Original Article

Shortcut to Knowledge or Shortcut to Thinking? Investigating AI-Induced Metacognitive Laziness in Future Doctors

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Abstract

Background: The rapid expansion of artificial intelligence (AI) and machine learning has transformed industries, including education and healthcare. In medical education, AI is increasingly used for personalized learning and clinical decision-making. However, growing reliance on AI may contribute to metacognitive laziness, where students engage less in critical thinking and self-regulation.

Objective: This study examines the extent of AI reliance in medical students and its relationship with metacognitive laziness.

Methods: The study involved medical and dental students, with data collected via a four-point Likert scale-based questionnaire. Content validity was ensured by expert ratings on relevance and clarity, and reliability was determined using Cronbach's alpha. Descriptive statistics with median response category were used to describe students' AI reliance, and Spearman's rank correlation was used to analyze the relationship between AI reliance and metacognitive laziness, with a significance level set at $p = 0.05$.

Results: The initial 47-item questionnaire was refined to 36 items, with an S-CVI/Ave of 0.88 and a CCA of 90%. Cronbach's alpha was 0.936, indicating excellent reliability. The survey revealed that 74.4% of students relied on AI for learning, with 61.3% reporting decreased motivation for independent analysis and 62.4% expressing concerns about its impact on future patient care. Spearman's rank correlation showed a moderate positive relationship ($\rho = 0.621$, $p = 0.000$).

Conclusion: The increasing reliance on AI among medical students is associated with metacognitive laziness, emphasizing the need for careful AI integration to promote independent learning and critical thinking.

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Introduction

The fourth industrial revolution is characterized by the rapid expansion of artificial intelligence (AI) and machine learning,[1] transforming industries, including education and healthcare. With the growing

use of AI, its role is shifting from mere task automation to augmenting human capabilities through human-AI collaboration, giving rise to the concept of hybrid intelligence.[2] Hybrid intelligence combines human and machine intelligence, and augments human capabilities instead of replacing them, to achieve goals that neither could attain alone.[3] In education, hybrid intelligence has useful implications for lifelong learning, with learners' ability to self-regulate playing a vital role in human-AI collaboration.

A foundational component of self-regulated learning is metacognition, first introduced by Flavell as 'thinking about thinking'.[4] Metacognitive strategies are triggered when learners face cognitive difficulty, activating System 2 processing and prompting them to engage in deliberate analytical thinking.[5] However, such cognitive difficulty may be reduced by over-reliance on external aids, such as AI, raising concerns about AI's potential to undermine metacognitive processes.[6]

In medical education as well, AI is increasingly used not only for information retrieval but also to provide personalized learning, and help in clinical decision-making and problem-solving.[7] This growing reliance on AI has led to the concept of 'Metacognitive laziness',[6] which occurs when learners passively accept AI-generated outputs without critical analysis, engage less in deep learning, and exhibit reduced self-regulation.[8] This is particularly concerning for medical students as it may hinder the development of essential skills for clinical practice, such as clinical evaluation and real-time adjustment during patient care.

The current literature has primarily focused on AI's benefits in terms of knowledge acquisition and diagnostic accuracy.[9,10] However, little attention has been given to its impact on students' metacognitive processes. This research aims to fill the gap by examining the relationship between AI reliance and metacognitive laziness in medical students. The research questions are: What is the extent to which medical students rely on AI for learning? and What is the relationship between AI reliance and metacognitive laziness in medical students?

The findings of this study will contribute to the growing body of knowledge on AI's role in education by highlighting the unintended consequences of relying on AI for learning. Understanding the relationship between AI reliance and metacognitive laziness will help educators design medical curricula that balance AI's benefits with its potential drawbacks, ultimately promoting the development of metacognitive skills.

Methods

The ethical approval for the study was obtained by the Institutional Review Committee at Riphah International University (Appl. # Riphah /IRC/25/1052). This study was conducted over a period of three months from February 2025 to April 2025.

