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ARTIFICIAL INTELLIGENCE IN STUDENT LEARNING: A COMPREHENSIVE REVIEW OF OPPORTUNITIES, CHALLENGES, AND IMPLICATIONS FOR NURSING EDUCATION

Jibby Varghese, Neethu M *, Lincy S Cheruvathur, Nandu AL, Geethu S and Anju R Nath

SI-MET College of Nursing, Tanur, Malappuram, Kerala, India.
* Corresponding Author

ORCID Details
Neethu M: https://orcid.org/0009-0002-4796-9161

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ABSTRACT

Artificial intelligence (AI) is increasingly transforming education through personalized learning, intelligent tutoring, automated assessment, learning analytics, and generative AI-based academic assistance. This review examines the applications of AI in student learning, its educational opportunities and challenges, and its implications for nursing education. AI can support individualized and self-directed learning, provide immediate feedback, improve access to educational resources, strengthen research skills, and assist educators in assessment and learning analytics. In nursing education, AI offers opportunities to support clinical reasoning, simulation, research, digital literacy, personalized learning, and preparation for technology-enabled healthcare environments. However, its increasing use raises concerns regarding academic integrity, data privacy, algorithmic bias, inaccurate information, unequal access, and excessive dependence on AI. Over-reliance may contribute to cognitive offloading, reduced independent reasoning, diminished ownership of learning, and reduced human interaction. Emerging evidence also indicates concerns regarding AI dependency and addiction-like patterns of use, although this remains an evolving area of research. Responsible integration therefore requires AI literacy, ethical awareness, critical evaluation of AI-generated information, privacy protection, appropriate institutional policies, and continued educator involvement. AI should complement rather than replace teachers, human interaction, and students' independent cognitive effort. A balanced, human-centred approach can enable AI to enhance educational outcomes while preserving the cognitive, professional, ethical, and interpersonal competencies essential to nursing education and practice. UNESCO is committed to supporting Member States to harness the potential of AI technologies for achieving the Education 2030 Agenda, while ensuring that its application in educational contexts is guided by the core principles of inclusion and equity. The AI should not increase the technological gap within or between countries. The concept of AI for All means ensuring that everyone has equal opportunities to benefit from technological advancements, innovation and knowledge. The AI should be developed and used in ways that promote inclusion equality and shared progress for all.

Keywords: Artificial intelligence; Student learning; Generative AI; Nursing education; AI dependency; Critical thinking

1 INTRODUCTION

Artificial intelligence (AI) has emerged as an influential innovation in modern education. It refers to computer systems capable of performing tasks traditionally requiring human intelligence, including learning, reasoning, problem-solving, decision-making, language processing, and pattern recognition. Advances in machine learning, natural language processing, and generative AI have expanded its educational applications, supporting teaching, personalized learning, and timely academic assistance[1]. The growth of digital learning environments and demand for flexible education have accelerated AI adoption in student learning. AI is increasingly used in adaptive learning platforms, intelligent tutoring systems, virtual assistants, automated assessment, learning analytics, and generative AI tools to provide individualized support, immediate feedback, and access to educational resources.[2,3]

Students generally perceive AI as a useful educational resource. Vieriu and Petrea reported that AI-enhanced learning environments support personalized learning, engagement, and academic development [4]. While Firdos et al. found that university students recognized AI for improving learning efficiency, academic development, and access to educational resources.[5] However, its educational value depends on appropriate implementation and integration with established pedagogical approaches. Despite its potential, AI raises concerns regarding academic integrity, accuracy, privacy, algorithmic bias, and excessive reliance on automated assistance.[1,3,4] Excessive dependence may reduce opportunities for independent reasoning and critical engagement. Effective integration therefore requires institutional guidance, AI literacy, ethical awareness, and meaningful human involvement.

These concerns are particularly relevant to nursing education, where students require theoretical knowledge alongside clinical reasoning, decision-making, communication, problem-solving, and professional competencies. AI can support personalized learning, virtual tutoring, simulation, academic writing, research, and preparation for technology-enabled healthcare, but its use requires attention to accuracy, professional judgement, ethical practice, data privacy, and excessive dependence. Therefore, this review examines AI applications in student learning, its educational opportunities and challenges, and its cognitive, psychological, and behavioural implications, with particular focus on its responsible use and future directions in nursing education.

