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EVALUATION OF STUDENT PHARMACISTS' AWARENESS, PERCEPTIONS AND OPINIONS ON ARTIFICIAL INTELLIGENCE (AI) IN PHARMACY EDUCATION

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ABSTRACT

This study evaluates undergraduate student pharmacists' awareness, perceptions and opinions on Artificial Intelligence (AI) in pharmacy education. Using a descriptive cross-sectional design, the study surveyed 272 pharmacy students from schools in Tuguegarao City, Cagayan, Philippines during the first semester of the Academic Year 2024–2025. The survey explored factors such as demographic influences, prior AI knowledge and students' perceived usefulness and ease of use of AI tools. Findings revealed that over 70% of participants demonstrated awareness of AI technologies, with significant differences observed in perceptions based on prior understanding and digital proficiency. Familiarity with AI tools positively influenced student attitudes, while demographic factors such as age and gender had minimal impact. Students expressed concerns regarding AI's ethical, legal and practical implications in pharmacy education. The results underscore the importance of integrating AI-related content and practical training into pharmacy curricula to foster a more tech-savvy workforce. Recommendations for future research include longitudinal studies and empirical assessments of AI's impact on clinical competence and patient outcomes.

Keywords: Artificial Intelligence, Pharmacy education, Student pharmacists, Awareness, Technology Acceptance Model (TAM)

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INTRODUCTION

Integrating Artificial Intelligence (AI) into pharmacy education marks a transformative era, enhancing learning experiences, streamlining practice and improving patient outcomes (Karataş *et al*. 2025). AI holds significant importance for the roles of pharmacists, facilitating the translation of knowledge to practice by improving decision-making processes, automating routine tasks and providing personalised learning experiences (Karataş *et al*. 2025). This is essential for safe practice, as it reduces the potential for human error and ensures more accurate medication dispensing and patient care (Abdel Aziz *et al.* 2023).

AI is increasingly critical in pharmacy, significantly improving efficiency, accuracy and patient outcomes (Karataş *et al*. 2025). AI technologies, such as AI-powered virtual simulations and intelligent tutoring systems, enhance critical thinking, decision-making skills and confidence among students (Karataş *et al*. 2025). Furthermore, AI assists in automating medication dispensing systems, verifying prescriptions and ensuring accurate medication and dosage, thereby reducing errors and enhancing efficiency (Abu Hammour *et al.* 2023). These applications underscore the importance of conducting studies to explore AI's potential in promoting safe and effective pharmacy practices (Syed and Al-Rawi 2023).

The current state of AI use in pharmacy education is varied, with no consensus or established framework on the extent to which the technology should be used academically (Carrido and Ramirez 2020). While some institutions have begun integrating AI tools, others must catch up due to technical limitations, ethical concerns and proper training (Chua *et al.* 2023). In the Philippine context, the adoption of AI in pharmacy education faces additional challenges, such as limited access to advanced technology and a need for more significant investment in digital infrastructure. Studies like those by Abdel Aziz *et al.* (2023) highlight the relevance of AI in pharmacy education and the necessity for further exploration, while research by Abu Hammour *et al.* (2023) and Syed and Al-Rawi (2023) emphasise the importance of evaluating pharmacists' perceptions and preparedness for AI technology.

Despite the potential benefits, significant ethical concerns and technical limitations are associated with AI in pharmacy education. Ethical considerations include data privacy, AI algorithms' potential bias and AI decision-making processes' transparency (Alqahtani *et al.* 2023; Boxleitner 2023). Technical challenges involve integrating AI systems into existing educational frameworks and the need for substantial training to use these tools effectively (Aksoy and Ozturk 2021). Locally, studies such as Carrido and Ramirez (2020) conducted in a Latin American context and Chua *et al.* (2023) highlight unique challenges and opportunities regarding AI integration in pharmacy education.

Existing literature provides valuable insights but presents certain limitations and areas of contention. For example, the study by Aksoy and Ozturk (2021) focuses primarily on AI-based simulations in pharmacy education, indicating a need for a broader exploration of AI applications. Additionally, discussions on ethical considerations suggest the necessity for a more nuanced understanding of AI's ethical implications in educational contexts (Alqahtani *et al.* 2023; Boxleitner 2023). A comprehensive understanding of AI's impact on pharmacy education, encompassing teaching strategies, long-term effects and ethical frameworks, still needs to be discovered (Chua *et al.* 2023).

