ARTIFICIAL INTELLIGENCE (AI) TOOL USE VERSUS EXPERT-LED INSTRUCTION IN PRECLINICAL MEDICAL EDUCATION: A CROSS-SECTIONAL SURVEY OF STUDENT EXPERIENCE, PERCEPTIONS, AND ACADEMIC PERFORMANCE

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Abstract

Background: Artificial Intelligence (AI) is increasingly integrated into preclinical medical education. Despite rapid adoption, comparative data on student satisfaction, perceptions, learning preferences, and academic outcomes remain limited. This study aimed to evaluate these outcomes among preclinical medical students.

Methods: A cross-sectional study was conducted among preclinical medical students at Phramongkutklao College of Medicine, Bangkok, Thailand (June 2024–May 2025). A validated questionnaire was administered. Academic performance was measured by cumulative grade point average (GPAX) and stratified by AI usage intensity: more-AI-using (>5 h/week) and less-AI-using (≤5 h/week). Statistical analyses included the Wilcoxon signed-rank test and an independent t-test ($p < 0.05$).

Results: A total of 220 students completed the questionnaire (Year 2: 44.1%; male: 55.9%; mean age: 19.4 ± 1.6 years). 90.9% had previously used AI tools in preclinical studies, most commonly for 3–5 hours per week. Expert-led instruction was rated significantly higher than AI for effectiveness, preclinical confidence, clinical readiness, and overall satisfaction. 90.5% preferred expert-led instruction as the primary modality; however, 87.7% endorsed an integrated AI–expert framework (concurrent or AI after expert). Despite 93.6% of students reporting that AI positively impacted their learning outcomes and 82.7% reporting improved problem-solving skills, GPAX did not differ significantly between the more AI-using (>5 hours/week, 3.21 ± 0.64) and less AI-using (≤5 hours/week, 3.27 ± 0.56) groups ($p = 0.100$).

Conclusion: Preclinical medical students used AI tools extensively but rated expert-led instruction higher in terms of overall satisfaction. No significant association was found between self-reported AI-use intensity and academic performance. Students favored a blended model that positions AI as a complement to expert-led instruction. These findings support incorporating AI literacy and ethics into preclinical curricula while preserving the strengths of expert-led instruction.

Keywords: artificial intelligence, preclinical medical education, medical students, academic performance, expert-led instruction

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Introduction

Artificial Intelligence (AI) is a branch of computer science that focuses on using big data, developing algorithms, and creating software that mimics human learning and decision-making.(1) AI has the potential to improve medical education by enabling students in three primary applications: providing guidance and feedback to support learning, collaborating with students during lessons, and reinforcing knowledge during review sessions.(2, 3) Other applications of AI in medical education include self- and interpersonal assessment, intelligent tutoring systems, virtual patients, and adaptive learning systems and curricula.(3, 4) AI has also proven effective in personalized learning, offering students real-time feedback and adaptive learning pathways that help identify knowledge gaps and effectively develop additional skills.(5) AI is increasingly being integrated into preclinical medical education, with applications ranging from enhancing learning environments to automated assessment and simulation.(6, 7) In preclinical settings, AI supports personalized learning, enabling students to deepen their understanding of complex subjects like anatomy and pathology before advancing to clinical practice.(7, 8) These technologies help develop diagnostic and decision-making skills in preclinical medical students, a crucial step before they enter clinical exposure.(3, 9) Regarding perceptions and attitudes, medical students held generally positive views toward AI in healthcare, and those who had received AI training were significantly more confident and knowledgeable about its clinical application.(10) A previous study showed the average frequency of AI-assisted learning among medical students was about 5 times per week, and most students used more than 2 AI tools.(11) While excessive digital screen time, defined by daily usage exceeding 8 hours for smartphones, 6 hours for tablets, or 5 hours for computers, is almost half of university students, and academic screen time correlated positively with examination marks, the total screen time showed no significant correlation with performance.(12, 13)