AI holds immense potential to enhance learning efficiency and academic performance, its successful implementation requires addressing concerns related to accuracy, cognitive disengagement, and ethical implications. A study conducted among students, using purposive sampling. 85 participants were selected and data were collected through a questionnaire. The findings revealed that AI offers significant benefits including personalized learning, improved educational outcomes, and enhanced student engagement and challenges like over-reliance on AI, diminished critical thinking skills, data privacy risks were also identified. [4]

2 TYPES OF AI TOOLS USED IN STUDENT LEARNING

AI technologies used in student learning encompass a range of applications designed to support instruction, learning activities, assessment, communication, and academic development. Although these tools differ in their functions and technological approaches, they can be broadly categorized according to their primary educational applications.

2.1 Intelligent Tutoring Systems

Intelligent Tutoring Systems (ITS) are AI-based educational systems designed to provide individualized instruction, guidance, and feedback. They can assess learners' responses, identify areas of difficulty, and adapt instructional content or questions according to the learner's performance. By providing support that resembles aspects of individualized tutoring, ITS can assist students in developing knowledge and skills according to their learning needs.[1]

2.2 Adaptive Learning Platforms

Adaptive learning platforms use algorithms to modify the sequence, level, or type of educational content according to learner performance. These systems analyse students' responses and progress and can adjust subsequent learning activities accordingly. Adaptive platforms are particularly useful for providing differentiated learning pathways within technology-supported educational environments.[1,4]

2.3 Generative Artificial Intelligence Tools

Generative AI tools, including Chat GPT, Gemini, Claude, and Microsoft Copilot, use large language models to generate text and other forms of content in response to user prompts. Data camp is an entirely unique technology and different lessons are generated dynamically and adapted entirely to the individuals. Claude is strong for creative writing. Grammarly is a technology which reads the persons tone and suggest how to make the writing more concise. Adobe podcast maintain high audio quality. Students may use these tools for explanations, summarization, brainstorming,

question generation, language assistance, and academic writing support. Their increasing use has also raised concerns regarding accuracy, academic integrity, authorship, and excessive dependence on AI-generated content.[1,3]

2.4 AI-Powered Chat bots and Virtual Assistants

AI-powered educational chatbots and virtual assistants use natural language interaction to provide students with on-demand academic assistance. They can respond to questions, explain concepts, guide learners through educational materials, and facilitate interaction outside conventional classroom hours. Their conversational nature enables students to access learning support in a flexible manner. [1,4]

2.5 Automated Assessment and Feedback Systems

AI-based assessment systems can assist in evaluating assignments, quizzes, written responses, and other learning activities. They can provide automated or individualized feedback and help identify areas in which students may require further learning. These systems have the potential to support timely feedback and reduce some routine assessment tasks for educators. [3]

2.6 Learning Analytics Systems

Learning analytics systems use educational data to identify patterns in learner participation, performance, progress, and engagement. AI-based analytics can help educators recognize learning difficulties and identify students who may benefit from additional support. At the institutional level, such information can also contribute to educational planning and decision-making.[3]

2.7 Language Learning and Writing Support Tools

AI-powered language learning and writing-support applications provide assistance with areas such as grammar, vocabulary, pronunciation, translation, and written communication. These tools can support students in practising language skills and developing academic writing. However, students should critically evaluate AI-generated suggestions and retain responsibility for the content and originality of their academic work. [3]

Overall, AI tools used in student learning differ in their specific functions but increasingly share common capabilities such as personalization, natural language interaction, automated feedback, and analysis of learner data. The educational value of these tools depends not only on their technological capabilities but also on how appropriately they are integrated into learning activities and guided by educators. [1,4]

3 BENEFITS OF AI IN STUDENT LEARNING

The integration of artificial intelligence into education provides students with new opportunities for individualized learning, timely academic support, interactive learning experiences, and access to educational resources. The benefits of AI, however, depend on the quality of implementation, the educational context, and appropriate guidance from educators. [6]

3.1 Personalized learning

AI can support personalized learning by adapting educational content, learning activities, and feedback according to individual learner performance and needs. Adaptive systems can identify areas of difficulty and provide additional learning opportunities while allowing students to progress at an appropriate pace. Personalized learning may therefore support learner engagement and academic development when appropriately integrated into instructional practice.[4]

3.2 Immersive learning experiences

The integration of AI with technologies such as virtual reality and augmented reality has the potential to create interactive and immersive learning environments. Such approaches can provide opportunities for students to explore simulated situations and practice concepts in more engaging ways. Their effectiveness depends on appropriate instructional design and alignment with learning objectives.

