Scoping Review

Using Artificial Intelligence in Online Learning Environments for Positive Student Outcomes: A Scoping Review

Noor-i-Kiran Naeem,[1] Haris Iqbal,[2] Zil-e-Fatima Naeem,[3] Asfanyar Anwer[4]

[1]Department of Medical Education, School of Medical Sciences, University, Sains Malaysia, Kota Bharu, Malaysia; [2]Department of Ophthalmology, Dr. Rehmatullah's Hospital, Gojra, Pakistan; [3]Department of Medicine, Services Institute of Medical Sciences, Lahore, Pakistan; [4]Department of Medicine, Services Institute of Medical Sciences,

Abstract

With advancing technologies and advances in online learning, the potential of Artificial Intelligence (AI) tools to revolutionize education is undeniable. This scoping review aims to explore the roles that AI can play in online learning environments in higher education. Utilizing the revised Arksey and O'Malley protocol we identified 24 roles and 47 subroles that enhance learning in digital cyberspace. AI technologies using machine learning, natural linguistic processing and predictive analysis can enable cognitive skill development, provide personalized learning and undertake efficient content curation for the learners. These applications are supported by five identified AI Attributes- responsiveness, adaptability, predictiveness, proactiveness and decisiveness, each contributing to an interactive learning environment. By leveraging these attributes, educators and administrators can create data-driven, adaptive learning frameworks that improve student engagement and performance in online platforms. This scoping review consolidates existing research and provides a structured analysis of functions where AI can be used in education. Findings highlight AI's potential to not only enhance accessibility but also optimize learning outcomes through intelligent automation and personalized learning.

Received: 16-08-2024 | **Revision:** 21-02-2025 | **Accepted:** 30-05-2025

Corresponding Author | Dr. Noor-i-Kiran Naeem, Department of Medical Education, School of Medical Sciences, University, Sains Malaysia, Kota Bharu, Malaysia. **Email:** noorikiran@yahoo.com

Keywords | Artificial Intelligence, Online learning environment, Student outcomes

How to cite: Naeem NIK, Iqbal H, Naeem ZEF, Anwer A. Using Artificial Intelligence in Online Learning Environments for Positive Student Outcomes: A Scoping Review. Ann King Edw Med Univ.2025;31(spi2): 119-129

Introduction

With the recent trends of use of technology in the field of education, there have been profound advancements in using Artificial Intelligence.[1] AI-driven tools are reshaping the learning experience for the students by ensuring accessibility, enhancing engagement and providing personalized learning across online educational settings. The roles of AI have been documented from developing intelligent tutoring systems utilizing chatbots to automated grading, enabling adaptive learning experiences that cater to individual students' needs.[2,3]

The use of AI on education involves application of machine learning algorithms, data analytics, and natural language processing. Overall, these approaches can lead to personalized learning experiences, provide real time feedback and personalize educational content according to individual learner's needs.[4] The use of AI aims to make education more accessible, engaging and

Production and Hosting by KEMU

https://doi.org/10.21649/akemu.v31iSpl2.5811

2079-7192/

effective for the learners, irrespective of age and background.

The potential of AI ais also promising for online learning environments. Where AI has shown benefits in enhancing learning by providing timely feedback, content recommendations and personalized instruction. These include the integration of AI tools in various pedagogical practices and sociocultural dimensions that influence learning outcomes. This scoping review utilizes the " Technology Enhanced Learning Environments in Medical Education (TELEMED),[5] a framework that systematically delineates key components of online learning platforms to identify places where AI can be used for effective student experience.[6] In contrast to other frameworks, TELEMED incorporates cognitive, digital and institutional factors that contribute to effective AI integration. This holistic perspective allows for a more structured exploration of the role of AI in online education.

This scoping review utilizes the TELEMED framework to explore the multifaceted roles and attributes of AI in online learning platforms in higher education. Particularly, this review examines how AI can drive positive learner outcomes through personalized and adaptive learning interventions. To guide this inquiry, this scoping review aims to answer the following research question:

" How does Artificial Intelligence (AI) influence online learning environments in Higher Education?"

Methods

Scoping Review Protocol

We used the revised Arksey and O'Malley framework, using the six steps: (i) Research question identification, (ii) relevant studies identification, (iii) relevant studies selection, (iv)collection and charting of data, (v) results collation, summarization, and reporting, and (vi) seeking expert consultations. This protocol was selected due to tits systematic yet flexible approach, allowing us to identify, organize and synthesize complex and diverse literature on the roles and attributes of AI in online learning environments. Its iterative process ensures comprehensive coverage and meaningful insights into the research landscape.