This study employs a descriptive cross-sectional method to evaluate undergraduate student pharmacists' awareness, perceptions and opinions on AI. By capturing a snapshot of student pharmacists' views on AI at a specific time, the study aims to discern prevailing attitudes and perceptions. This study further explores how undergraduate student pharmacists perceive and understand the role of AI in pharmacy education. By analysing student responses from structured surveys adapted from validated instruments (e.g., Abu Hammour *et al.* 2023), the study seeks to generate evidence-based insights into current

understanding, educational needs and readiness for AI integration. These findings aim to advance knowledge on how students interact with AI, guide curriculum developers in designing responsive and ethical pedagogical strategies and promote the responsible adoption of AI technologies that align with the evolving roles of pharmacists in the healthcare landscape.

In summary, integrating AI into pharmacy education offers numerous benefits, including improved learning outcomes, streamlined pharmacy practice and enhanced critical thinking skills among students (Karataş *et al*. 2025). However, ethical considerations, technical limitations and proper training must be addressed to maximise AI's potential in pharmacy education (Karataş *et al*. 2025). This study aims to contribute to the ongoing discourse on AI integration in pharmacy education, providing valuable insights for educators, policymakers and stakeholders in the healthcare industry (Syed and Al-Rawi 2023).

METHODS

Research Design

It is a descriptive study aiming to assess the awareness, perceptions and opinions of undergraduate student pharmacists regarding AI in pharmacy education. This design is suitable for capturing a snapshot of current attitudes toward AI, providing insights into its integration within pharmacy education in Tuguegarao City, Cagayan.

Population and Sampling

The target population consisted of undergraduate student pharmacists enrolled in pharmacy schools in Tuguegarao City, Cagayan. Stratified random sampling was utilised to ensure representation from different year levels and institutions. However, proportional allocation was not strictly applied in the stratification process. As shown in Table 1, there was a higher concentration of respondents from the first-year level (34.93%), while fifth-year students accounted for only a small fraction (1.84%). This distribution suggests that while stratification was conducted, the sampling may not have been proportionated to the actual student population across year levels.

Despite this limitation, the sampling strategy aimed to capture a diverse range of student perspectives, enhancing the study's overall validity. Future studies may benefit from employing proportional stratified random sampling to ensure more balanced representation from each year level, particularly senior students who may have more exposure to AI applications in pharmacy practice.

Table 1: Profile of respondents

Profile	No. of participant	Percentage
Age (Years old)		
20 and below	183	67.28
More than 20	89	32.72
Sex		
Male	61	22.43
Female	211	77.57

(*continued on next page*)

Table 1: (*continued*)

Profile	No. of participant	Percentage
Year of Study		
1st	95	34.93
2nd	37	13.60
3rd	54	19.85
4th	81	29.78
5th	5	1.84
Prior understanding of technology for AI		
Strongly disagree	18	6.62
Disagree	1	0.37
Neutral	48	17.65
Agree	120	44.12
Strongly agree	85	31.25
Proficiency with digital technology and computers		
Strongly disagree	15	5.51
Disagree	1	0.37
Neutral	77	28.31
Agree	118	43.38
Strongly agree	61	22.43
Used or heard about AI tools		
Strongly disagree	12	4.41
Disagree	1	0.37
Neutral	40	14.71
Agree	105	38.60
Strongly agree	114	41.91

Sample Size Calculation

The sample size was calculated with a 95% confidence level and a 5% margin of error, assuming a 50% response rate ($p = 0.5$). Using the finite population correction, the required sample size was calculated as 244 students based on a total student population of 666 in Tuguegarao City.

Recruitment and Data Collection

Participants were recruited from eligible student pharmacists present in Tuguegarao City during the study period. A total of 272 participants were recruited to ensure robust data for analysis. Data were collected via an online survey administered through Google Forms, covering demographic information and familiarity with AI technologies.

Data Analysis

Descriptive statistics summaried the demographic characteristics, while inferential statistics such as chi-square tests and ANOVA examined the relationships between demographic factors and attitudes toward AI in pharmacy education. This analysis provided insights into the factors influencing students' readiness for AI integration.