3.3 Improved student engagement and motivation

AI creating immersive learning experiences also can result in boosting student engagement and motivation by making learning more interactive and personalized. Gamified learning platforms, powered by AI, incorporate game elements such as rewards, challenges and leaderboards to make learning fun and competitive. Additionally, artificial intelligence can provide instant feedback and support, helping students stay motivated and focused on their learning goals. [3,7]

3.4 Cost-effective learning

AI can contribute to cost-effective educational delivery by automating selected routine educational and administrative tasks and providing scalable learning support. Automated assessment, digital tutoring, and AI-supported learning resources may reduce the time and resources required for certain educational activities while allowing educators to devote more attention to teaching and student support. However, the cost-effectiveness of AI depends on implementation costs, infrastructure, training requirements, and equitable access to technology. [7]

3.5 Broader 24/7 access to educational resources

AI-powered educational tools can provide students with access to learning assistance and educational resources beyond conventional classroom hours. Conversational AI, intelligent tutoring systems, and other AI-supported platforms can provide on-demand explanations, clarification of concepts, practice questions, and learning guidance whenever students require assistance. This continuous availability may be particularly useful for students who prefer self-paced learning or require additional support outside scheduled teaching hours. AI-enabled translation and assistive technologies may further extend access to educational content for students with diverse linguistic and learning needs.[1,3,7]

3.6 Integrated learning and intelligent tutoring system

AI-driven intelligent tutoring systems can contribute to integrated learning by combining individualized instruction, continuous assessment, feedback, and access to relevant learning resources. These systems can identify knowledge gaps, recommend appropriate learning activities, and adjust the difficulty of tasks according to student performance. When integrated with conventional teaching, intelligent tutoring systems can provide additional opportunities for practice and individualized support without replacing the role of educators. [3,7]

3.7 Continuous evaluation and improvement in the long run

AI facilitates continuous evaluation and improvement by providing real-time insights into student learning performance and learning outcomes. Through data analytics, AI can track student progress, identify trends and highlight areas for improvement. [3,7]

3.8 Raising academic standards and educational quality

The integration of AI in education has the potential to raise academic standards and improve the overall quality of education. Artificial intelligence can help ensure consistency and accuracy in grading, provide access to high-quality resources and support educators in delivering effective instruction. By leveraging AI technologies, educational institutions can offer a more rigorous and comprehensive curriculum that meets the evolving needs of students. AI can facilitate collaborative learning environments, where students and educators can share knowledge and resources, fostering a culture of continuous learning and improvement. [6].

4 IMPLICATIONS OF AI FOR NURSING EDUCATION

4.1 Improves Clinical Decision-Making

It can process large amounts of patient information within seconds and help healthcare professionals identify patterns that may otherwise take longer to recognize.[8]. Most exciting aspects of AI in nursing is its ability to assist in the early identification of patient deterioration. It can predict risks such as sepsis, falls, or pressure ulcers and support evidence-based clinical decisions. These capabilities do not replace a nurse's expertise. Instead, they strengthen your ability to make When combined with professional judgment and compassionate care, AI can contribute to better patient outcomes and safer healthcare practices.

4.2 Enhances Patient Safety

AI is playing an increasingly important role in achieving patient safety.AI-powered systems can detect medication errors before they reach the patient. They can alert nurses when vital signs become abnormal and improve the accuracy of documentation and patient monitoring. These timely alerts provide healthcare professionals with an opportunity to intervene early and prevent complications.

4.3 Reduces Workload and Saves Time

AI can automate many of the routine activities and reduce administrative burden. Helps to spend\ less time in completing repetitive paperwork and give more time in providing emotional support, educating patients, and building meaningful connections with families. For nursing students, learning AI means preparing for a healthcare environment

where technology supports productivity rather than creating additional stress. It allows to focus on caring for patients with empathy and professionalism. [8]

4.4 Supports Personalized Patient Care

No two patients are exactly alike. Their medical history, lifestyle, treatment responses, and personal needs differ from one another. This is why personalized patient care has become an important focus in modern healthcare. AI can analyze patient history, genetics, lifestyle factors, and treatment responses to support individualized care plans. These insights help healthcare teams make better decisions that match the specific needs of each patient. [7, 8]

4.5 Strengthens Research Skills

AI tools can help nursing students search and summarize scientific literature, analyze research data, identify trends and patterns, and organize academic work more efficiently. This saves time and allows students to focus more on understanding and applying research findings. [7, 8]

