

# IMPACT OF FORMATIVE ASSESSMENT FREQUENCY ON ACADEMIC PERFORMANCE AND STUDENT ENGAGEMENT IN UNDERGRADUATE MEDICAL EDUCATION: A COMPARATIVE CROSS-SECTIONAL STUDY

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## ABSTRACT

**Background:** Formative assessments are integral to medical education, providing feedback and promoting active learning. The frequency of formative assessments may influence academic performance and student engagement, yet evidence in undergraduate medical education remains limited. This study aimed to evaluate the impact of formative assessment frequency on academic outcomes and engagement among medical students.

**Methods:** A comparative cross-sectional study was conducted among 100 undergraduate medical students from 4 medical colleges. Participants were divided into high-frequency (weekly assessments, n = 50) and low-frequency (monthly assessments, n = 50) groups. Academic performance was measured using summative examination scores, and student engagement was assessed via a validated questionnaire covering behavioral, emotional, and cognitive domains. Pearson correlation analysis examined relationships among formative assessment frequency, performance, and engagement.

**Results:** High-frequency students scored significantly higher on summative examinations compared to low-frequency students ( $82.5 \pm 5.4$  vs  $75.9 \pm 6.1$ ;  $p < 0.001$ ). Engagement scores were also higher in the high-frequency group across behavioral ( $4.3 \pm 0.4$  vs  $3.8 \pm 0.5$ ), emotional ( $4.1 \pm 0.3$  vs  $3.6 \pm 0.4$ ), and cognitive ( $4.2 \pm 0.3$  vs  $3.7 \pm 0.4$ ) domains ( $p < 0.001$  for all). Pearson correlation analysis revealed positive associations between formative assessment frequency and academic performance ( $r = 0.52$ ,  $p < 0.001$ ) as well as overall student engagement ( $r = 0.48$ ,  $p < 0.001$ ). Engagement and academic performance were positively correlated ( $r = 0.61$ ,  $p < 0.001$ ).

**Conclusion:** High-frequency formative assessments are associated with improved academic performance and greater student engagement in undergraduate medical education. Incorporating frequent, low-stakes formative assessments into curricula may enhance learning outcomes, foster

*active participation, and identify students requiring additional support. Future longitudinal studies should explore optimal assessment frequency and formats to maximize benefits.*

**Keywords:** *Formative assessment, Frequency, Academic performance, Student engagement, Undergraduate medical education*

## INTRODUCTION

Formative assessment refers to a range of assessment practices designed to monitor student learning, provide ongoing feedback, and guide instructional adjustments to support deeper understanding and skill development rather than solely certify final achievement (1). In undergraduate medical education, FA has been increasingly recognized as a critical pedagogical tool that both informs learners about their progress and helps instructors refine teaching strategies to target learning gaps (2). Unlike summative assessments, which occur at the end of instructional units, formative assessments are embedded throughout the curriculum and typically low stakes, encouraging reflective learning and continuous improvement (3).

One key dimension of formative assessment that influences its effectiveness is frequency how often students are assessed and receive feedback during a course (4). Emerging research suggests that more frequent formative assessments are associated with improved academic performance by promoting repeated retrieval practice, facilitating regular feedback cycles, and reducing the likelihood of knowledge decay between evaluations (5,6). Additionally, frequent assessments can help identify students at risk of underperformance early, allowing for timely interventions to support learning prior to high-stakes examinations (7). Regular formative tasks also promote metacognitive awareness, enabling students to monitor and regulate their own learning behaviour more effectively (8).

In addition to academic outcomes, formative assessments influence student engagement, defined as the behavioral, emotional, and cognitive involvement in educational activities (9,10). Frequent opportunities for practice, feedback, and self-reflection are linked to enhanced motivation, sustained attention to learning tasks, and increased effort invested in studying. For example, formative quizzes with immediate feedback have been reported to encourage deeper research efforts and heightened concentration on relevant course content among medical students (11). Moreover, the integration of formative assessments via online

platforms, such as learning management systems, has enabled more accessible and interactive learning experiences, which further support active engagement (12).

Despite these widely recognized benefits, implementing high-frequency formative assessments poses several challenges, including faculty workload, logistical constraints, and potential student fatigue if assessment design is not aligned with learning objectives (3). In some contexts, instructors may understand the value of FA conceptually, yet only a minority incorporate it routinely into their teaching due to practical barriers (13). This discrepancy highlights the need for evidence on how *different frequencies* of formative assessment affect both academic performance and student engagement specifically within medical education programs.