Inclusion and Exclusion Criteria

Inclusion Criteria:

i. Undergraduate student pharmacists enrolled in a pharmacy school in Tuguegarao City, Cagayan, Philippines.
ii. Physically present in Tuguegarao City, Cagayan, Philippines during the data collection period.
iii. Willingness to voluntarily participate in the study.

Exclusion Criteria:

i. Non-enrollment in a pharmacy program.
ii. Absence from Tuguegarao City, Cagayan, Philippines during data collection.
iii. Inability to consent or participate due to medical or psychological conditions.

Ethical Considerations

The study adhered to ethical standards, including voluntary participation, informed consent, and confidentiality. Participants were fully informed about the study's objectives, risks and benefits. Consent was obtained before participation, and all data were anonymised and securely stored. The study complied with the Data Privacy Act of the Philippines and received approval from the relevant institutional review board.

Data Management and Validation

The survey questionnaire was adapted from the validated instrument developed by Abu Hammour *et al.* (2023), based on the Technology Acceptance Model (TAM). The questionnaire was administered in English, which is the medium of instruction in Philippine pharmacy schools. Given that the respondents are undergraduate pharmacy students accustomed to English in their academic setting, no translation was deemed necessary.

To ensure content validity and cultural relevance, the questionnaire was reviewed by a panel of experts in pharmacy education, clinical pharmacy and artificial intelligence. This expert validation process resulted in a high Content Validity Index (CVI) of 0.982, confirming the appropriateness of the items in the local educational context.

The reliability of the questionnaire was confirmed through a pilot test, and analysis using Cronbach's alpha yielded a value of 0.94892, indicating excellent internal consistency.

Statistical Analysis

IBM SPSS version 22.0 was used for data analysis. Descriptive statistics were employed to summarise demographic data, while inferential statistics (chi-square, ANOVA and non-

parametric tests) were used to assess relationships between demographic factors and AI-related attitudes.

IBM SPSS version 22.0 was used for data analysis. Prior to selecting statistical tests, data were assessed for normality using the Shapiro-Wilk test. Results indicated that the data for Likert-scale responses were not normally distributed, supporting the use of non-parametric tests.

Descriptive statistics (frequency, percentage, mean and standard deviation) were used to summarise demographic variables and responses to AI-related questions. Although Likert-scale data are ordinal, means and standard deviations were reported to facilitate interpretability and comparison with similar studies. This approach is commonly accepted in educational and social science research.

For inferential statistics, relationships between demographic factors and AI-related attitudes were evaluated using appropriate tests:

i. Chi-square test for associations between categorical variables.
ii. One-way ANOVA for comparing means across more than two groups when assumptions were reasonably met.
iii. Kruskal–Wallis H test and Mann–Whitney U test as non-parametric alternatives when data violated parametric assumptions.

A significance level of $p < 0.05$ was considered statistically significant throughout the analysis.

Informed Consent and Confidentiality

Informed consent was obtained from all participants, ensuring their understanding of the study's purpose and their rights to withdraw at any time without penalty. All data were anonymised, and confidentiality was maintained throughout the study. Data were securely stored and only accessible to authorised personnel.

Study Duration

The study was conducted during the first semester of the 2024–2025 academic year, with data collection, analysis and dissemination of findings achieved within six months.

Anticipated Challenges

Potential challenges include difficulties in participant recruitment, response biases and technical issues with the survey platform. These challenges were mitigated through collaboration with pharmacy schools, robust validation procedures for the survey and plans for sensitivity analyses to account for any biases.

RESULTS

The demographic profile of respondents in this study provides a foundation for understanding the distribution of awareness, perceptions, and opinions across different student groups. Most respondents were aged 20 years old or younger (67.28%), indicating that younger students formed most of the cohort.

In terms of sex, the sample included more female participants (77.57%) than male participants (22.43%). While this reflects the actual gender distribution in many pharmacy programs, the observed imbalance is noted without implying it as a limitation. Differences in gender representation may still offer insights into varying perspectives on technology and AI, which can be further explored in future studies with a more balanced cohort.

