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ORIGINAL RESEARCH

Evaluating the Role of Generative AI and ChatGPT in Pharmacology Education: A Medical Student Perspective

[1]Dr. Durgaprasad Boddepalli, [2]Dr. Bhupendra Prakash Solanke

[1]Department of Pharmacology, Armed Forces Medical College, Pune, Maharashtra, India
[2]Associate Professor, Department of Pharmacology, Armed Forces Medical College, Pune, Maharashtra, India

Corresponding author
Dr. Durgaprasad Boddepalli
Department of Pharmacology, Armed Forces Medical College, Pune, Maharashtra, India

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ABSTRACT

Introduction: The integration of generative artificial intelligence (AI) into medical education is a rapidly growing trend, offering innovative ways to enhance learning, especially in complex subjects such as pharmacology. Generative AI tools like ChatGPT can produce interactive and visually dynamic content, offering students a more immersive learning experience. This study explores the knowledge and attitudes of medical students towards using generative AI in pharmacology education, specifically assessing the effectiveness of an educational intervention. **Materials and Methods:** A prospective crossover study was conducted at Armed Forces Medical College (AFMC), Pune, targeting second-year MBBS students. The study involved a pre- and post-workshop evaluation of students' knowledge and attitudes using a validated questionnaire. The educational intervention was a workshop that focused on the use of generative AI tools in pharmacology, including hands-on sessions with AI-generated images and interactive discussions. Data collection spanned one month, and statistical analysis was conducted to assess changes in students' knowledge and attitudes post-intervention. **Results:** The workshop included 140 participants (82.2% male, 17.8% female). Pre-workshop, only 26.6% of participants were familiar with generative AI technologies, which increased to 34.3% post-workshop. Participants demonstrated a broader knowledge of AI tools like ChatGPT, DALL-E, and AtomNet after the workshop. There was a significant increase in the belief that generative AI images enhanced learning. However, concerns regarding the accuracy of AI-generated images persisted, highlighting the need for further quality control in AI applications. **Discussion:** The study revealed a positive shift in students' knowledge and attitudes towards generative AI technologies in pharmacology education. The increase in familiarity with AI tools and the perceived educational benefits of AI-generated images underscore the potential of these technologies to improve the learning experience. **Conclusion:** Generative AI holds significant promise for enhancing medical education in pharmacology. This study demonstrates that targeted educational interventions can improve students' understanding and confidence in using AI tools.

Keywords: medical student, pharmacological education, chat GPT, generative AI images, knowledge and attitude

INTRODUCTION

The landscape of medical education is continually evolving, driven by rapid technological advancements that present new possibilities for teaching and learning. One such innovation is the application of generative artificial intelligence (AI), which holds the potential to revolutionize the way medical students interact with educational content. Generative AI encompasses any form of artificial intelligence capable of producing new content, such as text, images, videos, audio, code, or synthetic data. Modeled after the brain's structure, neural networks are mathematical systems that learn skills by detecting statistical patterns in large datasets [1]. The next major advancement came with large language models (LLMs) around 2018. Companies like Google, Microsoft, and OpenAI trained neural networks on vast internet text, including Wikipedia and digital books. These models unexpectedly learned to generate unique prose, write code, and hold complex conversations, marking a new era in generative AI [2]. Generative AI models can be categorized based on their architecture and applications. Transformer-based models, like GPT-4, excel in text generation by learning relationships between words in sequential data [3].

Multimodal models, like DALL-E and GPT-4, process various types of input, such as text and images, to produce more sophisticated outputs. Each model type is tailored for specific tasks, ranging from

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text and image generation to complex multi-input outputs [4-5]. Understanding the practical applications of GenAI in teaching pharmacology education is crucial for leveraging its full potential. Traditionally, pharmacology education has relied on textbooks, lectures, and static images to illustrate drug mechanisms, structures, and interactions. However, these conventional methods often struggle to fully capture the dynamic and multidimensional nature of pharmacological concepts. In contrast, generative AI, powered by algorithms trained on extensive datasets, can produce interactive and visually compelling representations that mimic real-world scenarios and molecular interactions [6].

