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Research Article

Role of Artificial Intelligence in Distance Education: A Bibliometric Analysis of Highly Cited Research Papers (2003-2023)

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ABSTRACT

This study investigates the research trends and focused areas in highly cited literature related to "Artificial Intelligence and Distance Education" over the past two decades (2003 to 2023). Utilizing the Scopus database, a search strategy involving relevant keywords identified 774 articles, from which the top 100 most-cited papers were selected, each having 100 or more citations. Analyzing these papers revealed that they collectively received a substantial number of citations and were authored by 439 researchers from 227 organizations across 43 countries. The findings highlight this field's significant external funding (50%) and international collaboration (37%). The United States, China, and the United Kingdom were the leading contributors, while Hong Kong, the UK, and India garnered higher citation impacts. The top-producing institutions included Nanyang Technological University and the University of Birmingham, with notable contributions from several impactful authors. Key journals such as *Computers and Education* and *IEEE Access* showcased the highest publication volumes and citation impacts. This study presents insights into global research trends, influential works, and performance metrics of organizations and authors, offering a comprehensive overview of the evolving landscape in AI and distance education research.

Keywords: Artificial Intelligence, Distance Education, E-Learning, Bibliometrics, Computer-Assisted Instruction.

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INTRODUCTION

In recent decades, the adoption of online learning has become increasingly prevalent among educators and researchers for delivering courses across various domains. However, numerous studies have highlighted ongoing challenges in this educational model, including low assignment completion rates and suboptimal learning outcomes (Smith and Johnson, 2021; Johnson and Lee, 2019). Integrating Artificial Intelligence (AI) into distance education transforms the educational landscape by personalizing learning experiences, automating administrative tasks, and providing valuable insights into student performance (Miller and Dyer, 2020).

Various scholars have employed bibliometric analysis to evaluate the current trends in "AI and Distance Education" research at both global and national levels. Khanal *et al.* (2020) provided a state-of-the-art overview of AI's role in e-learning, emphasizing machine learning's potential. Similarly, Tang *et al.* (2021) identified publication patterns related to AI-supported e-learning through a systematic review and co-citation network analysis of the Web of Science database, revealing that AI primarily facilitates adaptive learning environments. Hwang, Tu and Tan (2022) examined AI-supported online learning publications and found that the focus shifted from intelligent tutoring systems to a broader scope of applications over time. Gocmez and Okur (2023) visualized literature on AI applications in open and distance education from selected articles and noted a significant rise in publications after 2018, particularly due to the COVID-19 pandemic. Mustapha *et al.* (2024) analyzed 918 research articles on AI in distance education using topic modelling to identify ten coherent research themes. Similarly, Putra, Ramadhani and Sandy (2025) conducted a bibliometric analysis of 282 documents, highlighting emergent technologies and ethical considerations in AI and e-learning.

Despite these insights, a gap remains in comprehensive assessments evaluating AI's global impact in distance education,

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particularly in high-cited research contributions. This study aims to fill this gap by conducting a bibliometric assessment of high-cited papers on AI and distance education published from 2003 to 2023. By examining citation trends, influential authors, and organizational collaboration patterns, this research will provide a detailed overview of the evolving landscape of educational technology.

METHODOLOGY

Relevant documents were identified, retrieved and downloaded on "Artificial Intelligence and Distance Education" from the indexed literature covered in the Scopus database. For this purpose, a comprehensive search strategy was developed, which utilized a set of related keywords on "Artificial Intelligence" and a few Boolean operators from 2003 to 2025, as shown in search strategy presented below. In all, 1948 documents were identified in the Scopus database on this topic from 2002 to 2025, of which 774 were focused only on articles. These 774 articles were further sorted out by decreasing order of citations. The top 100 articles were selected for detailed analysis, with citation range 106 to 1192.

The extracted data for each downloaded publication included various bibliographical features, such as title (source), author, country, organization, serial, citation received, keywords, publication date and other related information, which were exported for final analysis. A subsequent analysis of the top 100 High-Cited Publications (HCPs) involved examining information related to authors, organizations, subject categories, collaboration, funding, and keywords using additional sorting features in the Scopus database. The Microsoft Excel and VOSviewer software were employed to study, map, and visualize the collaboration network of countries, organizations, authors, and keywords. A select number of bibliometric indicators centered on productivity, citation impact, and collaboration were used to assess research performance.

