Journal of Advances in Social Sciences
2025, Volume1, Issue1 | ISSN 3105-899X | eISSN 3105-9007

A Theoretical Analysis of Factors Influencing Nursing Professionals' Lifelong Learning in AI-Enhanced Environments

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Received
2025-9-18
Accepted
2025-10-3
Published
2025-10-28

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DOI: 10.65192/mkta0h94

Abstract

The rapid development of artificial intelligence (AI) has brought profound transformations to education systems worldwide. Nursing, as a profession that requires continuous learning and up-to-date clinical competence, faces both new challenges and opportunities in the AI era. The paper draws upon adult learning theory to analyse how AI-driven learning environments affect nurses' lifelong learning. This study analyzes the key factors influencing lifelong learning among nursing professionals in the context of AI: the convenience of intelligent applications, the diversity of learning places, the personalization of learning content, the interactivity of the learning process, and the effectiveness of learning evaluation. Finally, the study concludes with the presentation of a series of practical recommendations for nursing educators, hospitals, and policymakers, with a view to enhancing the integration of AI technology into continuing nursing education.

Keywords
Artificial intelligence; Lifelong learning; Nursing professionals; Adult learning

1. Introduction

Since the end of the 20th century, the rise of various "man-machine battles" has made people increasingly interested in AI. More and more countries have incorporated the development of AI into their national strategy (Ayeni et al., 2024). In May 2025, the International Conference on Artificial Intelligence and Education (ICAIE) was held in Suzhou, China, once again emphasizing the important role of AI in education and promoting the deep integration of AI and education. At present, AI has permeated various fields of society such as healthcare, finance and education, bringing about significant changes to our lives (Zhai et al., 2021). As AI technology continues to evolve, its impact on education and learning will become even more pronounced.

In recent years, there has been an increasing application of technologies such as intelligent tutoring systems, adaptive learning platforms, data-driven assessment, and virtual simulation to the training of nursing professionals (Hwang et al., 2024). It is imperative that nurses con-

tinually update their clinical knowledge, digital literacy, and decision-making skills in order to adapt to the rapidly evolving environment of healthcare. Consequently, lifelong learning is not merely a personal development requirement but also an essential professional competency for nurses. This is because nursing professionals frequently encounter onerous workloads, variable duties, and rapidly evolving clinical practices. Conventional forms of continuing education, including workshops, lectures and short-term training, frequently entail considerable time investment, are often constrained by geographical location, and can prove challenging to align with nurses' schedules (Mlambo et al., 2021). Consequently, a significant proportion of nurses encounter difficulties in sustaining consistent professional development while effectively managing their work and personal obligations. The advent of AI has furnished novel solutions to these challenges. AI-supported learning systems enable nurses to study at their own pace, utilising digital modules, micro-courses, or virtual clinical simulations that can be accessed at any time and in any location. Intelligent algorithms have the capacity to recommend learning content according to individual experience, practice area, or professional goals, while real-time analytics track progress and competency development (Ma et al., 2025).

Against this background, it is essential to explore the key factors that influence nurses' willingness and ability to engage in lifelong learning under the impact of AI. By identifying these factors, the study can provide insights into how hospitals, nursing associations, and policymakers can better design effective lifelong learning systems for nurses. This study uses a qualitative and literature-based conceptual approach to discuss these factors. Instead of collecting new data, the study relies on a careful review of existing research and theoretical discussions about nursing education, adult learning, and technology. It aims to build a clear understanding of how AI and adult learning theory together explain the process of lifelong learning for nursing professionals. The results are based on logical reasoning and integration of prior research, not on statistical testing. Although the study does not include field data, it offers a theoretical view that can guide future empirical research and practical strategies for supporting lifelong learning in nursing.

2. Artificial Intelligence and Lifelong Learning

Artificial Intelligence (AI) is a branch of computer science that constructs intelligent machines or intelligent systems through artificial methods and techniques, enabling machines or systems to simulate, extend and expand human intelligence. According to the process of the development of AI technology, it can be divided into three main stages: computational intelligence, perceptual intelligence, and cognitive intelligence. Computational intelligence is the most basic form of AI that uses the ability of computers to store and process data quickly to give machines the ability to calculate, store and transfer information like humans. In the field of education, computational intelligence can be used to store and transfer the resources needed for learning, and to build intelligent student information management systems. Perceptual intelligence, which enables machines to have various perceptual abilities such as sight, hearing and touch, and to interact with humans, is currently the main stage of AI development. In the field of education, it can be applied to areas such as speech teaching, oral language assessment, and image search. Cognitive intelligence is the ability to simulate human reasoning, association and knowledge organization. It is a hot topic in AI research and a breakthrough point for future development. It can support personalized and self-directed learning in the field of education (Wu et al., 2017).

