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Evaluation of Artificial Intelligence Tools in Learning General Pathology Concepts Among Medical Students at All Saints University School of Medicine: A Questionnaire-Based Qualitative Educational Study.

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Abstract

Background: Artificial intelligence tools are increasingly used by medical students for explanation, summarisation, question generation, and revision of complex pathology concepts. Evidence is still needed on how learners perceive these tools when applied to foundational medical subjects. ***Objectives:*** To evaluate medical students' experiences with artificial intelligence-assisted learning of general pathology concepts, identify perceived benefits and concerns, and compare broad perspectives between preclinical and clinical learners. ***Methods:*** A questionnaire-based qualitative educational study was conducted among 120 medical students at All Saints University School of Medicine. A semistructured tool collected participant characteristics, previous artificial intelligence exposure, and open-ended responses on academic use, learning value, accuracy, dependency, ethics, and institutional guidance. Data were analysed using inductive thematic analysis. ***Results:*** Of 120 participants, 64 were preclinical students and 56 were clinical students; 68 were female and 52 were male. Prior exposure to artificial intelligence for academic use was reported by 98 students. Five major themes emerged: accessible academic support, improved efficiency and self-directed learning, concerns regarding accuracy and incomplete medical context, fear of dependency with reduced critical thinking, and ethical uncertainty requiring institutional guidance. Preclinical students mainly emphasized concept clarification and revision support, whereas clinical students highlighted contextual reliability, professionalism, and patient-safety implications. ***Conclusion:*** Students viewed artificial intelligence as a useful adjunct for learning general pathology, but not as a replacement for textbooks, faculty teaching, or independent reasoning. Structured artificial intelligence literacy, source verification, and clear academic integrity guidance should accompany its curricular use.

Keywords: Artificial intelligence; General pathology; Medical education; Medical students; Qualitative study; Thematic analysis.

INTRODUCTION

Artificial intelligence (AI), particularly large language model-based generative tools, has become a visible component of contemporary medical education. These systems can produce conversational explanations, summaries, comparison tables, practice questions, case-based prompts, and revision notes within seconds. Reviews and conceptual papers have described their potential to support tutoring, feedback, curriculum adaptation, assessment preparation, and individualized learning pathways [1-5]. For medical students, this accessibility is attractive because undergraduate training requires sustained engagement with large volumes of biomedical information across preclinical and clinical phases.

General pathology is a central foundation for later clinical reasoning. Students must understand cell injury, inflammation, repair, hemodynamic disorders, immunopathology, and neoplasia before they can interpret disease mechanisms in clinical medicine. These topics are conceptually dense and require accurate terminology, sequence-based reasoning, and correlation with standard pathology resources.

AI tools can simplify difficult mechanisms, convert narrative explanations into flowcharts, create analogies, and generate active-recall questions. Such features suggest a useful role for AI as an adjunct to faculty teaching and textbook-based learning [1,3,4].

However, AI-supported learning also introduces specific risks. Large language models can generate fluent but inaccurate statements, omit relevant qualifiers, provide fabricated references, or overstate confidence when information is incomplete [1-4,6]. In pathology, these limitations are important because small errors in definitions, mechanisms, or classification can distort a student's conceptual framework.

Overdependence on AI-generated summaries can also reduce deep reading, reflective reasoning, and critical appraisal. Therefore, responsible use requires verification against recommended textbooks, peer-reviewed literature, and faculty guidance [5-10].

The growing use of generative AI among medical students has created a need for local evidence. Studies from different settings show that students often welcome AI for speed and convenience while remaining concerned about accuracy, plagiarism, dependency, privacy, and unclear institutional expectations [6-10]. Yet the educational value and perceived safety of AI remain context-dependent. Medical schools, especially those serving internationally diverse student groups, need data that reflect their own learning environment before designing AI literacy modules or institutional policies.

