Pharmacology and therapeutics resource session attendance and academic performance of pre-clerkship medical students in problem-based learning curricula

Khalid Ahmed Jassim Al Khaja 1*, Yasin Tayem 1, Henry James 1, Ahmed Jaradat 2 and Reginald Paul Sequeira 1

Abstract

Background: The relationship between large-group classroom attendance by students and test achievement in problem-based learning (PBL) curricula is unclear. This study examined the correlation between attendance at resource sessions (hybrid lectures in the PBL curriculum) and test scores achieved in pharmacology and determined whether the score achieved was related to student gender.

Methods: A cross-sectional observational study over one academic year of 1404 pre-clerkship medical students was performed. Class attendance during pharmacology resource sessions and MCQ test scores achieved in pharmacology were analysed.

Results: The percentage of students’ attendance in resource sessions declined over three years of the programme, from 78.7 ± 27.5 in unit I to 22.1 ± 35.6 (mean ± SD) in unit IX. A significant but weakly positive correlation was evident between attendance and achievement in pharmacology ($r = 0.280; p < 0.0001$). The mean score of the students who attended > 50% of the resource sessions was significantly higher ($p < 0.0001$). Students who attended ≤50% were more likely to achieve lower tertile scores. The mean score achieved and the number of higher tertile scorers were higher among students who attended > 50% of the resource sessions. Although female students’ attendance was significantly higher, no significant gender-related differences in either mean scores or top grades achieved were found.

Conclusions: In a PBL curriculum, the classroom attendance of students in pharmacology declined during the pre-clerkship phase. A weak positive correlation was found between attendance and academic achievement, as measured by MCQ test scores. Factors other than motivation and attendance may confound gender-based academic performance and merit further research.

Keywords: Pre-clerkship phase, Class attendance, Pharmacology achievement, Medical students, PBL curriculum, Kingdom of Bahrain
**Background**

It is well known that students’ absenteeism in class is a universal phenomenon that appears to transcend beyond the country, university, and subject discipline [1–3]. It is considered a challenge in curriculum implementation in tertiary education worldwide [2, 3]. Absenteeism indicates poor motivation for learning [2], affects student retention in programmes [4, 5], and has an adverse impact on students’ academic performance [6–12]. Student absenteeism has been attributed to faculty, student, and learning-environment-related factors [13–15]. Previous studies have confirmed that attendance and performance are related even after adjustments are made for several student-related variables [16–19].

There is a consensus among published studies that the absenteeism of medical students during the preclinical (pre-clerkship) phase [6–8] and the clinical (clerkship) phase [9–12, 20] results in poor academic and clinical achievements. In medical schools implementing traditional curricula, attending lectures appears to be crucial for achieving pharmacology-learning outcomes [7, 8]. However, much less information is available for integrated medical curricula, particularly from schools in which an integrated student assessment strategy is practised. The effect of class attendance on examination scores for male and female medical students is debatable [21].

Since its inception in the early 1980s, the College of Medicine and Medical Sciences at Arabian Gulf University (CMMS-AGU) has adopted a problem-based learning (PBL) curriculum that is divided into three phases: phase I (premedical, 1 year), phase II (pre-clerkship, 3 years), and phase III (clerkship, 2 years) [22]. Recently, we reported a significant positive correlation between student attendance in structured classroom educational activities and the total scores achieved by students on the objective structured practical examination (OSPE), which assessed prescribing skills [22]. However, to our knowledge, the relationship between students’ attendance in resource sessions (hybrid lectures in PBL) and student performance on written tests (comprising multiple-choice questions and short-answer questions to assess knowledge) has not been evaluated in any preclinical learning environments of medical schools that implement a PBL curriculum.

This study was conducted to (a) determine the trend of students’ classroom absenteeism during the three years of the pre-clerkship phase, (b) measure the correlation between students’ attendance at resource sessions and their performance in pharmacology and therapeutics in the pre-clerkship learning environment, and (c) determine whether such attendance-related test performance is affected by gender.

**Methods**

**Setting**

The study was conducted at CMMS-AGU among pre-clerkship medical students over one academic year (September 2013 to June 2014). The pre-clerkship phase (unit phase) comprises 94 weeks; each week, clinical problems are presented to students [22]. Of these problems, 64 had scheduled resource sessions in pharmacology and therapeutics, given in the form of large-group presentations by faculty (Table 1).