The findings from this study are expected to guide educators, curriculum developers, and policymakers in developing strategies to effectively utilize generative AI for enhancing pharmacology education and preparing future healthcare professionals.

MATERIALS AND METHODS

Study Design

This study was designed as a prospective crossover study aimed at evaluating the knowledge and attitudes of medical students regarding the use of generative AI images (Figure 1 and 2) and ChatGPT in pharmacology education. The study involved a pre- and post-session assessment conducted through a validated questionnaire. The educational intervention comprised a workshop focused on the application of generative AI images in pharmacology. The four QR codes of AI generated videos were also depicted on various interesting topics on medical education (Figure 3).

Study Setting and Participants

The study was conducted over a period of one month. The study was conducted at a tertiary care hospital. The target population consisted of volunteer second-year MBBS students. A total of 90 students participated in the study in pre-workshop and 70 in post-workshop questionnaire.

Intervention

The intervention involved a workshop designed to raise awareness and educate participants on the use of generative AI images in pharmacology education. This workshop provided hands-on experience and demonstrated the potential applications of AI-generated images in enhancing pharmacological learning.

Data Collection

Data was collected using a validated pre- and post-evaluation questionnaire. The questionnaire was specifically designed to assess the knowledge and attitudes of students towards the use of generative AI images and ChatGPT in pharmacology education. Under knowledge four question were asked before and after AI generative workshop. A questionnaire was designed to assess various aspects of students' interaction with generative AI in pharmacology, focusing on the following areas: Knowledge, attitudes, usage of Generative AI Images, Educational Impact, and Future Perspectives.

Ethical Considerations

Ethical approval was obtained from the institutional ethics committee. Participants were informed about the study's purpose, and informed consent was obtained from all volunteers before their inclusion in the study.

Data Analysis

The data collected from the pre- and post-intervention questionnaires were analyzed. All results attained were entered in Microsoft excel and the statistical calculations were executed using Graph Pad Instat. P value less than 0.05 was considered as statistically significant.

RESULTS

Demographics

The workshop participants showed a slight shift in gender distribution, with 16 females (17.8%) and 74 males (82.2%) attending the pre-workshop session, compared to 11 females (15.7%) and 59 males (84.3%) in the post-workshop session.

Knowledge of Generative AI in Pharmacology

Awareness of Generative AI Technologies:

Pre-workshop, 25 out of 90 participants (26.6%) were aware of generative AI technologies used in pharmacology, whereas, post-workshop, this number slightly decreased to 24 out of 70 participants (34.28%) (P=0.336).

Naming Two Generative AI Tools:

Before the workshop, ChatGPT was the most commonly mentioned tool, with some participants also familiar with Copilot. After the workshop, participants exhibited a broader knowledge of tools, naming ChatGPT, Copilot, AtomNet, Reinvent, Gemini, and DALL-E.

Understanding of Generative AI Technologies:

The satisfaction levels regarding understanding was 18.8% in pre-workshop which increased to 26.9% after the workshop (P=0.216). This indicate a more nuanced appreciation of these technologies, with a distribution across satisfaction levels.

Understanding of Prompt Engineering:

This concept was only introduced in the post-workshop evaluation, where participants were asked to define prompt engineering. The 47.7% of participants' corrected identified "prompt engineering" as "the science of giving command to Generative AI". This indicates that the workshop effectively conveyed this crucial aspect of working with AI.

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Use of ChatGPT in Academic Work:
Pre-workshop, participants reported using ChatGPT for various academic purposes, such as writing projects, essays, and assignments. This question wasn't repeated in the post-workshop evaluation, so no direct comparison can be made. However, the diverse use cases highlighted pre-workshop suggest a baseline familiarity with AI tools that likely contributed to the workshop's engagement.