AI is a further upgrade of Internet technology, which not only have the typical openness and globality of the Internet, but also fully demonstrate personalization and interactivity. The

development and application of the Internet have transformed the way people learn, and various online education industries are booming. With devices such as mobile phones, iPads and computers, people can search for a vast amount of learning resources and choose the time and place that suits them to study. However, in the face of various forms and difficulties of learning resources, many people do not know how to find a suitable learning path for themselves, resulting in problems such as "learning disorientation" and "knowledge overload", constantly facing questions such as "what to learn" and "what to learn next", this phenomenon greatly reduces the personalized advantage of online learning (Jiang et al., 2018). By using AI technologies such as data mining and personalized recommendations to conduct personalized analysis based on the characteristics of learners, it is possible to plan learning paths specifically, precisely recommend learning resources needed by different learners, thereby enhancing learning enthusiasm, improving learning quality, and promoting personalized development of learners (Feng, 2019). The application of perceptual intelligence technologies such as facial recognition and voice recognition can help teachers focus on the learning process of students, enable real-time interaction among students and between students and teachers, and fully enhance the experience of online courses. The combination of AI and virtual reality will further enrich the learning experience. In particular in the field of vocational education and training, through virtual classrooms, training in projects such as lathe operation and car repair can be achieved without being restricted by venues and equipment (Rojas-Sánchez et al., 2023).

To sum up, AI facilitates a continuous process in which individuals can acquire, update, and apply knowledge throughout their lives. This transformation is indicative of a more extensive shift towards Education 4.0, a paradigm in which learning systems are characterised by flexibility, interconnectedness, and a perpetual capacity for adaptation to technological and social change (Arias et al., 2025). Intelligent systems have the capacity to enable individuals to transfer skills and knowledge between workplaces, online platforms and educational institutions. This integration is congruent with the global demand for upskilling and reskilling, wherein learning is regarded as a lifelong necessity rather than a discrete phase of human development. Moreover, the field of AI has the potential to facilitate the establishment of learning societies that prioritise adaptability, digital competence, and equitable access to educational opportunities (Laupichle et al., 2022). A representative context for analyzing lifelong learning in the AI era is provided by nurses, who are typical adult learners who need to continuously update their professional knowledge. Therefore, it is essential to use adult learning theory, which provides a theoretical framework for comprehending the traits and requirements of adult learners, in order to more accurately interpret their learning behavior and motivation.

3. Adult Learning Theory and Its Relevance to the Lifelong Learning of Nursing Professionals

The characteristics of adult learning are determined by the uniqueness of adult learners themselves, which are quite different from those of general education learners. On the one hand, different adults have different developmental backgrounds and thus have certain uniqueness in terms of physical and mental development such as cognition, emotion and will. On the other hand, as adults are learners in society, they inevitably take on the role of workers, which significantly affects adult learning. In general, the characteristics of adult learning are mainly reflected in many aspects such as self-directed learning, practical learning content, relatively flexible learning time, unstable learning location and diverse learning forms.

First, the learning is self-directed. Knowles argues that as adults grow older, their self-concept shifts from dependent to self-directed, and psychologically and socially from dependent, het-

ero-regulated to independent, self-disciplined (Liu & Feng, 2016). This transformation turns adults into self-directed individuals, and as adult learners mature, their self-directed nature gradually increases. Adults are able to critically examine their situation and define the learning objectives they need. Generally speaking, adult learning purposes can be divided into three types. For the first category, the main purpose of learning is to improve technical skills, give oneself an advantage in competition, and thus find a better job or get a promotion and a raise. The main purpose of the second category of people is to obtain the corresponding diploma. In today's employment process, "academic qualifications" remain an extremely important stepping stone, so they must obtain the corresponding diplomas. Of course, there are also people who are forced to improve their academic qualifications for purposes such as promotion or professional title evaluation. The third group of people, whose main purpose of learning is to achieve self-improvement, view learning as a need for self-actualization, often without obvious utilitarianism.