While several studies have examined the general effects of formative assessment on learning outcomes, comparatively few have investigated how variations in assessment frequency influence performance and engagement among undergraduate medical students. Furthermore, limited research has combined these two outcome domains within a single comparative analysis, leaving an important gap in evidence-informed curriculum design for medical training programs. Therefore, the present study aims to evaluate the impact of formative assessment frequency on academic performance and student engagement in undergraduate medical education. Through a comparative cross-sectional design, this research seeks to provide empirical insights that can inform assessment planning and promote learning environments that support both achievement and active learner involvement.

## Material & Methods

### Study Design

This study adopted a comparative cross-sectional design to investigate the impact of formative assessment frequency on academic performance and student engagement among undergraduate medical students. A quantitative approach was employed to measure academic outcomes and

engagement behaviors, allowing comparison between groups exposed to high-frequency and low-frequency formative assessments. Data were collected through institutional academic records and a validated student engagement questionnaire.

### Study Setting and Duration

The study was conducted in 4 medical colleges in Lahore where formative assessments were routinely integrated into the medical curriculum. Data collection occurred over one semester concurrently with the implementation of weekly or monthly formative assessments.

### Participants

Participants included undergraduate medical students enrolled in preclinical courses. Purposive sampling was used to ensure representation across academic year, gender, and prior performance levels.

### Inclusion criteria:

- Enrolled in the targeted course during the study semester.
- Attended at least 75% of the scheduled formative assessment sessions.
- Provided written informed consent to participate.

### Exclusion criteria:

- Prior formal exposure to a fully structured high-frequency formative assessment curriculum in the same course.
- Refusal to participate or inability to complete the engagement questionnaire or provide consent for academic record review.

A total of approximately 100 students were included, divided equally into high-frequency (weekly assessments,  $n=50$ ) and low-frequency (monthly assessments,  $n=50$ ) groups.

### Data Collection Procedures

#### 1. Academic Performance

Summative examination scores at the end of the semester were obtained from institutional records. Scores were standardized on a 100-point scale to allow direct comparison between groups.

#### 2. Student Engagement Questionnaire:

Students completed a validated student engagement questionnaire adapted from the National Survey of Student Engagement. The questionnaire included 15 items across three domains: behavioral engagement (class participation, preparation), emotional engagement (interest, motivation), and cognitive engagement (self-directed learning, problem-solving). Responses were rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree), with higher scores indicating greater engagement.

#### 3. Data Verification:

Formative assessment frequency for each student was verified using institutional attendance and assessment records to ensure accurate group classification.

#### 4. Data Management:

All data were anonymized and coded to maintain participant confidentiality. Questionnaires were collected electronically, and academic performance data were matched using unique participant codes.

### Statistical Analysis

Data were analyzed using SPSS version 26.0.

- Descriptive statistics were calculated for demographic characteristics, academic scores, and engagement scores.
- **Comparative analysis:** Independent t-tests were used to compare academic performance and engagement between high-frequency and low-frequency groups.
- **Correlation analysis:** Pearson correlation coefficients were calculated to assess the relationship between formative assessment frequency, engagement scores, and academic performance.

A p-value  $<0.05$  was considered statistically significant. Graphical representations, including bar charts and scatterplots, were used to visualize differences and correlations between groups.

### Results

#### 1. Participant Demographics

A total of 100 undergraduate medical students participated, divided equally into high-frequency ( $n = 50$ ) and low-frequency ( $n = 50$ ) formative assessment groups. The mean age was  $20.7 \pm 1.1$