In the first phase, a questionnaire was developed to assess medical students' reliance on AI and potential metacognitive laziness. The existing literature was reviewed using pre-defined search terms with key references focusing on the impact of AI on medical students' learning,[11,12] AI usage and self-efficacy[13] and AI's potential contribution to metacognitive laziness.[6] A four-point Likert scale (ranging from 'strongly disagree' to 'strongly agree') was used to avoid indecisiveness bias.[14] The scale was designed to assess students' agreement with statements across two constructs: 1. AI reliance, including AI use in learning, clinical decision-making, and trust in AI tools; and 2) metacognitive laziness, including effort avoidance, cognitive reflection deficiency, and self-regulation erosion.

The content validity of the questionnaire was determined using Content Validity Index (CVI).[15] Fourteen medical education experts with a Master's in Health Professions Education and at least five years of experience were invited to rate the relevance and clarity of the items. Ten experts responded, rating relevance on a four-point Likert scale (1 = Not Relevant, 2 = Somewhat Relevant, 3 = Quite Relevant, 4 = Highly Relevant), and clarity on a three-point Likert scale (1 = not clear, 2 = item needs some revision; and 3 = very clear). Qualitative feedback was also taken on the items.

To determine the CVI for individual items (I-CVI) and the overall questionnaire (S-CVI), experts' relevance scores were recoded (scores 3 and 4 = 1,

scores 1 and 2 = 0). I-CVI for each item was calculated by adding the 1s and dividing by 10, and S-CVI was the average of all I-CVIs. Acceptable cutoffs for I-CVI and S-CVI were 0.78[16] and 0.90,[15] respectively. Item clarity was assessed using the Content Clarity Average (CCA), with a cutoff of 80%.[17] Expert feedback was used to refine the items.

To determine reliability, the questionnaire was piloted with 30 randomly selected students. Cronbach's alpha was calculated using pilot data scores in SPSS version 26.

In the second phase, medical and dental students from a private university in Pakistan were selected via convenience sampling. The minimum sample size, calculated using G*Power with moderate effect size, was 115, adjusted for non-response (~20%) to 138 medical students. Participants were medical and dental students from all academic years who used AI for learning; non-users were excluded. A poll was conducted via class WhatsApp groups to identify AI users, and the questionnaire was distributed via Google Forms to all those who voted "Yes".

For the first research question, descriptive statistics were used to analyze the Likert-type data, calculating the median response category for each statement.

For the second research question, composite AI reliance Metacognitive laziness scores were calculated for each student. Spearman's rank correlation was used to explore the strength and direction of relationship between AI reliance and metacognitive laziness among medical students. The following hypothesis was tested with a significance level of $p = 0.05$:

Null hypothesis: There is no relationship between AI reliance and metacognitive laziness in medical students.

Alternate hypothesis: Increasing AI reliance is associated with an increase in metacognitive laziness in medical students.

Results

A total of 391 students completed the questionnaire (Table 1).

The questionnaire initially had 47 items. Based on expert ratings, 11 items with a CVI below 0.78 were removed, and six items with a CCA below 80% were revised using the experts' qualitative feedback. The final questionnaire contained 36 items with an S-CVI/Ave of 0.88 and a CCA of 90% (Additional file 1). Cronbach's alpha for the questionnaire was 0.936, indicating excellent reliability (Table 2).

Table 1: *Demographic characteristics of the participants (N = 391)*

Category		Percentages (Number of participants)
Gender	Male	24% (94)
	Female	76% (297)
Year of Study	First	38.1% (149)
	Second	27.6% (108)
	Third	16.9% (66)
	Fourth	10% (39)
	Final	7.4% (29)
Program	MBBS	60.9% (238)
	BDS	39.1% (153)

Table 2: *Cronbach's alpha for the constructs and the full questionnaire*

Construct	Number of items	Cronbach's alpha
1	18	0.894
2	18	0.883
Full questionnaire	36	0.936

The survey revealed several key trends in AI use among students. A large proportion (74.4%) reported that AI has become essential to their learning, with 85.4% noting its positive impact on their educational journey. However, AI was found to be primarily used for quick solutions rather than deep learning, with 50.9% students favoring quick answers over in-depth learning, and 51.9% preferring AI-generated summaries over longer texts.