4.6 Prepares Nurses for Future Healthcare

AI-assisted diagnostic systems, smart hospitals, wearable health devices, remote patient monitoring, and virtual nursing assistants are already becoming part of everyday healthcare. Nurses who embrace innovation while preserving the caring values of their profession will continue to lead healthcare with confidence and compassion. [8]

4.7 Improves Digital and Data Literacy

Learning AI helps nursing students develop critical thinking, data interpretation skills, digital competence, and ethical decision-making regarding technology. These skills improve confidence and prepare students to work effectively in technology-driven healthcare settings. [8]

4.8 Encourages Lifelong Learning and Innovation

One of the fascinating things about AI is that it never stands still. New tools, new discoveries, and new applications continue to emerge, creating exciting opportunities for healthcare professionals. Learning AI encourages nursing students to stay curious, embrace innovation, and develop problem-solving skills. It inspires a mindset of continuous learning, which is essential in a profession that evolves every day. [8]

4.9 Promotes Ethical and Responsible Use of Technology

Technology should always serve humanity, and healthcare professionals have an important role in ensuring that it is used ethically and safely. Nursing students should understand patient privacy and confidentiality, data security, bias in AI algorithms, and the importance of human oversight in AI-assisted care. These principles help ensure that technology remains trustworthy and beneficial for patients.[7,8]

Table 1: Positive vs negative impacts on students at a glance [9]

Positive impacts	Negative impacts
Personalized learning according to individual needs and pace	Reduced independent thinking when AI is excessively relied upon
Improved access to academic support beyond regular class hour	Reduced sense of ownership and responsibility for learning
Timely feedback and learning assistance	Academic anxiety related to monitoring and data collection
Greater access for students requiring adaptive or assistive support	Reduced peer-to-peer interaction and collaboration
Support for self-directed learning	Risk of accepting inaccurate or biased AI-generated information
Increased flexibility in learning	Potential dependence on AI for routine and complex academic tasks

5 CHALLENGES OF USING ARTIFICIAL INTELLIGENCE IN EDUCATION

5.1 Data Privacy and Security

AI systems often require substantial learner data, including academic performance, behavioral information and interaction histories[11]. This creates risks concerning consent, ownership, secondary use and unauthorized disclosure.[12] Educational institutions must therefore establish clear rules for data minimization, secure storage, access control and responsible data sharing [13]. Privacy protection is particularly important because students may have limited ability to understand or challenge how their data are collected and processed [15].

5.2 Algorithmic Bias and Inequality

AI systems can reproduce or amplify biases present in training data, system design or deployment contexts. Biased recommendations, classifications or automated evaluations may disadvantage learners according to language, gender, disability, socioeconomic background or other characteristics. In addition, unequal access to devices, reliable internet connectivity and advanced AI tools can widen existing educational inequalities. Responsible implementation therefore requires fairness testing and policies that address both algorithmic and infrastructural inequality [16].

5.3 Academic Integrity and Assessment

Generative AI can produce essays, answers, code and summaries that students may submit as their own work. This creates difficulties for conventional assessment and raises questions about authorship, originality and the validity of grades. A systematic review of academic integrity literature identifies technological, institutional and social factors contributing to integrity violations [11]. Institutions consequently need clear AI-use policies and assessment designs that emphasize process, explanation, application and critical reasoning rather than relying exclusively on easily generated written outputs.

5.4 Accuracy, Reliability and Transparency

AI-generated content can contain factual errors, fabricated references, misleading explanations or outdated information. These problems are especially serious in education because learners may treat fluent responses as authoritative. The difficulty of understanding how some AI systems reach their outputs also limits transparency and accountability. Human verification, source checking and appropriate disclosure of AI use are therefore essential.

5.5 Teacher Readiness and Changing Professional Roles

Effective AI adoption depends on teachers having sufficient technical, pedagogical and ethical knowledge. Without professional development, educators may either over-rely on AI or avoid useful applications altogether. Recent literature on AI in education emphasizes the continuing importance of teacher intervention, institutional policies and professional development. AI should support teachers' judgement and capacity rather than reduce teaching to automated decision-making [12].

5.6 Digital Divide and Unequal Access

AI-enabled education may benefit students who have access to high-quality devices, broadband connectivity and paid or advanced AI services more than students with limited resources. Differences in digital skills can further widen this gap. Consequently, AI integration should be accompanied by investments in infrastructure, accessibility and digital literacy so that technological innovation does not reinforce existing social and educational disparities.

