Communication Competencies for Pharmacy Students in the AI Era: Challenges, Opportunities, and Implications

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ABSTRACT

The rapid adoption of generative artificial intelligence (AI) is transforming higher education and reshaping how students acquire, process, and communicate knowledge. In pharmacy education, effective communication is a core professional competency that requires the integration of scientific knowledge, clinical reasoning, and patient-centred communication. This paper examines how AI technologies, particularly Large Language Models such as ChatGPT and Gemini, are influencing communication competencies among pharmacy students and explores the educational implications of their growing use. Through a critical review of contemporary literature, the paper discusses the evolving nature of digital literacy, whereby students are increasingly required not only to retrieve information but also to interact with AI systems, formulate effective prompts, and critically evaluate generated content. The review highlights several challenges associated with AI-assisted learning, including cognitive offloading, overreliance on automated outputs, diminished self-regulated learning, and the potential erosion of critical thinking and clinical reasoning skills. Particular attention is given to the AI-translation paradox, in which AI-generated explanations may improve readability yet inadvertently compromise scientific accuracy, creating risks in healthcare communication. The paper also considers concerns related to academic integrity, authorship, and the reliability of AI-generated information, including the propagation of hallucinated or misleading content. In addition, disparities in institutional readiness and technological resources may contribute to unequal learning opportunities among students across higher education institutions. While AI offers significant opportunities to enhance writing, information synthesis, and communication training, its integration must be guided by sound pedagogical principles. Pharmacy curricula should therefore promote AI literacy, evaluation skills, reflective learning, and authentic assessment approaches that preserve independent thinking and professional judgement. Ultimately, generative AI should be viewed as a complementary educational tool rather than a substitute for human expertise, enabling future pharmacists to harness technological innovation while maintaining the communication competencies necessary for safe, ethical, and effective patient care.

Keywords: Artificial intelligence; Pharmacy education; Communication competencies; Digital literacy; Generative AI.

INTRODUCTION

The field of higher education worldwide is experiencing substantial shifts due to the increasing integration of artificial intelligence (AI). In Malaysia, these trends align with national initiatives to enhance digitalization, as detailed in directives from the Ministry of Higher Education and the National Digital Education Policy. Although academic discourse has started to explore the consequences of AI-generated material, pharmacy education

confronts distinct challenges related to language, academic standards, and ethical considerations. The practice of pharmacy necessitates proficiency in English, requiring professionals to skillfully navigate between specialized scientific terminology and comprehensible communication for patients (Chalasani et al., 2023; Suhaimi, 2017).

Malaysian pharmacy programmes are constructed according to the strict regulatory standards set by the Pharmacy Board of Malaysia and the Malaysian Qualifications Agency (MQA). Pharmacy students are expected to understand the basics of pharmacology, pharmacy practice, clinical pharmacy, pharmaceutical technology and health sciences. The curriculum also mandates these students to undergo attachment at the community pharmacy, hospital and pharmaceutical industry. Therefore, it is imperative for them to be able to develop effective communication skills for clinical and interprofessional contexts. For many students, however, English functions as a second or institutional language within a multilingual learning environment. This adds a layer of cognitive and linguistic demand, particularly when dealing with specialised clinical or pharmacy terminology and real-time patient interaction (Koć-Januchta et al., 2022).

The increasing use of tools such as ChatGPT and Gemini is reshaping this learning environment. Pharmacy students today use these platforms not only to search for information but also to assist with writing, summarising, and translating complex data into more accessible forms. While such tools can support language development and reduce barriers to expression, their widespread use raises important concerns (Suhaimi, 2024). These include over-reliance on automated outputs, minimal engagement in clinical discussion, and reduced development of communication skills. This paper examines how generative AI is influencing digital literacy, learning processes, and communication training in Malaysian pharmacy education whilst highlighting gaps in access and AI readiness across higher institutions.