Although AI has the potential to improve nearly every aspect of healthcare and medical education, many physicians and medical students remain doubtful about integrating it into their current medical practices.(4, 14) Traditional face-to-face lectures have long been a staple of medical curricula, whereas multimedia-based learning, such as electronic learning, has only recently been introduced into educational systems.(15, 16) Traditional face-to-face lectures involve an instructor and students gathering in the same physical space at the same time. This synchronous, teacher-centered model fosters immediate interaction, collaborative learning, and focused attention, free from physical or digital distractions.(17, 18) However, challenges to consider include time and location constraints, passive learning, and limited pacing.(19) Some studies have demonstrated that modern approaches, such as blended learning, can enhance the quality of learning across both specialized and general subjects.(15, 20, 21) Two recent randomized trials in preclinical medical students reinforce the complementary role of AI (ChatGPT) in clinical reasoning education, showing that both ChatGPT-assisted and conventional search-supported learning improved short-term clinical reasoning, and that ChatGPT-generated feedback was as effective as expert feedback for learning.(22, 23) Although AI tools are now widely used by medical students, direct comparative data on how preclinical students perceive AI relative to expert-led instruction, and on whether the intensity of AI use relates to academic performance, remain limited. To address this gap, this study aimed to evaluate preclinical medical students' satisfaction and perceptions of AI tool use and expert-led instruction, and to compare academic performance, as reflected in GPAX, between the more- and less-AI-using groups.

Methods

A cross-sectional study was conducted among preclinical medical students at Phramongkutklao College of Medicine in Bangkok, Thailand, from June 2024 to May 2025. The study primarily used validated questionnaires to assess perceptions and satisfaction with AI and expert-led instruction, as well as academic performance.

Participants

Preclinical medical students (years 1-3) who were literate, studying, and maintaining their status as medical students at Phramongkutklao College of Medicine, and who gave consent, were invited to participate in this study. The expected number of participants exceeded 138.

The questionnaire was developed and validated through construct definition, content validity assessment, and pilot testing with a small group of 10 participants, followed by psychometric assessment (Cronbach's alpha $\geq$ 0.70), test-retest reliability, and validity.[24-26] The questionnaire consisted of six main parts: (1) demographic data, (2) experience of AI instructor, (3) perception of AI instructor, (4) experience of expert-led instructor, (5) perception of expert-led instructor, and (6) learning preference and academic performance.

Outcomes and statistical analysis

The primary outcome was to determine the prevalence of satisfaction and perceptions regarding learning methods among preclinical medical students, specifically comparing the AI-based and expert-led instruction. Secondary outcomes included comparing academic performance (GPAX) between the more- and less-AI-using groups. For this comparison, students were dichotomized by self-reported weekly AI use: the more-AI-using group (>5 hours/week) and the less-AI-using group (≤5 hours/week). The >5 hours/week cut-off corresponded to the upper two usage categories (6–8 and >8 hours/week) and was chosen consistent with prior screen-time studies using a 5-hour cut-off for excessive use, to distinguish students whose AI use exceeded a typical supplementary self-study allocation; this threshold should therefore be regarded as exploratory. GPAX was compared between groups using an independent t-test. Data were analyzed using SPSS for Windows (version 23), and $p < 0.05$ were considered statistically significant. Descriptive statistics included percentages (%), means with standard deviations (SD) for normally distributed data, and medians with interquartile ranges and percentiles for non-normally distributed data. Associations were analyzed using the chi-square test, Wilcoxon signed-rank test, and independent t-test, with $p < 0.05$ considered statistically significant.

Ethical consideration and approval

Informed consent and study data were collected and managed using REDCap, an electronic data capture tool hosted at Phramongkutklao Hospital. (REDCap; Research Electronic Data Capture is a secure, web-based software platform designed to support data capture for research studies). The information and responses were anonymized and not linked to any personally identifiable data to ensure participant confidentiality. The study received ethical approval from the Ethics Committee and the Institutional Review Board of the Royal Thai Army (study number: M029q/67_Exp, reference number: IRBRTA 166/2567).