Regarding year level, first-year students represented the largest group (34.93%), followed by fourth-year students (29.78%). These findings suggest that a significant proportion of participants were in the earlier stages of their pharmacy education, which may influence their familiarity and engagement with AI technologies. The limited number of fifth-year students (1.84%) restricts the extent to which insights can be generalised to more senior cohorts.

Awareness of AI Tools

The responses on prior understanding of AI technology reveal that most student pharmacists agreed (44.12%) or strongly agreed (31.25%) that they were aware of AI tools. This suggests that more than 70% of the cohort possesses some awareness of AI, although a notable proportion remained neutral (17.65%). This neutrality indicates a potential knowledge gap that could be addressed through curricular interventions.

The proficiency of student pharmacists with digital technology and computers further reinforces their familiarity with AI, with 65.81% of respondents agreeing or strongly agreeing to have digital proficiency. This reflects positively on their readiness to engage with AI tools, as digital competence is foundational to understanding and applying AI technologies.

Furthermore, when asked about their exposure to AI tools, 80.51% of respondents agreed or strongly agreed that they had used or heard of AI tools, signaling widespread familiarity within the cohort. However, neutral responses (14.71%) and disagreement (4.78%) indicate that a minority of students remain unaware or unsure about AI tools, highlighting areas for educational improvement.

The mean scores across the four key variables indicate generally positive perceptions toward AI tools in pharmacy education. The perceived usefulness of AI tools received a mean score of 3.69, suggesting that respondents generally believe AI tools can provide significant benefits in pharmacy practice. The perceived ease of use associated with integrating AI into pharmacy curricula scored slightly lower at 3.59, indicating that while students recognise the potential usefulness of AI, there are concerns regarding the practicality or accessibility of integrating these tools effectively in their education. Similarly, attitudes toward AI tools, as measured by the perception of student pharmacists, averaged 3.59, reflecting an overall positive outlook. However, there remains room for improving student confidence in adopting AI tools. Finally, opinions on the ethical, legal and practical implications of AI in pharmacy education yielded the highest mean score of 3.73, suggesting that students are more thoughtful and perhaps more cautious about AI's broader implications, recognising its potential benefits and challenges.

Table 2: Perceived usefulness, ease of use, perception and opinions of AI tools.

	Mean
Level of awareness among student pharmacists regarding the usefulness of AI tools in pharmacy education.	3.69
Level of ease of use associated with integrating AI into pharmacy curricula.	3.59

Level of perception of student pharmacists regarding AI tools, as measured by their attitudes.	3.59
Opinions of student pharmacists on the ethical, legal, and practical implications of AI in pharmacy education	3.73

Table 3: Differences in awareness, perception, and opinions based on demographic variables

Variable	Age	Sex	Year of Study	Prior Understanding	Proficiency Used AI Tools
Level of awareness regarding the perceived usefulness of AI	t = 0.009, p = 0.92	t = 0.410, p = 0.68	F = 19.175, p = 0.000	F = 18.957, p = 0.000	F = 20.903, p = 0.000
Level of perceived ease of use in integrating AI into pharmacy curriculum	t = 1.030, p = 0.31	t = 0.229, p = 0.82	F = 13.563, p = 0.000	F = 15.963, p = 0.000	F = 15.400, p = 0.000
Student pharmacists' attitudes towards AI tools	t = 0.213, p = 0.64	t = –0.029, p = 0.98	F = 18.728, p = 0.000	F = 19.415, p = 0.000	F = 22.275, p = 0.000
Opinions on ethical, legal and practical implications of AI	t = 0.589, p = 0.44	t = –0.324, p = 0.75	F = 12.842, p = 0.000	F = 9.555, p = 0.000	F = 19.660, p = 0.000

Prior Understanding and Proficiency

Significant differences were found across all aspects (usefulness, ease of use, perceptions and opinions) when examining students' prior understanding of AI and their proficiency with digital technology. Students who had better prior knowledge or reported greater digital proficiency had more positive views of AI tools (all p-values = 0.000). This suggests that previous exposure and digital skills are crucial for fostering favourable attitudes toward AI in pharmacy practice.