Theoretical Perspectives on AI-Mediated Communication

Understanding how generative AI affects pharmacy education calls for an interdisciplinary approach that combines cognitive psychology, educational theory, and applied linguistics. Together, these fields shed light on how students learn, reason, and communicate in environments shaped by advanced technology. Generative AI can alter how students process information, solve problems, and build clinical reasoning skills (Sparrow et al., 2011). Educational theory helps explain the effects of AI on learning behaviors, self-regulation, and the construction of knowledge. Applied linguistics adds another layer by examining how students use language in professional and academic settings, especially when conveying complex medical information to diverse audiences (Sparrow et al., 2011). These perspectives offer a strong framework for examining AI-generated text in pharmacy education. Treating generative AI as more than just a tool reveals its wider impact on learning processes, communication practices, and the formation of professional competence. Grasping these interactions is crucial for assessing the opportunities and challenges AI brings to future pharmacy training.

The Risk of Cognitive Offloading

Cognitive Load Theory states that working memory has a limited capacity for processing new information (Fan et al., 2025). It distinguishes three types of cognitive load. Intrinsic load arises from the material's inherent complexity—for example, grasping the pharmacokinetics of drugs with a narrow therapeutic index. Extraneous load comes from how information is presented or tasks are organized, adding unnecessary mental effort. Germane load is the productive cognitive effort used to understand information and build meaningful mental structures, often called schemas (Fry et al., 2025; Naseer et al., 2024)

When students work on tasks like writing a clinical paper or translating medical content, they need to engage in productive cognitive effort. They must organise ideas, evaluate evidence, and choose language carefully. However, when generative AI tools are used to produce drafts or summaries, part of this mental work is shifted outside the learner. This process is known as cognitive offloading, that relies on external systems to do tasks the student would otherwise do (Skulmowski, 2023).

These tools can be useful for reducing unnecessary effort, such as fixing grammar or formatting. But concerns arise when they are applied to more complex activities like drafting or synthesizing information. In those cases,

students may interact less deeply with the material which limits how well they develop conceptual understanding. This can lead to a situation where written output appears fluent and polished, but the underlying conceptual grasp is weak. This creates a sense of false confidence that is not fully supported by genuine learning (Greengrass, 2026; Jošt et al., 2024).

The Shift in Digital Literacy

Digital literacy in pharmacy education has traditionally focused on finding, interpreting and evaluating scientific information. Students are taught to search biomedical databases such as PubMed, ScienceDirect, and Scopus using structured strategies, and then critically appraise the quality and relevance of the retrieved evidence (Laupichler et al., 2022; Santos, 2024). In this approach, the student acts as an active analyst, using peer-reviewed sources to support clinical understanding and decision-making. The rise of generative AI is changing what we mean by digital literacy. Instead of only searching for information, students increasingly learn by interacting with AI systems (Ng et al., 2021; Raza et al., 2022). This brings new skills into play such as generating effective prompts, iterating follow-up questions to refine results, and judging the trustworthiness of AI-generated content. Students move from being passive information consumers to active contributors who shape how content appears. Through guided interaction with AI tools, they participate in drafting, summarising, and adapting scientific content for different audiences and purposes (Chan & Hu, 2023). Although this opens new possibilities for learning, it also triggers concern about whether students can be critically engaged when part of the knowledge-production process is handled by AI (Diab Idris et al., 2024).

This learning change increases the demands on students' communication and practical language skills. Pharmacy students must have an increased awareness of how to use language effectively, especially when working with AI tools. That means crafting clear prompts for the intended audience, with a suitable level of complexity and clinical context (Roosan et al., 2024; Sharma et al., 2021). Because Large Language Models (LLMs) produce responses based on probabilistic patterns rather than verified facts, digital literacy increasingly requires strong skills in assessments (Mansoor et al., 2024). Students can no longer accept generated text at face value. Instead, they must review outputs carefully, question underlying assumptions, and verify alignment with established clinical guidelines (Alamäki et al., 2024; Tran et al., 2025). In this sense, the core challenge has shifted. It is not just about finding reliable information but about judging the quality and accuracy of AI-generated content. That demands sensitivity to subtle language cues, awareness of possible inaccuracies, and the ability to recognise when outputs are incomplete or misleading (Ndungu, 2024).