**Pre-clerkship teacher-centred activities**

At CMMS, pre-clerkship educational activities include tutorials, hybrid lectures (PBL resource sessions), laboratory skills and demonstrations, professional clinical skills, and community health activities training. A typical schedule of weekly educational activities is shown in Table 2. Attendance at these structured educational activities was mandatory for students, except for the resource sessions. Each PBL resource session lasts for an hour, with intervals of at least two days between sessions to allow the students to spend time meeting their problem-related learning needs. The resource session was typically shared by two faculty from basic or clinical science disciplines. During these sessions, the faculty deliver interactive lectures to a large group of students, with a primary focus on discipline content related to the problem of each week [23].

| Theoretical Year Unit | Number of students | Number of problems/unit | Number of pharmacology resources/unit | Time allocated for pharmacology resources/unit (hours:minutes) |
|-----------------------|--------------------|-------------------------|----------------------------------------|---------------------------------------------------------------|
| 2                     | I                  | 182                     | 11                                     | 9                                                             | 5:40                                                          |
| 2                     | II                 | 182                     | 8                                      | 4                                                             | 2:15                                                          |
| 2                     | III                | 182                     | 13                                     | 9                                                             | 4:50                                                          |
| 3                     | IV                 | 143                     | 12                                     | 9                                                             | 4:20                                                          |
| 3                     | V                  | 143                     | 12                                     | 9                                                             | 3:55                                                          |
| 3                     | VI                 | 143                     | 10                                     | 7                                                             | 3:25                                                          |
| 4                     | VII                | 152                     | 9                                      | 4                                                             | 1:55                                                          |
| 4                     | VIII               | 152                     | 12                                     | 9                                                             | 4:45                                                          |
| 4                     | IX                 | 152                     | 6                                      | 4                                                             | 2:50                                                          |
|                       |                    |                         | 93                                     | 64                                                            | 31:55                                                         |

*Laboratory skill* 16:00

*Dry laboratory* 4:00

*Total hours* 51:55

*Credit hours per semester* 1:35
Table 2 Schedule of weekly structured educational activities for pre-clerkship medical students

| Theoretical educational activity | Students’ attendance | Time       | Sunday | Tuesday | Thursday | Sunday |
|----------------------------------|----------------------|------------|--------|---------|----------|--------|
| Tutorial\(^a\)                   | Compulsory           | Forenoon   | 2–3 h  | –       | 2–3 h    | 2–3 h  |
| Resource session\(^b\)           | Optional             | Noon       | –      | 1 h\(^c\) | 1 h\(^d\) | 1 h\(^d\) |

\(^a\)Small group activity of 9–11 students
\(^b\)Large group activity in lecture theatres
\(^c\)Time shared by 1–3 faculty resource persons from different disciplines; d, review session with attendance of all students and discipline’s resource person
\(^d\)Other scheduled activities include laboratory skills, professional clinical skills, and community health activities

Pre-clerkship student assessment

At the end of each unit in phase II of the MD programme, student assessment was composed of a comprehensive written test with at least 75 A-type multiple-choice questions (MCQs) and 4–5 integrated short-answer questions (SAQs), each with 6–8 subcomponents. An OSPE test comprising 30–35 stations was administered in all units except in unit IX. All end-unit tests included the following: approximately 10–16 MCQs, 2–3 SAQs integrated with basic and clinical disciplines, and 2–3 therapeutics-related OSPE stations (usually 1 prescription, 1 chart order, and 1 calculation or data interpretation station). The majority of test items included a vignette (clinical scenario or interpretation of graph or figure) and placed less emphasis on factual recall and more emphasis on the interpretation and application of knowledge. Some of the MCQ items were cluster-type items with a focus on interdisciplinary integration to ensure that the assessment was congruent with the integrated curriculum. Most of the MCQs and OSPEs were developed and evaluated by discipline experts (resource faculty for the course), whereas SAQs were generated by the unit committee structuring interdisciplinary integration.

The number of test items and the weight for pharmacology and therapeutics in each end-unit exam was proportional to the input into the curriculum and was identified in terms of learning objectives and outcomes. An examination blueprint approved by each unit committee was routinely used for planning the exam in terms of the weight of test items for each discipline. Generally, an estimated 10–15% weight was allocated for pharmacology and therapeutics in written components of the test.

The standard setting procedure for the written and OSPE exams is based on the modified Angoff method [24], determined individually by a panel of 6–8 judges who were the unit committee members responsible for the planning and implementation of units. A standardized score based on the mean “cut-off” score judged by the panellists was the basis on which the pass/fail decision was made. The passing score was 60% for all units.

The final grades, reported as percentage scores (transformed into letter grades), was based on end-unit written and OSPE scores, clinical professional skills exam scores, and continuous evaluation scores based on performance in small-group tutorials graded by a faculty facilitator. Each end-unit exam score was reported using the compensatory approach [25].