The present study was conducted at All Saints University School of Medicine to evaluate how medical students perceive AI-assisted learning of general pathology concepts. The objectives were to explore students' reported patterns of AI use, identify perceived academic benefits and limitations, assess concerns related to accuracy, dependency, ethics, and responsible use, and compare broad differences in perspectives between preclinical and clinical learners.

METHODOLOGY

Study design and setting: This was a questionnaire-based qualitative educational study conducted among eligible participants in the Department of Pathology/Basic Medical Sciences, All Saints University School of Medicine. The study was carried out over a one-month period, from 1 May 2026 to 31 May 2026. A qualitative descriptive approach was selected because the study aimed to capture student experiences, perceived benefits, and practical concerns in language close to participants' own academic context.

The study focused on the educational use of AI tools for general pathology learning rather than formal grading or clinical decision-making. The reporting approach was informed by qualitative research guidance and thematic analysis principles [11-13].

Study population and sampling: The study population comprised medical students currently studying general pathology or recently exposed to foundational pathology concepts. Students from both preclinical and clinical phases were eligible when they were willing to participate and had access to an internet-enabled device. Students who declined consent, submitted incomplete responses, or did not answer the core open-ended items were excluded. A voluntary response sampling approach was used, and 120 valid responses were included in the final analysis.

Data collection tool: Data were collected using a semistructured questionnaire. The first section recorded phase of study, sex, and prior exposure to AI tools for academic learning. The second section explored how students used AI for pathology learning, including concept explanation, summarisation, flowcharts, MCQ generation, clinical examples, and revision support.

Additional questions addressed perceived usefulness, accuracy, overdependence, academic integrity, privacy, and the need for institutional guidance. No names, roll numbers, patient data, or confidential institutional assessment materials were collected.

Study procedure: Students were invited through institutional communication channels and were informed that participation was voluntary and unrelated to academic assessment. After consent, participants completed the electronic questionnaire anonymously. The questionnaire encouraged students to reflect on AI use for topics such as cell injury, necrosis, inflammation, tissue repair, thrombosis, embolism, shock, immunopathology, and neoplasia. Respondents were also asked to describe concerns and suggestions for safer use of AI in pathology education.

Data analysis: Responses were reviewed in full before coding. Inductive thematic analysis was performed through familiarisation, initial coding, grouping of related codes, theme development, review, and refinement [12,13]. Two reviewers independently examined the responses, and differences were resolved by discussion.

Theme frequencies were calculated descriptively to indicate how commonly each theme appeared; participants could contribute to more than one theme. Descriptive data were reported as frequency and percentage. Thematic sufficiency was considered during analysis, consistent with published guidance on saturation in qualitative research [14].

Ethical considerations Participation was voluntary, informed consent was obtained electronically, and students were free to decline without academic penalty. Data were anonymised, stored securely, and used only for research reporting.

RESULTS

A total of 120 medical students participated in the study. The sample included both preclinical and clinical learners, allowing comparison across stages of training. Of the total participants, 64 (53.3%) were preclinical students and 56 (46.7%) were clinical students.

Female students accounted for 68 (56.7%) participants and male students for 52 (43.3%). Prior exposure to AI tools for academic use was common, with 98 (81.7%) students reporting at least occasional use and 22 (18.3%) reporting minimal or no regular use. These characteristics are presented in Table 1.

Table 1. Participant characteristics of the study sample (N = 120)

Variable	Category	n	%
Phase of study	Preclinical students	64	53.3
	Clinical students	56	46.7
Sex	Female	68	56.7
	Male	52	43.3
Prior exposure to AI tools for academic use	At least occasional use	98	81.7
	Minimal or no regular use	22	18.3

Inductive thematic analysis identified five major themes related to AI-assisted pathology learning. The most frequently endorsed theme was AI as an accessible academic support tool, reported by 102 (85.0%) students. Improved efficiency, understanding, and self-directed learning were endorsed by 91 (75.8%) students.

