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Comparison of Academic Performance Between Hard Copy and E-Learning Approaches Among Final Year MBBS Students at DG Khan Medical College DG Khan

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ABSTRACT

Background: The choice of learning resources significantly influences medical students' academic achievement. Traditional hard copy materials continue to dominate, but the rapid adoption of e-learning has raised questions about its effectiveness in comparison to conventional approaches. **Objective:** To compare the academic performance of final-year MBBS students using hard copy study materials versus those relying on e-learning resources. **Material and Methods:** A comparative cross-sectional study was conducted at DG Khan Medical College, Pakistan, in 2024. A total of 140 final-year MBBS students were enrolled, with 70 using primarily hard copy resources and 70 using e-learning methods. Academic performance was assessed through written examination, clinical examination, internal assessment, and overall weighted scores. Descriptive statistics, independent samples t-tests, chi-square tests, and multiple linear regression were performed using SPSS version 26. **Results:** The mean overall score was significantly higher in the e-learning group (72.28 ± 4.42) compared to the hard copy group (67.08 ± 4.63; $p < 0.001$). Written (73.51 ± 7.50 vs. 67.71 ± 7.49; $p < 0.001$), clinical (70.12 ± 6.82 vs. 67.32 ± 6.90; $p = 0.017$), and internal assessment scores (72.46 ± 7.68 vs. 65.17 ± 6.82; $p < 0.001$) were also significantly higher among e-learning students. All students in the e-learning group passed, compared to 94.3% in the hard copy group ($\chi^2 = 4.118$, $p = 0.042$; Fisher's Exact $p = 0.120$). Regression analysis confirmed e-learning as an independent predictor of higher performance ($B = 5.04$, $p < 0.001$). **Conclusion:** E-learning was associated with superior academic performance compared to hard copy study methods, and remained an independent predictor after adjusting for confounders. These findings support the integration of digital learning tools into undergraduate medical education.

INTRODUCTION

The rapid digitalization of medical education—accelerated by the COVID-19 pandemic—has moved learning far beyond lecture halls, blending virtual platforms, multimedia resources, and self-paced study into routine undergraduate training [1,3]. While the initial shift was driven by necessity, a growing body of research now examines whether technology-enhanced approaches translate into equal or better academic outcomes for medical students, particularly in high-stakes final-year assessments [2,4,5]. In parallel, educators' guidance has matured from ad-hoc solutions to structured frameworks for design, delivery, and evaluation of online curricula, emphasizing alignment of pedagogy, assessment, and digital tools [3,6].

Evidence regarding effectiveness is increasingly robust. A recent systematic review focused on clinical skills found that well-designed digital learning can support competence acquisition, though study heterogeneity and variable instructional quality remain concerns [2]. Randomized and controlled designs are emerging: a 2023 trial reported that remote instruction could match or exceed classroom methods for specific diagnostic tasks among healthcare students [4]. Domain-specific syntheses also suggest that multimedia and video-based approaches yield moderate gains in knowledge and skills in medicine and allied health, provided materials are instructionally sound and integrated with practice opportunities [10]. For surgical and procedural teaching, reviews during and after the pandemic indicate that online components can enhance access, preparation, and feedback, even if hands-on skills still require in-person supervision [5].

Learner experience and engagement are central determinants of outcomes. Surveys across diverse settings

show students and faculty broadly accept online teaching, with a preference for synchronous, interactive sessions over purely asynchronous materials [7]. At the same time, perceived equivalence to face-to-face teaching is mixed and often hinges on interaction quality, feedback, and opportunities to apply knowledge [7,8]. Systematic reviews in clinical medicine emphasize that interactivity, usability, and flexible access are features most consistently linked to positive learning effects and satisfaction [9]. These observations align with evaluation guidance that calls for explicit criteria, multi-level outcomes (beyond satisfaction alone), and continual quality improvement of online courses [6].

Contextual factors—especially infrastructure—remain pivotal. Studies from middle-income settings highlight bandwidth, device access, and platform reliability as frequent barriers; when unresolved, these limit engagements and may blunt academic benefits despite sound instructional design [8,9]. Consequently, contemporary guidance recommends matching the modality to learning outcomes (e.g., case-based, problem-based, and video-supported activities for clinical reasoning), ensuring opportunities for repeated practice, and embedding timely feedback and analytics [3,6,9,10].