(KEY (artificial AND intelligence OR machine AND learning OR deep AND learning) AND KEY ("distance education" OR "distance learning") OR KEY ("remote education" OR "remote learning" OR "remote teaching" OR "e-learning" OR "electronic learning" OR "elearning" OR "online learning" OR "online education" OR "online course" OR "online teaching")) AND (EXCLUDE (PUBYEAR, 2025) OR EXCLUDE (PUBYEAR, 2001) OR EXCLUDE (PUBYEAR, 2000) OR EXCLUDE (PUBYEAR, 1999) OR EXCLUDE (PUBYEAR, 1998) OR EXCLUDE (PUBYEAR, 1997) OR EXCLUDE (PUBYEAR, 1996) OR EXCLUDE (PUBYEAR, 1992) OR EXCLUDE (PUBYEAR, 1990) OR EXCLUDE (PUBYEAR, 1989) OR EXCLUDE (PUBYEAR, 1988)) AND (LIMIT-TO (DOCTYPE, "ar"))

RESULTS

Year-wise Growth of Publications

The annual growth of HCPs from 2003 to 2023 increased from 1 in 2003 to 7 in 2023 (Figure 1), indicating a slow average annual growth rate of 0.54%. The most significant number of papers (17, 14 and 12) was reported in 2018, 2021 and 2016. The 9-10 years cumulative growth of publications increased from 23 during 2003-14 to 77 during 2015-23, depicting an absolute growth rate of 234.78% (Table 1).

The top 100 HCPs received 22970 citations, averaging 239.97 Citations per Paper (CPP) (Table 1). The citation impact per paper increased from 203.26 during 2003-14 to 237.60 during 2015-23. The top 100 HCPs have reported citation ranges from 106 to 1192, depicting uneven distribution: 48 and 47 papers were in citation ranges 106-193 and 203-485, as against only 5 papers in citation range (512-1192 citations) (Table 1).

Of the top 100 HCPs, several research agencies provided funded support to 50 funded papers (50.0% share), accumulating 12690 citations, with an average of 126.9 CPP. Among the participating funding agencies, Natural Science Foundation of China is the leading funder agency, supporting 9 papers, followed by National Science Foundation (7 papers), Europe Commission (6 papers), National Institute of Health, US Department of Health & Human Service and Horizon 2020 Framework Program (4 papers each), Engineering and Physical Sciences Research Council and UK Research and Innovation (3 papers each).

Of the top 100 HCPs, 35 publications involved the participation of only one organization (zero collaborative) and received 5401 citations (average=154.31 CPP). In contrast only 65 HCPs involved the participation of 2 or more organizations, of which 28 were national collaborative and 37 international collaborative papers.

Among 35 papers with single institution participation, the USA contributed 10 papers, followed by China (9 papers), Switzerland (3 papers), the UK and Australia (2 papers each) and 1 paper each by 23 other countries. The 28 (28.0%) national collaborative publications received 4623 citations, averaging 165.11 citations per paper. Among the national collaborative publications, the significant contribution comes from China (8 papers), followed by the USA (4 papers), Germany and Hong Kong (2 papers each), and 10 other countries with 1 paper each.

About 37 HCPs were involved in international collaboration and received 8545 citations, averaging 230.94 citations per paper. USA contributed the most significant number (16) to international collaborative papers, followed by China (15 papers); UK (10 papers), Canada (6 papers), Singapore (5 papers), Australia and Taiwan (4 papers each), India, Portugal, and South Korea (3 papers each), Denmark, Hong Kong, Turkey, Egypt. Brazil, Saudi Arabia and Pakistan (2 papers each).

Leading Countries

The 43 countries participated in the top 100 HCPs on "AI and Distance Education". Among them, the top 17 countries individually contributed 3 to 32 papers and together contributed 132 papers and 31108 citations, accounting for more than 100% share each in total papers and citations. Among the top 17 countries: (i) Six countries contributed more than the average productivity (7.76): USA (n=32), China (n=20), UK (n=20), Singapore (n=13), Taiwan and Canada (n=8 each); (ii) Seven countries registered citation impact (measured by CPP and RCI) more than their average (235.67 and 1.023: Hong Kong (370.0 and 1.61), UK (325.38 and 1.42), India (291.20 and 1.27), Netherlands (267.67 and 1.17), USA (267.56 and 1.16), South Korea (259.33 and 1.13), and Turkey (249.5 and 1.09) (Table 2). The share of international collaborative papers in the national output of the top 18 countries varied from

A co-authorship network mapping analysis was carried out among all 43 participating countries, which indicated that only 34 countries were interconnected. These 34 countries were further classified into six distinct clusters, with cluster 1 encompassing 8 countries, followed by clusters 2 to 4 each comprising 6 countries, cluster 5 consisting of 5 countries, and cluster 6 containing 3 countries. The network map displayed a total of 98 links with cumulative link strength of 122, as shown in Figure 2.

