


**EFFECTIVENESS OF BLENDED TEACHING OF PROBLEM-BASED LEARNING (PBL) AND ERROR-BASED LEARNING (ABE) IN GYNECOLOGY**

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## ABSTRACT

The aim of this study was to determine whether combined PBL-ABE teaching was effective in gynecology students. Methodology A prospective and observational study was carried out with 200 gynecology students of the tenth semester and internships, who were randomly divided into two groups for the combined PBL-ABE system and the traditional group. Pre- and post-class surveys were conducted to assess their perceptions and experiences with the method. Results: In the pre-class questionnaire, the traditional system obtained significantly higher scores than the PBL-ABE group (75.34 vs. 70.43 and 35.43 vs. 23.34),  $P = 6.39 \times 10^{-5}$ ). In the PBL-ABE group, basic knowledge and case analysis scores increased significantly, 72.23 vs. 68.51 and 31.23 vs. 30.24, respectively ( $P = 0.612$ ). The ABP-ABE group improved much more than the traditional group; the ABP-ABE saw an increase from 70.43 to 72.23 compared to the traditional one from 75.43 to 68.51. On the other hand, in terms of time spent in class, the ABP-ABE system scored significantly lower than the traditional system ( $P < 0.001$ ). Conclusion: PBL together with ABE can be an effective method to improve the performance and clinical skills of medical students and interns.

**Keywords:** Problem-based learning. Error-based learning. Traditional system. Lectures. Gynaecology. Practical clinical teaching. ABP. ABE.

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## INTRODUCTION

The normative education of health professionals is in line with the advancement of technology and scientific development in medicine, both locally and internationally. [1] [2] [3]. Medical careers are using a variety of strategies in the development of effective teaching methodology; to have a solid base of scientific knowledge and skills in medical students for the analysis of problems or cases that respond to the high demand of recent years, improving the gap in medical training. The traditional teaching system has been the learning method that medical education has adopted. Master classes have been the popular way of teaching, due to their effectiveness in transmitting knowledge, particularly due to the large number of students, however the research production presented by the master lectures are not effective for the learning of skills and critical thinking that is required in higher education such as medicine; This is because the traditional method is centered on the teacher who passively transmits knowledge to the student. [4] [5] [6] [7] [8]

Error-based learning (ABE) is an approach to teaching errors for the purpose of learning; teachers design errors for students to analyze and substantiate the causes of errors, and students acquire lasting and reasoned learning by correcting them. Problem-based learning (PBL) is defined as a learning strategy in which students develop autonomous learning skills and holistic thinking by solving problems through self-study, inquiry, and small group cooperation. This represents a pedagogical shift in the approach to teaching and learning. [9]

Compared to the traditional system, ABE focuses on outcomes that foster students' logical reasoning ability. Teachers ask students questions with errors using their observation, conclusion, and problem-solving skills. PBL is considered a method that allows divergent thinking that is oriented to problems by giving students the initiative in learning; therefore, it is the responsibility of students to voice their concerns and work in small groups to resolve them [10]

Research "on the effects of error generation on episodic memory" demonstrated that EBA is an effective strategy for problem-solving, such as the analytical skills of medical students and physicians [11] [12]. Compared to the traditional system, many systematic reviews showed high levels of satisfaction and active participation [13] [14]. But if PBL and EBA methodologies are used on their own, there are limitations [12] [15]. The EBA requires a lot of time for teachers to prepare for errors, accumulate enough materials to support clinical teaching, and formulate questions that students discuss, leading to students not actively participating and being exalted by the learning experience. PBL was not effective in curricula, which would improve knowledge foundations and clinical performance.



Computer-assisted learning (CAA), which does not replace traditional teaching, is one of the new tools suggested to facilitate the development of PBL. [16] [15]

PBL is student-centered and plays an important leadership role in the classroom, allowing you to have time to prepare problems and materials before each class, making it difficult for medical students. In addition, PBL induces initiative in students, but the lack of interest of teachers will make students understand the program, which affects the quality of the method. Therefore, the following hypothesis is raised: the combined teaching of PBL and EBA could improve the development of affective learning and the quality of learning of medical students.