Results

A total of 220 participants, comprising first-, second-, and third-year preclinical medical students, participated and completed the questionnaires. The majority were in their second year of study (97, 44.1%), followed by first-year students (95, 43.2%), and third-year students (28, 12.7%). The sample comprised 123 males (55.9%), 92 females (41.8%), and 5 who did not specify their gender (2.3%). The mean age of participants was 19.4 ± 1.6 years. Regarding baseline confidence in preclinical knowledge and clinical skills before the course, most participants rated themselves at a moderate level (98, 44.5%), followed by low (77, 35.0%), very low (36, 16.4%), high (7, 3.2%), and very high (2, 0.9%).

Most participants reported having used AI tools (e.g., question-answering and content-clarification applications) in their preclinical studies, whereas 20 students (9.1%) had not. **Table 1** summarizes the weekly usage frequency for both AI tools and expert-led instruction.

Among all respondents, the most common frequency of AI use was 3–5 hours per week. Cumulatively, 62.7% used AI for 3 hours or more per week, while 21.4% used it for more than 5 hours per week. In contrast, for expert-led instruction, the most common engagement was more than 8 hours per week (90, 40.9%).

Participants rated the effectiveness of AI tools for teaching reasoning and medical decision-making at 3.55 ± 0.74, whereas expert-led instruction received a significantly higher rating of 3.89 ± 0.67 ($p < 0.001$). Regarding perceived clinical readiness for real practice scenarios, participants rated themselves lower after AI-based learning than after expert-led instruction. Expert feedback usefulness was rated higher than that of AI (3.98 vs 3.69). These results were summarized in **Table 2**.

Table 1. Weekly frequency of AI tool use and expert-led instruction engagement (n = 220)

Usage Frequency	AI Tools n (%)	Expert-Led n (%)
No use / 0 hour/week	16 (7.3)	—
>0–2 hours/week	66 (30.0)	41 (18.6)
3–5 hours/week	91 (41.4)	54 (24.5)
6–8 hours/week	31 (14.1)	35 (15.9)
>8 hours/week	16 (7.3)	90 (40.9)

Table 2. Comparison of AI-based and expert-led instruction on key outcome measures (n = 220)

Outcome	AI-based (Mean ± SD)	Expert-led (Mean ± SD)	*p*-value
Effectiveness rating (1–5)	3.55 ± 0.74	3.89 ± 0.67	< 0.001
Confidence in preclinical knowledge (1–5)	3.21 ± 0.79	3.45 ± 0.81	0.001
Readiness for clinical scenarios (1–5)	3.00 ± 0.76	3.56 ± 0.68	< 0.001
Feedback usefulness (1–5)	3.69 ± 0.81	3.98 ± 0.74	< 0.001

Notes: Items rated on a 5-point Likert scale (1 = least agreement, 5 = most agreement). All comparisons use the Wilcoxon signed-rank test.

Most participants held positive attitudes toward AI in medical education. The highest-rated positive item was AI helping physicians and students access information more easily, followed by enhancing physician skills in patient education. Regarding potential drawbacks, the most prominent concern was the risk of breaching medical confidentiality. Expert-led instruction was strongly perceived across all positive items, with the highest ratings for enhancing physicians' skills in patient education. Pairwise Wilcoxon signed-rank comparisons revealed that expert-led instruction was rated significantly higher than AI on four items. In contrast, AI was rated significantly higher for facilitating patient access to medical services, and no significant difference was observed for information access, as shown in **Table 3**.

Overall, participants preferred expert-led instruction as the primary modality and the more beneficial approach for both preclinical learning and clinical reasoning, while endorsing an integrated AI–expert framework (**Table 4**).