Leading Organizations

All 227 organizations participated in global research on "AI and Distance Education". Of these, 18 organizations individually contributed 2 to 3 papers each and collectively contributed 39 papers and 9933 citations, accounting for 39.0% and 43.24% share in total publications and citations. Among the top 18 organizations: (i) Three organizations contributed more than the average productivity (2.17): Nanyang Technological University, Singapore (n=3), Singapore Management University (n=3) and University of Birmingham, UK (n=3); (ii) Seven organizations registered citation impact (measured by CPP and RCI) more than their average (254.69 and 1.11): California State University, Monterrey Bay, USA(494.5 and 2.15), University of Birmingham, UK (449.5 and 1.96), The Hong Kong Polytechnic University (372.5 and 1.62), Kyung Hee University, South Korea (358.0 and 1.56), Sungkyunkwan University, South Korea (358.0 and 1.56), University of Sheffield, UK(326.0 and 1.42), and University of Birmingham, UK (299.67 and 1.30) (Table 3). The share of international collaborative papers in the national output of the top 18 organisations varied from 0.0% to 100.0%, with an average of 58.97%.

A co-authorship network mapping analysis was carried out among all 227 participating organizations, indicating that only 14 organizations were interconnected through co-authorship links. These 14 organizations were further classified into three distinct clusters, Cluster 1 consisted of 6 organizations (represented in red), followed by cluster 2 with 5 organizations (denoted in green), and cluster 3 with 3 organizations (depicted in blue). The network map displayed 33 links, with no Total Link Strength (TLS) value attributed.

Leading Authors

All 439 authors participated in global research on "AI and Distance Education". Of these, 9 authors individually contributed 2 papers each and collectively contributed 18 papers and 4969 citations, accounting for 18.0% and 21.63% share in total publications and citations. Among the top 9 authors: (i) No authors contributed more than the average productivity (2.0); (ii) Five authors registered citation impact (measured by CPP and RCI) more than their average (276.06 and 1.20) (Table 4). The share of international collaborative papers in the national output of the top 9 authors varied from 0.0% to 100.0%, with an average of 44.44%.

A co-authorship network mapping analysis was carried out among all 439 participating authors, indicating that only 29 authors were interconnected through co-authorship links. These 29 authors were further classified into six distinct clusters. Cluster 1 comprised 17 authors, followed by cluster 2 with 5 authors, cluster 3 with 3 authors, cluster 4 with 2 authors, and clusters 5 and 6 with 1 author each. The network map displayed 150 links with total link strength, as shown in Figure 3.

Leading Journals

All 67 journals participated in global research on "AI and Distance Education". Of these, the top 19 journals individually contributed 2 to 6 papers each and collectively contributed 52 papers and 12235 citations, accounting for 52.0% and 53.27% share in total publications and citations. Among the top 18 journals: (i) the top 5 journals by publication productivity were *Computers and Education* (n=6), *IEEE Access* (n=5), *Neurocomputing* (n=4), *Expert Systems with Applications* and *IEEE Transactions on Neural Networks and Learning Systems* (n=3 each); (ii) the top 5 journals by citation impact per paper were:*Journal of Computer-Aided Molecular Design* (652.5 CPP), *Computer Methods and Programs in Biomedicine* (419.0 CPP), *Expert Systems with Applications* (386.0 CPP), *IEEE Transactions on Neural Networks and Learning Systems* (300.33 CPP) and *Neurocomputing* (251.0 CPP); and (iii) the top 5 journals by impact factor were: *Artificial Intelligence Review* (n=3)(IF=11.7), *IEEE Transactions on Neural Networks and Learning Systems* (n=3)(IF=10.4), *Computers in Human Behavior* (n=2)(IF=9.5), *IEEE Internet of Things Journal* (n=2) (IF=9.0) and *Expert Systems with Applications* (n=3)(IF=7.6) (Table 5).

Significant Keywords

All 1592 keywords appeared in 100 HCPs on "AI and Distance Education". Of these, 1331 keywords appeared once, 223 keywords 2-5 times, 20 6-10 times, 14 11-25 times, and 4 26-74

Table 1: Yearly growth of publications.