The medical teaching literature indicates that there is no combined PBL-EBA method in medical education, especially in gynecology interns, which is a fundamental specialty dedicated to the study of women.

This research implemented the combined PBL-ABE teaching system in students of the tenth semester of medicine and gynecology interns in their pre-professional practices. He compared the method to the traditional teaching system. This study provides insights into assessing students' reasoning in a variety of areas, from basic knowledge to problem-solving; it also analyzes their perspectives, their competencies, their self-perception and their satisfaction during the PBL-ABE learning process.

## **METHODS**

### **PARTICIPANTS**

Prospective, randomized, and controlled research. From September 2022 to April 2023, tenth-semester medical students from the Faculty of Medical Sciences of the University of Guayaquil and gynecology interns from the Ceibos Norte general hospital in the city of Guayaquil were registered. All required obstetric diseases were treated. The students were randomly divided into two groups: one for the PBL-ABE teaching system and one for the traditional lecture-based teaching system. Students didn't know what their group assignments were in the classroom. The groups were divided into different schedules and those who received classes at the same time were divided ascendingly according to their identification. Therefore, each student received a number ranging from 1 to 200; odd numbers were recorded in the PBL-ABE system, while even numbers were recorded in the traditional system. The instructor and three attending physicians from the gynecology service supervised these groups. The Ethics Committee of the Ceibos Hospital north of Guayaquil approved the informed consent of all participants.



## STUDY DESIGN

Because hypertensive disorders of pregnancy are considered the second leading cause of maternal death, we decided to use the combined ABP-ABE approach for this study. The ABP-EBA system program was organized as follows. The instructor prepared lecture videos and supplemental materials for the course prior to class. Students were provided with five reference articles related to the course topics, general diagnostic and treatment guidelines, and approximately 30-minute video materials on operating procedures. Each student was required to review these materials during free time outside of class. Before the start of the activities, a questionnaire with ten multiple-choice questions on hypertensive disorders of pregnancy was delivered.

The instructor introduced the topic and agenda of activities before the class session. Next, a problem of a patient with slides posing errors in the proposed instructions that focused on hypertensive disorders of pregnancy was presented. Second, under the direction of the instructor, students discussed in small groups. In discussions, participants are asked relevant questions with errors and asked to search for answers on the internet or in library databases. Third, the group leader gave the presentation to review the most important points of the lesson and give the group the answers that were solved and those that were not resolved. Finally, the instructor summarized the class and tweaked the challenging questions that came up in the discussion. At the end of these activities, students were asked to answer a post-class questionnaire that contained the same questions about hypertensive disorders of pregnancy as the pre-class questionnaire. Finally, they were asked to complete a ten-question questionnaire about their perceptions and experiences with the combined PBL-ABE classroom.

Later the traditional system was organized. Instead of watching videos or reading lengthy articles, they were asked to review a preview of the course. They were also asked to answer the pre-test questionnaire with the 10 multiple-choice questions that were used in the PBL-ABE system. The traditional teaching method used to teach students the content taught by the teacher with a full explanation of theoretical knowledge that was not divided into small groups to discuss the problem. After the classes, they were asked to answer the same questionnaire as the PBL-ABE group.

All students received an informed consent form, were told to participate in questionnaires and surveys on a voluntary basis. The results of the quizzes and survey had no impact (positive or negative) on students' grades or performance because ID numbers were used instead of real names. Students completed the questionnaires and survey

independently of their classmates and the teacher. A graphical description of the study design is shown in Figure 1.