Attitudes Towards Generative AI Images in Pharmacology

Belief That Generative AI Images Enhance Learning:
In the pre-workshop evaluation, 41 out of 90 participants (45.6%) agreed or strongly agreed that generative AI images enhanced their learning experience. In Post-workshop, 40 out of 70 participants (57.1%) agreed or strongly agreed (P= 0.146). Although the absolute numbers dropped, the percentage of positive responses increased, reflecting a more concentrated belief in the benefits of AI tools post-workshop.

Concerns About the Accuracy of Generative AI Images:
Pre-workshop, 35 out of 90 participants (38.9%) expressed concerns about the accuracy of AI-generated images. This concern remained steady post-workshop, with 30 out of 70 participants (42.9%) maintaining this view.

Belief That ChatGPT Will Blunt Reasoning in the Long Run:
Pre-workshop, a mixed reaction was noted, with 34 out of 90 participants (37.8%) remaining neutral and 31 out of 90 (34.4%) agreeing or strongly agreeing that ChatGPT might blunt reasoning. Post-workshop, this concern became more pronounced, with only 14 out of 70 participants (20%) neutral and 25 out of 70 (35.7%) agreeing or strongly agreeing.

Belief That ChatGPT Helps Create Quality Text and Saves Time:
Pre-workshop, 41 out of 90 participants (45.6%) agreed or strongly agreed that ChatGPT was an effective tool for creating quality text and saving time. Post-workshop, this number dropped slightly to 31 out of 70 participants (44.3%).

Usage of Generative AI Images

Use of Generative AI Images in Pharmacology Studies:
Pre-workshop, 30 out of 90 participants (33.3%) had used generative AI images in their studies. Post-workshop, this number increased to 36 out of 70 participants (51.4%), reflecting a significant rise in the adoption of AI tools after the workshop (P<0.05).

Frequency of Use:
In both the pre- and post-workshop evaluations, participants who used AI images reported using them "sometimes," with this frequency remaining consistent across both sessions. **Educational Impact**

Belief That Generative AI Images Help Understand Complex Concepts:
Pre-workshop, 38 out of 90 participants (42.2%) agreed or strongly agreed that AI images aided in understanding complex concepts. Post-workshop, this belief slightly increased, with 39 out of 70 participants (55.7%) sharing this view (P=0.09).

Preference for Traditional Images Over Generative AI Images:
Pre-workshop, 37 out of 90 participants (41.1%) remained neutral or disagreed with the preference for traditional images. Post-workshop, this number dropped to 25 out of 70 participants (35.7%), indicating a slight shift towards favouring AI-generated images over traditional ones after the workshop.
The summary of results is tabulated in Table 1.

Future Perspectives and Feedback

Rating of the Workshop:
Post-workshop, participants rated the workshop positively, with the majority (88.1%) considering it "good," "very good," or "excellent." The specific ratings were distributed across a scale from 1 to 5, showing a strong overall satisfaction with the workshop's content and delivery.

Confidence in Using Generative AI Images Post-Workshop:
Post-workshop, 37 out of 70 participants (52.9%) felt "very likely" to use AI images in the future, with 14 out of 70 (20%) remaining neutral

Concern about Misuse Potential:
While not explicitly addressed pre-workshop, the post-workshop evaluation revealed that participants had concerns about the misuse potential of AI tools. This reflects an increased awareness of the ethical implications of AI, likely spurred by discussions during the workshop.