The results also indicated that while 78.8% of students felt more confident with AI assistance, a concerning 61.3% acknowledged that AI reduced their motivation to critically analyze medical information independently.

Furthermore, the study revealed that although a substantial proportion of students (85.7%) believed AI-generated information should be verified with human expertise before clinical use, many exhibited behaviors that suggested a lack of verification. Specifically, 44.5% accepted AI-generated answers without verification, 60.1% avoided lengthy

Table 3: *Frequencies, Percentages, and Median Responses for Questionnaire items*

Items	Strongly Disagree	Disagree	Agree	Strongly Agree	Median response
A. AI Reliance					
Domain 1: Use of AI in learning process					
1. I rely on AI more than textbooks when searching for medical information.	36 (9.2%)	167 (42.7%)	161 (41.2%)	27 (6.9%)	Disagree
2. AI has become an essential part of my learning process.	16 (4.1%)	84 (21.5%)	230 (58.8%)	61 (15.6%)	Agree
3. I rarely study without consulting AI tools.	30 (7.7%)	191 (48.8%)	147 (37.6%)	23 (5.9%)	Disagree
4. AI has transformed the way I approach learning.	19 (4.9%)	79 (20.2%)	249 (63.7%)	44 (11.3%)	Agree
5. I actively seek out AI-powered tools and resources, for example, ChatGPT, Gemini etc. to enhance my learning experience.	18 (4.6%)	68 (17.4%)	253 (64.7%)	52 (13.3%)	Agree
6. I believe AI has positively impacted my overall educational journey.	12 (3.1%)	45 (11.5%)	275 (70.3%)	59 (15.1%)	Agree
7. I feel that AI has improved the quality of achievement of my learning outcomes.	12 (3.1%)	71 (18.2%)	261 (66.8%)	47 (12%)	Agree
8. I use AI to save time rather than to deepen my understanding.	28 (7.2%)	138 (35.3%)	184 (47.1%)	41 (10.5%)	Agree
9. I prioritize using AI for quick answers rather than using it for deep, reflective learning.	29 (7.4%)	124 (31.7%)	199 (50.9%)	39 (10%)	Agree
Domain 2: Use of AI in Clinical Decision-making					
10. Before analyzing a clinical case myself, I check AI-generated information first.	38 (9.7%)	196 (50.1%)	136 (34.8%)	20 (5.1%)	Disagree
11. I tend to opt for quick solutions/ answers to clinical problems through AI rather than first review my lecture.	49 (12.5%)	180 (46%)	138 (35.3%)	24 (6.1%)	Disagree
12. I trust AI-generated diagnoses more than my own reasoning.	41 (10.5%)	212 (54.2%)	126 (32.2%)	12 (3.1%)	Disagree

Items	Strongly Disagree	Disagree	Agree	Strongly Agree	Median response
A. AI Reliance					
Domain 3: Trust & Confidence in AI					
13. I feel more confident with the assistance of AI in my studies.	15 (3.8%)	83 (21.2%)	259 (66.2%)	34 (8.7%)	Agree
14. AI has become a trusted source of information for me.	15 (3.8%)	108 (27.6%)	235 (60.1%)	32 (8.2%)	Agree
15. I prefer consulting AI over asking a teacher or a senior for clarification.	33 (8.4%)	173 (44.2%)	147 (37.6%)	38 (9.7%)	Disagree
16. I would rather rely on AI than discuss complex topics with peers.	43 (11%)	176 (45%)	150 (38.4%)	22 (5.6%)	Disagree
17. I worry that over-reliance on AI might negatively affect my ability for patient care in the future.*	20 (5.1%)	127 (32.5%)	197 (50.4%)	47 (12%)	Agree
18. I believe AI should always be verified with human expertise before being applied in clinical decisions.*	8 (2%)	48 (12.3%)	230 (58.8%)	105 (26.9%)	Agree
B. Metacognitive laziness					
Domain 1: Effort Avoidance					
19. When AI gives an answer, I usually accept it without further verification.	41 (10.5%)	176 (45%)	155 (39.6%)	19 (4.9%)	Disagree
20. I avoid reading long explanations (from books or articles) if AI can give me a quick summary.	29 (7.4%)	127 (32.5%)	203 (51.9%)	32 (8.2%)	Agree
21. I prefer using AI to solve problems rather than working through them myself.	29 (7.4%)	195 (49.9%)	146 (37.3%)	21 (5.4%)	Disagree
22. I rarely reflect deeply on a problem/question after using AI for an answer.	28 (7.2%)	164 (41.9%)	178 (45.5%)	21 (5.4%)	Agree
23. I find myself increasingly using AI for basic concepts that I once understood.	23 (5.9%)	132 (33.8%)	212 (54.2%)	24 (6.1%)	Agree