To examine whether the intensity of AI tool use was associated with academic performance, students were classified into two groups: the more AI-using group (>5 hours per week; n = 47, 21.4%), and the less AI-using group (≤5 hours per week; n = 173, 78.6%). This grouping aligns with the >5 hours/week threshold identified as

Table 3. Participant perceptions of AI-based and expert-led instruction (n = 220)

Perception Item	AI-based (Mean ± SD)	Expert-led (Mean ± SD)	*p*-value
Positive Perceptions			
Helps access information more easily	**4.15 ± 0.84**	4.06 ± 0.80	0.099
Enhances physician skills in patient education	3.81 ± 0.92	**4.25 ± 0.76**	< 0.001
Empowers patients to manage their own health	3.54 ± 0.97	**4.09 ± 0.77**	< 0.001
Increases patient confidence in physicians	3.19 ± 1.14	**4.23 ± 0.77**	< 0.001
Enables more accurate medical decision-making	3.70 ± 0.88	**4.20 ± 0.75**	< 0.001
Facilitates patient access to medical services	**3.74 ± 1.00**	3.40 ± 1.01	< 0.001
Reduces errors in medical practice	3.67 ± 0.94	**3.77 ± 1.07**	0.215
Negative Perceptions (AI only)			
Risk of breaching medical confidentiality/privacy	3.31 ± 1.07	—	—
Reduces humanistic perspective in patient care	2.96 ± 1.07	—	—
Undermines doctor–patient trust	2.87 ± 1.08	—	—
Diminishes value/role of medical profession	2.58 ± 1.14	—	—
Adversely affects doctor–patient relationship	2.57 ± 1.09	—	—
Adversely affects physician–physician relationship	2.46 ± 1.16	—	—
Adversely affects physician–healthcare staff relationship	2.45 ± 1.13	—	—

Note. Items rated on a 5-point Likert scale (1 = least agreement, 5 = most agreement). All comparisons use the Wilcoxon signed-rank test.

Table 4. Participant learning preferences (N = 220)

Item	n	%
AI positively impacted learning outcomes		
Yes	206	93.6
Observed improvement in problem-solving/decision-making with AI		
Yes	182	82.7
Expert-led instruction is better for hands-on skill development		
Yes	204	92.7
Primary instructional modality preferred		
Expert-led instruction as primary	199	90.5
AI-based instruction as primary	4	1.8
Expert-led instruction unnecessary	6	2.7
AI-based instruction unnecessary	11	5.0
Most beneficial approach for preclinical education		
Expert-led instruction	137	62.3
Both equally beneficial	80	36.4
AI tools	3	1.4
Most beneficial approach for clinical reasoning and decision-making		
Expert-led instruction	134	60.9
Both equally beneficial	77	35.0
AI tools	9	4.1

Table 4. Participant learning preferences (N = 220) (Cont.)

Item	n	%
Preferred instructional sequence		
Concurrent (AI alongside expert)	101	45.9
AI after expert-led instruction	92	41.8
AI unnecessary	16	7.3
AI before expert-led instruction	8	3.6
Expert instruction unnecessary	3	1.4

potentially excessive in the preceding section. Academic performance, as reflected by the cumulative grade point average (GPAX), was 3.21 ± 0.64 in the more AI-using group and 3.27 ± 0.56 in the less AI-using group. The difference was not statistically significant (independent t-test, p = 0.100), indicating that more intensive AI engagement did not confer a measurable advantage or disadvantage in overall academic achievement during the preclinical years. **Figure 1** shows the scatterplot of GPAX and AI usage.

Discussion

This cross-sectional study of 220 preclinical medical students provides one of the earliest direct comparisons of student satisfaction, perceptions, learning preferences, and academic outcomes between AI tool use and expert-led instruction in a medical school. The high prevalence of AI use among preclinical students (90.9%) is consistent with growing global evidence in AI tool usage, particularly large language models and adaptive learning platforms.[5, 27] In our cohort, the highest-rated AI perception was easier access to information, which is consistent with a previous study demonstrating that AI is an effective and credible tool in medical education.[28]