Attendance and absenteeism monitoring

During the resource sessions, the students’ attendance was monitored based on their signatures on a paper-based attendance register.

Performance monitoring

The performance of students in pharmacology and therapeutics for MCQ components of the end-unit test was assessed based on the optical mark recognition test form. The rate of absenteeism/attendance per unit and the MCQ scores in each unit were correlated.

Operational definition

The resource session is used as an interchangeable phrase for large-group classroom sessions or classroom educational activities presented by content expert faculty members. Lower, mid, and higher tertiles represent students with ≤33.3, > 33.3% to ≤66.6 and > 66.6% scores (in pharmacology), respectively.

Statistical analysis

Data were entered and analysed using SPSS Version 25 (IBM®-Bahrain). Variables are presented as counts and percentages or as means and standard deviations where applicable. Two independent samples t-tests were used to test the significant mean differences in student performance in pharmacology and therapeutic scores with regard to percentage of attendance and gender. The Pearson correlation coefficient was used to measure the linear relationship between the pharmacology score and percentage of attendance. A chi-square test was used to compare the proportions of students in each tertile category according to attendance and gender. Additionally, the chi-square test was used to measure the association between students’ performance in pharmacology, attendance, and gender. A p-value < 0.05 was considered statistically significant.
Study approval
This study was approved by the Department of Pharmacology and Therapeutics Council for Course Evaluation.

Results
A total of 1404 medical student data were evaluated in this study; 812 (57.4%) were females, and 592 (42.2%) were males.

Resource session attendance
Resource session attendance of medical students during the year of study is shown in Fig. 1. The mean percentage ± SD resource session attendance of second-year students in units I, II and III declined from 78.7% ± 27.5% in unit I to 50.8% ± 33.3% in unit III (p < 0.0001). Similarly, during unit IV to unit VI, the mean percentage of attendance of third-year students declined from 53.4% ± 33.0% (unit IV) to 37.8% ± 34.8% (unit VI; p < 0.0001). Additionally, the attendance of fourth-year students showed a decline from 32.6% ± 36.8% (unit VII) to 22.1 ± 35.6% (unit IX; p = 0.02), except for a transient increase in unit VIII.

Test performance
The association between the percentages of attendance and academic achievement (MCQ score in pharmacology) is presented (Table 3). A significant but low positive correlation between the students’ resource session attendance and test achievement was evident by a correlation coefficient (r) value of 0.280 (p < 0.001). The association between attendance and performance for three cohorts of students representing years 2, 3, and 4 (pre-clerkship phase) was as follows: a) r = 0.240, p < 0.001 for 528 s-year students (units I, II, III); b) r = 0.267, p < 0.001 for 421 third-year students (units IV, V, VI); and c) r = 0.376, p < 0.001 for 455 fourth-year students (units VII, VIII, IX) (data not shown).

Table 4 presents the lower, mid, and higher tertile percentages and the mean score achieved by students who attended ≤50% versus > 50% of the resource sessions. The mean score in pharmacology achieved by students who attended > 50% of the resource sessions was significantly higher than that of those with poor attendance (66.7% ± 19.6% vs. 56.4% ± 19.8%; p < 0.0001). The lower tertile score of students who attended ≤50 resource sessions was significantly higher than the lower tertile score of students who attended > 50 (14.6% vs. 6.6%; p < 0.0001), but there was no significant difference in the mean lower tertile score achieved. On the other hand, the higher mean tertile score and mean score achieved were substantially higher among students who attended > 50% of the resource sessions than among those with ≤50% attendance (Table 4).

Gender-based attendance and performance
The patterns of gender-based attendance and test score achieved are shown in Table 5. Compared to male students, female students showed significantly higher overall mean resource session attendance (55.1% ± 37.2% vs. 39.1% ± 35.1%). Female students had a lower percentage of zero attendance (20.2% vs. 29.9%) and had a higher percentage of 100% attendance (22.7% vs. 9.3%) compared to male students. These differences were statistically significant (p < 0.0001; Table 5). Although the