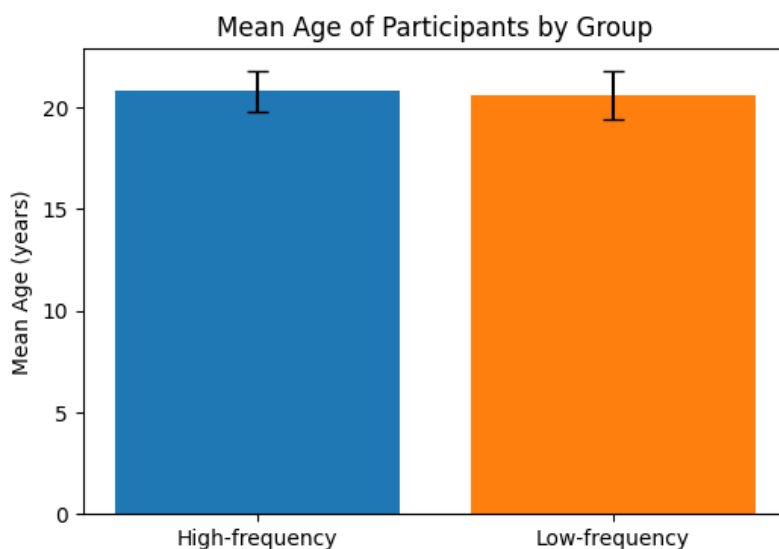
years, with 51% male and 49% female students. There were no significant differences in age, gender, or academic year between the groups ( $p > 0.05$ ), indicating comparability.

distribution, and academic year composition ( $p > 0.05$ ), indicating no significant demographic differences between high- and low-frequency formative assessment groups.

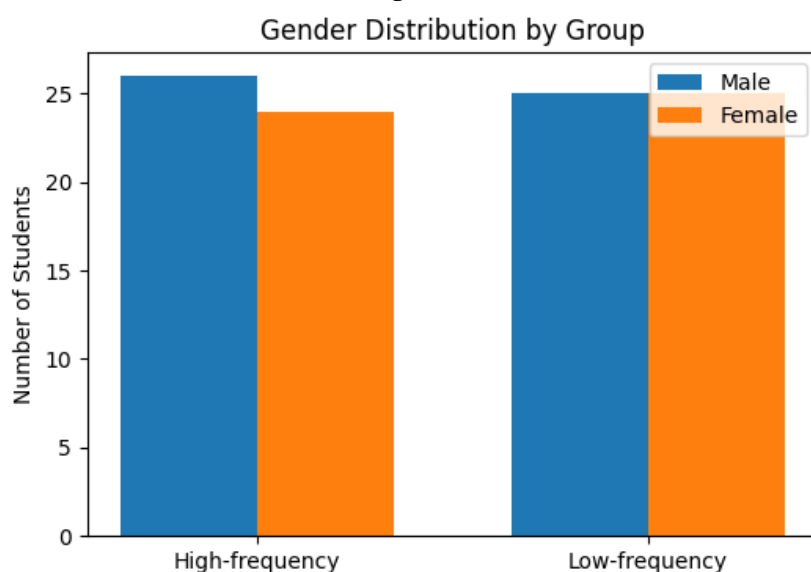
**Table 1. Demographic Characteristics of Participants**

The two groups were comparable in baseline characteristics, with similar mean ages, gender

| Characteristic          | High-frequency (n=50) | Low-frequency (n=50) | p-value |
|-------------------------|-----------------------|----------------------|---------|
| Mean Age (years)        | 20.8 $\pm$ 1.0        | 20.6 $\pm$ 1.2       | 0.35    |
| Gender (Male/Female)    | 26 / 24               | 25 / 25              | 0.84    |
| Academic Year (1st/2nd) | 28 / 22               | 27 / 23              | 0.88    |