## DATA EVALUATION AND STATISTICAL ANALYSIS

Pre- and post-course tests were conducted to assess what students learned in the Hypertensive Disorders in Pregnancy course. The question set includes basic theory questions (10 points) and problem analysis questions (10 points). All of the questions are based on Bloom's taxonomy, which classifies cognitive activities into six hierarchical levels, namely memory, comprehension, application, analytical skills, evaluation, and creativity. The categories "Remember" and "Understand" were combined into a single category called "Basic Theoretical Knowledge". Entries in any other category are considered "Clinical Case Analysis". [17] [18]

After the course, students in both groups were asked to complete the same anonymous questionnaire to assess their perceptions and experiences. The post-course questionnaire includes 10 questions, which included questions on motivation, comprehension, student-teacher interaction, free time during the course, end-of-course test, communication and communication skills, clinical reasoning ability, self-study skills, teamwork, skills, and knowledge absorption. The endpoints were based on a previous study. Depending on the level of improvement, the scores are divided into 5 levels, from 1 (poor) to 5 (excellent). Unlike the other areas recorded, for the free time consumed, 1 represents the lowest time consumption, while 5 indicates the most time. The reliability of the questionnaire was evaluated with Cronbach's alpha coefficient, which was 0.872. [17]

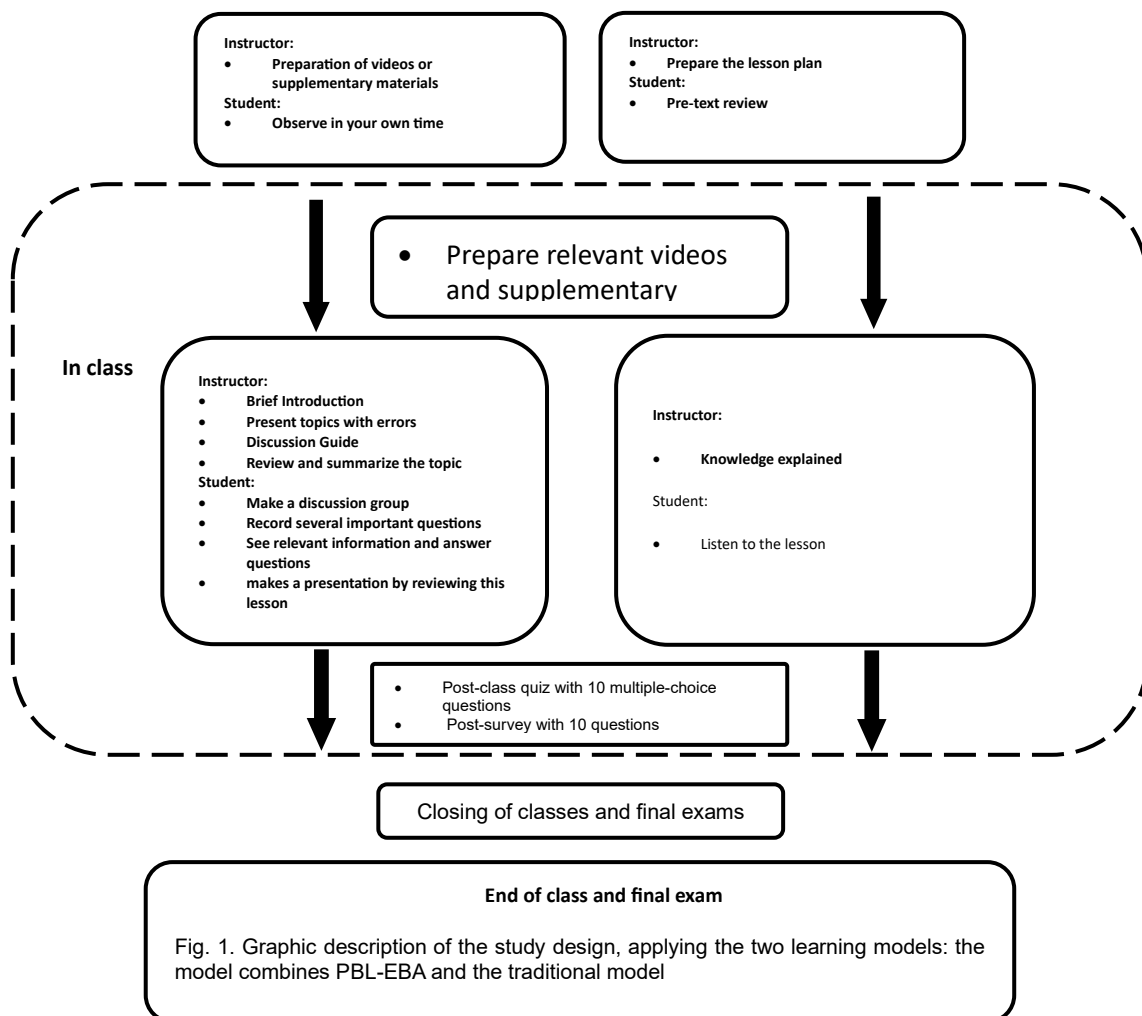


For each system, the time students spent preparing before class is measured. In the PBL-ABE system, students' preparation time was recorded by watching lecture videos and reading materials related to the course, as well as by searching for additional materials on the Internet. Meanwhile, in the traditional model, students use pre-recorded time to review textbooks.

We compared the effectiveness of PBL-ABE with traditional teaching methods for all tenth-semester and boarding students. In addition, to avoid biases related to different types

of students, we also observed two teaching methods with tenth-semester students and interns in subgroups.