![Fig. 1 Resource session attendance (mean ± SD) pattern of pre-clerkship medical students in different units and years in a problem-based learning curriculum](image-url)
### Table 3: The relationship between resource session attendance and performance in pharmacology MCQs score

| Year | Unit | No of students | 0% | 1–24% | 25–49% | 50–74% | 75–99% | 100% | Mean score ± SD | Correlation coefficient (r) | p-value |
|------|------|----------------|-----|--------|--------|--------|--------|------|----------------|-----------------------------|---------|
| 2    | I    | 176            | 51.9 ± 14.1 (8) | 46.1 ± 21.7 (6) | 54.7 ± 14.1 (9) | 50.3 ± 20.3 (28) | 55.4 ± 17.3 (40) | 62.9 ± 15.0 (85) | 57.7 ± 173 (176) | 0.264 | < 0.001 |
| 2    | II   | 177            | 63.1 ± 14.1 (21) | (0) | 67.4 ± 13.8 (22) | 64.4 ± 12.7 (33) | 71.3 ± 12.7 (49) | 73.9 ± 13.6 (52) | 69.3 ± 13.8 (177) | 0.268 | < 0.001 |
| 2    | III  | 175            | 42.6 ± 17.1 (19) | 53.7 ± 18.5 (38) | 56.8 ± 20.0 (19) | 66.3 ± 15.8 (42) | 66.7 ± 18.5 (41) | 62.5 ± 15.0 (16) | 59.7 ± 19.1 (175) | 0.349 | < 0.001 |
| 3    | IV   | 141            | 409 ± 154 (22) | 42.8 ± 18.0 (7) | 43.9 ± 20.0 (33) | 51.2 ± 220 (42) | 52.9 ± 24.4 (17) | 62.0 ± 23.3 (20) | 492 ± 21.7 (141) | 0.309 | < 0.001 |
| 3    | V    | 141            | 462 ± 166 (31) | 47.3 ± 20.5 (28) | 51.6 ± 21.3 (16) | 53.8 ± 197 (22) | 67.8 ± 19.3 (38) | 70.8 ± 15.6 (6) | 55.1 ± 21.0 (141) | 0.421 | < 0.001 |
| 3    | VI   | 139            | 647 ± 173 (45) | 66.7 ± 20.5 (18) | 81.5 ± 18.7 (21) | 85.6 ± 128 (30) | 82.6 ± 17.2 (16) | 92.6 ± 7.9 (9) | 759 ± 192 (139) | 0.493 | < 0.001 |
| 4    | VII  | 151            | 587 ± 186 (65) | (0) | 58.3 ± 18.4 (35) | 628 ± 209 (13) | 75.5 ± 21.4 (16) | 84.1 ± 10.9 (22) | 644 ± 204 (151) | 0.444 | < 0.001 |
| 4    | VIII | 152            | 519 ± 239 (29) | 60.4 ± 21.1 (16) | 61.5 ± 21.3 (27) | 602 ± 207 (31) | 70.5 ± 19.9 (39) | 75.3 ± 13.7 (10) | 62.5 ± 21.8 (152) | 0.309 | < 0.001 |
| 4    | IX   | 152            | 546 ± 171 (101) | (0) | 60.0 ± 15.2 (20) | 729 ± 191 (12) | (0) | 70.7 ± 14.0 (19) | 588 ± 178 (152) | 0.360 | < 0.001 |
| 1404 |      | 546 ± 189 (341) | 54.1 ± 20.7 (113) | 59.1 ± 21.0 (202) | 624 ± 210 (253) | 67.2 ± 19.6 (256) | 69.6 ± 16.9 (239) | 61.5 ± 204 (1404) | 0.280 | < 0.001 |
female students had a greater tendency to attend structured educational activities, their total mean test scores did not significantly differ from those of male students.

**Discussion**

It is well known that student attendance at classroom sessions in medical schools with PBL or lecture-based learning (LBL) curricula is on the decline globally [6–13, 26]. It is evident from our study that attendance at the optional resource session was very high at the start of the medical programme in unit I, but attendance declined as years progressed during the pre-clerkship phase (Fig. 1). This finding is consistent with that reported by Mattick et al. [26] among undergraduate medical students following LBL in the UK. Classroom absenteeism is influenced by student, teaching, and class/college environment-related factors [26–28]. Among the most frequent factors cited for absenteeism is a lack of interest in the topic discussed [27, 29], self-study preferences [30], inconvenient class schedules such as early morning lectures [14, 27, 30], dislike of teaching style [26, 27], online availability of lecture material [27], and classroom environment [27, 28].