5.7 Over-reliance and Loss of Human Learning Skills

Excessive dependence on AI may reduce opportunities for learners to practice writing, problem solving, information evaluation and independent reasoning. AI can be useful as a learning assistant, but it should not replace the cognitive effort through which learners develop durable knowledge and judgement. UNESCO therefore advocates a human-centered approach in which AI strengthens human agency rather than substitutes for it [13].

6 AI DEPENDENCY AND ADDICTION

6.1 AI Dependency in Education

AI dependency can be understood as excessive reliance on AI systems for tasks that learners could reasonably perform independently. An exploratory study was conducted to develop and validate a Scale for Dependence on Artificial Intelligence among university students, specifically highlighting concerns that excessive reliance may be associated with reductions in cognitive skills and motivation [21]. More recent empirical work among medical students has also examined

AI dependence alongside critical-thinking disposition, demonstrating that the issue is becoming a measurable research topic rather than only a theoretical concern.

6.2 Emerging Evidence of AI Addiction-Like Use

Recent research has begun to operationalize AI addiction-like behavior through dimensions including salience, excessive dependency, mood modification and functional impairment. A 2026 study involving undergraduate students reported that frequency of generative-AI use was a strong predictor of scores on these dimensions, with daily users showing higher levels across the measured domains [20]. Another mixed-methods study of nursing students reported themes of AI addiction and "AIlessphobia," describing distress associated with being without access to AI and perceived reductions in critical thinking [23]. These findings are important, but they should be interpreted cautiously because AI addiction is still an emerging construct and the evidence base is not yet equivalent to the evidence for established behavioral addictions.

7 FACTORS CONTRIBUTING TO AI DEPENDENCY

7.1 Convenience and Immediate Feedback

AI systems provide rapid answers and personalized explanations. This convenience can reinforce repeated use, especially when students experience academic pressure or limited time.

7.2 Academic Workload and Performance Pressure

Heavy workloads, deadlines and expectations for high performance may encourage students to delegate increasingly complex tasks to AI rather than using it only as a learning aid [24].

7.2.1 Reduced Cognitive Effort

When AI routinely generates ideas, explanations or solutions, learners may perform less independent planning, retrieval, writing and problem solving. Recent reviews of higher education research identify over-reliance and possible effects on independent learning as important concerns.

7.3 Emotional and Psychological Reinforcement

Conversational AI is available continuously and responds immediately. For some users, this may create reassurance or perceived companionship, increasing the likelihood of repeated interaction [24].

7.4 Limited AI Literacy

Students who do not understand AI limitations may interpret fluent responses as authoritative. Weak evaluation skills can encourage passive acceptance and deeper dependence.

7.5 Strategies to Prevent Harmful Dependence

Develop AI literacy programmes that teach students what generative AI can and cannot reliably do. Encourage a 'think first, AI second' approach in which learner's attempt independent reasoning before requesting AI assistance. Redesign assessments to include oral defense, process journals, drafts, reflection, project-based work and application of concepts. Teach students to verify AI-generated claims, references and calculations using authoritative sources [27].

Establish reasonable boundaries for AI use during study and assessment, including AI-free activities where independent skill development is the objective. Provide teacher training so educators can distinguish productive AI assistance from outsourcing of learning. Monitor signs of problematic use, such as inability to begin tasks without AI, distress when access is unavailable, or repeated use despite negative academic consequences. Use human judgement for high-stakes educational decisions and maintain clear institutional policies concerning privacy, authorship and responsible AI use.

8 COGNITIVE, PSYCHOLOGICAL AND BEHAVIORAL EFFECTS OF EXCESSIVE ARTIFICIAL INTELLIGENCE USE

8.1 COGNITIVE EFFECTS

8.1.1 Cognitive Offloading and Reduced Independent Reasoning

Cognitive offloading occurs when individuals transfer mental tasks to external tools. AI can reduce immediate mental effort by generating ideas, explanations, summaries and solutions. This may be beneficial when AI is used strategically,

but excessive offloading can reduce opportunities to practice retrieval, analysis, writing and problem solving. A recent study of university students found that greater AI dependence was associated with lower critical-thinking levels, while cognitive fatigue partially mediated the relationship [28].

8.1.2 Critical Thinking and Metacognition

Critical thinking depends on questioning evidence, comparing alternatives and forming justified conclusions. When users accept AI-generated outputs without verification, automation bias may weaken these processes. A 2025 systematic review and meta-analysis found that generative AI can improve several university learning outcomes, but the pooled effect on metacognition was not statistically significant, suggesting that improved performance does not necessarily mean improved self-regulated learning [18].