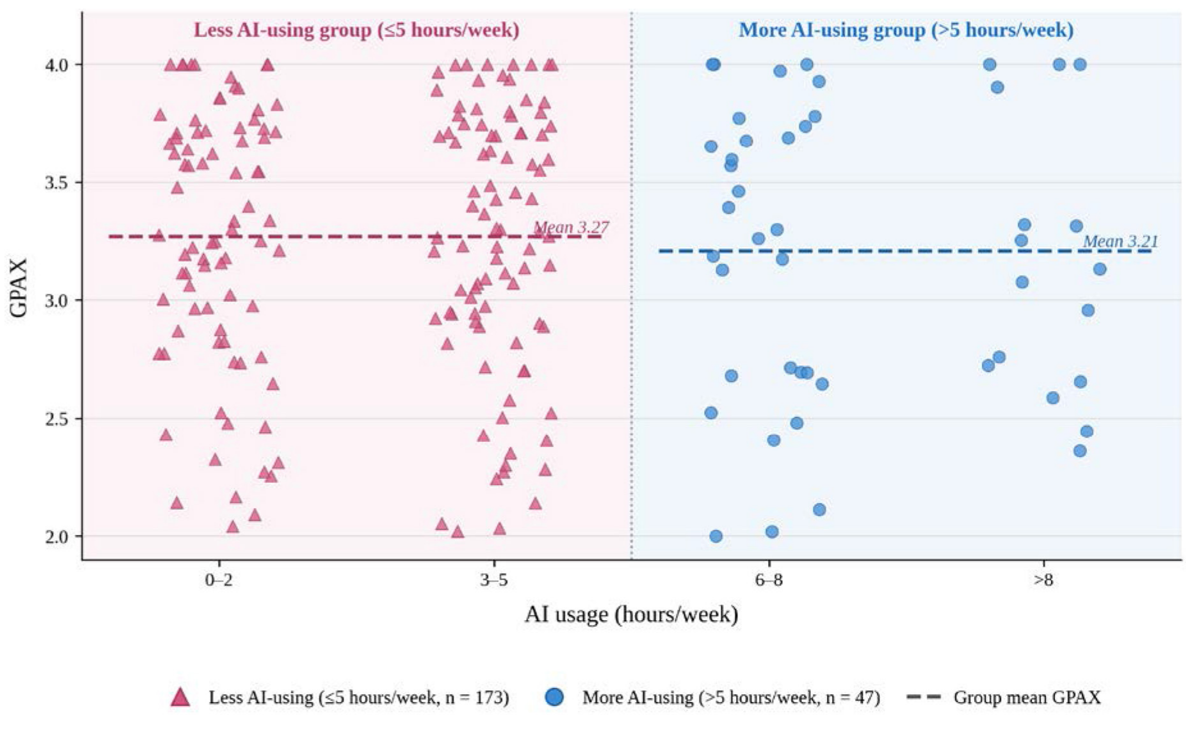

Figure 1. Scatterplot of GPAX by weekly AI usage in the more AI-using (>5 hours/week) and less AI-using (≤5 hours/week) groups

Notably, the majority of students in this study used AI for 3–5 hours per week, compared with more than 8 hours per week for expert-led instruction, which reflects a practical allocation. These findings indicate that students engaged more intensively with expert-led instruction weekly than with AI tools or AI supplements, but do not yet match the instructional volume of formal medical curricula.[29]

Satisfaction ratings revealed that expert-led instruction was rated significantly higher than AI across all key outcome domains: effectiveness, confidence, and clinical readiness, reflecting the primacy of expert-instructed feedback in building competence. According to a meta-analysis of 435 studies, feedback from knowledgeable others was identified as one of the most powerful influences on student learning, particularly when it addresses higher-order reasoning and is delivered in ways that reduce the gap between current performance and expert standards.[30] The clinical readiness gap observed in this study indicates that current AI tools cannot fully replicate, and AI feedback may lack nuance in complex cases; expert oversight remains important—and exposing students to its limitations can sharpen their critical appraisal of AI-generated content.[31, 32]