In the context of CMMS-AGU, factors such as inconvenient class schedule, poorly ventilated/overcrowded lecture halls, and students’ low income can be excluded as reasons for absenteeism because resource sessions are held at noon (Table 2) in air-conditioned lecture halls with state-of-the-art audio-visual facilities. Approximately 95% of students had full scholarship support from their countries. A lack of intrinsic motivation may be possible; some students may not realize that the study of medicine is rigorous and challenging [14, 27]. Absenteeism, therefore, can be one of the convenient ways to evade the curriculum [31]. Ready access to PowerPoint files used as an instructional tool in

**Table 4** Attendance tertiles and test mean scores

| Attendance tertiles | Attendance ≤ 50% | Attendance > 50% | p-value |
|---------------------|------------------|------------------|---------|
| Mean score in performance (n) | 56.4 ± 19.8 (719) | 66.7 ± 19.6 (685) | <0.0001 |
| Lower tertilea percentage (n) | 14.6 (105) | 6.6 (45) | <0.0001 |
| Lower tertile score | 25.6 ± 8.2 | 25.2 ± 6.2 | 0.759 |
| Mid tertileb percentage (n) | 47.6 (342) | 33.8 (232) | <0.0001 |
| Mid tertile score | 49.7 ± 7.7 | 51.3 ± 7.6 | <0.012 |
| Higher tertilec percentage (n) | 37.8 (272) | 59.6 (408) | <0.0001 |
| Higher tertile score | 76.7 ± 9.9 | 80.1 ± 10.1 | <0.0001 |

aStudents with ≤ 33.3% score in pharmacology
bStudents with > 33.3 to ≤ 66.6% score in pharmacology
cStudents with > 66.6% score in pharmacology

**Table 5** Patterns of gender-based attendance and test score achieved

| Students’ Characteristics | Male | Female | p-value |
|--------------------------|------|--------|---------|
| Total mean attendance (n) | 39.1 ± 35.1 (592) | 55.1 ± 37.2 (812) | <0.0001 |
| Lower tertilea percentage (n) | 11.5 (68) | 10.1 (82) | 0.406 |
| Lower tertile score | 25.6 ± 8.0 | 25.3 ± 7.4 | 0.778 |
| Mid tertileb percentage (n) | 43.1 (255) | 39.9 (319) | 0.154 |
| Mid tertile score | 50.6 ± 7.7 | 50.2 ± 7.8 | 0.480 |
| Higher tertilec percentage (n) | 45.4 (269) | 50.6 (411) | 0.055 |
| Higher tertile score | 79.1 ± 10.5 | 78.6 ± 9.9 | 0.543 |
| Total mean score (n) | 60.7 ± 20.5 (592) | 62.0 ± 20.2 (812) | 0.219 |
| 0% attendance (n) | 29.9 (177) | 20.2 (164) | <0.0001 |
| Mean score | 53.8 ± 18.0 | 55.5 ± 19.8 | 0.417 |
| 100% attendance (n) | 9.3 (55) | 22.7 (184) | <0.0001 |
| Mean score | 72.6 ± 16.4 | 68.7 ± 17.0 | 0.130 |
| Percentages of students with distinctiond | 8.4 (50) | 8.0 (65) | 0.766 |
| Mean score | 95.6 ± 4.0 | 95.2 ± 3.9 | 0.608 |

dStudents with ≤ 33.3% score in pharmacology
eStudents with > 33.3 to ≤ 66.6% score in pharmacology
fStudents with > 66.6% score in pharmacology
gStudents with grade ≥ 90%
resource sessions, along with the audio recording of lectures by some students, may be the main reason for absenteeism. In medical schools, the accessibility of online lecture contents has been reported to have a negative impact on students’ class attendance [11, 27, 32, 33]. A questionnaire survey of the students to study the actual reasons for absenteeism may provide better insight.

An growing body of evidence supports the positive correlation between classroom attendance and improved academic performance, such as conventional wisdom, across a wide variety of courses and colleges. This finding has been reported among pre-clerkship medical students in traditional curricula [6, 34], pharmacy students [35–37], students in obstetrics/gynaecology courses [10] and students in pharmacology courses in medical school [8, 38, 39]. Evidence-based data for this correlation in the PBL curriculum is lacking. The current study was conducted to determine the impact of resource session attendance on student achievement in the pharmacology knowledge component during the pre-clerkship learning environment that follows the PBL curriculum. A positive correlation was apparent between attendance and pharmacology achievement across all pre-clerkship phase units. The more resource sessions the student attends per unit, the higher the score achieved across all units (Table 3). This finding was further supported by the following: a) a lower tertile percentage that was significantly lower among students who had attended > 50% of the resource sessions and b) a higher tertile score that was substantially higher in students who attended > 50% of the resource sessions (Table 4). Therefore, resource session attendance appears to be one of the many critical determinants of the achievement of pharmacology learning outcomes by pre-clerkship medical students in the PBL curriculum. Our findings are in line with those of several studies conducted to assess pharmacology performance in medical schools with LBL curricula [8, 38, 39]. Among second-year medical students, high lecture attendance was found to be associated with higher examination scores [38]. A significant positive correlation was found between attendance and academic performance in pharmacology theory and practical examinations in second-year medical students [39]. Hamdi [8] reported that absenteeism had a significant effect on medical pharmacology achievement by fourth-year students, and the author emphasized the importance of regular attendance as an effective way of improving test scores.