Second, the learning content is practical. According to existing research results, intelligence can be divided into fluid intelligence and crystalline intelligence (Yuan, 2000). Fluid intelligence, which is based on physical development and gradually weakens with age, mainly refers to the ability of mechanical memory. Crystallized intelligence is closely related to social factors such as energy and experience. Generally, it does not decline with age and may even improve. It is mainly manifested as the use of already acquired knowledge and experience to absorb new knowledge and handle new problems. For adults, although the decline in fluid intelligence may affect memory ability, they have a certain experience and knowledge base, and are more likely to connect the learning of knowledge related to work and life with the existing knowledge structure, and can solve problems in real-world experience very well. Therefore, practical learning content related to work and life is more likely to be accepted by adult learners. Moreover, for the majority of adult learners who have left school, their learning content is often oriented towards various problems or difficulties encountered in real work and life, and the demand for learning content is obviously practical.

Third, the study time is relatively flexible. Adult learners are generally people who have entered society and hold some social positions. Financial burdens or job responsibilities make adult learning time relatively tight, with a prominent contradiction between work and study. Flexible schedules are a prerequisite for adults to study effectively. Adult learning is dominated by fragmented time utilization, making it difficult to ensure stable learning conditions for longer periods (Moore et al., 2023). In addition, adult learning usually occurs when problems or difficulties are encountered, and if the problems or difficulties are resolved, the learning activity comes to an end. Learning activities resume only when new problems or difficulties arise, so adult learning time is also discontinuous.

Fourth, the place of study is unstable. On the one hand, the entities providing services to adult learners are diverse, including institutions of higher learning and other social organizations such as companies, enterprises and communities. Schools are no longer the only place for learning. On the other hand, due to various reasons such as work, time and distance, the location of adult learning activities can only be chosen according to actual needs and is difficult to be fixed. Even for students participating in formal adult higher education, it is not guaranteed that they will study on campus for a long time. However, various forms such as correspondence and distance education allow for the selection and flexible arrangement of study locations as needed. In addition to formal and informal learning venues, many learning activities also take place in informal learning locations such as at home, on the vehicle, and in the workplace. Learning that takes place in the workplace alone can take place in meeting rooms,

workshops, restaurants, or even on sofas in leisure areas (Hrastinski et al., 2024).

Finally, the forms of learning are diverse. The particularity of adults enables adult learning to take on both formal and informal forms, as well as non-formal ones (Johnson & Majewska, 2022). In terms of the forms of adult higher education in our country, there are various forms such as traditional face-to-face courses, correspondence education based on correspondence materials through communication, and online education using the Internet and other communication media. Adult informal learning, on the other hand, is more flexible, with the ability to study anytime and anywhere through portable devices such as mobile phones and ipads.

In summary, adult learning theory emphasizes autonomy, self-direction, practical relevance, and flexibility—features that perfectly match the professional characteristics of nurses. Nurses, as adult learners, often balance clinical responsibilities, family life, and professional development. They prefer learning experiences that are relevant, problem-centered, and immediately applicable to their work. Adults learn best when they can control their learning pace, connect new knowledge with prior experiences, and understand the real-world purpose of learning. These principles apply directly to nursing continuing education, where learning should be authentic, flexible, and task-oriented. Based on this understanding, this study adopts adult learning theory as its main conceptual framework to analyze and interpret the factors that influence lifelong learning among nursing professionals. The theory serves as the bridge between the conceptual background and the analytical framework described in the next section, ensuring that the study's logic remains coherent and theoretically grounded.

4. Influencing Factors of Lifelong Learning for Nursing Professionals in the AI Era

In the context of AI-driven education and learning, lifelong learning for nurses is influenced by several interconnected factors. Based on the characteristics of AI and adult learning, this study identifies five core aspects: the convenience of intelligent applications, the diversity of learning places, the personalization of learning content, the interactivity of the learning process, and the effectiveness of learning evaluation. These factors jointly determine how nurses perceive, engage in, and benefit from lifelong learning supported by intelligent technologies.

First, the convenience of intelligent applications refers to the accessibility, flexibility, and efficiency of AI-based learning systems. Adult learners, due to the characteristics of physiological development, will gradually decline in mechanical memory and reaction speed, and due to social pressure and other reasons, are often less interested in new things than minors in coming into contact with and learning. Adults have a strong sense of self-esteem, and if they encounter insurmountable difficulties when exposed to new things, it may affect their self-confidence and, in turn, their enthusiasm for learning. The convenience of operating AI can affect adults' interest in using the technology to learn. Nursing professionals often work long and irregular hours, which makes it difficult to attend traditional training sessions. Intelligent online platforms allow them to learn anytime and anywhere, using mobile devices or hospital-based systems. For example, an AI-assisted continuing education platform can automatically recommend short learning modules during breaks or after shifts. When learning resources are embedded into daily work processes, such as electronic medical records linked to educational materials, nurses are more likely to engage in continuous learning without feeling an additional burden.