Step 1: Research question identification

The aim of this scoping review was to explore how Artificial Intelligence (AI) influences online learning environments in higher education. Using the Population-Concept-Context model for this review, the population was identified to be students or teachers of Higher Education, the concept was "Artificial Intelligence" and the context was "online learning environments"

Outcome variables for the review included student, teachers, and institutional experiences, perceptions and performances related to AI use in digital education platforms.

Step 2: Relevant Studies Identification

A literature search was conducted to locate peer reviewed, original articles published from January 2013 to September 2023. Four electronic databases (PubMed, Scopus, Science Direct, and Google Scholar) were used for literature search. Initially , key words were used and refined after preliminary search, and they included ((Online) AND (educational environment) OR (educational climate) OR (educational atmosphere)) OR (learning environment)) AND (Artificial Intelligence)) AND ((Higher education)).

Step 3: Relevant studies selection

We independently reviewed the articles obtained from the databases, aligning with the predefined eligibility criteria encompassing title, abstract, and full-text assessment. This comprehensive approach was adopted to ensure the robustness of article selection about using AI in online learning environments in Higher Education. A consensus was reached on accepting or rejecting the shortlisted articles based on predetermined eligibility criteria. This process resulted in a Kappa value of 0.872, indicating a high level of agreement among the raters. In instances of disagreement, the articles underwent further independent medical educationists until a consensus was ultimately achieved. A study selection was decided among the involved researchers for the selection of title, abstracts and full-text article, as shown in Table 1.

Step 4: Charting of Data

The chosen articles underwent a final review, during which their data were systematically extracted and presented in an Excel spreadsheet. This step aimed to create an unbiased and objective summary of the review's findings as reviewed by the researchers. All the obtained information was organised according to (i) Manuscript title, (ii) Publication year,(iii) Country, (iv) Research Design, (v) Intervention, (vi) Study participants, (vii)Outcome, (viii) Identified roles of AI, (ix) identified attribute of AI.

Table 1: *Study Selection Eligibility Criteria*

Eligibility criteria	Inclusion Criteria	Exclusion Criteria
Title	Articles + Proceedings published between January 2013 and September 2023	Articles in languages other than English
	Articles in English	Articles using AI Other than educational purposes
	Title reflecting use of Artificial Intelligence in Online learning environments	
Abstract	Abstract presenting an original article.	Articles covering primary and secondary education.
	Abstract tests/evaluating online teaching methodology/tool with AI	Review articles, books, short communication, research reports, letters to editor, and editorials will be excluded from the search process
	Abstract of a substantial study design: qualitative, quantitative or mixed method	
	Abstract indicating evaluation of AI evidence in online learning environments at HE level.	
	Measurable study outcomes (quantitatively or qualitatively)	
Full text	The article elaborating use of AI in online learning environments or its components.	Unrelated to AI in online learning environment
	The article using a well-designed research methodology and/or intervention.	Articles focussing on tool instead of learning.
	Context of Higher Education	Full text not available
	The article is available as a full-text article	-

**AI- Artificial Intelligence*

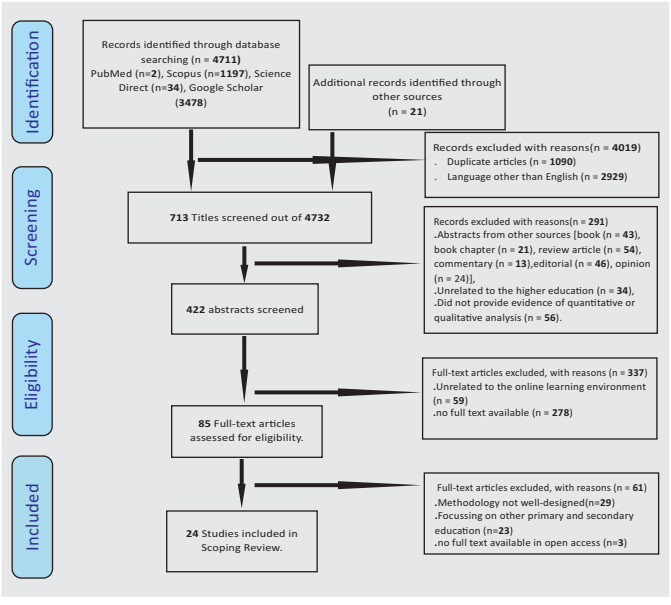

Figure-1: *Article selection flow for a scoping review.*

The process for article selection criteria, encompassing title, abstract, and full-text screening, are outlined in Figure 1.

Step 5: Data collation, summarisation, and results report

We performed content analysis using Microsoft Excel and used Braun and Clarke's approach for generating themes during analysis [7]. The initial steps of content analysis allowed us to get an overview of the various roles AI can play in online learning environments in Higher Education. Next, thematic analysis focused on generating these identified uses of AI according to the nine key domains of effective online learning environments using the TELEMED framework (Figure 2). The a-priori coding allowed to organise the uses of AI in various domains of online learning environments. Finally, the formulated themes and subthemes were reviewed and finalised

after consensus.

