curricula, the traditional teaching prevalent in the current evidence relies on lecture-based instruction and emphasizes the delivery of syllabi and concepts [4]. However, the term "traditional" is not clearly defined and may vary depending on the individual teacher. In this format, students first receive reading materials, including textbooks and the course syllabus, and then passively absorb knowledge through face-to-face classroom sessions, while teachers impart theoretical knowledge, answer questions, and repeat any knowledge points that students had not been fully understood in the class, via PowerPoint slides and handouts [5, 6]. This model often results in unsatisfactory learning outcomes as medical students acquire knowledge passively from instructors with little interaction, resulting in decreased motivation to study and innovate. Moreover, otolaryngology experience and training in medical schools have been gradually declining at undergraduate medical education worldwide [7, 8]. As a consequence, undergraduate students and primary care practitioners often exhibit low competency in managing ear, nose, and throat problems, such as difficulty in accurately diagnosing common conditions, limited proficiency in performing basic examinations, and insufficient knowledge of appropriate treatment protocols [4, 9–12]. Thus, it is crucial to restructure the current educational approach from conventional didactic learning, aiming to enhance students' competencies by incorporating focused teaching and skills training [3].

The BOPPPS (bridge-in, learning objective, pretest, participatory learning, post-test, and summary) model was a six-stage framework which was originally developed by the Center for Teaching and Academic Development, University of British Columbia, Canada [13]. It offered a comprehensive and coherent teaching process and theoretical foundation to achieve learning objectives [5]. Moreover, it clearly organized the teaching process and creates a closed-loop teaching unit with an integrated system that emphasizes the effectiveness of learning outcomes and the diversity of teaching methods [5]. Several studies have demonstrated that the BOPPPS model is more effective than traditional instruction in enhancing students' skills and knowledge, as well as improving their self-learning ability, academic performance, and learning satisfaction across various disciplines, such as ophthalmology, thoracic surgery and gynecology [5, 14–18]. However, the application of the BOPPPS model in otolaryngology education has not been fully explored.

In fact, we first applied the single BOPPPS teaching to integration cases in the spring of 2021 for the students of Class 2017, and then in 2022 for Class 2018. Unlike traditional teaching, the BOPPPS model encouraged active engagement from students through participatory learning activities, fostering deeper understanding, critical thinking, and application of knowledge. Moreover, while traditional teaching may focus primarily on content delivery, the BOPPPS model emphasized the integration of theoretical concepts with practical clinical scenarios, thereby promoting a more holistic approach to learning [6, 18]. In this study, we conducted a preliminary evaluation of the effectiveness of the BOPPPS model for otolaryngology education among five-year undergraduates.

Methods

Participants and recruitment

This study was a non-randomized controlled trial conducted at Anhui Medical University between April 1, 2023, and May 30, 2023. We recruited 167 students majoring in clinical medicine from Anhui Medical University who were undergraduate students studying otolaryngology in their eighth semester. Informed consent was obtained from each participant prior to enrolment in the study. Each participant voluntarily agreed to take part in this study. The students were from almost all regions of China and approximately half of them were residents of Anhui province. They all received systematic pre-college education under the same guideline and using the same textbooks after passing the requirements of the entrance

examination. The students were divided into 4 sections to be taught separately. Each section was usually taught by one teacher throughout the entire Otolaryngology course. All teachers had at least 10 years' experience of teaching and met the standard requirements of teaching after group rehearsal of the course contents. We assigned them to two groups: an experimental group that used the BOPPPS model and a control group that used the traditional instructional approach.

Study design and setting

The study conducted over two months, focusing on the effectiveness of the BOPPPS model in teaching otolaryngology. The experimental group applied the BOPPPS model, while the control group received traditional lecture-based instruction. Both groups covered a total of 49 topics related to otolaryngology, with chronic sinusitis being one example. The course comprised 27 sessions with 45 min per session. The study included 169 five-year undergraduate students from Anhui Medical University, with 49 students in the experimental group and 118 students in the control group. Students were allocated to these groups based on their class schedules and availability. The same curriculum was used as the teaching content for both groups of students. The teaching processes were completed within the same duration for the experimental group and the control group. The control group received mainly traditional teaching [19]. In the traditional lecture-based format, teachers delivered theoretical knowledge through PowerPoint slides, handouts, and lectures. Students passively received information and took notes. The traditional teaching sessions involved the following steps: *Reading Material*: Students first received the reading material, including textbooks and the course syllabus. *Classroom Instruction*: Teachers used overhead projectors and PowerPoint slides to deliver the content face-to-face, with minimal student interaction. *Teaching Materials*: Students had access to teaching materials and reference book. *Question and Answer*: Teachers answered students' questions and repeated any points that were not fully understood.

