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Current Use of AI by MBBS Students and Strategies to Enhance Its Effectiveness in Pharmacology Learning

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Abstract

Introduction: AI technologies are increasingly adopted by MBBS students to enhance their understanding of pharmacology. These tools provide significant benefits, such as personalized learning experiences. However, optimizing their application and addressing potential limitations is essential to improve learning outcomes and overall academic performance in medical education.

Aim/ Objective : To evaluate the utilization of AI tools by MBBS students in pharmacology studies and identify strategies for optimizing their integration to enhance learning effectiveness and academic performance.

Methodology: Data were collected from 250 medical students using a structured questionnaire designed to assess the use of AI tools in pharmacology learning. The study focused on the effectiveness and impact of these tools. Responses were analyzed to identify challenges, benefits, and limitations of AI integration. Based on the findings, recommendations were developed to enhance AI use, address limitations, and improve overall learning outcomes for students.

Results: Among 250 MBBS students surveyed, 79% reported using AI tools, including ChatGPT, Google Gemini, and Grammarly, for pharmacology studies. These tools were associated with increased engagement and a better understanding of complex concepts. However, 45% of students faced challenges due to inadequate integration of AI into the curriculum and limited access to advanced technologies. Benefits included personalized feedback and interactive learning experiences, which contributed to improved academic performance for 70.8% of participants.
Limitations included the high cost of technology and a need for enhanced training for effective use.
Despite these challenges, students found AI tools valuable in supporting their studies and recommended more comprehensive integration into their learning processes to maximize their benefits.

Conclusion: AI tools significantly enhance pharmacology education by providing interactive and personalized experiences. Effective integration and addressing challenges are crucial for improving educational outcomes and academic performance for medical students.

Keywords: AI Tools, Pharmacology Learning, MBBS Students, Educational Technology, Learning Outcomes, AI Integration

1. Introduction

Artificial Intelligence (AI) technologies are progressively reshaping medical education, with pharmacology emerging as a key discipline benefiting from these advancements.[1,2] Undergraduate medical students, particularly those pursuing MBBS, are increasingly incorporating AI-driven platforms such as ChatGPT, Google Gemini, and Grammarly into their learning routines.[3,4] These tools offer personalized guidance, interactive engagement, and simplified understanding of intricate pharmacological concepts.[5,6]

By enabling adaptive learning and real-time feedback, AI facilitates deeper comprehension and retention of complex subjects such as drug mechanisms, pharmacokinetics, and therapeutic applications.[3,7] However, to harness the full potential of AI in medical education, it is imperative to address existing challenges most notably, issues related to cost, digital accessibility, and equitable integration across institutions.[8] Strategic implementation and continuous evaluation will be essential to ensure that AI serves as a supportive adjunct to traditional pedagogical approaches in pharmacology education.[9,10]

2. Aims and Objectives

2.1 Aim:

- To evaluate the extent, patterns, and impact of AI tool utilization by MBBS students in pharmacology education.

2.2 Objectives:

1.Identify the most frequently used AI tools among MBBS students for pharmacology learning.

2.Analyze the perceived benefits and challenges associated with AI-assisted pharmacology education.

3.Assess the influence of AI on students' academic performance, conceptual understanding, and engagement.

4.Develop evidence-based strategies for the effective integration of AI tools in pharmacology curriculum.

3. Materials and Methods

3.1 Study Design: Cross-sectional, questionnaire-based study.

3.2 Sample Size: 250 MBBS students, single centric study

3.3 Data Collection: Structured questionnaire assessing AI tool usage in pharmacology learning.

3.4 Focus Areas of questionnaire:

- Type and frequency of AI tool usage
- Common AI platforms used (e.g., ChatGPT, Google Gemini, Grammarly)
- Perceived effectiveness and impact on academic performance
- Student engagement and learning experience
- Challenges and limitations in AI adoption
- Training received and integration into curriculum
- Suggestions for improvement and future features

3.5 Methodology: Data were collected from 250 medical students using a structured questionnaire designed to assess the use of AI tools in pharmacology learning. The study focused on the effectiveness and impact of these tools. Responses were analyzed to identify challenges, benefits, and limitations of AI integration. Based on the findings, recommendations were developed to enhance AI use, address limitations, and improve overall learning outcomes for students.