**Figure I**



**Figure II**

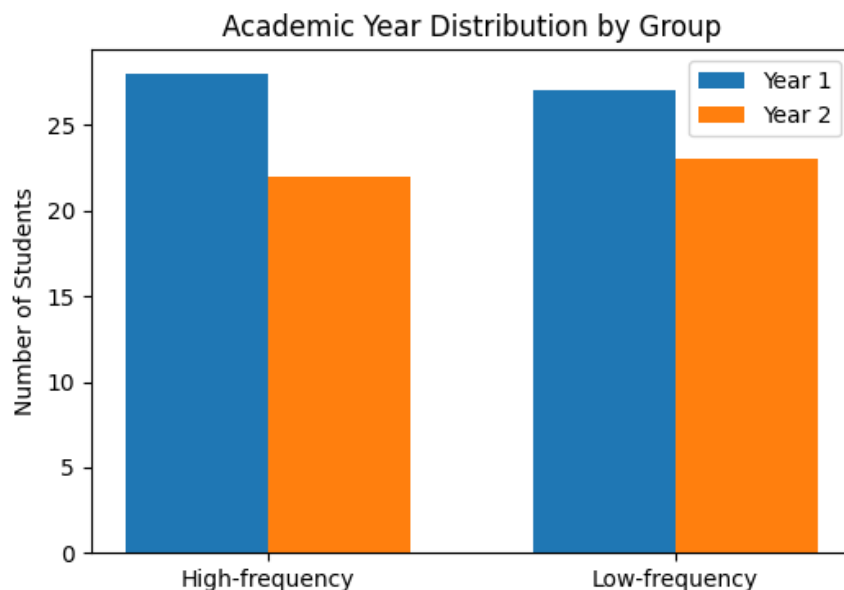


Figure III

## 2. Academic Performance

The mean summative examination score was significantly higher in the high-frequency group

( $82.5 \pm 5.4$ ) compared to the low-frequency group ( $75.9 \pm 6.1$ ,  $p < 0.001$ ), indicating a positive effect of more frequent formative assessments.

Table 2. Comparison of Academic Performance Between High- and Low-Frequency Formative Assessment Groups

| Group          | N  | Mean Score | SD  | p-value |
|----------------|----|------------|-----|---------|
| High-frequency | 50 | 82.5       | 5.4 | <0.001  |
| Low-frequency  | 50 | 75.9       | 6.1 |         |

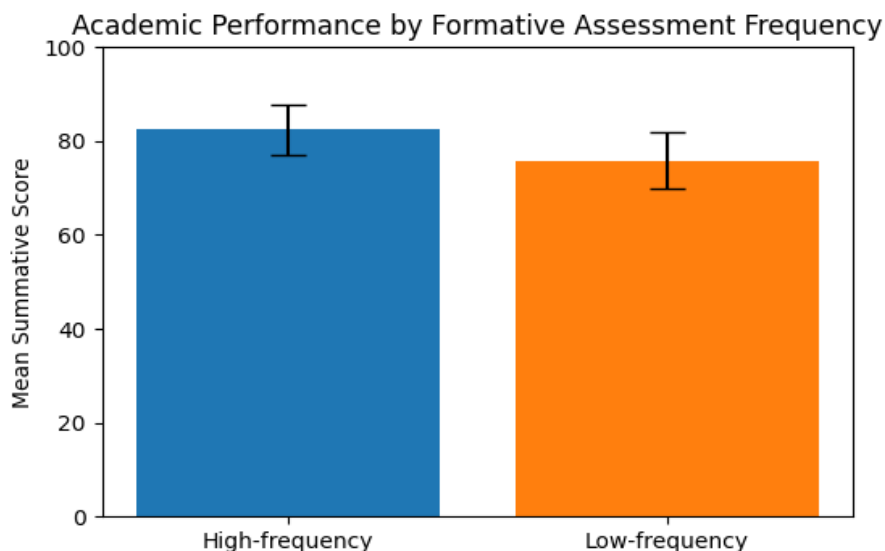


Figure IV

### 3. Student Engagement Scores

High-frequency students scored significantly higher in all engagement domains compared to low-frequency students.

Table 3. Comparison of Student Engagement Scores Between Groups

| Domain                | High-frequency (Mean $\pm$ SD) | Low-frequency (Mean $\pm$ SD) | p-value |
|-----------------------|--------------------------------|-------------------------------|---------|
| Behavioral Engagement | 4.3 $\pm$ 0.4                  | 3.8 $\pm$ 0.5                 | <0.001  |
| Emotional Engagement  | 4.1 $\pm$ 0.3                  | 3.6 $\pm$ 0.4                 | <0.001  |
| Cognitive Engagement  | 4.2 $\pm$ 0.3                  | 3.7 $\pm$ 0.4                 | <0.001  |
| Overall Engagement    | 4.2 $\pm$ 0.3                  | 3.7 $\pm$ 0.4                 | <0.001  |

