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Original Research Article

Evaluating the effectiveness of problem-based learning in promoting rational prescribing among undergraduate medical students

Mohosina Sultana Setu[1]*, M. Shajjad Hossain[2], Zannatul Ferdous[1], M. Mehedi Hasnat Al Amin[3], Akash Gupta[4], M. Emran Hossain[5]

[1]Department of Pharmacology, Dhaka Dental College, Dhaka, Bangladesh
[2]Department of Pathology, Dhaka Dental College, Dhaka, Bangladesh
[3]Department of Pharmaceutical Sciences, Bangladesh University of Professionals, Dhaka, Bangladesh
[4]Department of Pharmaceutical Sciences, North South University, Dhaka, Bangladesh
[5]Department of Pharmaceutical Sciences, Jahangirnagar University, Savar, Dhaka, Bangladesh

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***Correspondence:**
Dr. Mohosina Sultana Setu,
E-mail: shetukmc42@gmail.com

ABSTRACT

Introduction: Rational prescribing is a core competency for future physicians, but traditional pharmacology teaching often emphasizes factual recall rather than clinical application. Problem-Based Learning (PBL) is a student-centered approach that has been proposed to enhance problem-solving skills and rational prescribing. To evaluate whether a PBL-based pharmacology module improves knowledge transfer, problem-solving ability, and attitudes toward learning compared to conventional teaching.
Methods: This interventional study included two groups of undergraduate medical students. The intervention group received a structured PBL module on drugs used in bronchial asthma, while the control group was taught through conventional lectures and tutorials. Both groups were assessed with problem-based multiple-choice questions on bronchial asthma (direct knowledge) and peptic ulcer (transfer of knowledge). Assessments were conducted at four weeks and again at two months. Student attitudes toward PBL were also collected via a structured questionnaire.
Results: Students in the PBL group scored significantly higher than the control group in both assessments ($p<0.01$). While performance declined over time in both groups, PBL students consistently maintained superior outcomes. Feedback revealed positive attitudes toward PBL, with high ratings for problem-solving, motivation, teamwork, and overall satisfaction.
Conclusion: PBL is more effective than conventional teaching in enhancing rational prescribing skills and student engagement. However, sustained practice and curricular integration are recommended to maintain long-term benefits.

Keywords: Problem-based learning, Rational prescribing, Pharmacology, Medical education

INTRODUCTION

The competence of a physician is not only determined by clinical expertise and technical skills but also by the ability to apply a disciplined approach to problem-solving, critical thinking, and rational decision-making. Medical education, therefore, must evolve to equip future doctors with the knowledge, attitudes, and skills required to address real-life clinical challenges effectively. Traditionally, undergraduate medical education in pharmacology has been heavily teacher-centered, emphasizing memorization of drug classifications, mechanisms of action, and therapeutic uses.

While this approach ensures the acquisition of factual knowledge, it often fails to prepare students adequately for

rational prescribing and safe clinical practice.[1,2] Prescribing errors remain a global concern, particularly among junior doctors, highlighting the urgent need for reforms in pharmacology education.[3] PBL has emerged as a powerful student-centered approach to bridge this gap. First introduced in the late 1960s at McMaster University, Canada, PBL shifts the focus from passive information acquisition to active problem-solving through clinical scenarios.[4]

In this method, students work in small groups, guided by facilitators, to analyze real or simulated patient problems, identify learning objectives, engage in self-directed study, and synthesize findings collaboratively. This process fosters critical thinking, integration of basic and clinical sciences, and long-term retention of knowledge.[5] Harden et al emphasized that medical curricula should adopt the "SPICES" model student-centered, problem-based, integrated, community-based, elective-oriented, and systematic to promote deep learning.[6]

Several studies have shown that PBL enhances problem-solving abilities, promotes teamwork, and improves self-directed learning compared to conventional teaching methods.[7,8] In pharmacology specifically, PBL has been reported to encourage rational prescribing practices and improve the transfer of theoretical knowledge into clinical decision-making.[9,10] Moreover, students exposed to PBL demonstrate greater motivation, improved communication skills, and increased satisfaction with their learning experience.[11] A systematic review by Koh et al confirmed that PBL positively influences physician competence, particularly in problem-solving and clinical reasoning.[12] In Bangladesh, as in many other developing countries, pharmacology education continues to rely primarily on didactic lectures and tutorials. Although the Bangladesh Medical and Dental Council (BMDC) curriculum emphasizes rational prescribing, implementation remains limited within traditional frameworks.[13] Studies reviewing written pharmacology examinations in Bangladesh revealed a persistent emphasis on factual recall rather than problem-solving or clinical application.[14] Consequently, there is a growing recognition of the need to incorporate innovative teaching–learning strategies such as PBL into undergraduate medical education to produce safe and effective prescribers.

The present study was designed to evaluate the effectiveness of PBL compared to conventional teaching in undergraduate pharmacology. Specifically, it aimed to assess whether PBL improves problem-solving skills, knowledge transfer, and attitudes toward learning among medical students.

