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Research Article

Association between Student Participation in PBL Sessions and Performance in Integrated Modular Examinations

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ABSTRACT
Background: Problem-based learning (PBL) is widely used in integrated medical curricula to promote active learning, collaborative problem-solving, communication, and application of knowledge to clinical scenarios. There are, however, considerable variations between students in their active involvement in PBL sessions and it is important to further study the correlation between student involvement during PBL sessions and examination scores.
Objective: To determine the association between student participation in PBL sessions and performance in integrated modular examinations among undergraduate medical students.
Methods: This analytical cross sectional study was carried out in Rawal Institute of Health Sciences between March 2025 and September 2025. 85 undergraduate medical students were involved. The extent of participation in PBL was evaluated by attendance data and tutor assessment of knowledge gained through preparation, knowledge shared during group discussion, problem solving, collaborative efforts, and overall involvement. The students were divided into three groups – low, moderate and high participation groups. Academic achievement was measured by the scores earned in the integrated modular examination for the same academic standards. Descriptive statistics, one-way analysis of variance, Chi-square test, correlation analysis and multiple linear regression were used to analyze data. The significance of p value was <0.05.
Results: The mean PBL attendance was 82.6 ± 11.7%, while the mean overall active participation score was 73.9 ± 12.8%. Of the 85 students, 21 (24.7%) had low participation, 34 (40.0%) had moderate participation, and 30 (35.3%) had high participation. Mean integrated modular examination scores increased significantly across participation groups, from 63.2 ± 8.1% in the low-participation group to 72.2 ± 7.4% in the moderate group and 79.1 ± 7.0% in the high-participation group ($p < 0.001$). Examination pass rates were 61.9%, 82.4%, and 93.3%, respectively ($p = 0.018$). Overall active participation showed a strong positive correlation with examination score ($r = 0.62$, $p < 0.001$), while attendance demonstrated a moderate positive correlation ($r = 0.48$, $p < 0.001$). In multivariable analysis, active PBL participation and attendance remained significant independent predictors of examination performance.
Conclusion: Higher participation in PBL sessions was significantly associated with better performance in integrated modular examinations. Active engagement demonstrated a stronger relationship with academic achievement than attendance alone. These findings support the use of structured PBL activities that encourage meaningful student participation, discussion, preparation, and problem-solving within integrated medical curricula.

Keywords: Problem-Based Learning, Student Participation, Integrated Curriculum, Modular Examination, Academic Performance, Medical Education.

INTRODUCTION

The focus of medical education has shifted from teacher- to learner-centered, from didactic to methodologically integrating knowledge, to applying concepts into clinical situations. Integrated modular curricula: These curricula are developed with the aim of bringing together basic and clinical sciences together in one unit that would enable students to grasp the concepts in a more coordinated and clinically meaningful way. In these curricula, problem-based learning (PBL) has emerged as an important instructional approach, as it puts the student in the driver's seat, and involves them in the activity of identifying learning needs, investigating clinical issues, discussing possible explanations with others, and building knowledge together (1-3).

PBL generally involves small groups of students working through carefully designed clinical or biomedical problems under the guidance of a facilitator. The students are encouraged to recall previous knowledge, identify gaps in their understanding, make learning objectives, engage in self-directed learning, and return to the group to discuss and integrate new information. This process aims to foster the acquisition of factual knowledge and also clinical reasoning, communication skills, teamwork, problem-solving skills and self-directed learning. The skills are especially applicable to medical education where students are expected to be able to draw information from various specialities and use these in patient-centred contexts (4-6).

The outcomes of PBL might rely significantly on students' engagement, however, it could have significant educational benefits. Just being in school does not mean engaging in meaningful learning. Some students may be present physically in a session and contribute little to discussion, preparation, reasoning and collaborative problem solving. Whereas students that are actively engaged can ask and answer questions, explain concepts to others, propose hypotheses, formulate learning goals, and draw connections from across the curriculum. These activities can help to consolidate knowledge via retrieval, explanation, discussion, and application, and could result in improved learning (7, 8).