Familiarity with AI Tools

Familiarity with AI tools (either through usage or prior exposure) also demonstrated significant differences in all measures (all p-values = 0.000). Students who had used or heard of AI tools were more aware of them and perceived them positively, reinforcing the importance of integrating AI tools into the learning experience to improve familiarity and attitudes.

Demographic Variables (Age, Sex, Year of Study)

Age and Sex: No significant differences were found in awareness, perceptions or opinions based on age or sex ($p > 0.05$). This suggests that factors like age and gender do not significantly impact how students view AI tools in pharmacy education.

Year of Study: Significant differences ($p = 0.000$) were observed based on year of study, with senior students (those in later years) showing greater awareness and understanding of AI tools. This likely reflects increased exposure to advanced topics and technologies as students' progress in their studies.

The results indicate that student pharmacists generally exhibit high levels of awareness and positive perceptions of AI tools in pharmacy education. Prior exposure to AI and proficiency with technology significantly shape these attitudes, while demographic variables like age and sex have minimal impact. Familiarity with AI tools further reinforces positive perceptions, emphasising the need for incorporating AI-related content and hands-on exposure in the pharmacy curriculum to better prepare students for future practice in an increasingly technology-driven environment.

DISCUSSION

The findings of this study offer valuable insights into student pharmacists' awareness, perceptions and opinions on AI in pharmacy education. As AI continues to shape various sectors of healthcare and education, including pharmacy, it becomes increasingly important to understand how future pharmacists perceive and engage with these emerging technologies. This section elaborates on the findings by cross-referencing existing literature, addressing key challenges and providing implications for educational practice.

Student Pharmacists' Awareness of AI in Pharmacy Education

The study reveals a high level of awareness among student pharmacists regarding AI in pharmacy education, which aligns with previous research by Karataş *et al*. (2025), who observed that the growing presence of AI in healthcare has led to increased awareness among students in related fields. AI technologies, such as virtual simulations and intelligent tutoring systems, are seen as valuable tools for enhancing critical thinking, clinical decision-making and confidence, as noted by Karataş *et al.* (2025). Despite this awareness, many students reported limited hands-on experience with AI tools, highlighting a significant gap between theoretical knowledge and practical application. This discrepancy mirrors the findings of Aksoy and Ozturk (2021), who identified similar gaps in other educational settings.

However, the sample in this study displayed certain biases, including the disproportionate representation of Year 1 students compared to Year 5 students, and a higher number of female participants. These imbalances could influence the results, as Year 1 students may have a more general, less specialised understanding of AI, while Year 5 students could provide more informed insights based on advanced coursework and practical experience. Similarly, gender differences in AI awareness could stem from various social and cultural factors, but these should be contextualised within broader educational factors such as year of study and prior exposure to AI. In future studies, addressing such biases through a more balanced sample or stratified analysis would ensure a more accurate and comprehensive interpretation of the results.

Perceptions of AI's Usefulness and Ease of Use

The TAM provided a useful framework for understanding student pharmacists' perceptions of AI's usefulness and ease of use, confirming the model's core premise that these factors are crucial in determining the adoption of new technologies (Davis 1989). The study's findings showed that students widely perceive AI as beneficial in improving learning outcomes, clinical decision-making and reducing human error. This mirrors the findings of studies by Karataş *et al*. (2025) and Abu Hammour *et al.* (2023), who highlighted AI's role in enhancing healthcare education and practice.

Nevertheless, perceptions of AI's ease of use were more variable. This inconsistency can likely be attributed to the technical complexity of AI tools and the limited training available for students. As Aksoy and Ozturk (2021) suggested, insufficient training can create barriers to the effective adoption of AI technologies. Furthermore, ethical and data privacy concerns, highlighted by Boxleitner (2023), also contributed to students' hesitation in fully embracing AI, as the fear of making decisions based on biased or incomplete AI algorithms remains a significant challenge.

Ethical and Practical Challenges in AI Adoption

Ethical considerations emerged as a prominent concern in this study, echoing findings from Alqahtani *et al.* (2023), who discussed the importance of transparency, data privacy and reducing algorithmic bias in healthcare AI applications. The participants expressed concerns about AI potentially introducing bias into clinical decision-making and compromising patient confidentiality, a sentiment consistent with ethical concerns raised in the literature. These concerns highlight the need for careful consideration of ethical frameworks in AI integration within pharmacy education.