Items	Strongly Disagree	Disagree	Agree	Strongly Agree	Median response
B. Metacognitive laziness					
Domain 2: Cognitive Reflection Deficiency					
24. I verify AI-generated medical information with credible sources before applying it.*	44 (11.3%)	246 (62.9%)	88 (22.5%)	12 (3.1%)	Disagree
25. I make an effort to solve problems independently before using AI.*	12 (3.1%)	59 (15.1%)	276 (70.6%)	44 (11.3%)	Agree
26. I often question whether AI-generated responses are accurate.*	11 (2.8%)	58 (14.8%)	263 (67.3%)	59 (15.1%)	Agree
27. I develop my understanding of a topic before confirming/revising it with AI.*	14 (3.6%)	64 (16.4%)	263 (67.3%)	50 (12.8%)	Agree
28. I think critically about the gaps in my understanding before using AI to find the correct answer.	14 (3.6%)	70 (17.9%)	269 (68.8%)	38 (9.7%)	Agree
29. I rarely compare AI-generated information with what I have learned in class.	30 (7.7%)	160 (40.9%)	180 (46%)	21 (5.4%)	Agree
30. I feel that using AI reduces my motivation to critically analyze medical information on my own.	24 (6.1%)	127 (32.5%)	207 (52.9%)	33 (8.4%)	Agree
31. I feel that my ability for learning and solving problems independently has decreased since I started using AI.	30 (7.7%)	156 (39.9%)	182 (46.5%)	22 (5.6%)	Agree
32. When AI answers a question, I feel less inclined to challenge or critically evaluate that answer.	19 (4.9%)	126 (32.2%)	227 (58.1%)	19 (4.9%)	Agree
Domain 3: Self-Regulation Erosion					
33. I do not actively seek out different perspectives on a topic because AI often provides a sufficient answer.	30 (7.7%)	145 (37.1%)	199 (50.9%)	17 (4.3%)	Agree
34. I rely on AI to help me organize my learning, rather than creating my own study plans.	43 (11%)	167 (42.7%)	163 (41.7%)	18 (4.6%)	Disagree
35. I believe that my learning process has become more passive since I started using AI for studying.	23 (5.9%)	147 (37.6%)	195 (49.9%)	26 (6.6%)	Agree
36. I often feel that AI is filling in the gaps in my understanding, which reduces my motivation to study more deeply.	30 (7.7%)	138 (35.3%)	199 (50.9%)	24 (6.1%)	Agree

**Reverse scored items*

explanations if AI could provide a quicker summary, and 72.4% did not verify AI-generated medical information before applying it. Concerns about over-reliance on AI were also prevalent, with 62.4% worrying that it might negatively affect their future patient care abilities.

The detailed results of the questionnaire are presented in Table 3.

The Shapiro-Wilk test for both AI reliance and Metacognitive Laziness yielded p-values of 0.000, indicating non-parametric data. Spearman's rank correlation test revealed a moderate, significant positive correlation between AI reliance and metacognitive laziness, with the correlation coefficient = 0.621 and p-value = 0.000. This relationship is further illustrated by the scatter plot with a line of best fit (Figure 1). The R^2 value of 0.380 indicates that 38% of the variance in metacognitive laziness is explained by AI reliance, indicating a moderate strength of the relationship.