We sum the total scores and then compare the scores produced by both systems using a t-test of independent samples. We also compared the data generated by the system before and after the lesson using a paired sample t-test. To compare proportions, the chi-square test was used. All statistical analyses were performed with SPSS version 20.0 (Chicago, USA). United States of America). Alpha was set at 0.05 and P values below 0.05 were considered significant. The charts were created using RStudio, the "ggplot2" library was used to create the bar graph where the average result is shown, and the dplyr library, which allows you to manipulate and sort the data into data frames, ensuring that everything is organized.







## RESULTS

### FEATURES AND BASIC INFORMATION

From September 2022 to April 2023, a total of 200 students will enroll; 100 in the tenth semester in obstetrics and 100 in the obstetrics and gynecology internship. Of these, 100 students were assigned to the PBL-ABE system (50 students in the 10th semester and 50 boarders) and 100 to the traditional system (50 students in the 10th semester and 50 boarders). 17 students were excluded from the PBL-ABE group: 11 students withdrew before the course, despite having signed an informed consent, and 6 students were excluded for having incomplete values in their questionnaire. The average age of the students was  $22.49 \pm 1.443$  years. By gender, 100 students are female, or 50%. Table 1 compares the initial characteristics of students in the PBL-ABE system and the traditional system.

Felling 1. Basic characteristics of all participants

Item	ABP-ABE System (N=100)	Traditional system (N=100)	Statistics	P-Value
Degree			X <sup>2</sup> =0.001	0.981
Tenth semester	50	50		
Medical Interns	50	50		
Gender			X <sup>2</sup> =0.525	0.469
Man	55	45		
Woman	45	55		
Age	22.49+1.443	22.49+1.443	T=0.850	0.396

There were no significant differences between the two systems in terms of gender, age, or grades ( $P > 0.05$ ). In addition, tenth-semester students and interns of the traditional system did not show statistical significance in terms of demographic characteristics compared to the PBL-ABE system, in Table 2. The average time spent on pre-class preparation in the ABP-ABE systems and the traditional system was  $107.23 \pm 14.512$  and  $95.60 \pm 15.631$ , respectively ( $P < 0.001$ ).