The experimental group applied the BOPPPS model for teaching, using the topic on chronic sinusitis as an example. The BOPPPS model is composed of six parts [6, 20]: *Bridge-in*: Before class, the teacher introduces two problems of chronic sinusitis from online searching platforms (https://pubmed.ncbi.nlm.nih.gov) to motivate students' interest in learning clinical diseases characterized by "rhinorrhea" and "headache". The teacher also provides a clinical case with a framework for understanding the course's main content by asking students to recall the anatomy and physiology of the paranasal sinuses and the common symptoms of chronic sinusitis. *Objective*: According to the course syllabus of Anhui Medical University, the teacher clearly states the diagnosis and treatment of chronic sinusitis as the focus of the course. *Pre-assessment*: The teacher administers a quiz or a poll to assess the students' prior knowledge and understanding of chronic sinusitis. The teacher also asks students to share their questions or difficulties about the topic. *Participatory learning*: The teacher divides the students into small groups and assigns each group a clinical case related to chronic sinusitis. The students are instructed to discuss the case in their groups and answer questions based on the pre-assessment such as: what are the possible causes and risk factors of chronic sinusitis? what are the diagnostic tests and criteria for chronic sinusitis? what are the treatment options and goals for chronic sinusitis? how would you educate the patient about prevention and self-care? The teacher facilitates the discussion by providing feedback, guidance and additional information as needed. *Post-assessment*: The teacher conducts another quiz or a poll to evaluate the students' learning outcomes and progress after the participatory learning. The teacher also urges students to reflect on their learning experience and identify their strengths and weaknesses. The teacher adjusts the subsequent content to improve teaching efficiency based on the post-assessment. *Summary*: The teacher summarizes the main points and key concepts of chronic sinusitis. The teacher also reviews the learning objectives and emphasizes the clinical implications and applications of chronic sinusitis. The teacher encourages students to expand their learning beyond the course and seek further learning resources if interested, such as by consulting expert consensus and clinical guidelines (e.g., European Position Paper on Rhinosinusitis and Nasal Polyps, 2020). To ensure clarity and concision, the teaching flowchart is depicted in Fig. 1.

Assessment of teaching outcomes

To evaluate the efficacy of the BOPPPS instructional model, we administered an anonymous questionnaire to the students. The questionnaire was adapted from the course evaluation questionnaire [21]. The students from both groups filled out the questionnaire after completing the course. We quantified the students' perspectives and self-evaluations using a five-point Likert-type scale ranging from a score of one for strong disagreement to a score of five for strong agreement.

We also tested the students' understanding of the course content by administering a comprehensive final examination at the end of the semester. The written examination (with a total score of 100 points) assessed the theoretical knowledge of Otolaryngology. The examination questions consisted of three parts: medical-terms interpretation (28 points), single-choice questions (42 points) and short-answer questions (30 points). They were randomly selected from the examination