By introducing a structured PBL module in bronchial asthma pharmacology and comparing it with traditional teaching methods, this study seeks to contribute evidence that may guide curriculum reforms in Bangladesh and other similar contexts.

METHODS

Study type

This was an interventional study comparing the effectiveness of PBL and conventional lecture-based teaching in pharmacology.

Study place and period

The study was conducted in the Department of Pharmacology, Dhaka Dental College, Dhaka, Bangladesh, from September 2023 to February 2024.

Selection criteria

All second-year undergraduate medical students enrolled in the pharmacology course during the study period were eligible. Students who did not attend all sessions or missed assessments were excluded.

Procedure

Students were divided into two groups: an intervention group receiving a structured PBL module on Drugs Used in Bronchial Asthma, and a control group taught through traditional lectures and tutorials. The PBL module was designed following Harden's SPICES model and the Maastricht seven-jump approach. Students worked in small groups with facilitator guidance. Control sessions covered identical content and duration but used conventional methods.

Assessments were conducted at four weeks and two months using problem-based multiple-choice questions and transfer-of-knowledge scenarios. A structured feedback questionnaire measured student attitudes toward PBL on a five-point Likert scale.

Ethical approval

The study protocol was reviewed and approved by the Ethical Review Committee of Dhaka Dental College, Dhaka, Bangladesh (Approval No.: DDC/ERB/2023/04).

Statistical analysis

Data were analyzed using SPSS version 25. Results are presented as mean±standard deviation (SD). Independent sample t-tests and paired t-tests were applied, with $p<0.05$ considered statistically significant.

RESULTS

Table 1 presents the marks (Mean±SD) obtained by students in the first assessment. The intervention group (Problem-Based Learning, PBL) performed significantly better than the control group (conventional teaching) in both compartments and in total scores (Figure 1). Marks

obtained (Mean±SD) in Part A, Part B, and the total score of the second assessment. Orange bars represent the control group and blue bars represent the intervention group (Problem-Based Learning).

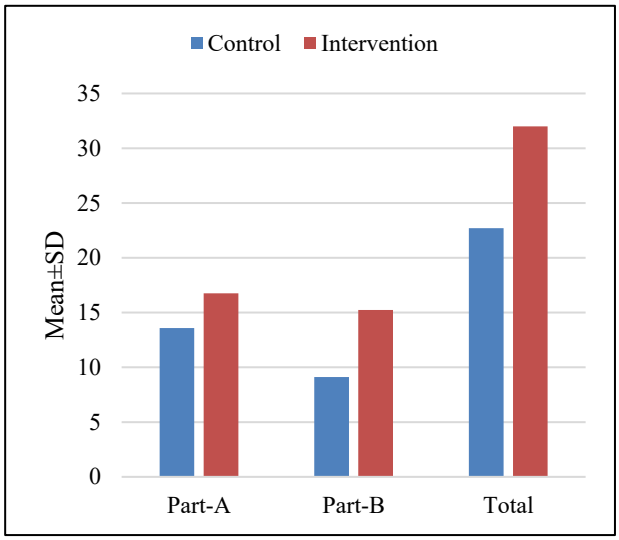

Figure 1: Marks obtained in second assessment.

The intervention group performed significantly better than the control group in all compartments. The mean Part A score was higher in the intervention group (16.76±1.81) compared to the control group (13.58±3.17, p<0.01). Similarly, in Part B, the intervention group scored 15.24±3.04 versus 9.12±3.03 in controls (p<0.01). The total score was also markedly higher in the intervention group (32.00±2.37) than in the control group (22.70±2.36, p<0.001).

Both groups showed significant improvement between the first and second assessments (p<0.01). In the control group, Part A and Part B scores decreased from 11.16±2.50 to 9.12±3.03, while the total score declined from 23.20±3.78 to 18.84±2.36. In the intervention group, greater reductions were observed, with Part A and Part B scores falling from 19.19 ± 0.92 to 15.24±3.04, and the total score decreasing from 38.15±1.50 to 32.00±2.37. Table 4 shows that students in the intervention group had a positive attitude towards PBL, with mean scores ranging from 4.2 to 4.7. Highest scores were for problem-solving ability (4.7±0.4), learning interest (4.6±0.5), self-study motivation (4.6±0.5), and overall satisfaction (4.6±0.5), indicating strong acceptance of the PBL approach.

Table 1: Marks obtained in first assessment (control vs intervention).

Compartment	Control (Mean±SD)	Intervention (Mean±SD)	P value
Part A	12.04±2.09	18.96±1.02	<0.01
Part B	11.16±2.50	19.19±0.92	<0.01
Total (40)	23.20±3.78	38.15±1.50	<0.01

Table 2: Marks obtained in second assessment (control vs intervention).

Compartment	Control (Mean±SD)	Intervention (Mean±SD)	P value
Part A	13.58±3.17	16.76±1.81	<0.01
Part B	9.12±3.03	15.24±3.04	<0.01
Total (40)	22.70±2.36	32.00±2.37	<0.001

Table 3: Comparison of scores (first vs. second assessment).