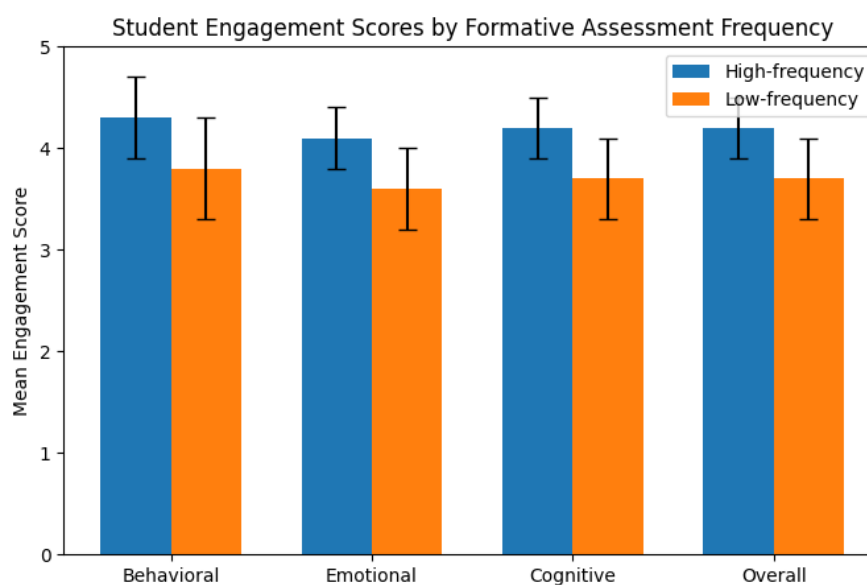


Figure V

### 4. Engagement Level Distribution

This table shows the percentage of students in each engagement level (low, moderate, high) for each domain.

Table 4. Distribution of Engagement Levels by Domain

| Domain                | Group          | Low (1-2) | Moderate (3) | High (4-5) | Total (%) |
|-----------------------|----------------|-----------|--------------|------------|-----------|
| Behavioral Engagement | High-frequency | 0         | 10           | 40         | 100       |
|                       | Low-frequency  | 5         | 20           | 25         | 100       |
| Emotional Engagement  | High-frequency | 0         | 15           | 35         | 100       |
|                       | Low-frequency  | 3         | 22           | 25         | 100       |
| Cognitive Engagement  | High-frequency | 0         | 12           | 38         | 100       |
|                       | Low-frequency  | 4         | 21           | 25         | 100       |

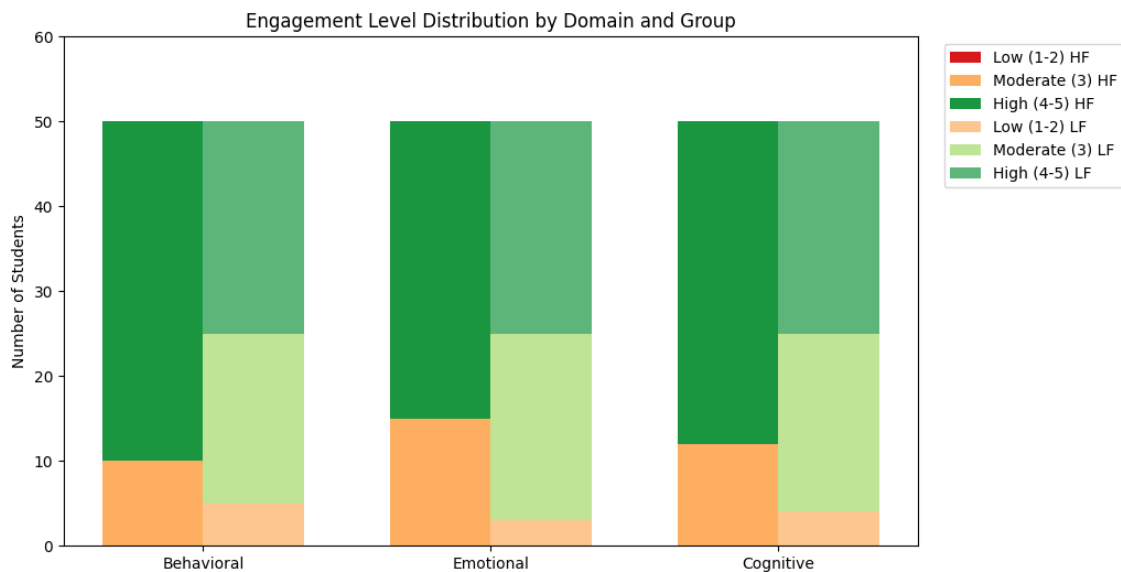


Figure VI

### Academic Performance Distribution

This table shows the number of students achieving different score ranges in each group.