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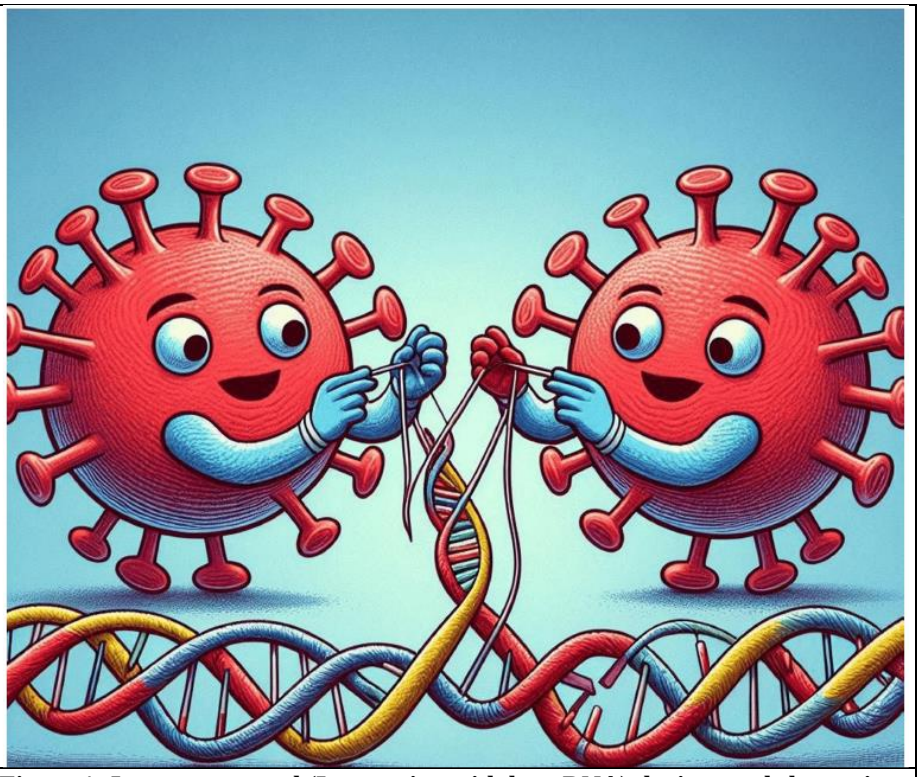

Figure 1: Image generated (Integrating with host DNA) during workshop using generative Artificial intelligence (Microsoft designer)

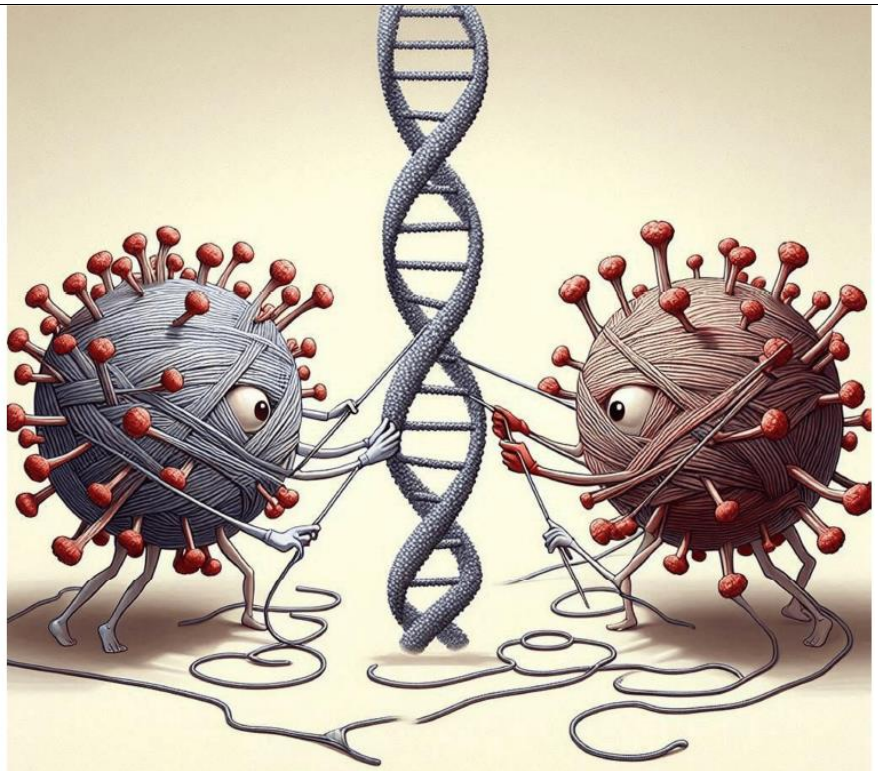

Figure 2: Image generated (Single strand DNA knotting to double strand) during workshop using generative Artificial intelligence (Microsoft designer)