Table 2 Comparison of test scores between ABP-EBA and the traditional group

Items.	System ABP-ABE (N=100)	System Traditional (N=100)	T	P-value
<b>Pre-Class Total Score</b>	70.43 $\pm$ 12.23	75.34 $\pm$ 12.3	-2.83	0.0051
Basic Knowledge Score Pre-Class	45.23 $\pm$ 15.32	68.35 $\pm$ 13.3	- 11.39	$2.28 \times 10^{-23}$
Case Analysis Score Pre-Class	23.34 $\pm$ 12.4	35.43 $\pm$ 13.2	-6.67	$2.43 \times 10^{-10}$
<b>Total post-class score</b>	72.23 $\pm$ 12.5	68.51 $\pm$ 11.32	2.205	0.028
Basic Knowledge Score Post-Class	48.25 $\pm$ 13.23	39.51 $\pm$ 13.3	4.65	$5.82 \times 10^{-6}$
Case Analysis Score Post-Class	31.23 $\pm$ 14.2	30.24 $\pm$ 13.4	0.507	0.612



The comparison of test scores between the ABP-ABE and the traditional pre- and post-class system; the mean pre-class test score and the basic knowledge and case analysis scores were  $70.43 \pm 12.23$ ;  $45.23 \pm 15.32$ ;  $23.34 \pm 12.4$  respectively.

While, for the traditional system they were  $75.34 \pm 12.3$ ;  $68.35 \pm 13.3$ ;  $35.43 \pm 13.2$ , respectively. It is notable that the pre-class test scores of the traditional system were significantly higher than those of the ABP-ABE system ( $P < 0.05$ ). After class, the mean total post-class test score and basic knowledge scores for the PBL-ABE group increased significantly, from  $72.23 \pm 12.5$ ;  $48.25 \pm 13.23$ ; respectively ( $P < 0.05$ ), with the exception of the post-class case analysis score which could not find significant differences in its means.  $31.23 \pm 14.2$ ;  $30.24 \pm 13.4$  ( $P < 0.05$ ) (Fig. 2).

Fig.2 Comparison of pre- and post-class scores: Traditional vs ABP-ABE  
 Comparación de puntuaciones previa y post clase: Tradicional vs ABP-ABE



Similarly, in the traditional system, the mean total score decreased significantly from  $75.34 \pm 12.3$  to  $68.51 \pm 11.32$  ( $P = < 0.05$ ); likewise, basic knowledge and case analysis scores also decreased significantly from  $68.35 \pm 13.3$  to  $39.51 \pm 13.3$  and from  $35.43 \pm 13.2$  to  $30.24 \pm 13.4$  respectively ( $P < 0.05$ ). Meanwhile, the mean total score and basic knowledge scores in the PBL-ABE system did not find significant differences in their means  $70.43 \pm 12.23$  to  $72.23 \pm 12.5$  and  $45.23 \pm 15.32$  to  $48.25 \pm 13.23$ , while for the

case analysis the scores increased significantly from  $23.34 \pm 12.4$  to  $31.23 \pm 14.2$  ( $P = <0.05$ ). (Tables 3 and 4) $4.31 \times 10^{-5}$

Table 3: Comparison of the pre- and post-class scores of the Traditional System

Items.	Pre-Class Scoring	Post-class scoring	T	P-value
Total	75.34 + 12.3	68.51 + 11.32	4.08	$6.39 \times 10^{-5}$
basic skills	68.35 + 13.3	39.51 + 13.3	15.33	$1.70 \times 10^{-35}$
Case Analysis	35.43 + 13.2	30.24 + 13.4	2.75	0.006

Table 4: Comparison of pre- and post-class scores of the PBL System

Items.	Pre-Class Scoring	Post-class scoring	T	P-value
Total	$70.43 \pm 12.23$	$72.23 \pm 12.5$	-1.02	-1.02
basic skills	$45.23 \pm 15.32$	$48.25 \pm 13.23$	-1.49	-1.49
Case Analysis	$23.34 \pm 12.4$	$31.23 \pm 14.2$	-4.18	-4.18

Table 5 assesses students' opinions based on self-perceived competence and competence between the PBL-EBA group and the traditional group; We found that students' motivation to learn, content comprehension, student-teacher interaction, self-assessment, communication skills, and clinical judgment; thinking ability; self-study skills; teamwork skills and the ability to absorb knowledge in the PBL-EBA group were significantly higher than in the traditional system ( $P < 0.05$ ) (Table 5). The score representing students' free time during class (time spent doing work before and after class) was significantly lower in the PBL-ABE group than in the traditional group ( $P < 0.05$ ) (Table 3).