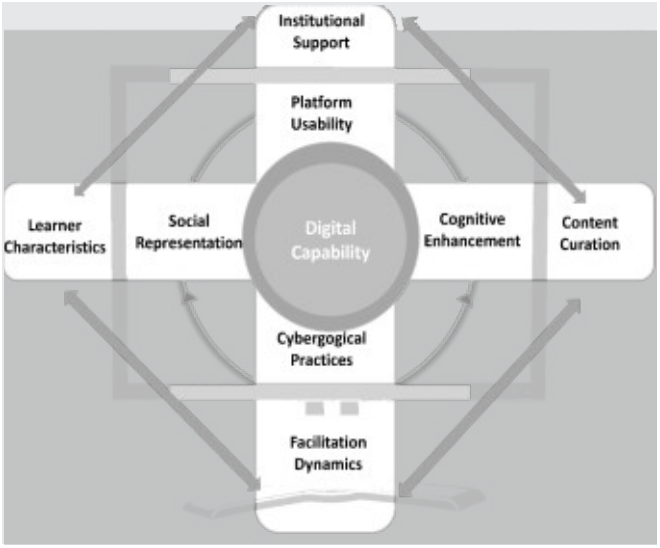

Figure-2: *TELEMED Model with its nine components*
TELEMED*: "Technology-enhanced learning environment in medical education"***

Step 6: Consultation

Two medical educationists with expertise in AI applications reviewed the selected articles as well as the emerging thematic analysis results of the literature review.

Results

Literature Search

On the basis of keyword search, the literature search identified 4,732 possible studies; of these, 1,090 were duplicates and 2,929 were in a language other than English and were removed. The 713 titles were evaluated in accordance with the criteria to identify the relevant research, of which 422 abstracts and 85 articles needed to be further reviewed. The final number of articles to be included in the review was 24.(See *Annexure 1* for selected articles for this review)

Study Characteristics

The selected 24 studies were published between January 2013 to September 2023 and involved 10,750 students, 276 teachers and 33 technical experts along with 1000211 data sets including student performance points and online discussion posts (Table 2). Majority of articles were published in 2022 (n=8). The reviewed studies were carried out in 15 countries. Among these 24 selected studies, 11 were quantitative, and the remaining consisted of eight qualitative and five mixed-methods design. (Table 2).

Table 2: *Selected Study Characteristics (n=24)*

Feature	Discipline	Number
Year of publication	2014	1
	2015	1
	2017	1
	2018	1
	2020	3
	2021	4
	2022	8
	2023 (September)	5
Country of publication	UK, USA, Korea	3 each
	China, Spain	2 each
	Greece, Saudi Arabia, Haram, Hong Kong, Romania, Italy, Kazakhstan, Brazil, Norway, Philippines	1 each
Study Approach	Quantitative	11
	Qualitative	8
	Mixed Methods	5
Study Participants	Students (n=10,750)	18
	Teachers (n=276)	3
	Technical experts, policymakers (n=33)	3
	Data (performance points, online posts)(n=1,000,211)	2

Identified Roles, sub roles and attributes of AI:

Thematic analysis identified 24 main roles/functions (themes) and 47 sub-roles (sub-themes) utilizing artificial intelligence in online learning environments in the nine domains identified by the TELEMED framework. These are presented in Table 3 along with related identified AI attribute.

AI supports cognitive enhancement by enhancing cognitive skills such as problem-solving.[8,9] For instance, it can enhance language skills through personalized feedback and real-time grammar suggestions, as shown in Marghany et al.'s study 8. Additionally, AI aids in metacognitive strategy training by implementing memory improvement techniques.[10]

Table 3: *Identified roles, sub roles and attributes of Artificial Intelligence in components of Online Learning Environments as defined by the TELEMED framework.*