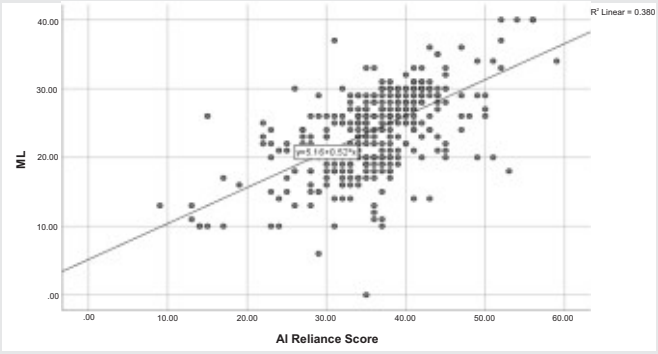

Figure 1: *Scatter plot with a line of best fit showing the relationship between AI reliance and metacognitive laziness scores.*

Discussion

The study aimed to examine medical students' reliance on AI for learning and its relationship with metacognitive laziness. We found that while most students had integrated AI into their learning, concerns remain regarding its impact on their metacognitive processes.

The study results revealed that a majority of students have adopted AI as an essential part of their learning. This widespread adoption can be attributed to several factors. First, the students reported a positive perception of AI's impact on their academic progress, aligning with Fawaz et al,[12] who found that AI enhances learning efficiency. The customized, self-paced learning opportunities offered by AI cater to individual preferences, which is consistent with Li and Qin's [18] suggestion that medical students rely on AI as it helps them grasp key concepts more effectively. Additionally, the high AI usage among undergraduate students may be linked to their status as digital natives. As demonstrated by Kwak et al.[19], students' technological self-efficacy, defined as the belief in one's ability to effectively use technology, plays a significant role in their engagement with AI. Other studies have similarly linked self-efficacy with increased usage of AI technologies, such as Chatbots, for educational purposes.[13,20] Collectively, these factors highlight the growing dependence of medical students on AI for learning, driven by its perceived benefits.

Despite the potential benefits of AI tools in education, their overuse presents risks that should not be overlooked. While AI tools were found to enhance learning speed and efficiency, the negative effects of excessive reliance became apparent. Our study highlighted that medical students are becoming less confident in their ability to make independent, informed decisions, instead relying on AI tools for diagnoses. This resonates with previous studies that suggest that AI could influence medical decision-making, potentially leading to over-reliance.[21,22] Furthermore, 52.1% of students reported a decline in their ability to solve problems independently since using AI, and 62.4% expressed concern that excessive AI reliance might adversely impact their future patient care capabilities. These concerns align with a Chinese study, where participants were found to worry that AI reliance could diminish their diagnostic and treatment skills.[18] Fawaz et al[12] also highlighted concerns about the lack of human oversight in the AI's responses, which could lead to inaccurate information particularly when dealing with complex topics. Despite these concerns, 72.4% of the students in our study admitted to not verifying AI-generated medical information with credible sources before applying it.

Our study found a direct association between increased AI reliance and higher levels of metacognitive laziness among medical students. This aligns with Fan et al,[14] who observed that students

relying on AI for learning support exhibited fewer metacognitive processes compared to those receiving support from human experts or checklists. Metacognitive laziness is linked to cognitive offloading,[23] where learners delegate tasks to external tools, reducing cognitive effort. While cognitive offloading helps manage cognitive load, prolonged use can diminish internal cognitive engagement, ultimately affecting metacognitive and self-regulation abilities. Similarly, Fawaz et al.[12] highlighted that AI's convenience and accessibility could inadvertently reduce independent thinking and hinder the development of essential cognitive skills. Bastani et al. further noted that excessive reliance on AI tools like GPT-4 initially boosts performance but weakens critical thinking and independent problem-solving over time.[24]

The mechanism behind metacognitive laziness may also be explained by automation bias, where users, particularly novices, trust AI recommendations without questioning them.[25] Such dependence can hinder the development of cognitive skills. To address this, a balanced approach to AI use that supports independent thinking while promoting cognitive skill development is essential. Therefore, in integrating AI into education, it is important to encourage its use as a supplementary tool while preserving students' independent thinking skills.