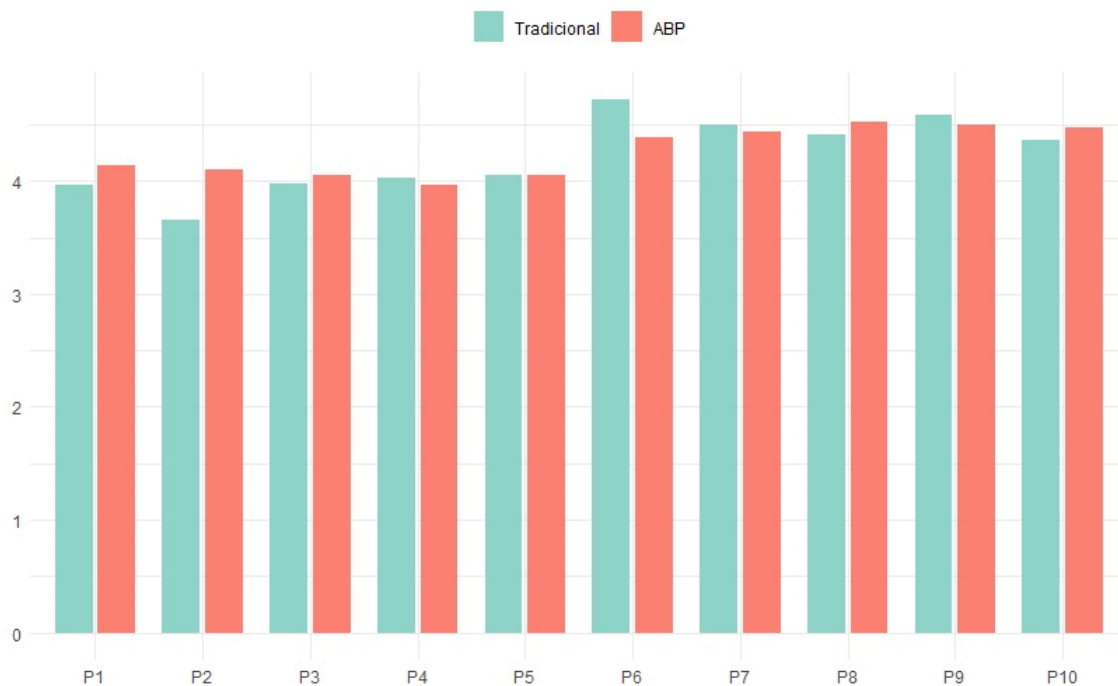
Academic satisfaction in both groups was assessed using follow-up tests, which were considered satisfactory if they obtained 80 points. In the PBL-ABE group, the skills of comprehension, communication, clinical reasoning, self-study, teamwork and knowledge acquisition obtained more than 80 points, a figure higher than that of the traditional group. However, there were no statistically significant differences between the two groups. (Table 5 and Figure 3).