The gender-related correlation between attendance and academic achievement in medical school is unclear [21]. The current study revealed that female students had significantly higher total mean (and 100%) attendance than male students. Nonetheless, no significant gender difference was evident concerning the overall mean score achieved and the distinction grade ≥ 90% in pharmacology (Table 5). Table 6 shows an association between the students’ performance in pharmacology and the percentage of attendance (p-value < 0.001), while there is no association between students’ performance in pharmacology and gender. Female students had to attend classes more frequently to earn scores comparable to those of males. These findings are consistent with those of published studies [35, 40]. Daud et al. [40] studied the impact of class attendance on test performance in community medicine of fourth-year medical students in LBL curricula and showed that male students had a significantly lower percentage of class attendance than female students; furthermore, a nonsignificant gender difference in scores was found. Cortright et al. [21] studied the effect of class attendance on gender differences in physiology performance and reported that the grades achieved above and below the class average by female but not male students were directly related to the number of classes attended.

Nevertheless, our findings differ from those reported by others [7, 41]. Bamuhair et al. [41] reported that no significant differences were observed concerning cardiology examination performance between male and female medical students in a PBL curriculum, although male students had slightly higher but statistically nonsignificant percentages of lecture attendance. In another study, continuous score assessment for second-year pharmacology students revealed that females achieved significantly higher total mean scores, although there was no significant gender difference in lecture attendance [7]. Based on the current study design, the plausible explanation for such gender differences is uncertain, but it may be attributed to various parameters, such as motivation, learning style preference, and self-regulated learning behaviour. These variables merit further research from the PBL perspective. Of note, students who attended classes are often those who are intrinsically motivated and have a genuine desire to learn [2, 21]. It is plausible that females may be more motivated, as suggested by their attendance, than male students (Table 5).

In contrast, male students may perceive that attending resource sessions has minimal impact on their grades. A focus group study may help to resolve this issue. Textbooks and other online supplements, audio-recorded lectures and faculty PowerPoint files of each resource session in pharmacology may offer useful alternative tools to support self-regulated learning behaviour and, hence, to attain grades comparable to those earned by female students.

The strength of this study is that the sample size of the pre-clerkship phase students (1404 students) is robust and included all pre-clerkship phase students of a PBL medical curriculum. The limitation of this study is that student attendance was monitored using paper-based attendance registers signed by the students. This approach has disadvantages because the time taken for
data collection reduces the lecture time and may lead to fake attendance by some students. The biometric method for recording classroom attendance is preferred. This study also did not evaluate student performance in other domains, including skills and their ability to integrate pharmacology concepts with other basic and clinical disciplines. A mixed-methods approach using both quantitative and qualitative methods would have been helpful to delineate the role of factors other than classroom attendance in explaining test performance. There is a considerable lag between the data collection and publication; thus, the findings may not necessarily reflect the current situation in the institution in which the study was performed. Moreover, the associations found in the study may not be robust because a multivariate analysis was not used to exclude confounding factors that could affect absenteeism and performance.

Conclusions
The present study highlights a significant positive correlation between resource session attendance and test scores achieved in pharmacology by pre-clerkship medical students in a PBL curriculum. Although female students showed a greater commitment to attend resource sessions, the overall gender-based score achieved was not statistically significant. Female students had to attend the resource session more frequently to earn comparable scores to those achieved by male students. The study did not permit a rational explanation for these findings. Further studies using mixed methodology are required to explore the gender-based variation concerning students’ intrinsic versus extrinsic motivation, learning style preferences and self-regulated learning behaviours to better understand the learning process of medical students in the PBL curriculum. A questionnaire survey of the students may be required to study reasons for their absenteeism.

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Authors’ contributions
KAJ was involved in the conception and design of the study; intellectual content, literature search, data acquisition, data analysis, statistical analysis, and prepared the first draft of the manuscript. HIT contributed to the literature search, manuscript editing and review. HJ contributed to the literature search, manuscript editing and review. AJ was involved in revising the manuscript concerning the statistical analysis. RPS was engaged in intellectual content, literature search, data analysis, manuscript editing and review. All authors read and approved the final version of the manuscript.