Against this backdrop, a focused comparison of academic performance between students using hard-copy materials and those primarily engaging with e-learning is timely and policy-relevant. Understanding whether e-learning confers an advantage in written, clinical, internal assessment, and overall scores among final-year MBBS students can inform resource allocation (e.g., LMS investments, faculty development), address equity concerns related to internet access, and guide sustainable post-pandemic curriculum design [2–4,6,9,10]. The present study addresses this gap in a single-institution cohort, using standardized assessments and adjusting for key covariates to estimate the independent association of learning approach with academic performance.

MATERIAL AND METHODS

This comparative cross-sectional study was conducted at DG Khan Medical College, DG Khan, Pakistan, during the academic session 2024. The objective was to compare the academic performance of final year MBBS students using hard copy learning resources with those relying on e-learning methods. The study population comprised all final year MBBS students of the college. Both male and female students were eligible. Students who reported primarily using either hard copy resources such as textbooks, printed notes, or hand-written material, or e-learning resources such as online lectures, digital notes, and medical learning applications were included. Students who reported equal reliance on both approaches, those absent during data collection, or those with incomplete records were excluded.

The independent variable in this study was the learning approach, classified into hard copy versus e-learning. The dependent variable was academic performance, defined as the aggregate percentage scores obtained in recent internal assessments, written theory examinations, and clinical/practical examinations. Control variables included age, gender, socioeconomic background, average study hours per day, internet accessibility, and previous academic record. Hard copy learners were defined as those studying mainly from printed books, notes, or photocopied material, while e-learning learners were defined as those who relied on digital platforms such as recorded lectures, mobile applications, and electronic notes.

Sample size was calculated using OpenEpi version 3.01 for comparison of two independent means. Reference was taken from a study conducted among medical students by Mastour et al. (2023), which compared e-learning with in-person education and reported significantly higher exam scores in the e-learning group ($P < 0.001$), with a total sample size of 126 students (BMC Med Educ 2023;23:4159). Based on this, and assuming a moderate effect size (Cohen's $d \approx 0.5$) with 80% power and a 95% confidence level, the required sample size was 63 students per group (126 total). To compensate for potential non-response or incomplete data, the final target sample size was increased to 140 students [11].

Data were collected through a structured questionnaire, which recorded demographic details such as age, gender, socioeconomic background, internet access, and average daily study hours, as well as the preferred mode of learning. Academic performance records were obtained from the official examination branch with prior administrative permission. A non-probability convenience sampling technique was applied, and students were grouped into hard copy or e-learning categories based on their reported primary study method.

Ethical approval was obtained from the Institutional Review Board of DG Khan Medical College. Written informed consent was taken from all participants, and anonymity was maintained by coding the data before analysis. Data were analyzed using IBM SPSS version 26. Continuous variables were presented as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Differences in mean academic scores between the two groups were assessed using the independent samples t-test, and categorical comparisons were made using the chi-square test. Multivariable linear regression was applied to adjust for possible confounding variables such as gender, study hours, and socioeconomic background. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Descriptive statistics for the study population (N = 140) showed a mean age of 23.59 ± 1.21 years and an average study time of 3.50 ± 0.77 hours/day. The mean previous academic percentage was 67.27 ± 6.59. For current assessments, the mean written score was 70.61 ± 8.01%, the clinical score was 68.72 ± 6.98%, and the internal assessment score was 68.81 ± 8.11%, yielding an overall mean score of 69.68 ± 5.21%.