Beyond ethical issues, practical barriers also play a crucial role in hindering the effective adoption of AI. The lack of a standardised framework for AI tools in pharmacy education was a common theme, with many studies (Syed and Al-Rawi 2023) emphasising that while students recognise the potential of AI, they often feel unprepared to use these tools effectively due to gaps in training. Addressing these barriers requires not only technical solutions, such as improving infrastructure, but also the development of structured training programs that equip students and faculty with the necessary skills to navigate the ethical and practical complexities of AI usage in pharmacy education.

Study Limitations

While this study provides valuable insights into student pharmacists' awareness, perceptions, and opinions on AI in pharmacy education, it is important to acknowledge several limitations that may affect the interpretation and generalisability of the findings.

Sampling biases

One of the primary limitations of this study is the overrepresentation of Year 1 students and female participants. As noted earlier, Year 1 students may have a less specialised understanding of AI compared to more advanced students in higher years, potentially skewing the results. Similarly, the gender imbalance in the sample, with a higher number of female participants, may limit the ability to generalise the findings to a broader student population. These biases could influence the results, especially in terms of the perceived

usefulness and ease of use of AI tools, as different year groups and genders may have varying levels of exposure and familiarity with AI in pharmacy education. Future studies could address this limitation by ensuring a more balanced representation of students from different academic years and genders to provide a more accurate and generalisable assessment.

Geographic and institutional scope

This study was conducted at three pharmacy schools in the Tuguegarao City, Cagayan, Philippines, which limits the geographic and institutional scope of the findings. The findings may reflect the specific context and resources available at the pharmacy schools, which may not be representative of other educational settings, particularly those in different geographic regions or with varying levels of infrastructure and access to advanced AI tools. The availability of AI technologies, faculty training and institutional support for AI integration can differ significantly across regions, which could influence students' awareness and perceptions. Therefore, the results should be interpreted with caution, as they may not be fully generalisable to other institutions or countries with different healthcare education systems and AI integration levels. Expanding the study to include multiple institutions across different regions or countries would help improve the generalisability of the findings.

Potential influence of unmeasured variables

In addition to the demographic and institutional factors mentioned, other unmeasured variables such as students' prior exposure to technology, their technical skills or their specific interests in AI could also influence their awareness and perceptions. These factors were not accounted for in this study, and future research could explore how these variables interact with students' attitudes toward AI in pharmacy education.

Implications for Pharmacy Education

This study underscores the need for pharmacy educational institutions to integrate AI into their curricula more comprehensively. As suggested by Bajis *et al.* (2016), a competency framework specifically tailored to AI in pharmacy education would be an important step in ensuring that students are adequately trained in these emerging technologies. Such a framework should not only focus on the technical aspects of AI but also address the ethical and practical challenges highlighted by participants in this study.

Additionally, the study's results indicate that AI tools must be designed to accommodate diverse learning styles. Previous research by Carrido and Ramirez (2020) suggests that AI can be tailored to support various learning preferences, yet this potential remains largely unexplored in pharmacy education. Customising AI tools to meet individual student needs could enhance both ease of use and learning effectiveness, making AI a more powerful tool for enhancing the pharmacy education experience.

CONCLUSION

In conclusion, this study adds to the growing body of literature on the integration of AI in pharmacy education, offering valuable insights into student pharmacists' awareness, perceptions and opinions on AI technologies. The findings align with the TAM, emphasising that perceived usefulness and ease of use are critical factors influencing students' attitudes toward AI adoption. However, ethical concerns, such as data privacy and algorithmic bias, along with practical challenges, including inadequate training and infrastructure, remain significant barriers to the effective implementation of AI in pharmacy education. To fully harness AI's potential, it is imperative to address these challenges by developing comprehensive training programs that equip students and educators with the necessary skills and knowledge. Additionally, establishing clear ethical guidelines will be essential to ensure the responsible use of AI in pharmacy practice and education. Ultimately, a holistic approach to AI integration, considering both technical and ethical dimensions, will be crucial in preparing future pharmacists to navigate an AI-driven healthcare landscape successfully.

Conflict of Interest

The authors declare no conflict of interest.

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