The factors that affect academic performance in integrated modular examination are the students' previous academic performance, study habits, motivation, quality of instruction, attendance, method of assessment, and learning characteristics. PBL participation could be another educational factor that can be changed. Learners that are actively involved in PBL can be more successful in comprehending complex topics and applying basic science concepts to clinical situations. But higher-achieving students might also be more likely to be engaged, which could present a causal link between academic performance at the outset, active engagement, and academic outcomes on the exams. This means that the influence of PBL participation on examination outcomes, after accounting for other school and student-level factors is important (9, 10).

Although PBL is increasingly incorporated into undergraduate medical curricula, evidence regarding the relationship between the level of participation within PBL sessions and performance in integrated modular examinations remains comparatively limited, particularly in local undergraduate medical education settings. Most evaluations focus on student perceptions, overall satisfaction, or comparisons between PBL and conventional teaching, rather than examining whether variation in active engagement among students is associated with measurable academic outcomes. Therefore, the present study was conducted to determine the association between student participation in PBL sessions and performance in integrated modular examinations among undergraduate medical students at Rawal Institute of Health Sciences. The study also aimed to examine the relationships of attendance, preparation, group discussion, problem-solving, teamwork, and tutor-rated participation with examination performance and to identify whether PBL participation independently predicted academic achievement.

METHODOLOGY

This analytical cross-sectional study was conducted at Rawal Institute of Health Sciences from March 2025 to September 2025. The study was designed to assess the association between the level of student participation in problem-based learning (PBL) sessions and academic performance in integrated modular examinations. Undergraduate medical students enrolled in the integrated modular curriculum and regularly participating in scheduled PBL

activities during the study period were considered eligible for inclusion.

A total of 85 undergraduate medical students were studied. Subject teachers were invited to participate from the respective academic year where PBL was a regular practice in the integrated modular curriculum. The students enrolled were included if they were officially enrolled in the selected module, attended the scheduled PBL sessions, took the integrated modular examination for the selected module and agreed to participate in the study. Students with incomplete attendance records, who did not sit the final modular examination, who withdrew from the module and students with incomplete academic records were not included in the analysis.

The students were recruited using the non-probability consecutive sampling technique with the aim of achieving the desired sample size of 85. Participants were given a study identification number for confidentiality, and there was no personally identifying information included in the analytical data set.

PBL sessions were integrated into the normal medical curriculum. Students were segmented into small groups and a structured clinical or biomedical problem was given that was related to the learning objectives of the corresponding module. A faculty tutor trained in PBL facilitated each of the PBL groups. The facilitator facilitated the discussion, facilitated student interaction, clarified any misunderstandings as needed, and evaluated the level of participation without directly giving solutions to the problems that were presented. In every PBL session students were required to identify the main problems/concerns in the case presented, to formulate and discuss possible explanations and to develop learning goals, address concepts and knowledge from various basic and clinical sciences and to participate in the group problem solving. In between sessions, students were also provided opportunities to prepare on their own and then share and discuss their learning with the rest of the group.

Student attendance in PBL sessions and tutor-based evaluation of structured PBL were used to determine student participation. Percent of PBL attendance was computed by taking the number of PBL sessions attended and dividing it by the number of PBL sessions scheduled and multiplying the quotient by 100. Active participation was evaluated by group pre-hearing, group discussion, relevant questions asked, group problem solving, explaining of learning objectives, team work, group co-operation and general participation during the session, as pre-defined domains. The ratings for the PBLs that were available were uniformly aggregated to create a participation score (as a percentage). Students were identified as being in low, moderate, or high participation groups based on their participation scores. All participants were categorized in the same way before results of examinations were used for analysis. Attendance percentage in PBL was retained as a continuous variable in correlation and regression analyses along with overall active participation score, preparation score, group discussion contribution, problem-solving contribution, teamwork score and tutor-rated participation score.