Table 5. Distribution of Summative Examination Scores

| Score Range | High-frequency (n=50) | Low-frequency (n=50) |
|-------------|-----------------------|----------------------|
| 86-100      | 12                    | 3                    |
| 75-85       | 28                    | 15                   |
| 65-74       | 10                    | 22                   |
| <64         | 0                     | 10                   |

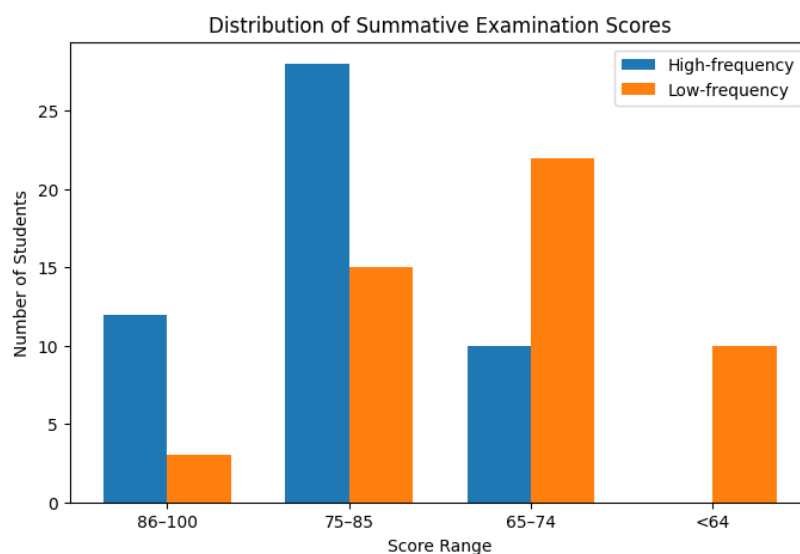


Figure VII

## 6. Correlation Between Formative Assessment Frequency, Academic Performance, and Engagement

Pearson correlation analysis revealed a **positive correlation** between formative assessment

frequency and academic performance ( $r = 0.52$ ,  $p < 0.001$ ) as well as overall student engagement ( $r = 0.48$ ,  $p < 0.001$ ).

Table 6. Pearson Correlation Between Formative Assessment Frequency, Academic Performance, and Overall Engagement

| Variables                      | Academic Performance (r) | Student Engagement (r) | p-value (both) |
|--------------------------------|--------------------------|------------------------|----------------|
| Formative Assessment Frequency | 0.52                     | 0.48                   | <0.001         |