Concerns regarding accuracy, reliability, and incomplete medical context were reported by 84 (70.0%) participants. Fear of dependency and erosion of critical thinking was identified in 76 (63.3%) responses, while 88 (73.3%) students expressed ethical uncertainty and the need for institutional guidance. The major themes are summarized in Table 2.

Table 2. Major themes identified from qualitative analysis

Theme No.	Major theme	Participants endorsing theme (n)	% of total sample
1	AI as an accessible academic support tool	102	85.0
2	Improved efficiency, understanding, and self-directed learning	91	75.8
3	Concerns regarding accuracy, reliability, and incomplete medical context	84	70.0
4	Fear of dependency and erosion of critical thinking	76	63.3
5	Ethical uncertainty and the need for institutional guidance	88	73.3

Students commonly described AI tools as readily available academic assistants. They used these tools to simplify difficult pathology mechanisms, summarize dense reading material, generate flowcharts, clarify terminology, and create revision questions. The perceived usefulness was most apparent for topics such as cell injury, inflammation, necrosis, thrombosis, embolism, and neoplasia. Participants also stated that AI helped them approach unfamiliar topics with greater confidence before returning to textbooks or faculty notes for confirmation.

A second important pattern was the perception that AI improved academic efficiency. Students described time-saving benefits in organising notes, creating mnemonics, preparing short-answer outlines, and generating MCQs for active recall. At the same time, respondents repeatedly emphasized that AI outputs needed verification. Several students reported that answers could be oversimplified, incomplete, or presented without appropriate source context. The theme-wise subthemes and interpretive summary are shown in Table 3.

Table 3. Theme-wise subthemes and interpretive summary

Major theme	Key subthemes	Interpretive summary
AI as an accessible academic support tool	Simplification of complex pathology concepts; summarisation of lengthy material; plain-language explanations; immediate clarification; revision support	Students viewed AI as a supplementary academic assistant, especially useful when faculty or peers were not immediately accessible.
Improved efficiency, understanding, and self-directed learning	Time-saving; note organisation; individualized explanations; mnemonics; MCQ generation; case-based examples	Participants felt that AI improved study efficiency and promoted self-directed learning by tailoring explanations to their level of understanding.
Concerns regarding accuracy, reliability, and incomplete medical context	Incorrect or outdated responses; oversimplification; lack of contextual depth; weak referencing; need for verification	Students acknowledged usefulness but emphasized that AI could not replace standard pathology textbooks, faculty teaching, or peer-reviewed sources.
Fear of dependency and erosion of critical thinking	Passive learning; reduced textbook reading; weaker reflective reasoning; reliance on ready-made answers	Participants worried that excessive AI use could reduce active engagement and weaken analytical thinking.
Ethical uncertainty and need for institutional guidance	Unclear boundaries for assignments; academic misconduct concerns; lack of policy; need for workshops; responsible disclosure	Students expressed uncertainty regarding acceptable AI use and favoured institutional guidance for responsible academic practice.

Preclinical and clinical students differed in emphasis. Preclinical students more often focused on concept clarification, simplified explanations, and examination-oriented revision. Clinical students more frequently raised concerns about contextual reliability, clinical reasoning, professionalism, and patient-safety implications. Both groups viewed AI as supportive, but neither group considered it a replacement for formal teaching or standard academic resources. Comparative observations between preclinical and clinical students are provided in Table 4.