Second, the diversity of learning places represents the richness and variety of learning resourc-

es provided by AI environments. The particularity of adults makes it difficult to fix the place where adults study. While people can choose different places for online and mobile learning, there are still many things to learn that have to go to a fixed place or cost a lot of money, such as training content that requires large equipment, or training that requires a lot of materials to repeat practical operations. The application of AI is expected to break down these barriers that restrict adult learning and completely change the situation. The combination of virtual reality technology and AI can not only provide a sense of "reality" in terms of perception such as vision and hearing, but also achieve a sense of "real" touch. If educators no longer have to spend a lot of money on materials and equipment, and learners do not have to squeeze out time to go to fixed places of study, learners' enthusiasm and efficiency will be greatly enhanced. The diversity of learning places should not be limited merely to the transformation of physical Spaces, but rather to the combination of physical and virtual Spaces. Traditional nursing training often relies on lectures or printed manuals, but AI technologies enable multi-modal learning experiences, such as video tutorials, virtual simulations, interactive quizzes, and case-based discussions (Roveta et al., 2025). For instance, a nurse learning about wound care may simultaneously watch clinical videos, interact with virtual patients, and participate in AI-facilitated peer discussions. The diverse formats not only make learning more engaging but also address different learning preferences and cognitive styles among nurses.

Third, the personalization of learning content is one of AI's most significant contributions to lifelong learning. The realization of personalized learning should first be based on the different characteristics of adult learners, with tailored learning strategies and personalized learning guidance provided at the same time; rich and personalized learning resources should also be provided for adult learners in different time and space settings; and it should enhance meaningful interaction between learners and learning resources as well as among learners themselves (Zhou, 2018). The development of the Internet has provided adults with a vast amount of learning resources, but adult learners have difficulty choosing the appropriate content to study, let alone planning their learning paths well. To truly achieve personalized learning, AI needs to have a deep understanding of adult learners and provide them with personalized learning methods and content. For example, intelligent algorithms analyze nurses' learning behaviors, previous performance, and interests to tailor content and pacing. An AI-driven learning management system might recommend advanced modules on intravenous therapy to a nurse who excels in basic nursing procedures, while another nurse might receive more foundational materials. Personalization ensures that learning remains relevant and efficient, helping each nurse to achieve competence at an appropriate level and speed. It also aligns with the self-directed nature of adult learning, giving nurses more control over their learning pathways.

Fourth, the interactivity of the learning process refers not only to the input and output of information between humans and machines, but also to the communication and interaction between learners as well as between learners and educators. Learning situations with good interactivity have a significant effect on efficient learning in adults. The better the interactivity, the more it can enhance the learning experience and efficiency of learners. Effective interaction between humans and machines enables timely understanding of adults' learning needs and learning dynamics, thereby providing corresponding feedback. Educators can also adjust their teaching strategies in a timely manner based on the learning situation of learners. Adult learners need to exchange learning experiences with each other and create a relaxed and supportive learning atmosphere. And this will all be thanks to the further development and application of AI technologies such as voice and facial recognition. For example, AI-based virtual patients can respond dynamically to nurses' interventions, creating a safe yet authentic learning environment. In addition, online communities supported by AI tools enable peer learning and mentor-

ship across institutions. Such interactive features strengthen motivation and improve clinical reasoning skills.

The final influencing factor is the effectiveness of learning evaluation, which involves real-time evaluation and feedback on the learning process and learning outcomes. Being accustomed to evaluating the outcome of learning while neglecting evaluation throughout the learning process not only affects the effectiveness of evaluation, but also affects learning enthusiasm and learning outcomes due to the lack of effective feedback during the learning period. To fully leverage the advantages of AI, real-time monitoring and analysis of various factors such as the characteristics, time and place of adult learning, and comprehensive assessment according to certain rules, both learners and educators can receive corresponding evaluation results in a timely manner. In addition, we should view the evaluation results dialectically, seek guidance and analysis from educators or others in a timely manner, and draw more appropriate conclusions. The era of subjective evaluation by educators is fading away. For instance, a nursing simulation system may track how accurately a nurse performs procedures and provide instant feedback. Predictive analytics can also identify them at risk of falling behind, allowing educators to offer timely support. Intelligent evaluation thus transforms assessment from a final check into an ongoing, formative process that guides learning improvement. Human-machine assistance will lead to more timely and effective learning evaluations, thereby better promoting nursing professionals' learning.