The AI-Translation Paradox in Pharmacy Education

A key goal of communication training in pharmacy education is helping students communicate the same information effectively to different audiences. This often means converting complex pharmaceutical and clinical terms into language that patients can easily understand (Barkhuizen, 2014). With generative AI now widely available, many pharmacy students use these tools to simplify pharmacotherapy concepts for patient counselling, patient education materials, and public health campaigns. While these tools can make medical information more accessible, they also create a challenge. AI-generated explanations are often clear and easy to understand but may fail to preserve the original scientific accuracy (Rasul et al., 2023). This phenomenon of delivering information with greater readability at the potential cost of lost clinical detail has been described as the AI-Translation Paradox. Consequently, students need not only to leverage AI for simplification but also to assess whether those simplified explanations remain accurate and suitable for professional healthcare (Tilton et al., 2025).

From an applied linguistics perspective, this represents a failure to use English appropriately in healthcare communication. Efforts to simplify explanations can sometimes replace accurate scientific terminology with expressions that are overly simplistic or misleading. Consequently, essential concepts such as receptor binding, reversibility, and the mechanisms underlying drug interactions may be overlooked. For instance, when asked to simplify the mechanism of a competitive H_1-receptor antagonist for a patient, an AI system might generate an explanation such as "this medicine destroys the chemicals that cause your allergy," rather than the more accurate

description that it "blocks the receptors that respond to histamine." Although the simplified version may appear clearer, it misrepresents the drug's actual mechanism of action.

A further concern is that the fluency of AI-generated text can create a false sense of confidence. In some cases, AI models may produce statements that appear credible but are not supported by reliable evidence, a phenomenon often referred to as hallucination (Jin et al., 2025; Namazi & Radfar, 2025; Pak et al., 2025). Students may assume that because a response is well written, it is also factually accurate (Durratul Hikmah, & Badilatil Walida, 2024). Over time, relying on AI for this kind of translation can limit deeper learning. When students do not engage directly in the process of interpreting and rephrasing complex ideas, they may struggle to develop both a solid understanding of scientific mechanisms and the ability to explain them clearly in clinical contexts.

Impact On Undergraduate Cognitive Skills And Academic Integrity

The growing use of generative AI in producing medical communication materials raises important questions about both student learning and academic integrity. Writing is a process through which students develop and organise their thinking (Pintrich & De Groot, 1990; Zimmerman, 2000). Overreliance on external tools such as AI systems may weaken the development of memory, problem-solving, and critical thinking (Risko & Gilbert, 2016). Another concern is that students may overestimate their own understanding because technology performs part of the work on their behalf.

Tasks such as preparing a clinical communication plan require students to weigh patient conditions, treatment goals, and level of health literacy. These activities involve certain skills such as interpretation, synthesis, and evaluation that are central to professional practice (Schunk & Greene, 2017). In the context of pharmacy education, this has implications for the development of higher-order thinking skills. When AI is used to generate initial drafts, the student's role may shift towards reviewing and editing rather than producing and structuring ideas independently. Research suggests that revising existing text generally requires less cognitive effort than generating original content, which may limit opportunities for deeper learning (Cain et al., 2023; Weidmann, 2024). Therefore, students may overestimate their understanding, especially when working with polished AI-generated outputs.

Over time, reduced engagement in the writing process may affect the development of analytical thinking and independent problem-solving skills. These are particularly important in clinical environments where professionals may need to make decisions without access to technological assistance (Abbas et al., 2024; Li et al., 2025). AI use also creates new challenges for conventional understandings of academic integrity. Although traditional plagiarism is generally easier to detect, AI-assisted writing introduces questions about authorship, originality, and the boundaries of acceptable support. Without clear guidelines, there is a risk that students may become increasingly dependent on automated tools for tasks that are fundamental to professional communication (Franco D'Souza et al., 2024).

Furthermore, frequent use of AI-generated content may encourage a more passive approach to learning, whereby students focus on obtaining answers rather than understanding the underlying concepts. Such patterns could affect students' confidence in performing professional tasks independently and may reduce their preparedness for situations in which AI support is unavailable or inappropriate. Consequently, educators face the challenge of integrating AI in ways that enhance learning while preserving active engagement for competent and reflective healthcare professionals.