Year	TP	TC	CPP
2003	1	167	167.00
2004	3	654	218.00
2006	2	319	159.50
2007	4	723	180.75
2008	1	149	149.00
2009	3	1024	341.33
2010	2	258	129.00
2012	2	390	195.00
2013	1	122	122.00
2014	4	869	217.25
2015	3	703	234.33
2016	12	4446	370.50
2017	9	1969	218.78
2018	17	3711	218.29
2019	4	1002	250.50
2020	5	1512	302.40
2021	14	2793	199.50
2022	6	1080	180.00
2023	7	1079	154.14
2003-14	23	4675	203.26
2015-23	77	18295	237.60
2003-23	100	22970	229.97

(TP: Total Publications; TC: Total Citations; CPP: Citations Per Publication).

times. From these, we have selected the top 50 keywords for detailed co-occurrence analysis, as shown in Figure 4. The resulting co-occurrence map was divided into five distinct clusters. Cluster 1, distinguished by 18 keywords denoted in Red, was succeeded by Cluster 2, comprising 11 keywords with green color; Cluster 3, with 10 keywords with blue color. Cluster 4 contains 7 yellow-colored keywords, and Cluster 5 contains 4 purple-colored keywords.

Cluster 1: (18 keywords, Red) includes e-learning (occur.=74; TLS=322); artificial intelligence (occur.=72; TLS=280); computer-aided instruction (occur.=14; TLS=88); teaching (occur.=9; TLS=54); education (occur.=8; TLS=53); distance education (occur.=8; TLS=53); data mining (occur.=5; TLS=33); big data (occur.=5; TLS=28); digital transformation (occur.=5; TLS=24); internet of things (occur.=5; TLS=18); education computing (occur.=4; TLS=17); 322); education data mining (occur.=3; TLS=21); data analytics (occur.=3; TLS=19); interactive learning environment (occur.=3; TLS=18); information management (occur.=3; TLS=15); multimedia systems (occur.=3; TLS=13); higher education (occur.=3; TLS=10) and; federated learning (occur.=3; TLS=8);

Cluster 2: (11 keywords, Green) includes learning algorithms (occur.=24; TLS=122); online learning (occur.=24; TLS=55); neural networks (occur.=13; TLS=84); algorithms (occur.=11; TLS=71); social networking (online) (occur.=4; TLS=17); theoretical model(occur.=4; TLS=23); fuzzy neural networks (occur.=3; TLS=21); robotics (occur.=3; TLS=20); 322); fuzzy logic (occur.=3; TLS=18); and real time systems (occur.=3; TLS=16), etc;

Cluster 3: (10 keywords, Blue) includes learning systems (occur.=47; TLS=245); machine learning (occur.=38; TLS=218); virtual reality(occur.=5; TLS=29); virtual screening (occur.=3; TLS=20); information retrieval (occur.=3; TLS=19); machine learning techniques (occur.=3; TLS=17); signal encoding (occur.=3; TLS=17); and android (operating system (occur.=3; TLS=16), etc;

Cluster 4: (7 keywords, Yellow) includes artificial neural network (occur.=23; TLS=144); deep learning (occur.=20; TLS=112); deep neural networks (occur.=3; TLS=22); convolutional neural network (occur.=8; TLS=62 computer-assisted diagnosis (occur.=8; TLS=59); statistical model (occur.=3; TLS=17); and statistical tests (occur.=3; TLS=21).

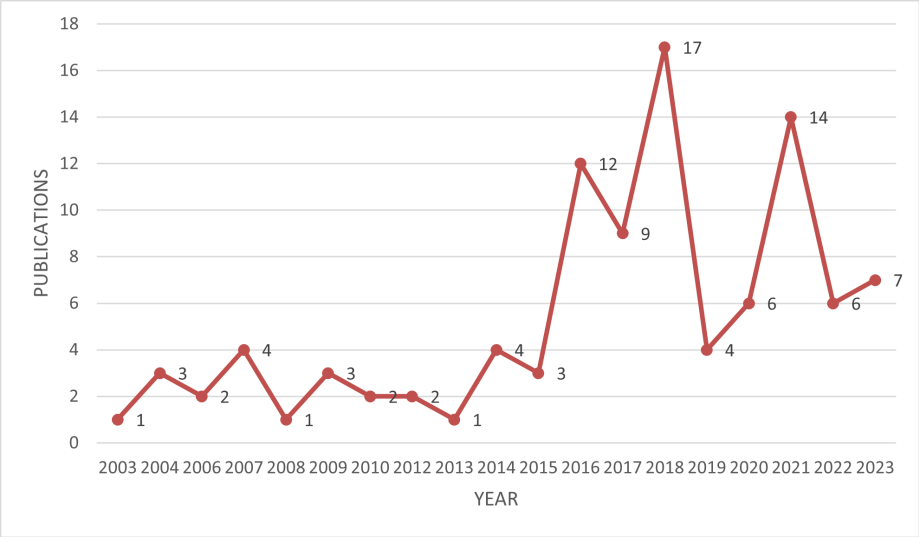

Figure 1: Yearly trend of publications of high-cited publications.