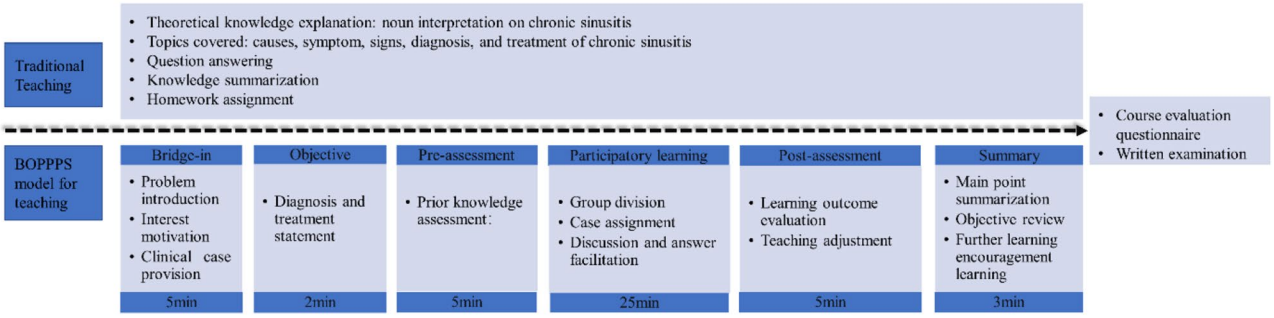

Fig. 1 Flowchart of BOPPPS and traditional instructional teaching using chronic sinusitis as an example. *Bridge-in*: following the problem introduction or a clinical case, delve into the interest motivation by exploring the symptoms of chronic sinusitis, such as "rhinorrhea" and "headache," commonly searched online, sparking our curiosity about this condition. *Objective*: diagnosis and treatment of chronic sinusitis based on the course syllabus. *Pre-assessment*: a quiz/poll; sharing any questions or areas of difficulty regarding the topic. *Participatory learning*: students are divided into small groups to analyze clinical cases of chronic sinusitis, discussing causes, diagnostics, treatments, and patient education. *Post-assessment*: quiz/poll, student reflection on learning experience, and subsequent content adjustment for improved teaching efficiency. *Summary*: the teacher summarizes key points of chronic sinusitis, reviews learning objectives, underscores clinical implications, and encourages students to explore additional resources for further learning

Table 1 Participant characteristics

Characteristics	Experimental group ($n=49$)	Control group ($n=118$)	χ^2/t	*p*-value
Gender				
Male, n (%)	30 (61.2)	87 (73.7)	2.581	0.108
Female, n (%)	19 (38.3)	31 (26.3)		
Age in years				
Range of age	20–23	19–23		
mean ± SD	21.29 ± 0.874	21.70 ± 1.024	2.356	0.120
Source of the students				
City, n (%)	Hefei, 43 (87.8)	Hefei, 109 (92.4)	0.903	0.342
Country, n (%)	49 (100)	118 (100)		

question bank, which encompassed the students' skills in Otolaryngology.

Statistical analysis

Statistical analyses were conducted using SPSS 26.0 (SPSS, Inc., Chicago, IL). The quantitative data were presented as means ± standard deviations and subjected to analysis using the t-test. Meanwhile, categorical data were analysed by the chi-square test. $P<0.05$ indicated that the difference was statistically significant.

Results

Demographic characteristics of the participants

Table 1 depicted the main demographic features of the two groups of undergraduate students. The experimental group consisted of 49 students (30 males, 19 females) with a mean age of 21.29 years. The control group comprised 118 students (87 males, 31 female) with a mean age of 21.70 years. The two groups were comparable in their general characteristics, such as sex, age, and origin of the students ($P>0.05$). No significant differences were observed between the two groups regarding sex, age, and family background ($P>0.05$).

Comparison of student perspectives

In Table 2, we compared students' perspectives in the control group to those of the experimental group. Students in both groups considered the otolaryngology course to be too heavy (3.56 ± 1.050 vs. 3.39 ± 0.894), overly theoretical and abstract (3.75 ± 1.139 vs. 3.36 ± 1.00) and needed a good memory (4.25 ± 0.700 vs. 4.13 ± 0.461). There was no significant difference in learning pressure (3.40 ± 1.125 vs. 3.20 ± 0.962, $P>0.05$), course comprehension (3.42 ± 1.164 vs. 3.30 ± 1.013, $P>0.05$), and time spent (3.73 ± 1.086 vs. 3.53 ± 0.910, $P>0.05$) between the two groups. More students in the experimental group agreed that BOPPPS model significantly enhanced their ability to plan their own work (4.27 ± 0.676 vs. 4.03 ± 0.581, $P<0.05$), developed their problem-solving skills (4.31 ± 0.624 vs. 4.03 ± 0.559, $P<0.01$), helped them work as a team member (4.19 ± 0.704 vs.3.87 ± 0.758, $P<0.05$), sharpen their analytical skills (4.31 ± 0.719 vs. 4.05 ± 0.622, $P<0.05$), and improved their motivation for learning (4.48 ± 0.618 vs. 4.09 ± 0.582, $P<0.01$) than the control group. Through the experimental group course, students felt more confident about tackling unfamiliar problems than through the control group course (4.21 ± 0.743 vs. 3.95 ± 0.636, $P<0.05$). Compared to those in the control group, students in the experimental group demonstrated a significantly clearer understanding of the teaching staff's expectations from the start (4.31 ± 0.552 vs. 4.08 ± 0.555, $P<0.05$). Furthermore, the experimental group perceived a greater effort from the staff to understand their difficulties (4.42 ± 0.577 vs. 4.13 ± 0.59, $P<0.01$), a stronger emphasis on comprehension rather than memorization (3.65 ± 1.176 vs. 3.18 ± 1.065, $P<0.05$), and received more helpful feedback from the teaching