3.6 Inclusion Criteria:

1. MBBS students currently enrolled in Phase II Pharmacology.

2. Students who provide informed consent.

3.7 Exclusion Criteria:

1. Students unwilling to participate or provide consent

3.8 Data Collection:

An online validated questionnaire was developed covering AI tool usage frequency, types of tools, perceived utility, challenges, and recommendations. The questionnaire had 15 multiple choice questions. Data were collected using Google Forms and anonymized for confidentiality.

3.9 Statistical Analysis:

Quantitative data were analyzed using Microsoft Excel. Categorical responses were expressed as percentages and represented using pie charts.

4. Results

4.1 Utilization of AI Tools by MBBS Students

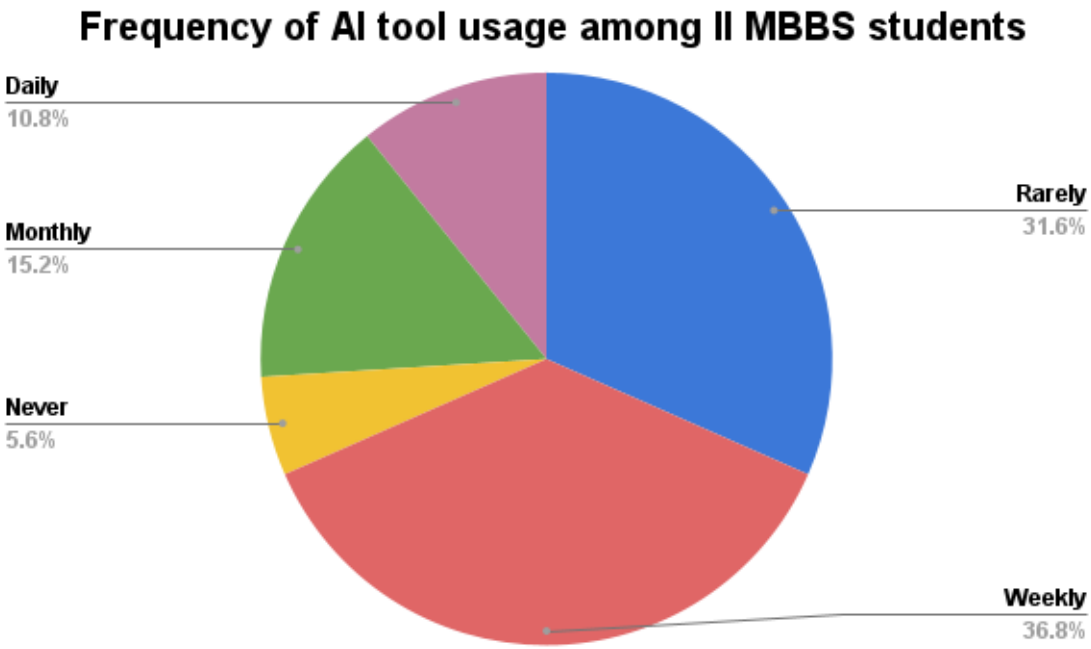
Out of 250 MBBS students surveyed, **79%** reported using at least one AI-based tool for pharmacology learning. Among these, the most frequently cited platforms were:

- **ChatGPT**
- **Google Gemini**
- **Grammarly**
- Others included tools like Quizzr, Powerdill, and AI-based summarizers.

Students also identified the types of AI tools used:

- **Interactive learning platforms** – 31%
- **Intelligent tutoring systems** – 24%
- **Virtual simulations** – 21%
- **Others** – 9%

Figure no: 1: Frequency of AI tool usage among MBBS students.