TELEMED Component	Roles of AI	Subroles	Attribute of AI
Cognitive Enhancement	Cognitive Skill Development	Problem-Solving Skills 8,9	Responsive Predictive
	Metacognitive Strategy Training	Memory Improvement Techniques 10	Responsive Predictive Adaptive
	Language Skill Enhancement	Language Skills Enhancement 8	Responsive Predictive
Content Curation	Personalized Content Recommendations	Tailored Learning Materials 11,12	Responsive Proactive
		Adaptive Content Selection 13,14	Decisive Adaptive
	Content Organisation and Search	Efficient Content Retrieval 13 Structured Information Presentation 13,14	Proactive Adaptive
	Quality Assurance	Content Evaluation and Improvement 15 Ensuring Relevance and Accuracy 11,15	Decisive Decisive Predictive
Cybergogical Practices	Self-Regulated Learning Support	Goal Setting and Monitoring 10 Study Strategy Guidance 10,16,17	Responsive Adaptive Proactive
	Learning Progress Tracking	Learning analysis 9,11 Feedback provision 10	Decisive Predictive Responsive
	Distraction Reduction	Minimizing Cognitive Overload 10 Focusing Attention on Learning Tasks 16	Proactive Proactive
	Cognitive Load Management	Content Organization and Simplification 18 Cognitive Load Reduction Techniques 14,18	Adaptive Proactive
Learner Characteristics	Personalized Learning Profiles	Individual Learning Styles 15 Adaptive Learning Plans 11,15	Adaptive Predictive Adaptive
	Learning Analytics for Individualization	Behavioral Insights for Personalization 15,16,19 Identifying Learning Gaps 10,19	Predictive Predictive
Digital Capabilities	Digital Literacy Development	Digital Skill Assessment 12,20 Training in Digital Proficiency 8	Adaptive Responsive
	Digital Civility Enhancement	Online Behaviour tracking 21 Digital wellbeing monitoring 21	Proactive Proactive
Platform Usability	User-Friendly Interface Design	Intuitive Navigation 14,22 Accessibility Features 14	Responsive Adaptive Adaptive
	Task Efficiency Enhancement	Streamlined Learning Processes 16,22 Time-Saving Features 23,24	Predictive Predictive
	Safety and Security	Data Protection Measures 17 Cybersecurity Integration 17,25	Predictive Predictive

TELEMED Component	Roles of AI	Subroles	Attribute of AI
Facilitation Dynamics	Learning Process Support	Facilitating Learning Activities 26	Responsive Adaptive
		Enhancing Student Engagement 16,26	Responsive Proactive Predictive
	Student-Teacher Communication Improvement	Feedback Mechanisms 18,26,27	Adaptive
		Communication Tools Integration 26,27	Adaptive
	Routine Task Automation	Administrative Efficiency 28	Responsive Proactive
		Grading and Assessment Automation 26	Responsive Decisive Proactive
Social Representations	Social Connection Enhancement	Building Virtual Communities 3,29	Adaptive Predictive
		Facilitating Peer Interaction 3,27,29	Predictive Responsive
	Social Presence Mediation	Emulating Face-to-Face Interaction 10	Responsive
		Fostering Instructor Presence 30	Responsive
Institutional Support	Administrative Efficiency Improvement	Streamlining Institutional Processes 17,28	Responsive Adaptive
		Resource Allocation Optimization 17	Adaptive Responsive
	Policy Compliance and Monitoring	Ensuring Regulatory Adherence 15	Proactive
		Data Governance Frameworks 11,17	Proactive Decisive
	Data-Driven Decision Making	Informed Strategic Planning 15,17,28	Decisive
		Performance Evaluation Metrics 11,17,18,22	Decisive Predictive

In terms of content curation, AI offers personalized content recommendations, delivering tailored learning materials to meet individual needs.[11,12] It chooses adaptive content according to the advancement of learners, it structures information that is easy to operate and facilitates structured presentation.[13,14] Another important role is achieving quality assurance, where AI is continuously monitoring, evaluating and adapting content to maintain its relevance.[11,15]

AI can do much for digital practices that enhance self-regulation of learning. Using AI to set and monitor goals, guide study strategy, and track progress in learning.[10,16,17] It offers such roles as feedback, reducing concurrent loads on cognitive resources and helps to concentrate the mind toward learning areas 10. Further, AI supports cognitive load management by structuring and summarising information in an optimal way to prevent knowledge overload through a collection of focus tactics.[14,18]

Personalised learning is characterised by the creation of learner profiles where each individual's style and adaptive plans can be developed using AI.[11,15] Learning analytics generates behaviour insights that can be used to better personalize learning experiences and also identify gaps in a learner's knowledge.[10,19]

AI fosters digital literacy among learners by evaluating and coaching on their digital abilities.

Digital capabilities are enhanced through AI by

assessing and training learners in digital literacy.AI provides personalised assessments and training to improve digital proficiency and ensures digital

civility through online behaviour tracking and digital wellbeing monitoring.[21]

AI provides infrastructure support in education by making platforms more usable, aiding the design of a user-friendly interface and navigation, and incorporating multiple accessibility features for diverse learners.[14,22] Artificial intelligence enhances the speed of the learning process, and it also minimizes time-consuming features via automated grading involving human services, thereby optimising overall task efficiency.[16,22] In addition, AI supports online security by embedding privacy perfectionism through data protection leads to cybersecurity synergies.[17,25]

AI is also reported to be a "fuel" in the facilitation dynamics for catalyzing learning activities with the aid of real-time interactivity, instant feedback to keep students engaged in online learning platforms.[16,26] AI further enhances student and faculty communication and automates routine administrative work like grading, assessments to reduce the workload of the instructor.[26,27]

Social representations in AI-supported environments stimulate social relationships, creating a virtual community and supporting peer interactions similar to face-to-face communication on one hand.[3,27,29] This eases the sense of isolation and creates a feeling of connectivity among learners.