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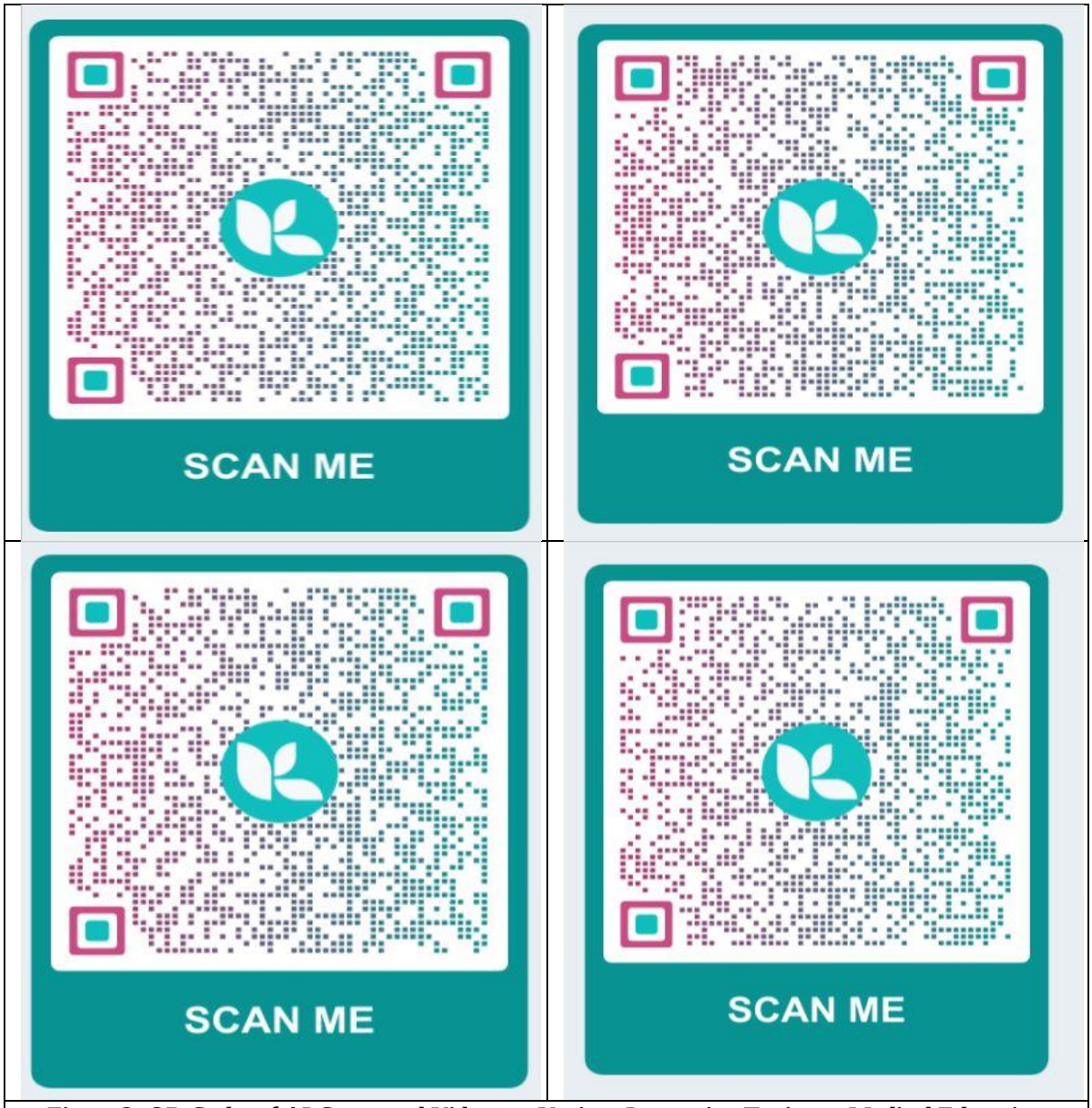