4.2 Perceived Benefits and Challenges of AI-Assisted Pharmacology Learning

When asked to rate the effectiveness of AI tools in enhancing their understanding of pharmacology on a 5-point Likert scale, the most frequent response was Rating 3 (Moderately Effective)—reported by 46.8% of students. Additionally, 25.2% rated AI tools as Rating 4, and 6% as Rating 5, reflecting a positive perception overall. In contrast, 16.8% gave a score of 2, and 5.2% rated it as 1, indicating limited effectiveness for a minority (Table 1).

Table no: 1 : Effectiveness rating of AI tools

Rating	Number of Students	Percentage (%)
1	13	5.2
2	42	16.8
3	117	46.8
4	63	25.2
5	15	6.0

Reported Benefits:

Students mentioned several advantages of using AI tools, including:

- Enhanced visualizations and illustrations of drug mechanisms
- Instant assessments for quick feedback
- Interactive simulations replicating clinical scenarios
- Improved comprehension of pharmacodynamics and adverse drug effects

Reported Challenges:

Despite these benefits, **45%** of respondents identified obstacles that limited the utility of AI-assisted learning. The major challenges included:

- **Limited access** to reliable or advanced AI tools (42%)
- **Technical issues** such as poor UI/UX or instability (38%)
- **Lack of formal integration** into medical curricula (35%)
- **High cost** or subscription fees for premium features (21%)

- **Inadequate training** in effective tool usage (30%)

Table no: 2 : Summary of Academic impact, Engagement, Training received by MBBS students

	Academic Impact	Engagement	Training Received
Moderately Deteriorated	6	0	0
Moderately Improved	177	0	0
No	0	33	142
No Change	52	0	0
Partially	0	0	62
Significantly Deteriorated	3	0	0
Significantly Improved	12	0	0
Unsure	0	74	0
Yes	0	143	46

4.3 Academic and Conceptual Impact

The influence of AI tools on academic performance in pharmacology was notable. Among the 250 participants:

- **177 students (70.8%)** reported **moderate improvement** in academic performance,
- **52 students (20.8%)** reported **no change**,
- **6 students (2.4%)** reported **moderate deterioration**,
- The remainder indicated varied impacts but generally positive trends.

When questioned on whether AI tools made pharmacology learning more engaging, **86.8%** of respondents answered "Yes." Students emphasized that features like conversational feedback (via ChatGPT), real-time clarifications, and interactive visual content significantly enhanced focus and interest.

In terms of training exposure:

- Only **24.8%** of students (**62 out of 250**) reported receiving **partial training**,
- **56.8%** had received **no training**,

- **17.6%** reported **adequate training** in AI tool usage.

4.4 Recommendations and Future Directions

A majority of students expressed a strong inclination to continue using and recommending AI tools for pharmacology learning. When asked about their likelihood of recommending AI-based platforms to peers:

- **58%** indicated they were **likely** or **very likely** to recommend,
- **26%** remained **neutral**,
- **16%** were **unlikely** to recommend.

Open-ended responses provided valuable insight into desired improvements and features. Key student suggestions included:

- **Tabulated summaries** of drug classifications and adverse effects for easier recall
- Integration of **video-based explainers** via platforms like YouTube or Marrow
- **Live AI-based sessions** and interactive dashboards
- Reduction of **cost barriers** through institutional subscriptions or free-access versions
- Better alignment of AI content with **NMC competencies** and standard pharmacology syllabi

Additionally, there was a clear demand for **formal training modules** and **faculty involvement** in AI literacy. Students emphasized that AI tools should supplement not replace conventional teaching, and that ethical boundaries, data privacy, and content accuracy must be maintained.

5. Discussion

This study explored the current use of artificial intelligence (AI) tools among MBBS students in pharmacology education and examined the benefits, challenges, and strategies for optimizing their integration. The findings reveal that AI platforms particularly ChatGPT, Google Gemini, and Grammarly are increasingly being incorporated into students' study routines, with a majority reporting improved academic performance and deeper engagement with complex pharmacological concepts.

