Original Article

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Pharmacology Section

Comparative Effectiveness of Interactive Panel Board and Chalkboard Teaching Aids among Second-year MBBS Students: A Quasi-experimental Study

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ABSTRACT

Introduction: The Competency-Based Medical Education (CBME) stresses practicality, reasoning, and engagement. Many consider pharmacology challenging, and hence, there is a need for an efficient way to teach the course. There is a paucity of literature comparing the effectiveness of interactive smart panel boards and chalkboard teaching based on objective parameters in India.

Aim: To evaluate and to compare interactive smart panel board and chalkboard teaching in undergraduate pharmacology.

Materials and Methods: The present quasi-experiment was performed on 103 second-year Bachelor of Medicine and Bachelor of Surgery (MBBS) students in the Department of Pharmacology, Hind Institute of Medical Sciences, Barabanki, Uttar Pradesh, India, from February 2025 to March 2025. Six topics related to the Central Nervous System (CNS) were covered by either the interactive panel board method (3 topics) or the chalkboard (3 topics) in random order. Change in knowledge was evaluated using pre-test and post-test Multiple-Choice Questions (MCQs). Perception was measured by a 17-item Likert scale questionnaire. Paired and independent sample Student's t-test was used to analyse data. Statistical significance was set at $p<0.05$.

Results: Both instructional methods demonstrated a significant improvement in post-test scores ($p<0.001$). The mean knowledge gain was notably higher with the smart panel board (3.74±1.02) compared to the chalkboard (2.73±0.96) ($p<0.001$). A majority of the students expressed a preference for the smart interactive panel board 48 students (46.6%) and mixed teaching techniques (30.1%), whereas only 16 (15.5%) indicated a preference for the chalkboard as the sole instructional method.

Conclusion: Smart teaching was more effective in terms of instant learning and engagement, whereas chalkboard was superior for note-taking purposes. A combined method of teaching could yield the best results.

Keywords: Bachelor of Medicine and Bachelor of Surgery, Learning outcomes, Medical education, Multimedia learning, Student engagement, Teaching methods

INTRODUCTION

Medical education has moved from traditional models, which were largely teacher-driven, to learner-centered, outcome-oriented, and competency-based models. Globally, CBME is becoming popular for knowledge acquisition and application, clinical reasoning, communication skills, and the ability to develop self-directed learning [1,2]. In the present context, selecting appropriate teaching-learning methods and instructional materials has become more important than ever before in undergraduate medical education.

Pharmacology is central to the undergraduate medical curriculum, forming the basis of safe and rational prescription practices. Despite its critical importance, most medical students find pharmacology challenging and difficult to understand, with its vast syllabi, complex drug action mechanisms, and pharmacokinetics. There is considerable evidence from research that when the pharmacological education provided by undergraduate studies is inadequate, there are negative consequences including poor prescription skills, more drug errors, and lower self-confidence in practice as interns [3,4]. This highlights the importance of using appropriate educational strategies to facilitate concept formation and retention in pharmacology.

The use of chalkboards in lectures still forms an essential element of medical learning with pedagogic advantages that continue to hold true. The chalkboard gives teachers the opportunity to develop points systematically, structure their thinking, and even adjust to feedback from the learners on-the-go while ensuring effective interaction between the teacher and students. This practice also ensures active participation of learners in taking down notes and actively processing information, something particularly useful in pharmacology where understanding mechanisms of action requires systematic thinking and reasoning [5,6]. However, chalkboards have limitations in the presentation of complex pathway relationships and changing drug interactions.

With the advent of technology in education, the widespread implementation of interactive smart panels in the medical field's classrooms is now possible. Interactive technology in learning integrates visual media through diagrams, animations, videos, and annotation capabilities to produce interactive classes. According to multimedia learning theory, combining visual and verbal inputs may enhance comprehension, though its effectiveness in pharmacology requires further empirical validation [7]. Such a tech-enabled teaching method would prove beneficial in pharmacology studies.

Research conducted within medical education suggests that interactive lessons enabled by technology increase learners' motivation, engagement, and learning outcomes in the short term. Active learning, facilitated through digital means, usually leads to better academic achievements compared to passive lessons based on lectures [8]. Within the context of medical education, research has suggested that smartboards as well as other digital instructional media help improve students' satisfaction, visually explain difficult concepts, and facilitate applied understanding [6,9]. It has been shown that engagement mediates the relationship between instructional design and learning outcomes [10].