Table 5: The comparison of perspectives and self-perceived competence in the PBL-EBA system versus the traditional system (for all participants)

Item	ABP-ABE System (N= 100)	Traditional system (=100)	T	95% confidence interval	P-value
The teachers motivated me to do my teaching activities better.	4.72 ± 0.64	3.97 ± 1.04	6.14	(0.50,0.99)	5.91 x 10 <sup>-9</sup>
My teachers explained the contents clearly in lectures and other theoretical activities.	4.39 ± 0.96	4.14 ± 1.005	1.79	(-0.024,0.52)	0.07
Carry out, at the direction of the teacher, bibliographic research activities, case discussions or other teaching activities using the English language	4.5 ± 0.80	3.66 ± 1.19	5.85	(0.55,1.12)	2.30x 10 <sup>-8</sup>
The professors assigned me independent work (homework) to do collectively with other students in my course.	4.44 ± 0.92	4.1 ± 0.85	2.7	(0.09,0.58)	0.007
During practical activities in the hospital ward or other health care scenarios, I have had the accompaniment of my professors.	4.41 ± 1.00	3.98 ± 0.93	3.14	(0.16,0.69)	0.001
The types of teaching activities and their distribution in the subject were sufficient for the achievement of my practical skills.	4.53 ± 0.86	4.06 ± 0.93	3.71	(0.22,0.71)	0.0002
During the course I had opportunities to develop the professional skills that corresponded to the objectives of the teaching program.	4.59 ± 0.71	4.03 ± 0.91	4.85	(0.33,0.78)	2.57x 10 <sup>-6</sup>
I applied the knowledge acquired in Medical Embryology, Microbiology and Parasitology in the theoretical and practical activities of this subject.	4.50 ± 0.85	3.97 ± 0.91	4.25	(0.28, 0.77)	3.21x 10 <sup>-6</sup>
This subject helped me learn to self-evaluate myself and other students.	4.36 ± 1.04	4.06 ± 0.97	2.10	(0.019,0.58)	0.036
The subject contributed to developing my problem-solving skills.	4.48 ± 0.87	4.06 ± 1.03	3.11	(0.15,0.68)	0.002

Fig.3. We observe the perspectives and self-perceived competencies with PBL-EBA compared to the traditional model

Comparación de perspectivas y competencia auto percibida en el sistema ABP-ABE vs Tradicional



## DISCUSSION

The traditional education system is the most economical and effective means of providing theoretical education. However, this system is not suitable for advanced medical students to develop communication skills and clinical reasoning. With the advent of the Internet, information has grown rapidly and personal computers and mobile devices have turned e-learning into a tool in higher education, allowing medical students to obtain useful information in a short time. Think and ask questions; Getting new information is an important part of education. In this process, PBL and ABE teaching strategies, which differ from traditional teaching methods, aim to facilitate health and encourage students to actively move from "what I learned" to "what I want to learn." [19] [20] [21] [22] [23]

Most studies focus specifically on PBL and EBA compared to traditional education systems, and some studies have demonstrated the advantages of PBL or EBA. For example, PBL created an approach to small group learning characterized by broader communication between faculty and students to achieve individual learning goals, while ABE emphasized that staff prepare clinical case reports and documentation to help students develop holistically. and effective clinical skills. The student learns theoretical techniques. Taking into account these individual strengths, this study combined PBL and ABE teaching methods so that they could complement and enhance each other. [24] [25] [26] [27] [28] [14] [29] [30] [31]



We study the effectiveness and acceptability of the teaching method integrating PBL-ABE in the subject of obstetrics and gynecology compared to traditional teaching systems. We recognize that integrated PBL-ABE training has not yet been implemented in obstetrics and gynecology courses. In our study, the overall score of the case analysis and the pretest in the traditional system was much higher than the score in the ABP-ABE system (75.34 vs. 70.43 and 35.43 vs. 23.34), this shows the advantage of the pretest. Because students in the traditional education system memorize basic knowledge from textbooks.

In contrast, students in the PBL-ABE group had no study materials and were close to clinical practice. Therefore, it is believed that the difference in pre-test scores between the two systems is not due to the quality of the study materials. But due to the different characteristics of teaching methods, the traditional method possesses more knowledge through book memorization.