Emerging Empirical Evidence from Health Professions Education

Although evidence remains relatively limited, emerging empirical studies suggest that students across health professions increasingly utilize generative AI for various purposes. Alexander et al. reported that pharmacy students generally viewed generative AI as a valuable tool for supporting learning, improving efficiency, and assisting with academic tasks. However, students also expressed concerns regarding misinformation and potential erosion of critical thinking skills (Alexander et al., 2025). More recently, Halford and Heitz evaluated a curriculum-aligned, oncology-focused chatbot across multiple cohorts of pharmacy students. Their findings

demonstrated that AI-supported educational tools can enhance learner engagement and provide targeted support for complex therapeutic content when integrated within a structured curriculum (Halford & Heitz, 2026).

Similarly, Morbitzer et al. described practical strategies for incorporating generative AI into pharmacy teaching and learning activities, highlighting applications such as patient counselling practice, case-based learning, content generation, and formative assessment (Rodgers et al., 2026). Collectively, these studies suggest that AI can serve as an effective educational adjunct when implemented within clear pedagogical frameworks that emphasise clinical reasoning and professional judgement. The emerging evidence therefore supports a balanced approach in which pharmacy students learn not only to use AI technologies effectively but also to critically appraise and verify AI-generated information before applying it in academic or clinical communication contexts.

Institutional Readiness And Access To Ai-Supported Learning

In Malaysia, national initiatives have encouraged the adoption of digital technologies in teaching and learning, yet differences in infrastructure, funding, and technological support continue to shape students' experiences with AI tools. The integration of AI into higher education has opened new possibilities for learning and communication, but its benefits are not experienced equally across all institutions (Subaveerapandiyan et al., 2024). Students studying at well-resourced universities may have access to advanced digital platforms, institutional subscriptions, workshops on AI use, and reliable internet connectivity. These resources provide greater opportunities to explore emerging technologies and to develop the digital competencies needed to use AI effectively in academic and professional settings. In contrast, students in institutions with more limited resources may rely primarily on freely available tools and face constraints related to internet access, software availability, or technical support (Chiu et al., 2024). These differences have important implications for learning. Opportunities to develop these competencies may vary depending on the resources and support available within individual institutions.

From a communication perspective, unequal access to AI-supported learning may also influence the development of academic and professional language skills (Daher, 2025; Skulmowski, 2023). Students who have more exposure to advanced digital tools may gain additional experience in adapting, refining, and evaluating written content across different contexts. Ensuring that all students have access to appropriate technological resources, training, and guidance will therefore be important in supporting equitable learning opportunities and preparing future pharmacists for an increasingly digital healthcare environment.

In addition, access alone does not guarantee meaningful learning outcomes. Students require structured support to understand the limitations, biases, and potential inaccuracies of AI-generated content. Differences in academic support and digital resources may therefore create disparities in students' ability to benefit from AI technologies. This may widen existing educational inequalities, as some students become proficient in using AI as a learning tool while others lack the knowledge or opportunities to do so effectively. Consequently, institutions play a vital role in ensuring that AI integration is accompanied by equitable access, appropriate training, and clear ethical guidelines that enable all students to participate confidently and responsibly in an increasingly AI-driven educational environment.

Several international institutions have already begun integrating AI into healthcare and pharmacy education through structured teaching activities. Examples include the use of ChatGPT-assisted clinical case discussions (Öncü et al., 2025), AI-supported literature appraisal exercises (Liu & Wang, 2024), and simulated patient counselling activities (Maurya, 2024) in which students compare AI-generated recommendations against evidence-based guidelines. These approaches emphasize verification, reflective practice, and critical evaluation. Such initiatives demonstrate that AI can be incorporated into pharmacy education in ways that strengthen communication and clinical reasoning competencies when supported by appropriate educational oversight.

Supporting Educators in AI-Enhanced Learning Environment

While many pharmacy students quickly adopt AI tools as part of their study routines, lecturers may have varying levels of experience and confidence in using these technologies within their own teaching practices (Faust & Mayweg-Paus, 2024). One of the challenges is the rapid pace at which AI technologies are evolving. Lecturers

are often expected to respond to changes in student learning behaviours while simultaneously navigating new concerns related to assessment, academic integrity, and the reliability of AI-generated content. Without adequate professional development and institutional guidance, some may feel uncertain about how best to incorporate these tools into teaching and assessment.