5. Strategies for Enhancing AI-Enabled Lifelong Learning in Nursing

Based on the five influencing factors discussed above, several strategies can help improve the integration of AI into lifelong learning for nursing professionals. These recommendations are aimed at three levels—institutions, educators, and individual nurses.

5.1 Institutional strategies

First, develop intelligent learning platforms. Hospitals, universities, and nursing associations should invest in digital infrastructure that supports AI-based learning management systems. A well-designed platform can offer modular courses, virtual simulations, and personalized progress tracking. For example, hospitals can collaborate with universities to create shared platforms where nurses complete required continuing-education credits through AI-assisted micro-courses.

Second, integrate learning with clinical workflows. AI systems can link learning resources with electronic medical records or daily clinical tasks. When a nurse documents patient care, the system might suggest short, relevant learning materials such as updated wound-care guidelines. This contextualized learning reduces time barriers and makes education a seamless part of professional practice.

Third, ensure data security and equity. Institutions must also guarantee information safety and equal access. Data collected through AI platforms should be anonymized and used only for educational purposes. Special attention should be paid to nurses in rural or resource-limited hospitals to ensure they have equal opportunities for AI-supported learning.

5.2 Strategies for nursing educators

First, adopt a blended-learning mindset. Nursing educators should combine AI-enabled online learning with traditional mentoring and clinical instruction. Blended models can balance effi-

ciency and human interaction, which remains critical in developing professional empathy and ethical judgment.

Second, enhance digital literacy and instructional design skills. Educators need professional development to design effective AI-based courses. Understanding how to interpret learning analytics, adjust algorithms, and evaluate learner data will help teachers use AI more meaningfully. Universities can organize training workshops or certification programs on digital pedagogy for nursing faculty.

Third, focus on reflective learning and critical thinking. While AI can provide information quickly, educators must guide nurses to reflect, question, and apply what they learn. Assignments that connect AI-generated feedback with real clinical cases can strengthen critical thinking and judgment.

5.3 Strategies for individual nurses

First, strengthen self-management and motivation. Lifelong learning requires self-discipline. Nurses should actively schedule learning time, set personal goals, and use AI tools to monitor their progress. Gamified learning modules or digital badges can increase motivation.

Second, develop digital and information literacy. Nurses need to understand how AI systems operate and how to evaluate digital resources. Basic knowledge of data ethics, privacy, and algorithm bias can help them use AI safely and responsibly.

Third, build collaborative networks. AI platforms that support social learning allow nurses to share experiences and solutions. Participating in online communities of practice encourages knowledge exchange across departments or hospitals, enhancing professional growth.

6. Conclusion

The integration of AI into nursing education marks a new stage in the development of lifelong learning. AI technologies expand the possibilities for continuous professional development by making learning more accessible, diverse, and data-driven. This study identified five major influencing factors that shape nurses' engagement with AI-based learning: the convenience of intelligent applications, the diversity of learning places, the personalization of learning content, the interactivity of the learning process, and the effectiveness of learning evaluation. As adult learners, nurses benefit from flexible and relevant learning experiences that connect directly to their clinical work. AI provides technical means to support these needs through intelligent recommendation systems, adaptive simulations, and real-time feedback. Yet technology alone cannot guarantee effective learning. Institutional support, educator competence, and individual motivation remain decisive factors.

Future research should explore empirical evidence on how AI affects learning outcomes and patient care quality. Longitudinal studies and mixed-methods approaches could measure how nurses' skills, satisfaction, and confidence evolve through AI-supported learning. Policymakers and hospital administrators should view AI not as a substitute for human instruction but as a collaborative partner that enhances the capacity of both teachers and learners. Ultimately, AI-enabled lifelong learning can offer a sustainable pathway for building a professional, innovative, and compassionate nursing workforce capable of meeting the complex demands of modern healthcare.

Funding

There is no funding to report.

Conflicts of Interest

The author(s) declare no conflicts of interest regarding the publication of this paper.

Ethics Statement

Not applicable.