Last but far from the least, AI aids in operational support by enabling smooth and optimised processes, allocation of resources, as well as compliance with regulations.[17,28] It helps to stay compliant with policies by implementing data governance frameworks and enables informed decision-making through strategic planning, followed by the performance assessment.[11,17,18,22]

Frequency of identified AI Attributes:

The following figure represents the frequency of identified AI Attributes that are used in online learning environments including (i) Responsive AI, (ii)Adaptive AI, (iii) Decisive AI, (iv) Proactive AI, and (v) Predictive AI.

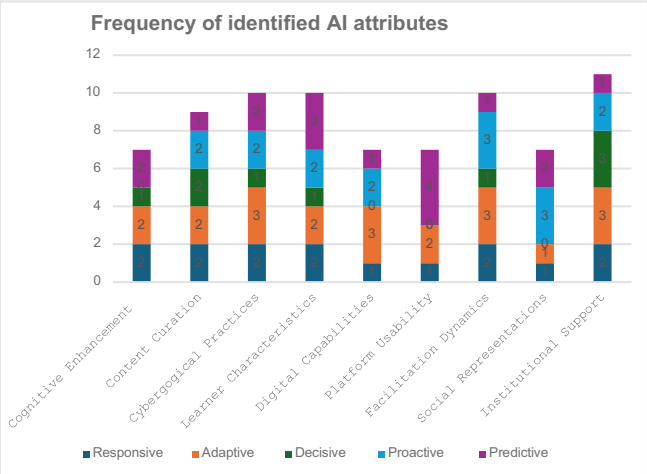

Figure-3: *Frequency of identified AI attributes in online learning environments*

Based on the scoping review findings, three attributes i.e. AI being responsive, adaptive and predictive were present in all the nine domains of online learning environments. The attribute of AI being proactive was evident in five domains, whereas AI being decisive was observed in four out of the nine domains of digital learning environments.

Discussion

This scoping review highlights the multifaceted roles of AI in online learning environments, demonstrating its potential to enhance student outcomes through adaptive, predictive, responsive, proactive, and decisive functionalities.

Adaptive AI

Adaptive AI refers to the ability of an AI system to adjust its behaviour or outputs in response to the specific needs and preferences of individual learners. Bennani et al.[31] discussed the adaptiveness of AI towards personalized learning experiences by tailoring learning experiences to the unique needs and preferences of each student. This involves adjusting the difficulty level of content, recommending relevant resources, and providing personalized feedback based on individual learning progress.[11,32] Adaptive AI can help students achieve their full potential by addressing their specific strengths and weaknesses, fostering a sense of ownership over their learning journey.

Minn et al underscored the adaptability of AI in developing curriculums and assessment materials that evolve in real-time with the changing learners'

needs. Such adaptability guarantees that the curriculum is still up-to-date, relevant and challenging and meets the needs and capacities of the students 33. AI makes learning more engaging and interesting by continuously adjusting the learning materials and assessments. Adaptive AI remains important as it helps to deal with students' diverse learning needs and styles. Shu & Gu 34 discussed how adaptive AI can promote student engagement and success in virtual learning settings. AI personalizes learning paths and content, allowing students with distinct learning skills to benefit from the educational offerings equally.

Responsive AI

Responsive AI refers to the ability of an AI system to provide real-time feedback or assistance to learners. In online learning environments, responsive AI can be used to answer student questions, provide immediate feedback on submitted work, and offer support during learning activities 35. For example, a responsive AI system could provide instant feedback on multiple-choice questions or offer suggestions for improving written assignments. Gunness et al. 36 have shown that by responding in a timely manner, responsive AI can enhance student engagement, reduce frustration, and promote a sense of connectedness to the learning environment. Further, Kang et al. 37 demonstrated the potential of teacher-AI collaboration to make learning experiences more engaging and effective. AI systems can promptly accommodate user inputs, resulting in enhanced navigation ability and interactive online platforms that create a conducive learning environment. It means that AI can monitor and make immediate interventions. Through tracking student progress, AI tools can give learners the required assistance and support as and when needed, thus keeping them on track with the learning objectives 33. This aspect of responsiveness is essential in detecting and addressing learning challenges as they occur, enabling prompt and efficient intervention.

Decisive AI:

Decisive AI refers to the ability of an AI system to make decisions and take action without human intervention. Decisive AI automates routine tasks and streamlines processes, freeing up educators' time to focus on higher-order activities such as personalised instruction and student support 38. This includes grading assignments, providing automated feedback on practice exercises, and managing administrative tasks. Decisive AI can enhance the efficiency of online learning environments, allowing educators to devote more time to their core responsibilities. For example, a decisive AI system could automatically grade multiple-choice quizzes, provide individualized feedback on essay writing, or recommend relevant articles and videos based on a student's learning interests 34.