The discussion about the superiority of digital instruction devices to conventional ones remains open. Intelligent whiteboards can enhance visual effects and learner participation; however, they also create concerns about the risk of cognitive overload, fast content delivery, and fewer opportunities for reflective writing when technology is not applied prudently [11]. In addition, learners' preference for innovative devices does not always correspond to improved objective outcomes, emphasising the necessity for objective assessment of instructional technologies.

Despite increasing adoption of digital teaching aids in medical education, there is limited objective evidence from Indian undergraduate pharmacology settings comparing interactive panel boards with traditional chalkboard teaching using both knowledge-based assessment and structured perception analysis. Most available studies rely predominantly on subjective feedback [12]. The present study aimed to evaluate and compare the effectiveness of interactive panel board teaching and traditional chalkboard teaching in undergraduate pharmacology.

The present study aimed to evaluate and compare students' learning experience and classroom engagement during interactive smart panel board and chalkboard-based teaching sessions, to assess students' perceptions regarding clarity of concepts, visualisation of pharmacological mechanisms, applied and clinical understanding, student–teacher interaction, and overall satisfaction with each teaching aid and to determine students' preferences regarding the teaching aids used in pharmacology lectures.

MATERIALS AND METHODS

The present quasi-experimental study was conducted in the Department of Pharmacology, at Hind Institute of Medical Sciences, Barabanki, Uttar Pradesh, India, between February 2025 and March 2025. The study obtained clearance from the Institutional Ethics Committee (HIMS/IHEC/2024-25/Faculty). Informed consent was obtained from all the participants. The current study included second-year MBBS students (batch 2023) pursuing a degree in Pharmacology.

Inclusion criteria: The study subjects comprised second-year MBBS students enrolled in Pharmacology courses and willing to participate in the research, and were exposed to the two interventions.

Exclusion criteria: Students who did not provide informed consent. Students who missed any of the intervention sessions, failed to take part in the pre-test or post-test, or had an incomplete questionnaire response were considered for exclusion from the final statistical analysis.

Sample size calculation: As all eligible and willing second-year MBBS students were invited to participate, complete batch inclusion was attempted. Based on a moderate effect size (Cohen's d=0.6) with an alpha level of 0.05 and 80% power, the minimum sample size was calculated to be 45 using standard sample size estimation methods [13]. Of 118 eligible students in the second year of MBBS, 103 were included in the analysis. Process was explained to the whole batch in order to encourage voluntary participation.

Three of the six topics were randomised for teaching through an interactive panel board, and the rest were randomised to be taught with a traditional chalkboard. Randomised allocation sequencing (computer- generated) was used to allocate the topics to teaching methodologies in an attempt to control for any possible selection bias. Randomisation was applied to topics only; participants were not randomised.

Study Procedure

Six cycles involved six CNS pharmacology topics of equal complexity and importance to clinical practice and academics. Topics were selected with input from lecturers to ensure uniform complexity among topics. These topics were antiepileptics, antipsychotics, antidepressants, sedatives-hypnotics, opioids, and drugs used in Parkinsonism.

Variability due to individual differences in teaching methods and delivery was reduced through the use of one teacher who taught the classes for each session, had more than five years of experience in teaching and who was previously acquainted with and had undergone basic training for smart panel board teaching. The topics and learning objectives were consistent among sessions to further minimise variability. Although efforts were made to minimise variability, teaching styles may still differ slightly even if the same teacher conducted each session. To avoid carryover effects, sessions were done on different days and on different topics.

Each session took 60 minutes. For each topic, 10 MCQs were asked as pre-test and post-test. The score for each question was one point, making the total maximum score 10 per topic. For each session, therefore, two sets of identical MCQs were used in the pre- and post-tests. MCQs were written by subject experts for assessing the knowledge and comprehension of the learners.

Perceptions of students were measured using a 17-question structured Likert scale questionnaire after completing all six CNS modules. The 17-question survey comprised eight paired comparison questions regarding the two teaching aids in key educational domains, one question regarding general preference for the teaching aids. The questionnaire assessed overall satisfaction, comprehension of materials, applicability in clinical settings, level of engagement, clarity and visibility of slides, ability to take notes, interest, and student-teacher interaction. A Likert scale was utilised in the present study because it is a recognised tool to measure constructs like perception, attitude, and satisfaction in education. It provides an opportunity to quantify the students' responses in different areas, like understanding and engagement, among others, which can be statistically compared between different modes of teaching. It was a self-designed tool based on research findings. The survey was piloted among a sample of students ($n \approx 15$) to test its understandability and feasibility. Content validity of the tool was established through its assessment by content experts from the disciplines of pharmacology and medicine education, for inclusion of relevant items within the instrument. Some minor changes were made based on their suggestions. The final survey exhibited strong internal consistency (α=0.84). Ratings ranged from 1 (Strongly disagree) to 5 (Strongly agree) [14]. The questionnaires were distributed electronically using Google Forms at the following link: https://forms.gle/rVkmafNNMeb7NPk78.