Baseline characteristics of the two groups are presented in Table 1. In the hard copy group, there were 43 (61.4%) males and 27 (38.6%) females, while the e-learning group included 40 (57.1%) males and 30 (42.9%) females. Among hard copy users, 42 (60.0%) had regular internet access, 22 (31.4%) had limited access, and 6 (8.6%) had no access. In the e-learning group, 44 (62.9%) reported

regular access and 26 (37.1%) reported limited access; none reported no access. Regarding socioeconomic status, the hard copy group had 20 (28.6%) low, 40 (57.1%) middle, and 10 (14.3%) high SES, while the e-learning group had 17 (24.3%) low, 38 (54.3%) middle, and 15 (21.4%) high SES. In terms of result status, 66 (94.3%) students in the hard copy group passed and 4 (5.7%) failed, whereas all 70 (100.0%) students in the e-learning group passed. (Table 1)

Table 1

Baseline Characteristics and Result Status by Learning Approach (n = 140)

Variable	Category	Hard Copy (n = 70)	E-Learning (n = 70)	Total (N = 140)
Gender	Male	43 (61.4%)	40 (57.1%)	83 (59.3%)
	Female	27 (38.6%)	30 (42.9%)	57 (40.7%)
Internet Access	No access	6 (8.6%)	0 (0.0%)	6 (4.3%)
	Limited	22 (31.4%)	26 (37.1%)	48 (34.3%)
	Regular	42 (60.0%)	44 (62.9%)	86 (61.4%)
Socioeconomic Status	Low	20 (28.6%)	17 (24.3%)	37 (26.4%)
	Middle	40 (57.1%)	38 (54.3%)	78 (55.7%)
	High	10 (14.3%)	15 (21.4%)	25 (17.9%)
Result Status	Fail	4 (5.7%)	0 (0.0%)	4 (2.9%)
	Pass	66 (94.3%)	70 (100.0%)	136 (97.1%)

Values are presented as n (%).

Comparison of academic performance between groups is shown in Table 2. The mean written exam score was 67.71 ± 7.49% in the hard copy group and 73.51 ± 7.50% in the e-learning group ($p < 0.001$). Clinical exam scores were 67.32 ± 6.90% and 70.12 ± 6.82%, respectively ($p = 0.017$). Internal assessment scores were 65.17 ± 6.82% in the hard copy group and 72.46 ± 7.68% in the e-learning group ($p < 0.001$). The overall academic score was 67.08 ± 4.63% in the hard copy group and 72.28 ± 4.42% in the e-learning group ($p < 0.001$). (Table 2)

Table 2

Comparison of Academic Performance Between Groups (n=140)

Academic Variable	Hard Copy (Mean ± SD)	E-Learning (Mean ± SD)	p-value
Written Exam (%)	67.71 ± 7.49	73.51 ± 7.50	< 0.001
Clinical Exam (%)	67.32 ± 6.90	70.12 ± 6.82	0.017
Internal Assessment (%)	65.17 ± 6.82	72.46 ± 7.68	< 0.001
Overall Score (%)	67.08 ± 4.63	72.28 ± 4.42	< 0.001

Values are presented as mean ± standard deviation. Independent samples t-test applied.

The association between learning approach and examination result status is presented in Table 3. In the hard copy group, 66 (94.3%) students passed and 4 (5.7%) failed, compared to a 100% pass rate in the e-learning group. The Pearson chi-square test indicated a statistically significant association (χ^2 (1) = 4.118, $p = 0.042$). Fisher's Exact Test, however, was not statistically significant ($p = 0.120$). (Table 3)

Table 3

Association Between Learning Approach and Result Status (n = 140)

Result Status	Hard Copy (n = 70)	E-Learning (n = 70)	Total (N = 140)	p-value
Pass	66 (94.3%)	70 (100.0%)	136 (97.1%)	0.042[1]
Fail	4 (5.7%)	0 (0.0%)	4 (2.9%)	

Values are presented as n (%). Pearson Chi-square test applied. [1]Fisher's Exact Test = 0.120 (2-sided).