Chang et al. 39 has demonstrated the role of AI In curriculum design and decisions in selecting content that is relevant , updated according to latest educational trends and according to students' needs. The decisive role of AI allows fostering an environment that stimulates students' creativity and critical thinking in long run 40.

Proactive AI:

Proactive AI is related to the capacity of an Artificial Intelligence System to identify upcoming issues or learning difficulties and then immediately provide preventive benefits on those matters. Proactive AI predicts potential challenges faced by students and supports the identification of such students who are prone to fall behind 41. For example, proactive AI can be used to identify students who are at risk of falling behind, provide early warning signs of potential plagiarism, and suggest strategies for overcoming procrastination 42,43. This includes creating models for predicting how likely a student is to drop out, red flag indicators of plagiarism and potential remedies for procrastination. By intervening early on, Proactive AI can help set students up for a successful outcome.

Predictive AI:

Predictive AI refers to the capability of an AI system to make predictions with data on events or outcomes yet to come. Predictive AI uses data to create individualized learning pathways for students and aid educators in making decisions about how their expertise can be best employed. Studies have mentioned varying utility of Predictive attributes of AI, including prediction of student performance, identification of potential areas of improvement and suggesting online content for covering that gap 34,44. Hence, Predictive AI can supplement teachers' support at every stage of their learning process. For example, predictive AI can analyse a student's past performance and use demographic data to score on how likely they are to succeed in each course, which

the institutions can make use of at the time of admissions. At the individual level, AI can recommend a personalised learning plan best suited for a learner based on their strengths and identified areas of improvement.

A call to action for educators and researchers

The expanding data regarding AI's utility in cognitive enhancement, particularly in problem-solving, presents a valuable opportunity for educators and researchers to drive meaningful enhancement in both educational practice and scholarship. By using AI-powered platforms, educators can create personalised learning experiences that can dynamically adapt to a learner's needs and preferences. Further AI-driven content curation can allow instructional designers to adjust the course content at an appropriate level of difficulty. Students can receive targeted support through step-by-step AI-assisted problem-solving, reinforcing conceptual understanding and critical thinking. In short, by integrating AI into educational frameworks, educators and researchers can bridge the gap in digital learning, maximising AI's potential to enhance the learning experience, leading to improved learning outcomes.

Limitations and future directions

While this scoping review provided valuable insights into AI's roles in online learning environments, several limitations must be acknowledged. Since this review was conducted with the earliest data, more advancements in AI roles need to be incorporated into the results in future studies. Moreover, while the studies with positive AI impacts may be overrepresented, further work regarding AI failures or challenges needs to be done. Another limitation in this review was the lack of longitudinal data, as most of the studies conducted were with short-term experimental settings. There is also an identified gap in empirical research directly linking AI applications to sustained improvements in student performance and engagement.

Conclusion

This scoping review highlights the transformative role of AI in online learning environments, demonstrating its ability to enhance student outcomes through personalised learning, cognitive enhancement, and content curation. The identified AI attributes– responsiveness, adaptability, decisiveness, proactiveness, and predictiveness - play an important role in enhancing the effectiveness of AI-powered learning environments in terms of improving engagement, optimising learning pathways, automating administrative processes and fostering data-driven decision making in education. The educators, administrators and policymakers must take proactive steps toward ethical and equitable AI integration by taking a strategic research-informed approach.

Ethical Approval: Ethics approval and consent to participate are not required for this scoping review.

Conflict of Interest: None

Funding Source: None

Authors' Contribution:

NKN: Idea conception, literature search, analysis, manuscript writing and approval of final version to be published

HI: Article selection, content analysis

ZFN: Literature search, thematic analysis

AA: Thematic analysis, manuscript writing

References

1. Bates T, Cobo C, Mariño O, Wheeler S. Can artificial intelligence transform higher education? Int J Educ Technol High Educ. 2020;17(1):1-12. https://doi.org/10.1186/s41239-020-00218-x.
2. Han ER, Yeo S, Kim MJ, Lee YH, Park KH, Roh H. Medical education trends for future physicians in the era of advanced technology and artificial intelligence: An integrative review. BMC Med Educ. 2019;46(1):460.
3. Nalli G, Amendola D, Smith S. Artificial Intelligence to improve learning outcomes through online collaborative activities. European Conference on e-Learning. 2022;21(1):475–9.
4. Wang T, Lund BD, Marengo A, Pagano A, Mannuru NR, Teel ZA, et al. Exploring the Potential Impact of Artificial Intelligence (AI) on International Students in Higher Education: Generative AI, Chatbots, Analytics, and International Student Success. Appl Sci.2023;13(11):6716. https://doi.org/10.3390/-app13116716.
5. Naeem NIK, Yusoff MSB, Hadie SNH, Ismail IM, Iqbal H. Understanding the Functional Components of Technology-Enhanced Learning Environment in Medical Education: A Scoping Review. Med Sci Educ. 2023;33(1):1-15.https://doi.org/10.1007/-s40670-023-01747-6