Students were instructed to fill out the forms individually and avoid discussing them with other participants. Investigators were present just to help solve procedural issues and not influence students' answers. To eliminate social desirability bias, no personal information was gathered.

STATISTICAL ANALYSIS

Data were entered into Microsoft Excel for data management and subsequently analysed using Statistical Package for the Social Sciences (SPSS) software (version 25.0, IBM Corp., Armonk, NY, USA). Continuous data were expressed in terms of means and standard deviations. Categorical data were presented as frequencies and percentages. The primary outcome measure was knowledge gain, which was compared within groups with a paired t-test and between the two groups with an independent t-test. Other outcomes, like perception and engagement, were evaluated using the mean scores on the Likert scale, and differences between the groups were tested with an independent t-test. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 15 students were excluded from the study, comprising 12 who did not attend all lecture sessions and three who submitted incomplete responses to the Google Form questionnaire. Thus, the final analysis included 103 second-year MBBS students. All participants were exposed to both teaching modalities-interactive smart panel boards and traditional chalkboards. The mean age of the cohort was 20.4±0.7 years, with 58 (56.3%) females and 45 (43.7%) males.

Both teaching methods produced statistically significant improvements in post-test scores compared to pre-test scores ($p<0.001$). However, the mean post-test score for sessions conducted with interactive smart panel boards was significantly higher than that for sessions using chalkboards ($p<0.001$). Similarly, the knowledge gain was greater with smart panel boards than with chalkboards ($p<0.001$). Despite the absolute difference in the mean knowledge scores being one point, it is one point higher on a scale of ten (equal to 10 percent of the highest score) and not 10 percent more knowledge acquired [Table/Fig-1].

Parameters	Smart panel board (Mean±SD)	Chalk board (Mean±SD)	Intergroup p-value**
Pre-test score	4.12±1.21	4.25±1.18	0.428
Post-test score	7.86±1.09	6.98±1.14	<0.001
*Intragroup p-values	<0.001	<0.001	<0.001
Mean score gain (Post-Pre)	3.74±1.02	2.73±0.96	

[Table/Fig-1]: Comparison of pre-test and post-test knowledge scores across two teaching aids.
*Paired Student's t-test **Independent Student's t-test.

The interactive smart panel board achieved significantly higher scores than the chalkboard across most perception domains, including satisfaction, comprehension, practical demonstration, engagement, clarity, interest, and student-teacher interaction ($p<0.001$). Conversely, the chalkboard was rated superior for note-taking, indicating a more conducive environment for organised notes [Table/Fig-2].

Parameters	Smart panel board (Mean±SD)	Chalk board (Mean±SD)	p-value
Overall satisfaction & effectiveness	4.42±0.53	4.01±0.61	<0.001
Better understanding of topic	4.38±0.56	3.96±0.63	0.001
Demonstration of applied aspects	4.46±0.50	3.88±0.65	<0.001
Engagement in class	4.49±0.52	3.79±0.66	<0.001
Visibility & clarity of content	4.55±0.48	3.84±0.69	<0.001
Ability to take notes	3.89±0.71	4.26±0.58	0.003
Stimulates interest in pharmacology	4.43±0.54	3.91±0.62	<0.001
Student-teacher interaction	4.31±0.57	4.05±0.60	0.012

[Table/Fig-2]: The interactive smart panel board scored significantly higher in most perception domains ($p< 0.05$), particularly in visualisation, engagement and applied learning. Chalkboard teaching scored significantly higher only in ability to take notes.

The perception questionnaire comprised 17 items. Of these, eight paired items (16 in total) directly compared the two teaching aids across key educational domains and are presented in [Table/Fig-2]. The remaining item, assessing overall student preference, is reported separately in [Table/Fig-3].

When asked about their preferred teaching aid for pharmacology lectures, 48 students (46.6%) favoured the interactive smart panel board, 16 (15.5%) preferred the chalkboard, and 31 (30.1%) opted for a combination of both. Additionally, eight students (7.8%) emphasised that the teacher's technique mattered more than the aid itself. Students noted that smart panels enhanced visualisation and engagement, while chalkboards facilitated structured note-taking and organisation of ideas [Table/Fig- 3].