The main result of the study was the performance of the students in the integrated modular examination at the end of the relevant module. The official institutional academic records were used for the collection of examination results. The total/integrated modular examination score was reported as a percentage. If available, the results from the written/MCQ and practical/OSPE portions were reported separately. Performance in overall examination was examined as a continuous variable and as a categorical variable. Students were deemed to have passed or failed based on the institutional passing criteria. Students with relatively high academic performance were also identified for descriptive analysis by a cut-off score of 75% and above.

Eligible students were identified based on the academic records after getting the necessary institutional permission. A structured data collection form was used to collect information about the demographic variables such as age and gender. The baseline academic ability was documented through examination performance in previous years, if available. PBL attendance data were collected from official attendance sheets, and scores related to participation were collected from the tutor's assessment documents. The official modular examination database was used to obtain examination scores. Minimisation of transcription errors by all information being cross checked before they were entered. Coded variables were used to enter data and each student's name was anonymised during the study. Attendance percentage at PBL and active participation score at PBL served as the main independent variables and integrated modular examination score as the main dependent variable. The additional explanatory variables were preparation prior to PBL sessions, participation

in discussion, problem-solving participation, teamwork, tutor-rated participation, age, gender and previous academic performance.

IBM SPSS Statistics was used to enter and analyze data. The continuous variables used were age, attendance percentage in PBL and participation scores and examination scores which were summarized by mean ± standard deviation (SD) when they were normally distributed. Categorical data including gender, participation category, pass/fail status and high performance status were displayed as frequencies and percentages. A one-way analysis of variance (ANOVA) was used to compare the means of examination scores for the three groups with different levels of PBL participation. If appropriate, post-hoc comparisons may be conducted to determine which of the participation groups were significantly different from each other. A Chi square test was used to determine if there was an association between level of participation in PBL and examination pass/fail, and Fisher's exact test was used if expected cell counts were small. Pearson's correlation coefficient (r) was used to determine the relationship between continuous PBL participation indicators and the integrated modular examination scores when the scores had normally distributed data. If the assumptions of Pearson's correlation were not met, Spearman's rank correlation might be used. Multiple linear regression was conducted on the question of whether participation in PBL was a predictor of performance in the integrated modular examination independent of the other predictors. Age, gender, previous examination score, PBL attendance percentage, overall active participation score, and tutor-rated participation score were regarded as explanatory variables, and the integrated modular examination percentage was used as the dependent variable. Reported were regression coefficients together with their standard errors, standardized beta coefficients and p-values. All statistical tests were 2-sided, and a p value <0.05 was considered statistically significant.

RESULTS

Eighty-five undergraduate medical students were analyzed. The median age of the participants was 21.3 ± 1.4 years ranging from 19 to 24 years. Of the total participants, 47 (55.3%) were female and 38 (44.7%) were male. The majority of students' previous academic achievements were satisfactory, with a mean previous examination score of 69.8 ± 8.1%.

Table 1. Demographic and Academic Characteristics of the Study Participants (n = 85)

Variable	Frequency (%) / Mean ± SD
Age, years	21.3 ± 1.4
Male	38 (44.7%)
Female	47 (55.3%)
Previous examination score, %	69.8 ± 8.1
Previous score <60%	10 (11.8%)
Previous score 60–74%	47 (55.3%)
Previous score ≥75%	28 (32.9%)

There was a wide range of participation in PBL sessions among students. Overall, the average percentage of PBL students was 82.6 ± 11.7% and the mean overall active participation score was 73.9 ± 12.8%. Overall participation score was used to classify the children and 21 (24.7%) children were classified as having low participation, 34 (40.0%) children moderate participation, and 30 (35.3%) with high participation. The students' overall scores were better for the areas of teamwork and group cooperation than for asking questions and guiding discussions.

Table 2. PBL Attendance and Participation Characteristics of Students

PBL-related variable	Mean ± SD / n (%)
PBL attendance, %	82.6 ± 11.7
Overall active participation score, %	73.9 ± 12.8
Preparation before PBL sessions, %	72.8 ± 13.5
Group discussion contribution, %	74.6 ± 13.2
Problem-solving contribution, %	73.5 ± 12.7
Teamwork/cooperation score, %	78.4 ± 11.9

Tutor-rated participation score, %	75.1 ± 12.4
Low participation	21 (24.7%)
Moderate participation	34 (40.0%)
High participation	30 (35.3%)

The total grade of the Integrated modular examination was 72.4 ± 9.6%. Sixty-nine students (81.2%) passed the examination while 16 (18.8%) failed to meet the minimum passing mark. 32.9% of the students (28) achieved an examination score of 75% or more.