Figure 3: QR Codes of AI Generated Videos on Various Interesting Topics on Medical Education

Table 1: Summary of Key Findings

Category	Pre-Workshop (%)	Post-Workshop (%)	P value significant (Yes/No)
Female Participants	17.8	15.7	No
Male Participants	82.2	84.3	No
Awareness of Generative AI	26.6	34.3	No
Belief AI Images Enhance Learning	45.6	57.1	No
Concern About AI Image Accuracy	38.9	42.9	No
Belief ChatGPT Blunts Reasoning	34.4	35.7	No
Belief ChatGPT Helps Text Creation	45.6	44.3	No
Use of AI Images in Pharmacology Studies	33.3	51.4	Yes
AI Images Help Understanding	42.2	55.7	No
Preference for Traditional Images	41.1	35.7	No

DISCUSSION

Demographics

The gender distribution in the workshop highlighted a consistent male dominance across both the pre- and post-workshop evaluations. The slight decline in female participation post-workshop by 2.1% is indicative of a persistent gender gap in the field of AI and pharmacology, which mirrors broader trends

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observed in STEM fields, where women are underrepresented. Future workshops should consider gender inclusive strategies to balance participation rates. [7]

Knowledge of Generative AI in Pharmacology

Awareness of Generative AI Technologies:

Increased awareness was observed regarding Generative AI technologies. This shift in percentage suggests the workshop attracted a more informed group during the post-session. The overall increase aligns with the growing interest in AI applications in medicine and pharmacology, particularly as AI-driven tools become increasingly integrated into clinical practice. [8]

Naming Two Generative AI Tools:

Post-workshop, participants exhibited a broader understanding, mentioning AtomNet, Reinvent, Gemini, and DALL-E in addition to the previously mentioned tools. This diversification in knowledge reflects the workshop's success in introducing participants to a range of generative AI tools. Exposure to these tools may lead to enhanced integration of AI technologies in pharmacological education and research, as the field continues to innovate. [9]

Understanding of Generative AI Technologies:

While pre-workshop satisfaction levels regarding understanding were not recorded, post-workshop feedback suggested an improved comprehension of generative AI technologies. The broader naming of tools and better understanding highlights the importance of educational interventions like workshops to elevate awareness and practical knowledge in cutting-edge technology fields.

Understanding of Prompt Engineering:

Prompt engineering was introduced only in the post-workshop evaluation, where participants demonstrated an understanding of the concept as "the science of giving command to Generative AI." This knowledge is crucial for effectively interacting with AI models and ensuring accurate outputs. As generative AI becomes more prevalent in academic and clinical settings, prompt engineering will likely emerge as a key skill for medical professionals. [10]

Use of ChatGPT in Academic Work:

Pre-workshop, participants reported using ChatGPT for tasks such as writing essays, projects, and assignments. This suggests that generative AI tools like ChatGPT are already embedded in academic workflows. However, with no post-workshop comparison available, it is difficult to gauge how the workshop influenced further use of ChatGPT. Similar finding was observed by Heather D. Anderson et al in 2024 showed while observing pharmacy students which showed that the most common personal use for ChatGPT was answering questions and looking-up information (67.0%). The top academic reason for using ChatGPT was summarizing information or a body of text (42.6%), while the top clinical reason was simplifying a complex topic (53.3%) [11].

Attitudes Towards Generative AI Images in Pharmacology

Belief That Generative AI Images Enhance Learning:

Pre-workshop, 45.6% of participants agreed that generative AI images enhanced learning, which increased to 57.1% post-workshop. This rise in positive responses demonstrates that the workshop effectively communicated the educational benefits of AI-generated images. This was also supported by many studies in which Zhiyi Xu in 2024 [12] concluded that AI enhances education by personalizing learning, creating adaptive lessons and assessments, utilizing data analytics, and fostering immersive learning environments, all aimed at improving outcomes.