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Author details
1 Department of Pharmacology & Therapeutics, Arabian Gulf University, Manama, P.O. Box 22979, Kingdom of Bahrain. 2 Department of Family & Community Medicine, College of Medicine & Medical Sciences, Arabian Gulf University, Manama, Kingdom of Bahrain.

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References
1. Cleary-Holdforth J. Student non-attendance in higher education. A phenomenon of student apathy or poor pedagogy? 2007. https://arrow.dit.ie/cgi/viewcontent.cgi?article=1037&context=level3. Accessed 10 July 2019.
2. Wadesango N, Machingambi S. Causes and structural effects of student absenteeism: a case study of three south African universities. J Soc Sci. 2011;26(2):89–97.
3. Kottasz R. Reasons for student non-attendance at lectures and tutorials: an analysis. Investig Univ Teach Learn. 2005;2(2):5–16.
4. Bowen E, Price T, Lloyd S, Thomas S. Improving the quantity and quality of attendance data to enhance student retention. J Further High Educ. 2005;29(4):375–85. https://doi.org/10.1080/03098770500353714.

5. Smith EM, Beggs BJ. A new paradigm for maximising student retention in higher education. Engineering Education Conference. 2003;12:1–4. https://doi.org/10.1049/cp:20030219.

6. Millis RM, Dyson S, Cannon D. Association of classroom participation and examination performance in a first-year medical school course. Adv Physiol Educ. 2009;33(3):139–43. https://www.physiology.org/policies/pdf/10.1152/advan.00028.2009. Accessed 10 July 2019.

7. Fernandes LB, Maley M. The impact of online lecture recordings on learning outcomes in pharmacology. IAMSE. 2008;18(2):62–9.

8. Harid RM, Dyson S, Cannon D. Effects of lecture absenteeism on pharmacology course performance in medical students. JANE. 2006;16(1):27–30.

9. Deane RP, Murphy DJ. Student attendance and academic performance in undergraduate obstetrics/gynecology: a cross-sectional survey. Adv Med Pract. 2016;7:233–40 https://doi.org/10.21274/AMPE599447.

10. Deane RP, Murphy DJ. Student attendance and academic performance in undergraduate obstetrics/gynecology clinical rotations. JAMA. 2013;310(2):2282–8. https://doi.org/10.1001/jama.2013.292298.

11. Hamdy H, Prasad K, Anderson MB, et al. BEME systematic review: predictive values of measurements obtained in medical schools and future performance in medical practice. Med Teach. 2006;28(2):103–16 https://doi.org/10.1080/01421850600662273.

12. Smith LB. Medical school and on-line learning: does optional attendance create absentee doctors? Med Educ. 2012;46(2):137–8 https://doi.org/10.1111/j.1365-2923.2011.04182.x.

13. Nevins EI, Moori PL, Alexander L, Richards B, Bleasdale V, Sharma AK. Could attendance data to enhance student retention. J Further High Educ. 2005;29(3):375–8 https://doi.org/10.1080/00220485.1990.10844659. Accessed 11 July 2019. https://doi.org/10.1020/bm8.2067.

14. Sharmin T, Azim E, Choudhury S, Kamrun S. Reasons of absenteeism among medical students from subspecialty undergraduate obstetrics/gynecology clinical rotations. JAMA. 2013;310(21):2028–29 https://doi.org/10.1001/jama.2013.282228.

15. Chaudhry S, Iqbal J. Absenteeism of medical students from subspecialty undergraduate obstetrics/gynecology clinical rotations: a qualitative study. J Coll Physicians Surg Pak. 2019;29(1):45–60.

16. Schmidt RM. Who maximizes what? A study in student time allocation. Am Econ Rev. 1983;73(2):23–8.

17. Park KH, Kerr PM. Determinants of academic performance: A multinomial logit approach. J Econ Educ. 1990;21(2):101–11. https://www.tandfonline.com/doi/abs/10.1186/1472-6920-14-81. https://doi.org/10.1186/1472-6920-14-81.

18. Romer D. Do students go to class? Should they. J Econ Perspect. 1993(Summer;7(3):167–74.

19. James H, Tayem YI, Al Khaja KA, Veeramuthu S, Sequeira RP. Prescription writing in small groups as a clinical pharmacology educational intervention: perceptions of preclerchship medical students. J Clin Pharmacol. 2016;56(8):1028–34 https://doi.org/10.1002/jcph.692.

20. Corrigth RN, Lujan HL, Cox JH, DiCarlo SE. Does sex (female versus male) influence the impact of class attendance on examination performance? Adv Physiol Educ. 2013;37(4):416–20 https://doi.org/10.1152/advan.00021.2011.