Despite these limitations, AI demonstrated a significant advantage in facilitating patient access to medical services and helping access information more easily. These findings resonate with the study, which showed that AI's most immediate clinical impact lies in democratizing access to information, enabling both providers and patients to retrieve, synthesize, and act on medical knowledge at unprecedented speed and scale.[33, 34] In the educational domain, students believed AI had a positive impact on their learning outcomes and reported improvements in problem-solving and decision-making after using AI tools, findings consistent with evidence that AI-driven intelligent tutoring systems improve knowledge retention and reasoning skills.[34]

A key academic performance finding was the absence of a significant difference in GPAX between the more-AI-using group (>5 hours/week) and the less-AI-using group (≤5 hours/week). This result reflected that greater AI use intensity confers neither an academic advantage nor a measurable disadvantage. Although heavy AI users reported higher satisfaction with and perceived effectiveness of AI tools, they did not achieve higher grades, suggesting that the association between AI engagement and learning experience is largely affective rather than cognitive-performance-based, consistent with the idea that access to or enthusiasm for a given technology does not automatically translate into differences in academic outcomes.[35, 36] These findings did not align with previous research indicating that academic screen time was positively correlated with examination marks.[13] Future longitudinal research should examine the relationship between screen time and academic performance.

Students' learning preferred instructional sequences further support the model of AI as a complement to, rather than a replacement for, expert instruction. The largest group preferred concurrent delivery, followed by AI after expert-led teaching, leading most students to endorse some form of integrated AI-expert framework. These results demonstrated that blended learning approaches, integrating face-to-face and digital components, promoted deeper learning strategies compared with either modality alone, and debriefing yielded the most durable improvements in both competence and confidence.[21, 37]

The highest-rated negative perception of AI was the risk of breaching medical confidentiality or of personal data being compromised. This finding showed that preclinical students are already recognized and sensitive to these concerns, even before significant clinical exposure, reflecting an encouraging readiness for ethical AI literacy and supporting the incorporation of AI ethics into early preclinical education.[38, 39]

The strength of this study is that the findings can be applied to the design of preclinical medical curricula. Medical schools should develop clear, evidence-based policies for AI integration that capitalize on AI's strengths while blending the advantages of expert-led instruction, real-time feedback, and the cultivation of humanistic professionalism. Concurrently, AI literacy and ethics curricula, as well as the boundaries of AI-assisted learning, should be directed at medical students.

Several limitations of this study warrant acknowledgment. First, the cross-sectional design precludes causal inference; associations between AI use and academic or attitudinal outcomes cannot be attributed to AI use per se. Second, the study was conducted at a single center, and findings may not generalize to other cultural, institutional contexts, different curricula, AI access, or educational traditions. Third, all outcome measures were self-reported: perceived effectiveness, confidence, readiness, and satisfaction are subject to response and social desirability bias. Fourth, GPAX reflects cumulative academic performance and may not be sensitive to preclinical learning directly attributable to AI use, as year of study, baseline academic ability, and prior confidence may confound GPAX comparisons. Fifth, the AI tools students used were heterogeneous and uncontrolled; differences in tool quality, reliability, and pedagogical design were not assessed.

Future research should employ longitudinal and randomized designs to establish the causal effects of structured AI integration on objective, domain-specific learning outcomes, examine prospective cognitive outcomes, and test pedagogical frameworks that harness AI's benefits while safeguarding competency development.

Conclusion

In this single-center cross-sectional study, preclinical medical students reported frequent use of AI tools yet preferred expert-led instruction, which was rated higher for overall satisfaction. No significant association was observed between AI-use intensity and GPAX. Students valued AI most for access to information and favored a blended model that combines AI with expert-led teaching. These findings, reflecting student preferences and perceptions, support the thoughtful integration of AI alongside, rather than in place of, expert-led preclinical instruction.

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Data Availability Statement

The data supporting the findings of this study are available upon request.

Competing interests statement

There is no conflict of interest to declare for all authors.

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