Table 2 Comparison of the modified course experience questionnaire between the experimental group and control group

Question	Experimental group	Control group	t-value	*p*-value
To do well in this course all you really need is a good memory	4.25 ± 0.700	4.13 ± 0.461	1.342	0.181
The course is overly theoretical and abstract	3.75 ± 1.139	3.36 ± 1.006	2.061	0.053
There was a lot of pressure on me to do well in this course	3.40 ± 1.125	3.20 ± 0.962	1.051	0.297
The sheer volume of work to be got through in this course means you can't comprehend it all thoroughly	3.42 ± 1.164	3.30 ± 1.013	0.595	0.554
The work was too heavy	3.56 ± 1.050	3.39 ± 0.894	1.021	0.310
I was generally given enough time to understand the things we have to learn	3.73 ± 1.086	3.53 ± 0.910	1.125	0.264
My course helped me to develop the ability to plan my own work	4.27 ± 0.676	4.03 ± 0.581	2.134	0.036
The course improved my skills in written communication	4.31 ± 0.589	3.96 ± 0.643	3.426	0.001
The course developed my problem-solving skills	4.31 ± 0.624	4.03 ± 0.559	2.771	0.007
As a result of my course, I feel confident about tackling unfamiliar problems	4.21 ± 0.743	3.95 ± 0.636	2.121	0.037
The course sharpened my analytic skills	4.31 ± 0.719	4.05 ± 0.622	2.213	0.030
The course helped me to develop my ability to work as a team member	4.19 ± 0.704	3.87 ± 0.758	2.533	0.012
The staff here make it clear right from the start what they expect of students	4.31 ± 0.552	4.08 ± 0.555	2.506	0.014
The staff make a real effort to understand difficulties students may be having with their work	4.42 ± 0.577	4.13 ± 0.596	2.796	0.006
Staff seem more interested in testing what you've memorized than what you've understood	3.65 ± 1.176	3.18 ± 1.065	2.455	0.015
Teaching staff here normally give helpful feedback on how you are doing	4.40 ± 0.574	4.08 ± 0.585	3.246	0.002
Our lecturers are extremely good at explaining things to us	4.42 ± 0.539	4.08 ± 0.619	3.454	0.001
Teaching staff here work hard to make their subjects interesting	4.50 ± 0.546	4.08 ± 0.632	4.253	0.000
The teaching staff of this course motivated me to do my best work	4.48 ± 0.618	4.09 ± 0.582	3.816	0.000
Overall, I am satisfied with the quality of this course	4.56 ± 0.542	4.34 ± 0.641	2.153	0.033

This survey adopted a five-point Likert-type scale (1, strongly disagree; 2, disagree; 3, neutral; 4, agree; 5, strongly agree). Values are means ± SD.

staff (4.40±0.574 vs.4.08±0.585, $P<0.01$). Additionally, students in the experimental group found the lecturers to be significantly better at explaining concepts (4.42±0.539 vs.4.08±0.619, $P<0.01$) and perceived a higher level of effort in making the subjects interesting (4.50±0.546 vs. 4.08±0.632, $P<0.01$) than those in the control group. Overall, the experimental group was significantly more satisfied with the course than the control group (4.56±0.542 vs. 4.34±0.641, $P<0.05$).

Evaluation of academic performance

The experimental group achieved significantly higher final examination scores compared to the control group (87.7±6.7 vs. 84.0±7.7), and the difference was statistically significant ($P=0.004$). The experimental group also obtained significantly higher scores in noun-interpretation than the control group (27.0±1.6 vs. 26.1±2.4, $P=0.005$). However, there was no statistically significant difference in single-choice scores between the two groups (31.8±6.1 vs. 30.0±4.9, $P=0.076$), as well as in short-answer scores (28.2±3.3 vs. 28.0±3.4, $P=0.690$) (Fig. 2).