8.1.3 Cognitive Fatigue

Intensive interaction with AI can also create cognitive demands through continuous evaluation, prompt refinement and verification of generated information. Tian and Zhang reported cognitive fatigue as a partial mechanism linking AI dependence with critical-thinking outcomes [28]. This suggests that the psychological effect of AI is not simply a matter of reduced effort; poorly managed AI interaction may also create additional mental load.

9 PSYCHOLOGICAL EFFECTS

9.1 Emotional Reliance and Attachment

Conversational AI differs from conventional digital tools because it can respond in a socially engaging and apparently personal manner. Research has begun examining AI chatbots as sources of perceived social support for loneliness and anxiety, while also highlighting questions about the limits of machine-mediated support [27]. Emerging work on anthropomorphic chatbots further suggests that repeated interaction may contribute to emotional attachment and dependency in some users. These findings warrant caution, particularly when AI begins to substitute for human relationships.

9.2 Anxiety, Uncertainty and Loss of Confidence

Heavy reliance on AI may alter users' confidence in their ability to perform tasks independently. If individuals repeatedly depend on AI for writing, decision-making or problem solving, the absence of the tool may produce uncertainty or perceived inability. This possibility is especially relevant among students who are still developing foundational academic skills.

9.3 Psychological Well-being

The psychological effects of AI use are heterogeneous. A 2025 systematic scoping review of empirical research on school students identified cognitive, emotional and behavioral responses to AI as important areas of investigation. The literature includes potential benefits such as engagement and support as well as concerns about over-reliance and other adverse outcomes [26]. Therefore, excessive AI use should be understood within a broader framework of digital well-being rather than assumed to have one universal psychological effect.

10 BEHAVIOURAL EFFECTS

10.1 Habit Formation and Repetitive Use

Convenience, immediate feedback and constant availability can reinforce repeated AI use. Over time, users may develop a habit of consulting AI before attempting a task independently. Such behavior can shift AI from an optional aid to a default first response [29].

10.2 Academic and Workplace Behavior

Excessive AI assistance may change how people approach writing, research, decision-making and problem solving. In educational settings, students may outsource substantial portions of assignments; in professional settings, workers may increasingly delegate judgement-intensive tasks. Such changes can improve efficiency but may also reduce opportunities for skill development [30].

10.3 Social Behavior

When AI is repeatedly used for advice, emotional support or companionship, interpersonal behavior may change. AI can supplement social support, but replacing human interaction with artificial interaction may reduce opportunities to

develop communication, empathy and conflict-resolution skills [31]. Evidence in this area is still emerging and should not be interpreted as proof of a universal social harm.

10.4 Self-Regulation

Healthy AI use requires users to determine when assistance is useful and when independent effort is necessary. Weak self-regulation can lead to frequent checking, automatic prompting and difficulty completing tasks without AI. AI literacy and metacognitive strategies can help users maintain control over these behaviors.

11 CONCLUSION

Artificial Intelligence is transforming education by making learning more personalized, accessible, interactive, and efficient. AI tools can support students in understanding difficult concepts, developing skills, receiving timely feedback, and accessing learning resources according to their individual needs. However, excessive dependence on AI may reduce independent thinking, creativity, problem-solving abilities, and meaningful human interaction, and may contribute to psychological and behavioral concerns.

Therefore, AI should be viewed as a supportive educational tool rather than a replacement for teachers, human interaction, or students' independent efforts. In nursing education, responsible integration of AI can support learning, clinical reasoning, research skills, digital literacy, and preparation for technology-enabled healthcare. The future of AI in education holds considerable potential when it is used responsibly, ethically, and in a balanced manner. With appropriate guidance, AI literacy, and human oversight, AI can complement traditional education and contribute to an effective, inclusive, and future-ready learning environment.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

All authors have disclosed any potential competing interests as per the checklist provided. No conflicts of interest are declared.

Declaration of Originality and Authorship

This manuscript is based on original work and has not been published in part or whole in any print or electronic media. It is also not under consideration elsewhere, except as an abstract in conference proceedings.

- All listed authors meet the following authorship criteria:
- Contributed to the conception/design or analysis/interpretation of data.
- Drafted or critically revised the article for important intellectual content.
- Approved the final version to be published.

No person who contributed substantially has been excluded from authorship. Contributors with limited roles have been acknowledged within the manuscript.

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