Multiple linear regression analysis was performed to evaluate independent predictors of overall academic performance. The model was statistically significant ($F(7,132) = 6.832$, $p < 0.001$) and explained 27% of the variance in overall scores ($R^2 = 0.266$). Among all predictors, only the learning method was statistically significant, with students in the e-learning group scoring on average 5.04 percentage points higher than those in the hard copy group ($B = 5.040$, $p < 0.001$). Age, gender, study hours per day, SES, internet access, and previous academic percentage were not statistically significant predictors. (Table 4)

Table 4

Multiple Linear Regression Predicting Overall Academic Score (%)

Predictor Variable	B (Unstandardized Coefficient)	95% CI for B	Std. Error	Beta	p-value
Constant	56.621	—	8.469	—	< 0.001
Learning Method (Group)	5.040	[3.39, 6.69]	0.834	0.486	< 0.001*
Age (years)	0.099	[−0.55, 0.75]	0.329	0.023	0.762
Gender	−0.008	[−1.58, 1.56]	0.800	−0.001	0.992
Study Hours per Day	0.172	[−0.90, 1.24]	0.545	0.025	0.752
Socioeconomic Status (SES)	−0.746	[−1.93, 0.44]	0.602	−0.095	0.217
Internet Access	0.552	[−0.82, 1.93]	0.697	0.061	0.430
Previous Academic (%)	0.038	[−0.08, 0.15]	0.061	0.048	0.534

*Statistically significant at $p < 0.001$.

Model Summary: $R^2 = 0.266$, Adjusted $R^2 = 0.227$, $F(7,132) = 6.832$, $p < 0.001$.*B = Unstandardized regression coefficient; CI = Confidence Interval.*

DISCUSSION

This study revealed that final-year MBBS students using e-learning significantly outperformed those using hard copy materials across all academic domains—written, clinical, internal, and overall scores—and had higher pass rates. Notably, learning method remained an independent predictor of overall academic performance after adjusting for age, gender, study hours, socioeconomic status, internet access, and previous academic performance.

These findings align with recent literature in health professions education. Ertl et al. (2025) showed that case-based blended learning improved medical students' exam outcomes, reinforcing the benefits of e-learning designs that embed active, scenario-driven engagement [12]. In Pakistan, Ashraf et al. (2024) found that blended learning enhanced student performance, particularly through strategies targeting self-regulation and digital literacy [13]. At a global scale, Zavala-Cerńa et al. (2025) found improved knowledge acquisition and participant satisfaction through e-learning in the multi-country DigiMed study [14].

In skill-focused instruction, Gross et al. (2025) reported that blended learning significantly enhanced communication skills relative to pure lecture-based instruction, confirming the educational value of interactive online components [15]. In nutritional science education, Regmi et al. (2024) found that blended learning was

associated with higher academic outcomes, engagement, and self-efficacy compared to traditional methods [16]. Lozano-Lozano et al. (2020) demonstrated in randomized trials that blended approaches improved motivation, mood, and satisfaction in health science students, which may underlie performance gains in our cohort [17].

However, the effectiveness of e-learning is not universal. Akpen et al. (2024) cautioned that benefits may diminish when student engagement lapses or digital supports are weak [18]. Abbas et al. (2024) reported mixed student preferences for e-learning in preclinical settings, suggesting readiness and context influence outcomes [19]. Importantly, our findings echo those of Mastour et al. (2023); they similarly demonstrated that medical students using e-learning substantially outperformed peers in traditional learning settings—underscoring cross-context consistency in e-learning effectiveness [11]. Furthermore, the chi-square analysis in our study suggested a significant difference in pass rates ($p = 0.042$), but the Fisher's exact test was non-significant ($p = 0.120$)—highlighting the challenge of interpreting categorical outcomes with small failure numbers, a limitation also noted in other e-learning studies during the pandemic [20].

Strengths and Limitations

Key strengths include a robust comparative design with multiple performance measures and regression adjustment for confounders. Limitations include its cross-sectional nature, which restricts causal inference, and single-institution context, reducing generalizability.

Implications and Future Directions

These findings support the integration of well-structured e-learning components within undergraduate medical curricula. Future research should explore the long-term, blended, and context-specific nuances of digital learning effectiveness, especially in resource-limited settings, while focusing on enhancing student engagement and self-regulatory skills.

CONCLUSION

This study demonstrated that final-year MBBS students who adopted e-learning achieved significantly higher scores in written, clinical, internal assessments, and overall academic performance compared to those relying on hard copy study materials. Pass rates were also higher in the e-learning group, with no recorded failures, while regression analysis confirmed learning method as an independent predictor of overall performance, irrespective of demographic and academic covariates. These findings highlight the academic advantages of digital learning approaches and support their integration into undergraduate medical education.

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