6. Arksey H, O'Malley L. Scoping studies: Towards a methodological framework. International Journal of Social Research Methodology. Int J Soc Res Methodol: Theory and Practice. 2005;8(1):19–32.
7. Braun V, Clarke V, Hayfield N, Terry G. Thematic analysis. In: Handbook of Research Methods in Health Social Sciences. Springer, Singapore. 2019:843-60. https://doi.org/10.1007/978-981-10-5251-4_103.
8. Marghany Mahmoud Marghany A. Using artificial intelligence-based instruction to develop EFL higher education students' essay writing skills. CDELT Occas Pap Dev Engl Educ. 2023;82(1):219–40.
9. Leung ACM, Santhanam R, Kwok RCW, Yue WT. Could Gamification Designs Enhance Online Learning Through Personalization? Lessons from a Field Experiment. Inf Syst Res. 2023;34(1):27–49. https://doi.org/10.1287/isre.2022.1123
10. Jin SH, Im K, Yoo M, Roll I, Seo K. Supporting students' self-regulated learning in online learning using artificial intelligence applications. Int J Educ Technol High Educ. 2023;20(1):1–21.
11. Tapalova O, Zhiyenbayeva N. Artificial Intelligence in Education: AIEd for Personalised Learning Pathways. EJEL. 2022;20(5):639–53.https://-doi.org/10.34190/ejel.20.5.2597
12. Al A, Ahmed A. Creation of Automated Content With Embedded Artificial Intelligence A Study on Learning Management System for Educational Entrepreneurship. Acad Entrep J. 2021;27(3):1–10.
13. Ramos De Melo F, Flôres EL, Diniz De Carvalho S, Gonçalves De Teixeira RA, Batista Loja LF, De Sousa Gomide R. Computational organization of didactic contents for personalized virtual learning environments. Comput Educ. 2014;79:126–37.
14. Perez-Ortiz M, Dormann C, Rogers Y, Bulathwela S, Kreitmayer S, Yilmaz E, et al. X5Learn: A Personalised Learning Companion at the Intersection of AI and HCI. International Conference on Intelligent User Interfaces, Proceedings IUI . 2021;70–4. https://dl.acm.org/doi/10.1145/-3397482.3450721
15. Bucea-Manea-ţoniş R, Kuleto V, Gudei SCD, Lianu C, Lianu C, Ilić MP, et al. Artificial Intelligence Potential in Higher Education Institutions Enhanced Learning Environment in Romania and Serbia. Sustainability. 2022;14(10):5842.
16. Rodríguez ME, Guerrero-Roldán AE, Baneres D, Karadeniz A. An Intelligent Nudging System to Guide Online Learners. IRRODL. 2022;23(1):41–62.
17. Albright J, Fidas CA, Belk M, Constantinides A, Portugal D, Martins P, et al. Ensuring Academic Integrity and Trust in Online Learning Environments: A Longitudinal Study of an AI-Centered Proctoring System in Tertiary Educational Institutions. Educ Sci. 2023;13(6):566.
18. Giannakos MN, Chorianopoulos K, Chrisochoides N. Making Sense of Video Analytics: Lessons Learned from Clickstream Interactions, Attitudes, and Learning Outcome in a Video-Assisted Course. IRRODL. 2015;16(1):260–83.
19. Toribio NF. Analysis Of Chatgpt And Other AI's Ability To Reduce Anxiety Of Science-Oriented Learners In Academic Engagements. J Namib Stud: History Politics Culture. 2023;33(1):5320–37. https://doi.org/10.59670/jns.v33i.3132
20. Luckin R, Cukurova M, Kent C, du Boulay B. Empowering educators to be AI-ready. Computers and Education: AI. 2022 ;3(1):100076.
21. Stoll A, Ziegele M, Quiring O. Detecting impoliteness and incivility in online discussions: Classification approaches for german user comments. Comput Commun Res. 2020;2(1):109–34. https://doi.org/10.5117/-CCR2020.1.005.KATH.
22. Al-Abdullatif AM, Al-Dokhny AA, Drwish AM. Implementing the Bashayer chatbot in Saudi higher education: measuring the influence on students' motivation and learning strategies. Front Psychol. 2023;14(1): 1129070. https://doi.org/10.3389/-fpsyg.2023.1129070.
23. Chandel S, Yuying Y, Yujie G, Razaque A, Yang G. Chatbot: Efficient and utility-based platform. Advances in Intelligent Systems and Computing. Springer International Publishing. 2019 ;858(1):109–22.
24. Ahmed T, Bulathwela S. Towards Proactive Information Retrieval in Noisy Text with Wikipedia Concepts. CEUR Workshop Proc. 2022;3318(1).
25. Noriega P, Verhagen H, Padget J, D'Inverno M. Ethical Online AI Systems through Conscientious Design. IEEE Internet Comput. 2021;25(6):58–64.
26. Bañeres D, Rodríguez ME, Guerrero-Roldán AE, Karadeniz A. An Early Warning System to Detect At-Risk Students in Online Higher Education. Appl Sci. 2020;10(13):4427. https://doi.org/10.3390/-app10134427.
27. Seo K, Tang J, Roll I, Fels S, Yoon D. The impact of artificial intelligence on learner–instructor interaction in online learning. Int J Educ Technol High Educ. 2021;18(1):54.
28. Kim JH, Kim M, Kwak DW, Lee S. Home-Tutoring Services Assisted with Technology: Investigating the Role of Artificial Intelligence Using a Randomized Field Experiment. J Mark Res. 2022;59(1):79–96.
29. Wang Q, Jing S, Goel AK. Co-Designing AI Agents to Support Social Connectedness Among Online Learners: Functionalities, Social Characteristics, and Ethical Challenges. DIS 2022 - Proceedings of the 2022 ACM Designing Interactive Systems Conference: Digital Wellbeing. 2022;13:541–56.