Discussion

The evolution of medical education has been driven by advancements in medical knowledge and pedagogy, as well as the need to address the complexities of chronic disease management and adapt to demographic, economic, and organizational changes in the healthcare system [22, 23]. In the past few decades, medical education has shifted from a disease-oriented approach to a problem-based approach, and finally to a competency-based approach [24, 25]. This transformation signified a crucial shift towards a more holistic and integrated model of otolaryngologic medical education [26–28]. It recognized the dynamic and complex nature of the field and the changing healthcare environment, where the demands on future otolaryngologists extended far beyond mere anatomical knowledge.

This study was the first application of the BOPPPS model in otolaryngologic education for the fourth year undergraduates in terms of students' perspectives and examination scores. The findings revealed several positive outcomes. Firstly, the BOPPPS model significantly developed students' problem-solving skills, improved teamwork, sharpened analytical skills, and increased students' motivation for learning by engaging students in challenging clinical scenarios and encouraging them to analyse complex situations. Those skills are crucial and essential to make quick and accurate decisions for optimal patient treatment. Several studies demonstrated that the BOPPPS model enhanced clinical practice abilities and increased student satisfaction, and that it better inspired enthusiasm and enhanced comprehensive abilities in clinical teaching practice, which was consistent with our findings [6, 18]. Secondly, the model promoted effective communication and cooperation by engaging