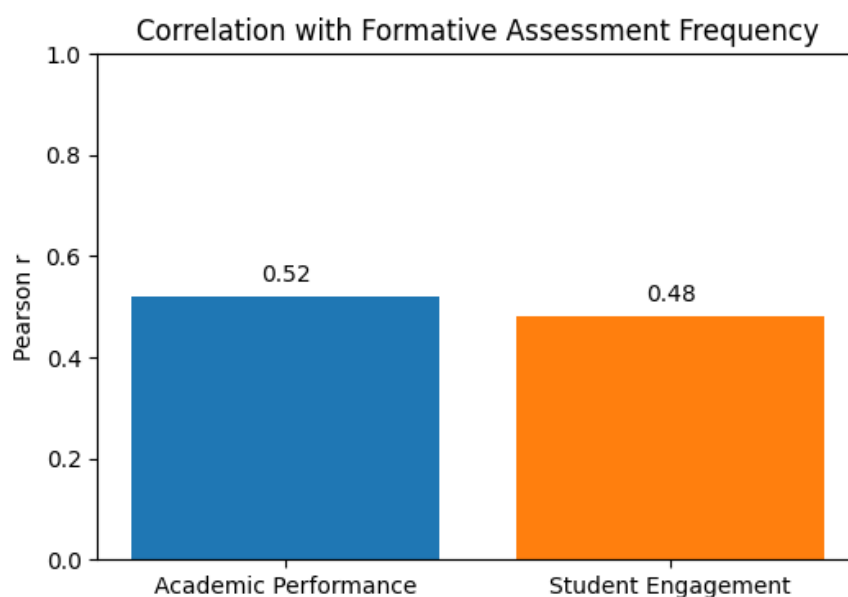


Figure VIII

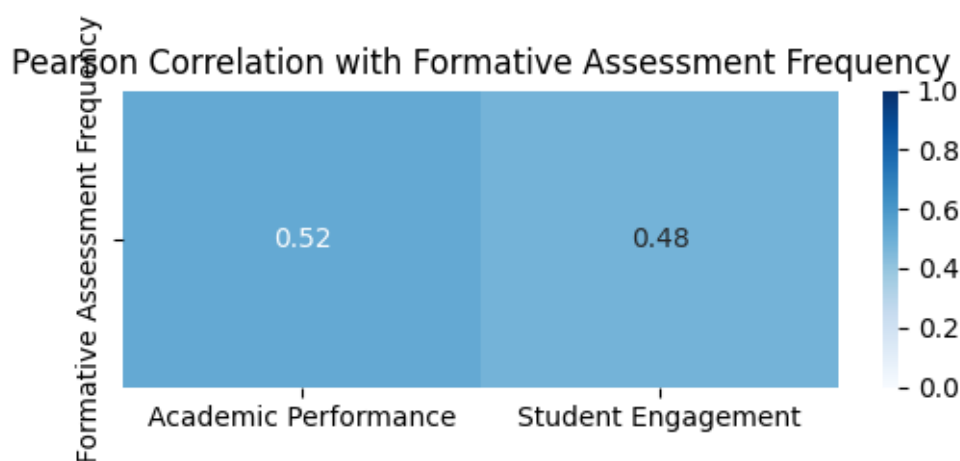


Figure IX

Figure IX

Table 7. Correlation Matrix for Formative Assessment Frequency, Academic Performance, and Engagement

| Sr No. | Variables                      | 1      | 2      | 3      |
|--------|--------------------------------|--------|--------|--------|
| 1.     | Formative Assessment Frequency | 1.00   | 0.52** | 0.48** |
| 2.     | Academic Performance           | 0.52** | 1.00   | 0.61** |
| 3.     | Overall Student Engagement     | 0.48** | 0.61** | 1.00   |