Table 3. Performance in the Integrated Modular Examination

Examination outcome	**Mean ± SD / n (%)**
Integrated modular examination score, %	72.4 ± 9.6
Written/MCQ component, %	71.6 ± 10.1
Practical/OSPE component, %	73.2 ± 9.8
Passed examination	69 (81.2%)
Failed examination	16 (18.8%)
Score ≥75%	28 (32.9%)
Score <75%	57 (67.1%)

There was a gradual increase in examination performance as the number of PBL sessions increased. The mean integrated examination score of students who participated in the program at high level was 79.1 ± 7.0%, while that of students who participated at the moderate level was 72.2 ± 7.4% and that of students who participated at low level 63.2 ± 8.1%. This significant difference ($p < 0.001$) was found between the three groups.

Likewise, pass rates were 61.9% for low participation, 82.4% for moderate participation and 93.3% for high participation. There was a significant relationship between the participation category and the pass/fail status ($p = 0.018$).

Table 4. Integrated Modular Examination Performance According to PBL Participation Level

PBL participation level	**n**	**Examination score, Mean ± SD**	**Passed, n (%)**	**Failed, n (%)**
Low	21	63.2 ± 8.1	13 (61.9%)	8 (38.1%)
Moderate	34	72.2 ± 7.4	28 (82.4%)	6 (17.6%)
High	30	79.1 ± 7.0	28 (93.3%)	2 (6.7%)
p-value		**<0.001**	**0.018**	

The result of this correlation shows a positive relationship between the participation in PBL and the examination performance, with PBL participation resulting in a higher examination score. The integrated modular examination score was most strongly correlated with the overall active participation score ($r = 0.62$, $p < 0.001$). There was also a positive correlation between PBL attendance and examination performance ($r = 0.48$, $p < 0.001$). The examination scores were moderately positively correlated with tutor rated participation and preparation before PBL sessions.

Table 5. Correlation between PBL Participation Indicators and Integrated Modular Examination Score

Variable	**Correlation coefficient (r)**	**p-value**
PBL attendance percentage	0.48	<0.001
Overall active participation score	0.62	<0.001
Preparation before PBL sessions	0.44	<0.001
Group discussion contribution	0.53	<0.001
Problem-solving contribution	0.55	<0.001
Teamwork/cooperation score	0.39	<0.001
Tutor-rated participation score	0.58	<0.001

A multiple linear regression model was used to determine factors independently associated with integrated modular examination performance. Following adjustment for age,

gender and previous examination score, both overall PBL participation score and PBL attendance were significant independent predictors of examination performance. There was a strong, positive relationship between the percentage increase in active PBL participation and the change in integrated examination score (R = .285, approximate 10-point increase in PBL participation for each 3.2-point increase in examination score). The final examination score was also independently related to previous academic performance.

Table 6. Multiple linear Regression Analysis of Predictors of Integrated Modular Examination Performance

Predictor	B	Standard Error	Standardized β	p-value
Age, years	0.18	0.42	0.03	0.671
Female gender	0.74	1.31	0.04	0.574
Previous examination score, %	0.31	0.08	0.27	<0.001
PBL attendance, %	0.15	0.06	0.18	0.014
Overall PBL participation score, %	0.32	0.06	0.43	<0.001
Tutor-rated participation score, %	0.11	0.06	0.14	0.072

Overall, the findings demonstrated that students who attended PBL sessions regularly and participated more actively in discussions, problem-solving activities, and collaborative learning achieved significantly higher scores in integrated modular examinations. Active participation showed a stronger relationship with academic performance than attendance alone, suggesting that the quality of student engagement during PBL sessions may be particularly important for academic achievement.