Concerns About the Accuracy of Generative AI Images:

Concerns about the accuracy of AI-generated images remained consistent across pre- and post-workshop evaluations, with a slight increase from 38.9% to 42.9%. This suggests that while participants recognized the benefits of AI tools, they also developed a more critical perspective on their accuracy and reliability. These concerns are reported by Geoffrey M. Currie in 2024 [13], generative AI in text-to-text and text-to-image tasks contains inherent biases, particularly regarding gender and ethnicity, which may lead to misrepresentation in nuclear medicine. Currie highlighted the risks of integrating these AI tools into medical education, image interpretation, and patient education, warning that they could amplify these biases.

Belief That ChatGPT Will Blunt Reasoning in the Long Run:

The concern that ChatGPT might blunt reasoning increased post-workshop, with 35.7% of participants expressing this view, compared to 34.4% pre-workshop. This concern reflects broader anxieties about the overreliance on AI for cognitive tasks, which may hinder critical thinking and problem-solving skills (Carr, 2020). Participants' growing apprehension indicates that while AI tools are beneficial, their use should be balanced to avoid negative cognitive effects. [14]

Belief That ChatGPT Helps Create Quality Text and Saves Time:

Pre-workshop, 45.6% of participants felt that ChatGPT helped create quality text and saved time, slightly decreasing to 44.3% post-workshop. This stable response indicates that participants generally value ChatGPT for its efficiency, even if their perceptions of its limitations grew post-workshop. Generative AI's ability to expedite routine tasks has been well-documented in academic and professional settings. [15]

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Usage of Generative AI Images

Use of Generative AI Images in Pharmacology Studies:

There was a significant increase in the use of generative AI images post-workshop, from 33.3% to 51.4%. This suggests that the workshop motivated participants to adopt AI tools in their studies. While traditional methods like chalk talks still engage and inspire students, new approaches are emerging. AI, now a key tool in advancing the medical field, is also impacting medical education. AI-generated art offers medical educators a powerful resource to enhance teaching, particularly in narrative medicine and educational imagery creation. [16]

Frequency of Use:

The frequency of use remained consistent across both sessions, with participants indicating that they used AI images "sometimes." This suggests that while the workshop increased the adoption of AI tools, participants may require further engagement or resources to integrate these tools into their regular study routines.

Educational Impact

Belief That Generative AI Images Help Understand Complex Concepts:

Pre-workshop, 42.2% of participants agreed that AI images helped them understand complex concepts, increasing to 55.7% post-workshop. This indicates that participants found AI-generated images to be a valuable tool for learning, corroborating research that AI-enhanced visual aids can improve understanding in medical education. Generative AI (GAI) models have emerged as valuable tools in medical teaching, offering significant potential to enhance understanding of complex concepts. Siva sai et al in 2020 explores various applications of GAI in healthcare, including medical imaging, drug discovery, personalized treatment, medical simulation, and clinical trial optimization. The technology's flexibility and reliability are evident in this study [17].

Preference for Traditional Images Over Generative AI Images:

The post-workshop decline in preference for traditional images, from 41.1% to 35.7%, suggests a growing openness to AI-generated content. This shift highlights the potential for AI to complement or even replace traditional educational materials in pharmacology, providing more personalized and interactive learning experiences (Luckin, 2017) [18].

Future Perspectives and Feedback

The post-workshop feedback was overwhelmingly positive, with most participants rating the workshop highly and expressing confidence in their ability to use AI images moving forward. Participants' concerns about the potential misuse of AI tools reflect a growing awareness of the ethical challenges posed by AI in education. These concerns align with broader discussions on AI ethics, particularly regarding issues like bias, misinformation, and data security as published by Vinuesa et al., 2020 [19].

CONCLUSIONS

The workshop successfully expanded participants' understanding of generative AI tools while promoting a critical and balanced approach to their use. The increased adoption of AI technologies in pharmacology education, alongside growing awareness of ethical and accuracy concerns, emphasise the need for ongoing education and dialogue regarding the responsible integration of AI into medical education.

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