21. Al Khaja KA, James H, Sequeira RP. Effectiveness of an educational intervention on prescription writing skill of preclerchship medical students in a problem-based learning curriculum. J Clin Pharmacol. 2013;53(5):483–90 https://doi.org/10.1002/jcph.68.

22. Albanese MA. Problem-based learning. In: Jeffries WB, Huggett KN, editors. An Introduction to Medical Teaching. Dodrecht, Springer Science Business Media B.V. 2010. p. 41. https://doi.org/10.1007/978-0-481-3641-4_4.

23. Angoff WH. Scales, norms, and equivalent scores. In: Thorndike RL, editor. Educational measurement. 2nd ed. Washington DC: American Council on Education; 1971. p. 508–600.

24. Friedman B-DM. AMEE guide no. 18: standard setting in student assessment. Med Teach. 2000;22(2):120–30.

25. Empick K, Crocker G, Blish J. Medical student attendance at non-compulsory lectures. Adv Health Sci Educ Theory Pract. 2007;12(2):201–10. https://doi.org/10.1007/s10459-005-5492-1.

26. Desalegn AA, Berhan A, Berhan Y. Absenteeism among medical and health science undergraduate students at Hawassa University, Ethiopia. BMC Med Educ. 2014;14:81. https://doi.org/10.1186/1472-6920-14-81.

27. Batu AH, Mandriaciglu A, Orgun F, Govsa F. Why do students miss lectures? A study of lecture attendance amongst students of health science. Nurse Educ Today. 2013;33(6):596–601. https://doi.org/10.1016/j.nedt.2012.07.010.

28. Moore S, Armstrong C, Pearson J. Lecture absenteeism among students in higher education: a valuable route to understanding student motivation. J High Educ Pol Manag. 2008;33(1):15–24. https://doi.org/10.1080/00220485.2008.10482688.

29. Hafeez K, Khan M, Javaid M, Haroon S. Low attendance in lectures at medical colleges of Karachi – a cross sectional survey. J Postgrad Med Inst. 2014;28(2):161–4. 

30. Park KH, Kerr PM. Determinants of academic performance: A multinomial logit approach. J Econ Educ. 1990;21(2):101–11. https://www.tandfonline.com/doi/abs/10.1080/00220485.1990.10844659. Accessed 11 July 2019. https://doi.org/10.1002/bm8.2067.

31. Ruiz JG, Mintzer MJ, Leipzig RM. The impact of E-learning in medical education. Acad Med. 2006;81(3):207–12. 

32. Davis EA, Hodgson Y, Macaulay JD. Engagement of students with lectures in biochemistry and pharmacology. Biochem Mol Biol Educ. 2012;40(3):300–9. https://doi.org/10.1111/j.1365-2923.2011.04182.x.

33. Chilwant KS, Hundekaji JC. Effect of class attendance on performance in 2nd year medical students. IOSR J Res Method Edu. 2013;3(3):31–38.

34. Varu M, Veggad A, Shah C, Mehta H, Kacha Y. Attendance, attitudes and academic performance: a study on first year MBBS students attending physiology classes. UMESE. 2016;3(1):31–7.

35. Lundin M, Jorge PJ. Class attendance and academic achievement of pharmacy students in a European university. Curr Pharm Teach Learn. 2015;7(I):78–83. https://doi.org/10.1016/j.cptl.2014.09.013.

36. Hidayat L, Vansal S, Kim E, Sullivan M, Salbu R. Pharmacy student absenteeism and academic performance. Am J Pharm Educ. 2012;76(1):61–6. https://doi.org/10.5688/ajpe7618.

37. Pwers CA, Carroll MA. Student attendance at pharmacology lectures and its relation to exam performance: a two year observational analysis. FASEBJ. 2017;31(Suppl 1): Abstract Number8104.

38. Mohanan LK, Harichandran DT, Vijayan SM. Association of class attendance and academic performance of MBBS students in pharmacology - a retrospective cohort study. Natl J Physiol Pharm Pharmacol. 2017;7(10):1056–60.

39. Daud S, Javaid F. Effect of class attendance of medical students’ tests performance. PJWHS. 2012;6(2):295–7.

40. Barnhur SS, Al Farhan AI, Alhubaiti A, Ur Rahman S, Al-Kadri HM. class attendance and cardiology examination performance: a study in problem-based medical curriculum. Int J Gen Med. 2016;9:1–5. https://doi.org/10.2147/IJGM.S96627.

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