Supporting educators through training, institutional policies, and collaborative sharing of best practices can help ensure that AI is integrated in ways that complement, rather than replace meaningful learning. Ultimately, effective use of AI in education depends not only on students' digital skills but also on the ability of educators to guide its responsible and pedagogically sound application. Rather than focusing solely on restricting AI use, there is growing recognition that pharmacy students benefit from open discussions about responsible and ethical engagement with these technologies. Clear guidance can help students understand when AI tools can support learning, and when independent effort and professional judgement are essential. Such an approach also creates opportunities for lecturers to model critical evaluation, encouraging students to question and verify AI-generated information rather than accepting it uncritically.

Future Directions and Policy Recommendations

As generative AI becomes increasingly common in higher education, pharmacy programmes will need to adapt their communication and language curricula to reflect changing learning practices. The Ministry of Higher Education (MOHE), the Malaysian Qualifications Agency (MQA), and the Pharmacy Board of Malaysia must issue updated joint programmatic guidelines that explicitly address the use of automated systems in clinical training. The goal should not be to prohibit the use of AI tools entirely, but to help students use them in ways that support learning while maintaining professional standards and academic integrity (Purushottam Ashtikar et al., 2025). In pharmacy education, this is particularly important because communication errors can have direct implications for patient care (Ogbuagu et al., 2023). It is imperative to teach the students to become responsible users of these technologies.

Educators may also need to help students understand both the capabilities and limitations of these technologies for responsible AI use. Furthermore, assessment strategies may need to evolve from focusing primarily on final written outputs towards evaluating the learning process itself. Such approaches can help preserve the development of higher-order thinking skills while preparing students to work effectively alongside AI technologies in future healthcare environments (Allam et al., 2025). Assessment strategies should emphasise clinical reasoning, communication performance, and reflective practice in healthcare scenarios. More hands-on activities and discussions may encourage students to engage more actively with clinical problems.

In addition, universities can play an important role by providing clear guidelines on the ethical use of AI and offering professional development opportunities for educators. Supporting both students and faculty in developing AI-related competencies will help create a more consistent and informed approach to technology use across programmes. Ultimately, the challenge is not whether AI should be included in pharmacy education, but how it can be integrated in ways that strengthen learning, communication, and professional development. By combining technological innovation with sound educational practices, pharmacy programmes can prepare graduates who are both digitally capable and professionally competent in an AI-supported healthcare environment (Babayev, 2025).

A practical framework for AI-assisted communication training may incorporate five interrelated domains: AI literacy, critical appraisal, communication practice, reflective learning, and ethical professionalism (**Figure 1**). Students should first develop foundational competencies in prompt construction and AI evaluation. Subsequently, learning activities can require students to compare AI-generated explanations with evidence-based resources, identify inaccuracies, and revise outputs for different patient populations. Communication training can further incorporate simulated patient counselling exercises where students evaluate AI-generated responses before delivering information to patients. Assessment should prioritize reasoning processes, clinical justification, and reflective analysis rather than solely evaluating final written products. Such an approach enables pharmacy programmes to harness the benefits of AI while safeguarding the development of communication competence and professional judgement.