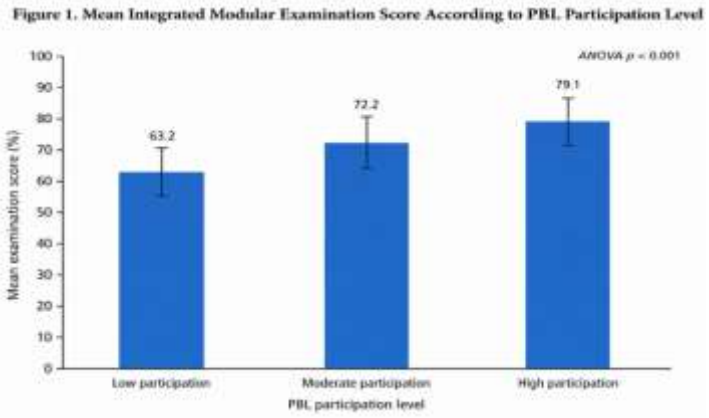

Figure 1. Mean Integrated Modular Examination Score According to PBL Participation Level

The bar chart shows the mean integrated modular examination scores among students with low, moderate, and high participation in PBL sessions. Students with high participation achieved the highest mean examination score, followed by those with moderate and low participation. Error bars represent standard deviation, and the difference among the groups was statistically significant (**ANOVA p < 0.001**).

DISCUSSION

The present study demonstrated a significant positive association between student participation in problem-based learning (PBL) sessions and performance in integrated modular examinations. Students with high PBL participation achieved the highest mean examination score (79.1 ± 7.0%**),** followed by those with moderate **(**72.2 ± 7.4%**)** and low participation (63.2 ± 8.1%**),** with a statistically significant difference among the groups (p < 0.001). In addition, examination pass rates increased progressively from 61.9% in the low-participation group to 93.3% in the high-participation group. These findings suggest that meaningful involvement in PBL activities may contribute to improved understanding and application of integrated medical knowledge. This is consistent with the broader evidence supporting PBL as an effective student-centered educational strategy. Studies reported that PBL generally produced academic performance comparable to or better than conventional teaching and provided additional benefits in problem-solving, communication,

self-directed learning, and collaborative skills (11-13).

An important result of the present study was that involvement seemed to be more closely related with examination results than attendance. The overall active participation exhibited a strong positive correlation with the examination scores ($r = 0.62$, $p < 0.001$) while PBL attendance showed moderate correlation ($r = 0.48$, $p < 0.001$). This indicates that attending a PBL session might not serve the same educational purpose as engaging in problem-solving, concept clarification, learning goal formulation, and collegial interaction. In learning environments where the students are allowed to learn in an active manner, similar results have been observed regarding the relationship between learning participation and performance in collaborative learning activities, highlighting the importance of being active in the learning process rather than just passive. Another study that compared distance and face-to-face PBL found that students engaged in face-to-face PBL had significantly higher overall tutorial scores, and demonstrated higher scores on participation, communication, preparation, critical thinking, and group skills. The results here support the notion that the quality of interaction that takes place during PBL is a key factor of the educational effectiveness of PBL (14, 15).

A positive correlation between PBL attendance and exam results is also strengthened by research investigating attendance in medical education. Studies found that the attendance and academic performance were significantly positively associated with the MBBS students, indicating that the students who passed the exams had better attendance than those who failed. In the same way, it was known that attending classes was positively associated with the result of professional examinations at the end of the first semester in medical students on undergraduate study, and that the result of professional examinations at the end of the previous semester was even more of a predictor. This relationship is also reflected in evidence from other forms of collaborative learning; it was reported that first-year medical students who attended near-peer teaching sessions performed better academically. Together, these results suggest that structured education activities support continuity of learning but that this is not necessarily determined by attendance (16, 17).