Students in the PBL-EBA system reviewed material throughout the course without detailed case analysis or discussion topics, and comparing the total course scores as well as case analysis, showed that the PBL-EBA group achieved significantly better results than the traditional group (72.23 vs. 68.51). and (31.23 vs. 30.24). This explains the effectiveness of the PBL-ABE training model. The mean total score and basic knowledge score were not significantly different on average between the two systems ( $P < 0.05$ ); The use of the combined PBL-ABE teaching system helps to reduce students' free time compared to the traditional system, which indicates its effectiveness in the application of medical chairs ( $P < 0.05$ ).

All questions in the questionnaire are based on Bloom's taxonomy, which is used in educational research to classify learning activities into different cognitive levels, from basic memory to higher-order learning objectives such as memory, comprehension, application and analysis of skills, assessment, and creativity. Texts are the primary source of basic knowledge and require students to read and memorize. Meanwhile, problem analysis requires students to analyze events in the context of real-life medical situations, using the knowledge gained to solve real-life medical and clinical problems. The results of the ABP-ABE system score analysis show that the clinical case analysis score is much better than the basic knowledge score, which means that the ABP-ABE integrated knowledge model can develop communication, creative thinking, and knowledge skills. This is very similar to the general goal of medical education. [32]

Based on an analysis of students' perspectives and skills, measured through surveys in both systems, it was found that students in the PBL-ABE group were more likely to model using a balanced approach between study and work. Positive effects of the PBL-ABE



teaching model on students have been recorded in extracurricular areas such as comprehension, communication skills, clinical reasoning, self-study skills, collaboration skills, communication skills, and knowledge acquisition.

Although previous studies have attempted to implement PBL or ABE training models in teaching in different types of universities, very few studies have focused on integrating PBL-EBA training in obstetrics and gynecology. Ginzberg et al. He applied problem-based teaching and case-based learning (PBL-ABC) in medical students' discussions of cost-related health issues, demonstrating that problem-based teaching and case-based learning (PBL-ABC) are effective ways to interact with public health. Another study implemented an ABP-ABC teaching method in six lessons to improve students' leadership skills without taking time away from academic training. In addition, Naing et al. It combines flipped classroom and PBL into one hyperthyroidism course, thereby improving student learning and outcomes. [33] [12] [17] [34] [20] [8]

This study was similar to the studies mentioned above, suggesting that mixed methods improve learning outcomes in students. In terms of the time required, we agree with Ginzburg, but we disagree with Naing et al. In addition, we differ from all previous studies by being a study conducted on the different skills that students can acquire by incorporating the PBL-EBA teaching method in the process of analyzing different types of small groups. It includes students enrolled in the tenth semester and gynecology interns. In summary, this study investigates the effectiveness of the ABP-ABE integrated teaching method in improving overall understanding of the professional environment, student-teacher interaction and communication skills, student-teacher communication skills, clinical reasoning, and self-study skills. Cooperation and understanding skills. It should be noted that EBA eliminates the need for explicit error removal procedures, which benefits people with significant memory impairment [34] [8] [35]

This study is similar to the studies mentioned above, suggesting that mixed methods improve student learning outcomes. In terms of the time needed, our study had some limitations. First, we analyze the results of a chair from the boarding school department, which may vary in the facilities. Second, there was no blinding procedure in this study, so some bias in the analysis was inevitable preventing teachers from blindly observing students' leadership qualities that is influenced by self-efficacy and the development of interpersonal relationships. Third, our study was based on a gynecology course; In the future, it is proposed to carry out multicenter randomized trials with large samples, with different chairs and long-term follow-up.



## CONCLUSION

The PBL-ABE teaching method can be effective in improving the clinical skills and learning capacity of medical students, particularly those of gynecology. This method made it easier to prepare before class and provided immediate feedback. In addition, the ABP-ABE integrated teaching method improved student understanding, student-teacher interaction, communication skills, clinical thinking skills, self-study skills, cooperation, and the ability to absorb knowledge.

## THANKS

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