The study has several limitations. Our sample comprised solely of MBBS and BDS students. Including students from other health professions disciplines could increase the generalizability of results. Participation from final-year students was limited; future studies should aim for a more balanced representation. Our cross-sectional design also prevented the examination of causal relationships or changes over time. Longitudinal studies would be valuable to explore how AI reliance evolves and impacts metacognitive engagement in the long term. Furthermore, our study did not account for other factors influencing metacognitive laziness, such as study habits, teaching quality, or prior knowledge. These variables may have influenced the relationship between AI reliance and metacognitive laziness, and future studies should consider controlling these factors. Finally, qualitative methods could provide deeper insights into the reasons for students' reliance on AI and their perceptions of its impact on metacognitive processes.

Conclusion

This study highlights the growing reliance of medical students on AI for learning and its potential impact on metacognitive laziness. Our findings emphasize the need for careful AI integration in medical education, ensuring that it serves as a supplementary resource without compromising independent thinking and cognitive development. Educators should consider strategies that promote critical analysis and self-reflection while using AI.

Ethical Approval: The Institutional Review Committee, Islamic International Medical College, Rawalpindi has approved this study vide letter Appl. # Riphah /IRC/ 25/1052.

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Authors' Contribution:

MS: Conceptualization, study design, acquisition of data, analysis & interpretation, drafting of manuscript

NA: Acquisition of data, analysis & interpretation of results, finalization of the manuscript

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RAK: Critical revisions and final approval of the version to be published

References

1. Bühler MM, Jelinek T, Nübel K. Training and Preparing Tomorrow's Workforce for the Fourth Industrial Revolution. Educ Sci. 2022;12(11):782. doi: https://doi.org/10.3390/educsci12110782
2. Holstein K, Aleven V, Rummel N. A conceptual framework for human–AI hybrid adaptivity in education. In: Artificial Intelligence in Education: 21st International Conference, AIED 2020, July 6–10, 2020, Proceedings, Part I 21. Springer; 2020. p. 240-54. doi: 10.1007/978-3-030-52237-7_20
3. Akata Z, Balliet D, De Rijke M, Dignum F, Dignum V, Eiben G, et al. A Research Agenda for Hybrid Intelligence: Augmenting Human Intellect with Collaborative, Adaptive, Responsible, and Explainable Artificial Intelligence. Comp. 2020;53(8):18-28. doi:10.1109/MC.2020.2996587.