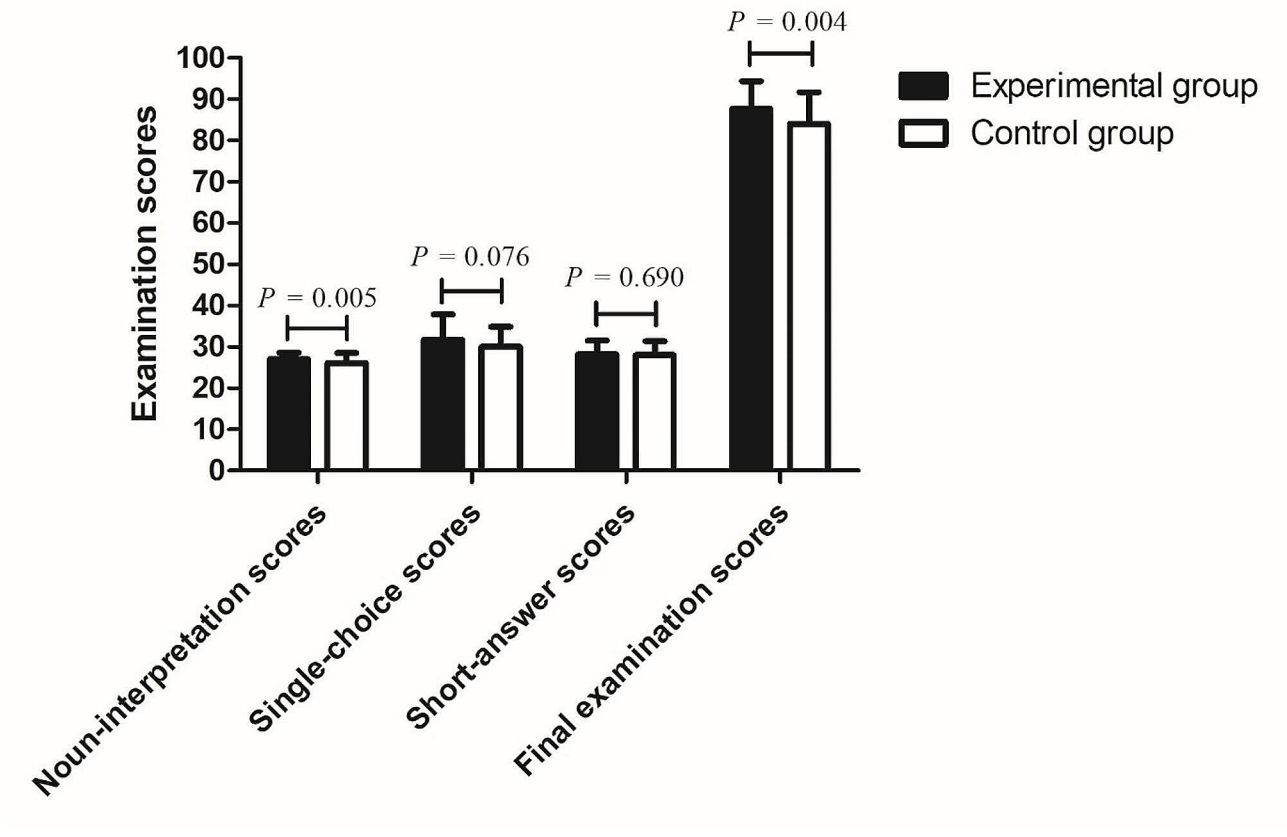

Fig. 2 Comparison of examination scores between experimental and control groups

students in participatory activities and group discussions. This approach enhanced critical thinking abilities during problem-solving exercises, enabling students to assess medical information, interpret diagnostic findings, and explore diverse treatment alternatives. Thirdly, it cultivated a supportive and engaging learning environment, leading to increased confidence and a deeper understanding of the subject matter for students. By prioritizing comprehension over memorization and providing personalized guidance, the model optimized students' learning strategies. These results were confirmed by a recent meta-analysis, which highlights the significant impact of the BOPPPS model across multiple disciplines in Chinese medical education [5]. The most crucial outcome was the significantly higher final examination scores achieved by the experimental group. These scores were not only important for evaluating the students' academic achievement, but also for measuring educational quality in the field [6, 18]. The application of the BOPPPS model with or without innovative teaching in medical education demonstrated its effectiveness, fulfilling the requirements of competency-based teaching, equipping future otolaryngologists with the necessary skills to make quick and accurate decisions in patient treatment, and meeting the needs of modern medical education [14, 16, 29, 30].

Competency-based education was an outcomes-centered approach that focused on mastering specific skills and knowledge required in a field of study, rather than memorizing facts and information [31–33]. In our study, the BOPPPS model, a six-stage framework, was used to design and deliver effective and engaging instruction for otolaryngology education. Our results demonstrated significant improvements in analytical skills, problem-solving abilities, and motivation, thereby supporting the effectiveness of the BOPPPS model in achieving competency-based educational outcomes. Each stage has a specific purpose and function in the teaching process [20, 34].

1 Bridge-in: This stage aims to capture the students' attention and interest by linking their prior knowledge and experience to the new topic or concept. This stage can help students activate their existing competencies and connect them to the new learning objectives, as well as motivate them to learn more.
2 Objective: This stage defines the clear and measurable learning outcomes that the students are

expected to achieve by the end of the lesson. This stage can help students concentrate on mastering specific competencies required in their field of study, as well as provide them with clear criteria and expectations for assessment.

3 Pre-assessment: This stage evaluates the students' current level of knowledge and skills related to the topic, as well as their learning needs and preferences. This stage can help teachers identify the students' strengths and weaknesses, as well as tailor their instruction accordingly. This stage can also help students self-assess their competencies and set their own learning goals.

4 Participatory learning: This stage engages the students in active and collaborative learning activities that help them acquire and apply the new knowledge and skills. This stage can help students develop and enhance their competencies through problem-solving exercises, case studies, simulations, role-plays, and other interactive methods. This stage can also help students practice their critical thinking, communication, teamwork, and other soft skills that are essential for their field of study.

5 Post-assessment: This stage evaluates the students' learning outcomes and progress by measuring their achievement of the learning objectives. This stage can help teachers provide feedback and guidance to the students on their performance and improvement. This stage can also help students demonstrate their competencies and reflect on their learning process.

6 Summary: This stage reviews and reinforces the main points and key concepts of the lesson, as well as provides feedback and guidance for further learning. This stage can help students consolidate their competencies and transfer them to other contexts, as well as identify their areas for further development.

Implications for practice

As a result, the BOPPPS model could provide a structured and systematic way to assess and enhance students' competencies, as well as encourage active participation and collaboration among students [6, 18, 35]. By using the BOPPPS model, teachers could create a meaningful and memorable learning experience for their students, preparing them for real-world challenges in their field of study. By focusing on practical application, personalized feedback, and collaborative learning, the model fostered a transformative learning experience that empowered students to become competent and well-rounded professionals in their chosen field [5, 17]. The model's application provided a comprehensive and in-depth approach to develop students' abilities, ensuring they were well-prepared for their future careers.