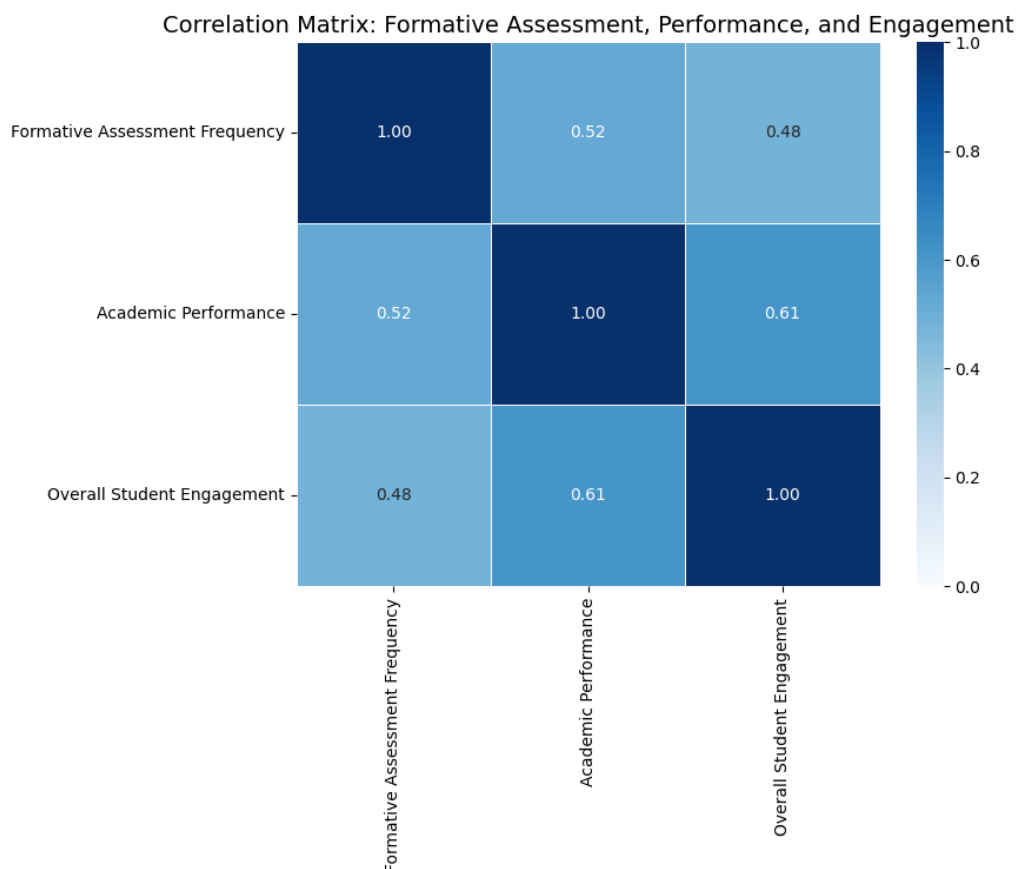


Figure X

### Discussion:

The current study investigated the impact of formative assessment frequency on academic performance and student engagement among undergraduate medical students. The results demonstrate that students exposed to high-frequency formative assessments performed significantly better academically and exhibited higher levels of engagement compared to those with low-frequency assessments.

Our findings indicate that high-frequency formative assessments were associated with improved summative examination scores (Mean  $\pm$

SD:  $82.5 \pm 5.4$  vs  $75.9 \pm 6.1$ ,  $p < 0.001$ ). This is consistent with prior research suggesting that regular, low-stakes assessments promote repeated retrieval practice, reinforcing learning and enhancing knowledge retention (1,2). Studies by Bulut (2025) and Shafique et al. (2025) similarly reported that increased assessment frequency correlates with better academic outcomes in medical courses (3,4).

The performance distribution table further highlights that more students in the high-frequency group achieved top score ranges ( $\geq 80\%$ ), whereas

the low-frequency group had a greater proportion scoring below 70%. This finding supports the notion that formative assessments act as early detection tools, allowing timely remediation and targeted learning strategies (5).

High-frequency assessment also positively influenced student engagement across all domains (behavioral, emotional, and cognitive). The high-frequency group had significantly higher mean engagement scores (Overall:  $4.2 \pm 0.3$  vs  $3.7 \pm 0.4$ ,  $p < 0.001$ ) and a higher proportion of students classified as “highly engaged” in each domain. This aligns with previous studies reporting that frequent, structured feedback enhances motivation, self-regulation, and active participation in medical learning (6,7).

Behavioral engagement, reflected in attendance, participation, and preparation, was higher in the high-frequency group, suggesting that frequent assessments encourage students to consistently engage with course content rather than cramming before summative exams. Emotional engagement, including interest and motivation, was also enhanced, indicating that formative assessments may reduce anxiety associated with high-stakes testing by providing low-risk practice opportunities (8). Cognitive engagement, such as self-directed learning and problem-solving, was similarly improved, supporting the theory that formative assessments promote metacognitive skills (9).

Pearson correlation analysis revealed positive relationships between assessment frequency and both academic performance ( $r = 0.52$ ,  $p < 0.001$ ) and engagement ( $r = 0.48$ ,  $p < 0.001$ ). These findings indicate that students who engage more frequently with formative assessments not only achieve higher grades but also demonstrate greater involvement in learning activities, confirming the dual benefit of frequent formative assessment (3,10).

The positive correlation between engagement and academic performance ( $r = 0.61$ ,  $p < 0.001$ ) further emphasizes that student engagement mediates the relationship between formative assessment and learning outcomes, consistent with prior research in medical and higher education settings (11,12).

### Implications for Medical Education

These results have several implications for curriculum design:

1. Integration of frequent formative assessments should be prioritized in

undergraduate medical programs to enhance both learning outcomes and engagement.

2. Assessment frequency should balance effectiveness with feasibility, considering faculty workload and student fatigue.
3. Faculty should consider online or quiz-based assessments to provide frequent, low-stakes practice with immediate feedback, which has been shown to enhance motivation and engagement.
4. Continuous monitoring of engagement and performance can help identify students at risk and tailor support interventions.

### Conclusion

High-frequency formative assessments are associated with improved academic performance and higher student engagement in undergraduate medical education. Incorporating frequent, low-stakes assessments into medical curricula may enhance learning outcomes, foster active participation, and support early identification of students requiring additional guidance. Future research should explore longitudinal effects and examine the optimal frequency and format of formative assessments for maximal impact.

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### Conflict of Interest

The authors declare **no conflicts of interest** related to this study. All procedures and analyses were conducted independently without any influence from funding bodies or institutional affiliations.

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