4. Flavell JH. Metacognition and Cognitive Monitoring: A New Area of Cognitive-Developmental Inquiry. Am Psychol. 1979;34(10):906-11. doi:10.1037/0003066X.-34.10.906
5. Alter A, Oppenheimer D, Epley N, Eyre R. Overcoming Intuition: Metacognitive Difficulty Activates Analytic Reasoning. J Exp Psychol Gen. 2007;136(4):569–76. doi:10.1037/00963445.-136.4.569
6. Fan Y, Tang L, Le H, Shen K, Tan S, Zhao Y, et al. Beware of Metacognitive Laziness: Effects of Generative Artificial Intelligence on Learning Motivation, Processes, and Performance. Br J of Educ Technol. 2024;56:489-530. doi:10.1111/-bjet.13544
7. Alam F, Lim M, Zulkipli I. Integrating AI in Medical Education: Embracing Ethical Usage and Critical Understanding. Front Med. 2023;10:1279707(7)-:543. doi: https://doi.org/10.3389/fmed.2023-.1279707
8. Esbin HB. Hidden costs of artificial intelligence: metacognitive laziness and imagination deficit. LinkedIn; 2025. [Cited on 25 April 2025]. Available from: https://www.linkedin.com/pulse/hidden-costs-artificial-intelligence-metacognitive-esbin-phd-0xqvc/
9. Tejani AS, Elhalawani H, Moy L, Kohli M, Kahn CE. Artificial Intelligence and Radiology Education. Radiol Artif Intell. 2022;5(1):220084. doi: 10.1148/ryai.220084
10. Masters K. Artificial intelligence in medical education. Med Teach. 2019;41(9):976–80. doi: 10.1080/0142159X.2019.1595557
11. Capinding AT. Development and Validation of Instruments for Assessing the Impact of Artificial Intelligence on Students in Higher Education. Int J Educ Method. 2024;10(2):197-211. doi: https://-doi.org/10.12973/ijem.10.2.997
12. Fawaz M, El-Malti W, Alreshidi SM, Kavuran E. Exploring Health Sciences Students' Perspectives on Using Generative Artificial Intelligence in Higher Education: A Qualitative Study. Nurs Health Sci. 2025;27(1): 70030. doi: https://doi.org/-10.1111/nhs.70030
13. Falebita OS, Kok, PJ. Artificial Intelligence Tools Usage: A Structural Equation Modeling of Undergraduates' Technological Readiness, Self-Efficacy and Attitudes. J STEM Educ Res. 2025; 8, 257-82. https://doi.org/10.1007/s41979-024-00132-1
14. Krosnick JA. Survey research. Annu Rev Psychol. 1999. 50(1), 537-67. doi: https://doi.org/10.1146/-annurev.psych.50.1.537
15. Polit DF, Beck CT, Owen S V. Focus on research methods: Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. Res Nurs Health. 2007;30(4):459–67. DOI: 10.1002/nur.20199
16. Yusoff MSB. ABC of Content Validation and Content Validity Index Calculation. Educ in Med J. 2019;11(2):49–54.
17. Silva AM. Content validity of the questionnaire on learning experiences associated with the use of digital information and communication technologies by undergraduates. EPESS. 2015;3:66–73. Available from: www.isres.org
18. Li Q, Qin Y. AI in medical education: medical student perception, curriculum recommendations and design suggestions. BMC Med Educ. 2023;23(1);852. doi: https://doi.org/10.1186/s12909-023-04700-8
19. Kwak Y, Ahn JW, Seo YH. Influence of AI ethics awareness, attitude, anxiety, and self-efficacy on nursing students' behavioral intentions. BMC Nurs. 2022;21(1);267. doi: https://doi.org/10.1186/-s12912-022-01048-0
20. Esiyok E, Gokcearslan S, Küçükergin KG. Acceptance of Educational Use of AI Chatbots in the Context of Self-Directed Learning with Technology and ICT Self-Efficacy of Undergraduate Students. Int J Hum Comput Interact. 2024;41(1):1-10. doi:10.1080/10447318.2024.2303557
21. Jackson P, Ponath Sukumaran G, Babu C, Tony MC, Jack DS, Reshma VR, et al. Artificial intelligence in medical education - perception among medical students. BMC Med Educ. 2024;24(1):804. doi: https://doi.org/10.1186/s12909-024-05760-0
22. Weidener L, Fischer M. Artificial Intelligence in Medicine: Cross-Sectional Study Among Medical Students on Application, Education, and Ethical Aspects. JMIR Med Educ. 2024;10(1):51247. doi: https://doi.org/10.2196/51247
23. Risko EF, Gilbert SJ. Cognitive Offloading. Trends Cogn Sci. 2016;20(9):676–88. doi: https://doi.org/-10.1016/j.tics.2016.07.002
24. Bastani H, Bastani O, Sungu A, Ge H, Kabakcı O, Mariman R. Generative AI Can Harm Learning. The Wharton School Research Paper. 2024;15;4895486. doi: http://dx.doi.org/10.2139/ssrn.4895486
25. Straw I. The automation of bias in medical Artificial Intelligence (AI): Decoding the past to create a better future. Artif Intell Med. 2020;110:101965. doi: 10.1016/j.artmed.2020.101965