Table 2: Top 17 countries with three or more papers.

Sl. No.	Name of the country	TP	TC	CPP	RCI	ICP	%ICP	TLS	Collaborating countries
1	United States	32	8562	267.56	1.16	16	0.5	46	UK (13), China (8), Singapore (4), India (4), Germany (3), Netherlands (2), Egypt (2), Turkey (2), Taiwan (2)
2	China	20	4077	203.85	0.89	15	0.75	38	USA (10), Singapore (7), Taiwan (4), Hong Kong (3), India (2), UK (2), Germany (2).
3	United Kingdom	13	4230	325.38	1.42	11	0.84615	29	USA (9), India (4), Brazil (2), Pakistan (2), Germany (2), Netherlands (2)
4	Singapore	8	1479	184.87	0.80	5	0.625	11	China (8), USA (2)
5	Taiwan	8	1297	162.12	0.71	4	0.5	14	USA (3), China (2), Egypt (2)
6	Canada	7	1308	186.86	0.81	6	0.85714	13	USA (2), Austria (2), Denmark (2)
7	South Korea	6	1556	259.33	1.13	3	0.5	9	Australia (3), Canada (2), Egypt (2)
8	Germany	6	1325	220.83	0.96	3	0.5	15	USA (3),
9	India	5	1456	291.2	1.27	3	0.6	13	UK (5), USA (2), Australia (2), South Korea (2)
10	Australia	5	995	199	0.87	4	0.8	12	South Korea (3). USA (2), Egypt (2)
11	Turkey	4	998	249.5	1.09	2	0.5	4	USA (2), UK (2)
12	Saudi Arabia	3	468	156	0.68	2	0.66667	9	
13	Pakistan	3	389	129.67	0.56	2	0.66667	6	UK (3)
14	Hong Kong	3	1110	370	1.61	1	0.33333	2	China (2)
15	Egypt	3	596	198.67	0.86	2	0.66667	3	
16	Portugal	3	459	153	0.67	3	1	14	UK (3), USA (2), Serbia (2), Pakistan (2)
17	Netherlands	3	803	267.67	1.17	1	0.33333	2	
	Total of top 17 countries	132	31108	235.67	1.03	1	100.0	2	
	Global total	100	22970	229.7	1.00				

(TP: Total Publications; TC: Total Citations; CPP: Citations Per Publication; RCI: Relative Citation Index; ICP: International Collaborative Papers; TLS: Total Link Strength).

Table 3: Top 18 organizations with two or more papers.

Sl. No.	Name of the organization	TP	TC	CPP	RCI	ICP	%ICP	TLS
1	Nanyang Technological University, Singapore	3	593	197.67	0.86	2	66.67	4
2	Singapore Management University	3	584	194.67	0.85	2	66.67	6
3	University of Birmingham, UK	3	899	299.67	1.30	3	100.00	11
4	King Abdulaziz University, Saudi Arabia	2	331	165.50	0.72	1	50.00	3
5	The Hong Kong Polytechnic University	2	745	372.50	1.62	2	100.00	3
6	National University of Singapore	2	302	151.00	0.66	1	50.00	4
7	Carnegie Mellon University, USA	2	231	115.50	0.50	1	50.00	2
8	Kyung Hee University, South Korea	2	716	358.00	1.56	0	0.00	2
9	University of Patras, Greece	2	400	200.00	0.87	0	0.00	2
10	Sungkyunkwan University, South Korea	2	716	358.00	1.56	0	0.00	2
11	University of Bielefeld, Germany	2	433	216.50	0.94	0	0.00	2
12	HONDA Research Institute Europe, Germany	2	433	216.50	0.94	0	0.00	2
13	University of Birmingham, UK	2	899	449.50	1.96	2	100.00	11
14	University of Sheffield, UK	2	652	326.00	1.42	2	100.00	8
15	California State University, Monterey Bay, USA	2	989	494.50	2.15	1	50.00	12
16	University of Chicago, USA	2	319	159.50	0.69	2	100.00	6
17	Western University, Canada	2	372	186.00	0.81	1	50.00	3
18	Institute for Infocomm Research, ASTAR, Singapore	2	319	159.50	0.69	2	100.00	6
	Total of 18 organizations	39	9933	254.69	1.11	23	[58.97	89
	Global total	100	22970	229.70	1.00			
	Share of the top 18 organizations in the global total	39.00	43.24					

(TP: Total Publications; TC: Total Citations; CPP: Citations Per Publication; RCI: Relative Citation Index; ICP: International Collaborative Papers; TLS: Total Link Strength).