Preference option	n (%)
Only interactive panel board	48 (46.6)
Only chalkboard	16 (15.5)
Combination of both techniques	31 (30.1)
Teaching style more important than aid	8 (7.8)

[Table/Fig-3]: Distribution of student preference regarding teaching aids.

DISCUSSION

The present study extends the existing literature by providing empirical evidence from a quasi-experimental within-subject design comparing interactive smart panel board teaching with traditional chalkboard instruction in undergraduate pharmacology education. Unlike prior studies that emphasised subjective perceptions, this work integrates both objective (knowledge scores) and subjective (student perceptions) outcomes within the same cohort.

Findings demonstrate that both methods have merits, yet interactive smart panel board teaching showed a clear advantage in learning gains, visualisation, and engagement. Both modalities produced statistically significant improvements in post-test scores, reinforcing the continued relevance of traditional chalkboard teaching in medical education. Chalkboard instruction has long been valued for its logical progression, adaptability, and facilitation of teacher-student interaction [6,15]. These qualities are particularly important in pharmacology, where understanding drug mechanisms, pharmacodynamics, and pharmacokinetics requires sequential reasoning.

Nevertheless, the substantially higher post-test scores and greater knowledge gains with smart panel boards suggest additional cognitive benefits. The incorporation of visuals-diagrams, flowcharts, animations, and colour illustrations-enhances conceptual clarity. Consistent with Mayer's Cognitive Theory of Multimedia Learning, instructional designs that combine visual and verbal inputs promote meaningful learning by activating dual channels and reducing extraneous cognitive load [7].

Pharmacology is often perceived as abstract and challenging due to its breadth and clinical relevance. Prior studies highlight the value of visual and interactive aids in subjects requiring practical understanding [16]. In the present study, students rated smart panel boards highly for demonstrating practical applications, underscoring the role of visualisation in fostering higher-order thinking, particularly in rational drug prescription [17].

Perception analysis revealed significantly more positive responses for smart panel board teaching in domains such as engagement, clarity, visualisation, interest stimulation, and satisfaction. These findings align with research showing that interactive, technology-supported methods enhance learner motivation and attention, thereby increasing involvement [9,16]. Engagement itself is a critical mediator between instruction and learning, with higher engagement linked to improved academic achievement [10,18].

At the same time, chalkboard instruction was superior for note-taking. Cognitive psychology and educational research suggest that slower instructional pacing with manual note-taking facilitates deeper processing and comprehension. The chalkboard's inherent pacing allows students time to construct organised notes, an especially valuable skill in pharmacology, where synthesis of concepts is essential [19].

Student preference analysis highlighted complementary attributes of both methods. While nearly half favoured smart panel boards alone, about one-third preferred a blended approach. This supports recent evidence that no single method meets all learner needs. A blended mode allows instructors to leverage visualisation through smart panels while retaining the chalkboard's strengths in structured explanation [20]. Notably, a subset of students emphasised that teaching effectiveness depends more on pedagogy than on the aid itself. This reinforces a key principle in medical education: technology cannot compensate for poor teaching. Faculty development studies consistently show that clarity, enthusiasm, interaction, and flexibility remain central to learning success [21-23]. Although teaching variability was minimised, the influence of individual teaching style and learner preference on outcomes cannot be fully excluded. The crossover design and objective assessments, however, reduce the likelihood of bias. A combined approach integrating both methods is therefore recommended for CBME programs.

Limitation(s)

The present single-centre study with a limited sample size may restrict generalisability. Knowledge assessment was confined to immediate post-test scores, without evaluation of long-term retention. Selected CNS topics varied in complexity, which may have influenced outcomes. Although topics were randomised, no washout period was included, and topic equivalence was based on faculty consensus, leaving potential heterogeneity. Teaching variability was minimised but not eliminated. Use of identical MCQs may have introduced recall bias. Future studies should employ larger samples, validated topic equivalence, parallel assessments, and long-term follow-up.

CONCLUSION(S)

The present study highlights that teaching aids in pharmacology are complementary rather than universally effective. Smart panels enhance visualisation and engagement, while chalkboards support cognitive processing through structured explanations and note-taking. A blended approach may therefore provide the most comprehensive learning experience for undergraduate medical students. Ultimately, teaching style and student-teacher interaction remain decisive factors, with technology serving as a valuable adjunct to sound pedagogy.

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