Score type	Group	First (Mean±SD)	Second (Mean±SD)	P value
Part A	Control	11.16±2.50	9.12±3.03	<0.01
	Intervention	19.19±0.92	15.24±3.04	<0.01
Part B	Control	11.16±2.50	9.12±3.03	<0.01
	Intervention	19.19±0.92	15.24±3.04	<0.01
Total Score	Control	23.20±3.78	18.84±2.36	<0.01
	Intervention	38.15±1.50	32.00±2.37	<0.01

Table 4: Attitude of intervention group students towards problem-based learning.

Item (summary)	Mean±SD
PBL makes learning more interesting	4.6±0.5
PBL improves problem-solving ability	4.7±0.4
PBL enhances understanding of pharmacology	4.5±0.6
PBL motivates self-study	4.6±0.5
PBL improves teamwork and communication	4.3±0.7
PBL applicable to clinical decision-making	4.4±0.6

Continued.

Item (summary)	Mean±SD
PBL encourages integration of knowledge	4.5±0.5
PBL increases long-term retention	4.2±0.7
PBL assessment reflects true understanding	4.3±0.6
Overall satisfaction with PBL approach	4.6±0.5

Scale: 1=strongly disagree, 5=strongly agree

DISCUSSION

The results of the present study demonstrate that the PBL approach produced markedly superior learning outcomes compared to conventional lecture-based teaching. As shown in Table 1, students in the intervention group achieved significantly higher scores in the first assessment across all compartments. In Part A, the PBL group scored 18.96±1.02 versus 12.04±2.09 in the control group ($p<0.01$), while Part B scores were 19.19±0.92 compared to 11.16±2.50 in controls ($p<0.01$). The total score in the intervention group was 38.15±1.50, markedly higher than the control group's 23.20±3.78 ($p<0.01$). These findings indicate that PBL not only enhances knowledge acquisition but also supports the development of integrated problem-solving skills. The superiority of PBL persisted in the second assessment, although a modest decline in performance was observed (Table 2 and Figure 1). Part-A and Part-B scores in the intervention group decreased from 19.19±0.92 to 16.76±1.81 and from 19.19±0.92 to 15.24±3.04, respectively ($p<0.01$), while the total score decreased from 38.15±1.50 to 32.00±2.37 ($p<0.001$). In contrast, the control group showed smaller declines, with total scores decreasing from 23.20±3.78 to 18.84±2.36 ($p<0.01$).

The comparison between first and second assessments (Table 3) highlights that although PBL students initially achieved higher gains, retention may diminish over time if learning experiences are not continuously reinforced. This suggests that sustained engagement and repeated application of knowledge are crucial for long-term consolidation, consistent with previous observations that retrieval practice strengthens retention.[15] The observed declines also underscore the importance of integrating ongoing PBL exercises within the MBBS curriculum. Without reinforcement, the performance gap between students exposed to PBL and those in conventional lectures may narrow over months, emphasizing that PBL is most effective when embedded as a continuous learning strategy rather than a one-time intervention.

Student perceptions of the PBL approach further support its value as an active learning method. As shown in Table 4, participants expressed strong agreement that PBL improved problem-solving ability (4.7±0.4), made learning more interesting (4.6±0.5), and motivated self-directed study (4.6±0.5). High scores were also reported for teamwork and communication (4.3±0.7), knowledge integration (4.5±0.5), and applicability to clinical decision-making (4.4±0.6). Overall satisfaction with PBL was 4.6±0.5, indicating a highly positive reception. These results align with prior international studies, which have shown that PBL fosters collaboration, independent thinking, and deeper conceptual understanding.[7,16] This study provides robust evidence that PBL enhances both cognitive performance and learner engagement compared to traditional teaching methods. While short-term gains are substantial, sustaining these benefits requires ongoing practice, integration into the curriculum, and reinforcement of knowledge and skills over time. Student feedback confirms that PBL is not only effective but also enjoyable and motivating, supporting its adoption as a central pedagogical approach in medical education.

This study was conducted at a single institution with a limited sample size, which may restrict the generalizability of the findings.

CONCLUSION

This study confirms that Problem-Based Learning is more effective than conventional teaching in enhancing problem-solving skills and knowledge transfer among medical students. While students showed positive attitudes toward PBL, the decline in performance over time highlights the need for repeated practice and reinforcement within the curriculum to ensure long-term sustainability of learning outcomes.

Recommendations

Problem-based learning should be progressively incorporated into the undergraduate pharmacology curriculum as a core teaching method, rather than as an isolated intervention. Regular reinforcement through repeated PBL sessions, integration across multiple clinical topics, and alignment with assessment systems would ensure long-term retention of knowledge and skills. Faculty development programs should also be implemented to train facilitators, and institutional support is necessary to overcome logistical challenges, such as organizing small groups and allocating resources.

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