The important relationships found for group discussion, problem-solving, preparation, teamwork and tutor rated participation also demonstrate the ways in which PBL might enhance performance in integrated modular exams. Problem-solving contribution was positively correlated with examination performance ($r = 0.55$), group discussion contribution was correlated ($r = 0.53$) and tutor-rated participation was correlated ($r = 0.58$); all correlations were statistically significant. PBL asks students to access some previously learned content, determine what they don't know, link basic science to clinical scenarios, debate and discuss other possible explanations and defend their arguments. These processes can facilitate understanding instead of rote-learning. Studies of PBL's effectiveness for biostatistics teaching revealed significantly greater examination results with PBL than with didactic teaching, and reported benefits in analytical thinking, critical thinking, and autonomous learning. In the same way, medical students who engaged in case-based learning in Pakistan, studies found interactive case-based learning useful for the purposes of understanding concepts, problem solving, keeping them engaged and applying concepts to real life situations (18, 19).

The multivariable analysis confirmed the primary results, as overall PBL participation and attendance was independently associated with the overall examination score after controlling for age, gender and prior examination score. In particular, one additional percentage point of active involvement in PBL led to a 3.2-point increase in examination scores, and prior academic performance was also an independent predictor. These results suggest that the relation of PBL involvement to test performance is not only due to initial academic performance differences. However, academically more capable or motivated students may be more likely to be active, read ahead and attend regularly. Hence, the present observations were indicative of an association, but not causal. The extant literature also acknowledges that there are several complex factors that impact on educational performance such as prior academic performance, motivation, attendance, self-directed learning practices, quality of teaching and learning, assessment system, and access to alternative learning materials (20).

The findings have practical implications for institutions using integrated modular curricula. PBL is not to be viewed as a "must attend" activity, but instead the classroom should be a place where students can meaningfully engage

in the work. This can be done through a tutor ensuring that students have equal opportunities to contribute, to set clear learning goals, to have evidence-based discussion and to receive constructive feedback. Where a student has limited participation on a regular basis, they might benefit from early academic support, especially when combined with a fall in examination performance. In parallel, the assessment of participation should also be standardized to avoid this variation in tutor ratings among groups. Faculty development and/or the application of structured PBL assessment rubrics can enhance consistency. The literature also suggests that implementation quality and tutor preparation are relevant to the implementation of PBL because PBL demands a lot from faculty and teachers' continued training to achieve the intended educational outcomes.

Several limitations should be considered when interpreting the findings. First, the study was performed in one institution with a sample of 85 students, restricting the findings to the generalizability to other medical colleges/curricula. Second, it is not possible to conclude that higher examination scores directly resulted from the increased PBL involvement. Lastly, the scores from tutor-rated participation might vary between observers, even when structured assessment criteria are employed. The level of student motivation, learning style, independent study time, socioeconomic factors, prior knowledge and use of external educational resources were not fully assessed and may have had an impact on participation rates and examinations' performance. However, the use of objective attendance data, examination outcomes, some dimensions of PBL engagement, and multivariable analysis, is a significant strength. The results of future multicenter prospective studies with larger sample sizes, standardized participation rubrics for PBL, repeated measurements over a number of modules, and assessment of potential confounding factors like motivation and independent study behavior would benefit. These kinds of studies would provide information on whether or not there is measurable and lasting improvement in academic outcome when active PBL engagement is improved.

CONCLUSION

The study demonstrated a significant positive association between student participation in PBL sessions and performance in integrated modular examinations. Students with greater participation achieved substantially higher examination scores and higher pass rates than those with lower participation. Active engagement in PBL, particularly through discussion, problem-solving, preparation, teamwork, and interaction with tutors and peers, showed a stronger relationship with academic performance than attendance alone. Overall PBL participation remained an independent predictor of examination performance even after accounting for previous academic achievement and selected demographic factors.

These findings support the incorporation of well-structured and actively facilitated PBL sessions within integrated medical curricula. Medical institutions should emphasize meaningful student engagement rather than attendance alone**,** supported by standardized participation assessment, faculty development, constructive tutor feedback, and early identification of poorly engaged students. Further prospective and multicenter research is warranted to establish the causal effect of active PBL participation on academic performance and longer-term knowledge retention.

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