References

Arias, J., Salas, J. I., Chiappe, A., & Sáez Delgado, F. (2025). The Extended Education 4.0: Lifelong Learning in Times of Artificial Intelligence. *Applied Sciences*, *15*(17), 9352. https://doi.org/10.3390/app15179352

Ayeni, O. O., Al Hamad, N. M., Chisom, O. N., Osawaru, B., & Adewusi, O. E. (2024). AI in education: A review of personalized learning and educational technology. *GSC Advanced Research and Reviews*, *18*(2), 261-271. https://doi.org/10.30574/gscarr.2024.18.2.0062

Feng, X. Q. (2019). Research hotspots and development trends of data mining technology in personalized learning: Visual analysis based on CiteSpace V. *The Chinese Journal of ICT in Education*, *26*(21), 19-24+63.

Hrastinski, S., Paul, E., & Akerfeldt, A. (2024). Temporal-spatial and pedagogical flexibility in distance education. *Distance Education*, *46*(3), 435–451. https://doi.org/10.1080/01587919.2024.2380370

Hwang, G. J., Tang, K. Y., & Tu, Y. F. (2024). How artificial intelligence (AI) supports nursing education: profiling the roles, applications, and trends of AI in nursing education research (1993–2020). *Interactive Learning Environments*, *32*(1), 373-392. https://doi.org/10.1080/10494820.2022.2086579

Jiang, Q., Zhao W., Li S., & Wang P. J. (2018).Research on the Mining of Precise Personalized Learning Path in Age of Big Data: Analysis of Group Learning Behaviors Based on AprioriAll. *Journal of E-education Research*, *39*(02),45-52. https://doi.org/10.13811/j.cnki.eer.2018.02.007.

Johnson, M., & Majewska, K. (2022). *Formal, non-formal, and informal learning: What are they, and how can we research them?* Cambridge Assessment.

Laupichler, M. C., Aster, A., Schirch, J., & Raupach, T. (2022). Artificial intelligence literacy in higher and adult education: A scoping literature review. *Computers and Education: Artificial Intelligence*, *3*, 100101. https://doi.org/10.1016/j.caeai.2022.100101

Liu, F. Y., & Feng, L. (2016). Exploration of Knowles' ideas on effective adult learning. *China Adult Education*, *25*(18), 10-13. https://doi.org/CNKI:SUN:ZCRY.0.2016-18-003

Ma, J., Wen, J., Qiu, Y., Wang, Y., Xiao, Q., Liu, T., ... & Sun, Z. (2025). The role of artificial intelligence in shaping nursing education: A comprehensive systematic review. *Nurse Education in Practice*, *84*(104345). https://doi.org/10.1016/j.nepr.2025.104345

Mlambo, M., Silén, C., & McGrath, C. (2021). Lifelong learning and nurses' continuing professional development, a metasynthesis of the literature. *BMC nursing*, *20*(1), 62. https://doi.org/10.1186/s12912-021-00579-2

Moore, R. L., Hwang, G.-J., & Moses, C. (2023). A systematic review of mobile-based microlearning in adult learner contexts. *Education and Information Technologies*, *28*(8), 9171–9195. https://doi.org/10.1007/s10639-023-11784-0

Rojas-Sánchez, M. A., Palos-Sánchez, P. R., & Folgado-Fernández, J. A. (2023). Systematic literature review and bibliometric analysis on virtual reality and education. *Education and Information Technologies*, *28*(1), 155-192. https://doi.org/10.1007/s10639-022-11167-5

Roveta, A., Castello, L. M., Massarino, C., Francese, A., Ugo, F., & Maconi, A. (2025). Artificial Intelligence in Medical Education: A Narrative Review on Implementation, Evaluation, and Methodological Challenges. *AI*, *6*(9), 227. https://doi.org/10.3390/ai6090227

Wu, Y. H., Liu, B. W., & Ma, X. L. (2017). Constructing an ecosystem of "artificial intelligence + education". *Journal of Distance Education*, *35*(05), 27-39. https://doi.org/10.15881/j.cnki.cn33-1304/g4.2017.05.003

Yuan, X. S. (2000). A new interpretation of the significance of fluid intelligence and crystallized intelligence. *Journal of Jining Teachers College*, *21*(01), 79-82. https://doi.org/CNKI:SUN:JNSI.0.2000-01-015

Zhai, X., Chu, X., Chai, C. S., Jong, M. S. Y., Istenic, A., Spector, M., ... & Li, Y. (2021). A Review of Artificial Intelligence (AI) in Education from 2010 to 2020. *Complexity*, *2021*(1), 8812542. https://doi.org/10.1155/2021/8812542

Zhou, N. (2018). A study on the application status of intelligent technology in adult education. *Journal of Guangdong Open University*, *27*(06), 19-23+66. https://doi.org/10.13974/j.cnki.51-1645/z.2018.06.005