A significant proportion of students (79%) indicated active usage of AI tools, with ChatGPT emerging as the most widely utilized platform. This reflects a growing shift towards self-directed learning models, consistent with recent global trends in medical education [2, 3]. Tools offering adaptive feedback, instant explanations, and dynamic visualization (such as drug interaction maps or therapeutic algorithms) were particularly valued by learners. These findings align with those reported by Blazquez et al., who observed improved knowledge retention and satisfaction among students using AI-enabled pharmacology modules [3].

The effectiveness rating data showed that nearly 78% of respondents rated AI as moderately to highly effective. Students highlighted interactive features, simulations, and personalized assessments as key contributors to conceptual clarity especially in understanding pharmacokinetics, mechanisms of action, and adverse drug reactions. These results support conclusions drawn by Szarek et al., who noted that AI tools facilitate integration of pharmacological knowledge into clinical reasoning when paired with traditional methods [5].

Despite the benefits, several limitations were reported by students. The most commonly cited barriers were limited access to AI technologies (42%), technical difficulties (38%), lack of integration into formal curriculum (35%), and high cost (21%). Furthermore, only 24.8% of students received any form of training in AI use, which may partially explain the underutilization of advanced AI features. These findings are echoed in literature from Guilding et al. and Wartman et al., who stressed that digital inequity and low digital literacy remain significant barriers in the effective deployment of educational AI [4, 11].

Importantly, the self-reported impact of AI tools on academic performance was positive, with over 70% reporting moderate to significant improvement. Additionally, 86.8% of students found AI-enhanced learning more engaging, indicating its role in boosting motivation and focus critical components in mastering pharmacological content. Ahmadi et al. have previously argued that such engagement is a crucial mediator of successful outcomes in digital learning environments [9].

However, the study also uncovered gaps in curricular alignment and institutional support. Many students recommended the inclusion of structured training modules, tabulated pharmacological summaries, and integration with platforms like YouTube or Marrow for video-based reinforcement. These suggestions reflect a desire to blend AI tools with conventional learning systems, rather than replacing faculty-led instruction. As Patel et al. emphasized, the most effective AI-enhanced learning environments are those that operate within a guided pedagogical framework [7].

5.1 Limitations

This study was conducted in a single medical college, which may limit the generalizability of the findings. Responses were self-reported and may have been influenced by recall bias or overestimation of benefit. Additionally, the cross-sectional design limits the ability to assess long-term academic outcomes or behavioral changes related to AI use.

5.2 Scope for Future Research

Longitudinal studies evaluating performance trends across semesters, randomized comparisons between AI-augmented and traditional learning groups, and faculty perception surveys could further validate the role of AI in medical education. Exploration of ethical concerns, content reliability, and the psychological impact of AI-dependent learning also warrant further investigation.

5.3 Implications

The results underscore the transformative potential of AI in pharmacology education. By providing personalized, adaptive, and engaging learning experiences, AI tools offer a viable complement to traditional teaching strategies. Institutional support, curricular integration, and structured training modules are essential to ensure that AI's potential is fully realized in shaping the next generation of rational prescribers.

6. Conclusion

The integration of artificial intelligence tools in pharmacology education is no longer a future possibility it is an active and evolving reality. This study demonstrates that AI platforms such as ChatGPT, Google Gemini, and Grammarly are being increasingly utilized by MBBS students to enhance comprehension, engagement, and academic performance. Students found these tools beneficial in navigating complex pharmacological content, reinforcing conceptual understanding, and promoting self-directed learning.

Despite these advantages, the effectiveness of AI tools is currently constrained by limited access, lack of structured training, and minimal curriculum integration. Addressing these challenges through institutional support, formal training modules, and ethical integration strategies will be crucial to ensure AI serves as an enabler not a disruptor in medical education.

By embracing AI thoughtfully and inclusively, pharmacology educators can create a learning environment that is not only technologically advanced but also pedagogically sound, equitable, and aligned with the evolving competencies required of future physicians.

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8. Conflict of Interest

None declared.

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