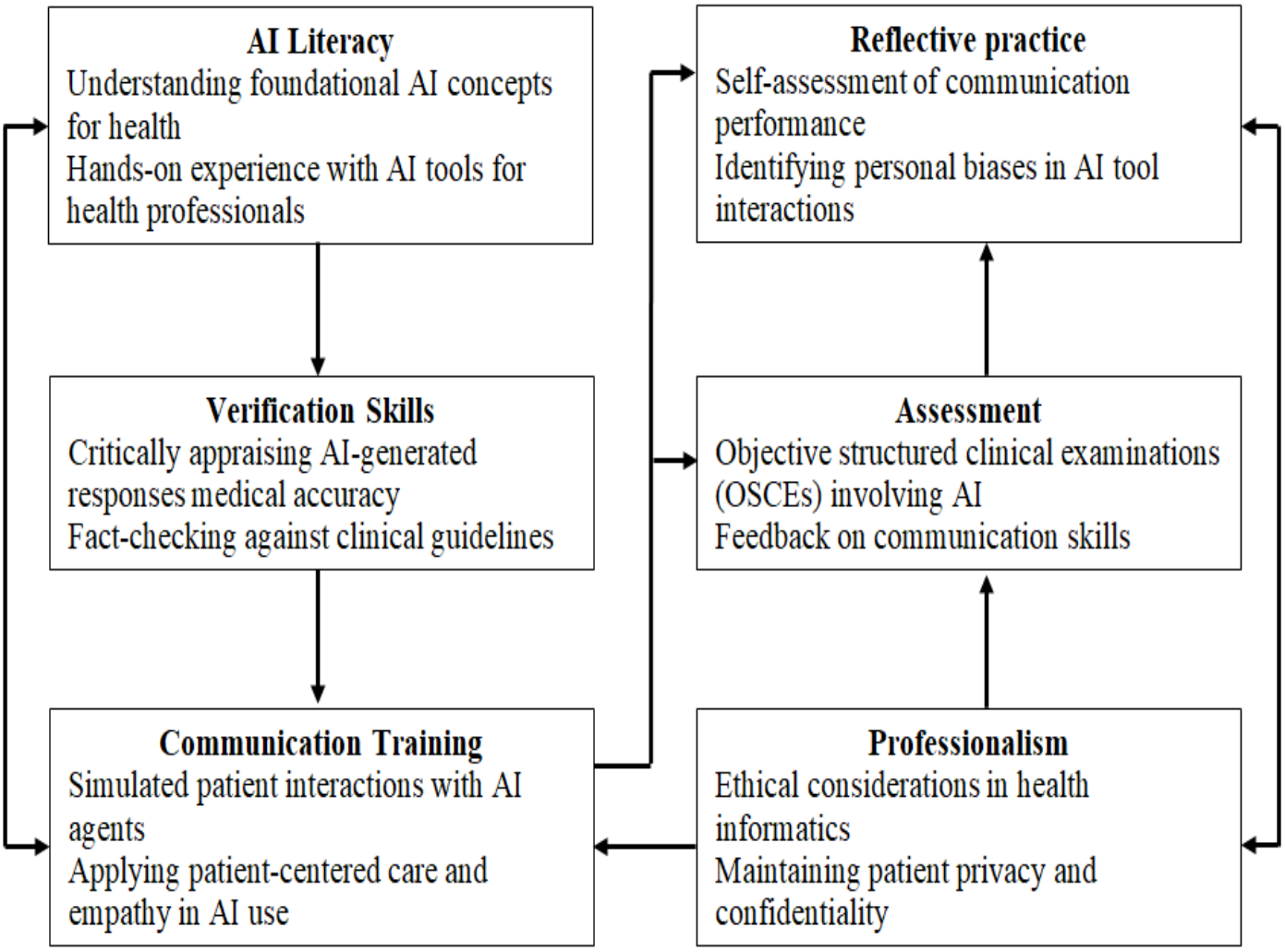

Figure 1: AI-assisted communication training framework for pharmacy students.

Limitations

This paper is primarily a narrative and conceptual review and therefore does not present original empirical data from pharmacy students or educators. The arguments presented are derived from contemporary literature and theoretical frameworks examining AI adoption, digital literacy, communication competencies, and higher education. Consequently, the conclusions should be interpreted as conceptual rather than causal.

CONCLUSION

The growing use of generative AI is reshaping how students learn, access information, and communicate within pharmacy education. As LLMs become more common in academic settings, pharmacy students are increasingly expected to develop new forms of digital literacy alongside traditional communication and clinical skills. While these technologies can support learning by assisting with writing, information synthesis, and language adaptation, they also raise important questions about critical thinking, professional judgement, and the development of independent expertise.

This paper highlighted several challenges associated with the use of generative AI in pharmacy education. These include the potential for over-reliance on automated tools, difficulties in evaluating the accuracy of AI-generated information, and unequal access to digital resources across institutions. At the same time, the ability to communicate complex scientific information accurately and appropriately remains a fundamental requirement for future pharmacists. Pharmacy education should rather seek to integrate these tools in ways that support learning while preserving the development of essential professional competencies.

Ultimately, these technologies should be viewed as a resource that can support, rather than replace, the learning process. Pharmacy programmes can prepare graduates who can utilize emerging technologies effectively while maintaining the knowledge and communication skills required for safe and effective patient care through the combination of technological innovation and strong educational practices.

Conflict of Interest

The authors declare no conflict of interest.

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