Table 4. Comparative observations between preclinical and clinical students

Domain	Preclinical students	Clinical students
Primary academic use	Clarification of foundational pathology mechanisms and terminology	Review of disease mechanisms, differential diagnosis principles, and clinicopathological correlation
Perceived benefit	Simplification of complex concepts and support for examination revision	Integration of theoretical knowledge with patient-oriented reasoning
Main concern	Dependence on simplified material and reduced textbook reading	Accuracy, contextual depth, and inappropriate application to clinical reasoning
View on reliability	Useful for introductory understanding and summaries	Useful only as a supplementary aid after verification
Ethical and professional awareness	Focused mainly on academic utility and assignment boundaries	Greater concern regarding professionalism, patient safety, and responsible use

Overall, the findings show a balanced student perspective. AI tools were viewed as useful, accessible, and efficient for learning general pathology, yet students clearly rejected the idea that AI could function as an autonomous learning authority. Across all major themes, participants favoured supervised, critical, and ethically guided integration of AI into medical education.

DISCUSSION

The present study found that medical students viewed AI-assisted pathology learning with conditional acceptance. Students appreciated the ability of AI tools to provide rapid explanations, summaries, flowcharts, and practice questions, but they also recognized limitations related to accuracy, contextual depth, dependency, and ethics. This balanced view is consistent with recent literature describing large language models as promising educational adjuncts rather than independent academic authorities [1-5].

The strongest positive themes were accessibility and efficiency. Participants used AI to clarify difficult pathology concepts, organise study material, and support self-directed learning. These findings are comparable with published studies reporting that medical students value generative AI for convenience, rapid clarification, and individualized learning support [6-10]. In general pathology, such support is relevant because students must connect mechanisms of cellular injury, inflammation, repair, and neoplasia with later clinical reasoning. AI-generated stepwise explanations and examples can therefore reduce the initial cognitive barrier when used carefully.

The concern about accuracy was equally important. Students reported that AI responses could appear fluent while remaining incomplete, outdated, or lacking adequate medical context. This concern closely parallels reviews that have highlighted hallucination, inconsistency, weak source transparency, and overconfident responses in large language model outputs [1-4]. Pathology education demands precision in definitions, mechanisms, and classifications. Therefore, unverified AI-generated content can distort conceptual understanding. The student preference for checking AI outputs against textbooks, faculty notes, and reliable literature supports the need for explicit source-verification training.

Dependency and reduced critical thinking formed another prominent theme. Participants distinguished between AI as a learning scaffold and AI as a substitute for active reasoning. This distinction is educationally important. Medical students must learn not only facts but also disciplined interpretation, uncertainty management, and professional judgement. Excessive reliance on ready-made summaries can weaken deep reading and reflective analysis. Similar concerns regarding academic integrity, overdependence, and blurred boundaries of legitimate assistance have been reported in recent medical education studies [6-10].

The comparison between preclinical and clinical learners further strengthens the interpretation. Preclinical students emphasized concept clarification and examination support, whereas clinical students focused more on reliability, professionalism, and patient-safety consequences. This suggests that AI literacy should be stage-specific. Early learners need guidance on concept checking and responsible academic use, while clinical learners require stronger training in contextual interpretation, privacy, professionalism, and the limits of AI-generated clinical reasoning [5,7,10]. The findings support a proactive curriculum response that teaches prompt design, source appraisal, transparent disclosure, and ethical use rather than either unrestricted adoption or total prohibition.

LIMITATIONS

This study was conducted in a single medical school and reflects one institutional context. Participation was voluntary, introducing self-selection bias. Experiences were self-reported and were not triangulated with observed AI use or academic performance. Open-ended survey responses limited probing of nuanced views. Theme frequencies were descriptive and not quantitative effect estimates.

CONCLUSION

Medical students perceived AI tools as useful adjuncts for learning general pathology, especially for simplifying difficult mechanisms, preparing revision material, and supporting self-directed study. However, they also identified concerns regarding factual accuracy, contextual depth, overdependence, and ethical ambiguity. The findings indicate that students prefer guided and accountable AI integration rather than unrestricted use. Medical schools should incorporate AI literacy, source verification, academic integrity guidance, privacy awareness, and professionalism-oriented discussion into pathology teaching. Such structured use can help students benefit from AI-supported learning while preserving critical thinking, responsible scholarship, and the academic standards expected in medical training.

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