30. Kim J, Merrill K, Xu K, Kelly S. Perceived credibility of an AI instructor in online education: The role of social presence and voice features. Comput Human Behav. 2022;136(1):107383.
31. Bennani S, Maalel A, Ben Ghezala H. Adaptive gamification in E-learning: A literature review and future challenges. Comput Appl Eng Educ.2022:30(2):628–42. https://doi.org/-10.1002/cae.22477.
32. Kaswan KS, Dhatterwal JS, Ojha RP. AI in personalized learning. In: Advances in Technological Innovations in Higher Education: Theory and Practices. 2024:14(1)103–17.
33. Minn S, Vie JJ, Takeuchi K, Kashima H, Zhu F. Interpretable Knowledge Tracing: Simple and Efficient Student Modeling with Causal Relations. Proceedings of the AAAI Conference on Artificial Intelligence. 2022;36(11):12810–8.
34. Shu X, Gu X. An Empirical Study of A Smart Education Model Enabled by the Edu-Metaverse to Enhance Better Learning Outcomes for Students. Systems .2023;11(2):75. https://doi.org/10.3390/-systems11020075.
35. Van der Niet AG, Bleakley A. Where medical education meets artificial intelligence: 'Does technology care?' Med Educ. 2021;55(1):30-6.
36. Gunness A, Matanda MJ, Rajaguru R. Effect of student responsiveness to instructional innovation on student engagement in semi-synchronous online learning environments: The mediating role of personal technological innovativeness and perceived usefulness. Comput Educ. 2023;205(1):104884.
37. Kang J, Kang C, Yoon J, Ji H, Li T, Moon H, et al. Dancing on the inside: A qualitative study on online dance learning with teacher-AI cooperation. Educ Inf Technol (Dordr).2023;28(9):12111–41.
38. Li S, Du J, Yu S. Diversified resource access paths in MOOCs: Insights from network analysis. Comput Educ. 2023; 204(1); 104869.
39. Chang YS, Wang YY, Ku Y Te. Influence of online STEAM hands-on learning on AI learning, creativity, and creative emotions. Interact Learn Environ. 2023;32 (8):4719-38 Available from: https://www.tandfonline.com/doi/abs/10.1080/10494820.2023.2205898
40. Wingström R, Hautala J, Lundman R. Redefining Creativity in the Era of AI? Perspectives of Computer Scientists and New Media Artists. Creat Res J. 2022; 36(2), 177–93. https://doi.org/10.1080/-10400419.2022.2107850
41. Bearman M, Ajjawi R. Learning to work with the black box: Pedagogy for a world with artificial intelligence. Br J Educ Technol. 2023;54(5)-:1160–73.
42. Gunness A, Matanda MJ, Rajaguru R. Effect of student responsiveness to instructional innovation on student engagement in semi-synchronous online learning environments: The mediating role of personal technological innovativeness and perceived usefulness. Comput Educ. 2023;205(1):104884.
43. Liu B, Gui W, Gao T, Wu Y, Zuo M. Understanding self-directed learning behaviors in a computer-aided 3D design context. Comput Educ.2023;205(3):104882. https://doi.org/10.1016/-j.compedu.2023.104882.
44. Chen B, Zhu X. Integrating generative AI in knowledge building. Computers and Education: Artif Intell. 2023;5(1):100184.