The results of this study suggested that educators and institutions should explore integrating the BOPPPS model into their curricula to optimize the learning experience for aspiring otolaryngologists. The findings also supported the wider adoption of competency-based pedagogy, emphasizing the potential of BOPPPS to enhance students' perceptions, academic performance, and overall learning experiences in otolaryngology education and beyond, aligning with other studies [5, 17, 28, 35]. The findings underscored the significance of learner-centered and practice-oriented approaches in medical education, providing useful insights for curriculum design and instructional strategies [35]. As educators and institutions seeked to optimize learning outcomes and prepared competent healthcare professionals, the BOPPPS model served as a promising and effective tool for shaping the future of otolaryngology medical education [6, 18].

All students from the five-year undergraduate program acknowledged the course's heavy workload and its theoretical and abstract nature. They also recognized the importance of having a good memory for effectively navigating the course material. There were no significant differences between the two groups in terms of learning pressure, course comprehension, and the amount of time spent on the course. These findings indicated that while the BOPPPS model positively influenced some aspects of students' learning experiences and academic performance, it did not drastically alter their overall perceptions of the course's demands and challenges. The course's heavy workload and abstract content may remain inherent challenges of otolaryngology education, regardless of the teaching methodology employed. To further enhance the learning experience, future studies could investigate ways to reduce the perceived heavy workload and abstract nature of the course while continuing to utilize the strengths of the BOPPPS model [30, 36, 37]. Implementing additional interactive and hands-on learning opportunities, incorporating practical case studies, and providing tailored support for memory retention could be potential strategies to adopt. Moving forward, educators and institutions can build upon the strengths of the BOPPPS model while exploring additional strategies to optimize students' learning experiences in otolaryngology.

Limitations and future research suggestions

While this study offered valuable insights, it was important to recognize certain limitations in its design and scope. Firstly, the research focused on a specific group of fourth year undergraduates, potentially limiting the generalizability of the findings to students at different stages of their medical education. Expanding the study to include a more diverse cohort from various educational levels would provide a more comprehensive

understanding of the model's efficacy. Additionally, the study's single-institution setting and relatively short duration might restrict the applicability of the results to other medical schools. Conducting future research involving multiple institutional settings, larger sample sizes and a longitudinal investigation extending over multiple years would enhance the external validity and enable a broader assessment of the BOPPPS model's impact. In this study, the survey was designed to capture general aspects of the learning experience applicable to any teaching method, though we recognize the need for refined questions to better address the nuances of each methodology. While students from different classes had their teaching sessions conducted simultaneously to minimize information sharing, the possibility cannot be entirely eliminated. Furthermore, a crossover design was not feasible due to logistical constraints and the structured curriculum, but future research should incorporate this approach for a more direct comparison and to capture the long-term effects of the BOPPPS model on students' academic performance and perceptions.

Conclusion

In this study, BOPPPS model increased student satisfaction and improved learning outcomes in otolaryngologic medical education by fostering active learning, problem-solving skills, teamwork, analytical thinking, and motivation. This comprehensive approach showed great promise in effectively cultivating future otolaryngologists. Educators and medical institutions should consider adopting similar innovative teaching methodologies to enhance the learning experiences and academic achievements of medical students.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12909-024-05868-3.

Supplementary Material 1

Acknowledgements
Not applicable.

Author contributions
DC-F designed the study and drafted the manuscript. C-W designed the course evaluation questionnaire. XM-Q, SY-Q, Y-X, and YT-W collected data and assessed examination scores for eligibility. JX-H performed the statistical analysis and supervised the study. All authors critically reviewed and revised the manuscript. All authors read and approved the final manuscript.

Funding
This work was supported by the Natural Science Foundation of Anhui Provincial Education Department (KJ2021A0315).

Data availability
Data is provided within the manuscript or supplementary information files.

Declarations

Ethics approval and consent to participate
This study was conducted following the guidelines of the Helsinki Declaration, and approved by the local Ethics Committee of the Second Affiliated Hospital of Anhui Medical University (YX2024-034). The Ethics Committee of the Second Affiliated Hospital of Anhui Medical University approved all experimental protocols for this study. Each participant voluntarily took part in this study. Informed consent was obtained from all subjects and/or their legal guardian(s).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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Received: 11 February 2024 / Accepted: 6 August 2024
Published online: 09 August 2024

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