Cluster 5: (4 keywords, Purple) includes regression analysis (occurrence=6; TLS=37); knowledge acquisition (occurrence=4; TLS=22); performance assessment (occurrence=3; TLS=16); etc.

DISCUSSION

This study explores the evolving landscape of research at the intersection of AI and distance education by conducting a bibliometric analysis of HCPs published between 2003 and 2023. The analysis identified 774 AI and distance education articles in the Scopus database. From these, the top 100 HCPs were selected, which collectively garnered a notable number of citations, illustrating the importance of this research area. A substantial proportion of these papers emerged from countries including the United States, China, and the United Kingdom, indicating that these regions are leading the exploration of AI in educational contexts. Furthermore, the findings revealed that collaboration was prevalent, with approximately 37% of the articles involving international co-authorship, signaling an increasing trend toward collaborative research in this field.

One of the pivotal insights from this study is the vital role of external funding in advancing research on AI applications in distance education. Notably, 50% of the HCPs reported external funding, highlighting the growing acknowledgment of the need for sustainable investment in educational technology. This finding aligns with Hwang, Tu and Tan (2022), who emphasized that such funding bolsters research and promotes the development of innovative AI applications tailored for educational purposes. Furthermore, organizations such as Nanyang Technological University and the University of Birmingham demonstrated a strong output of impactful research on the subject, illustrating the importance of institutional support in fostering research initiatives. The significant citation impacts observed for institutions like the University of Sheffield and Yale School of Medicine also signify

the potential of interdisciplinary collaboration where AI research intersects with education.

The literature on AI and distance education continuously evolves, with significant contributions made over the past two decades. Khanal *et al.* (2020) provided an overview of machine learning's role in e-learning, asserting that personalized learning experiences can benefit greatly from AI technologies. This assertion is reinforced by our findings, which indicate a preference for adaptive learning environments facilitated by AI, allowing for tailored educational experiences that align with individual learner needs. Building on this, Tang, Chang and Hwang (2021) explored publication trends within AI-supported e-learning using systematic review methods and co-citation network analysis. Their work identified that research has increasingly focused on AI's capacity to adapt educational content to meet diverse student needs. This trend echoes our findings, as the selected highly cited papers predominantly addressed the benefits of adaptive learning technologies, confirming that the educational community recognizes AI's value in providing a customized learning experience.

Hwang, Tu and Tan (2022) conducted a thorough review of AI-supported online learning (AIoL) literature and observed a shift from intelligent tutoring systems toward a wider array of applications in online education, which is congruent with our observation about the expanding scope of AI within educational contexts. This reflects a vital trend wherein researchers increasingly leverage AI to solve complex educational challenges, such as improving learner engagement, retention rates, and personalized feedback. Furthermore, Gocmez and Okur (2023) highlighted a significant increase in AI-related publications during the COVID-19 pandemic, indicating the urgent need for effective online education solutions to accelerate research. This aligns with our findings, where we noted a surge in highly cited papers post-2018, emphasizing how global crises can invigorate research and innovation in educational sectors.

As the integration of AI in education continues to advance, future research should emphasize longitudinal studies examining the long-term effects of AI on educational practices and student outcomes. Such studies can provide insights into how AI-powered tools influence learning trajectories and informed decisions in educational settings. Additionally, exploring the ethical implications of AI in education remains critical. Ethical concerns about data privacy, algorithmic bias, and AI's role in the student-teacher relationship must be addressed to ensure equitable outcomes for all learners. Moreover, given the rapid pace of technological advancements, interdisciplinary research combining insights from psychology, cognitive science, and data analytics could yield innovative approaches to leveraging AI in education. The growing interest in generative AI,

Table 4: The top nine authors with two papers each.

Sl. No.	Name of the author	Affiliation of the author	TP	TC	CPP	RCI	ICP	% ICP	TLS
1	P. Zhao	Institute for Infocomm Research, ASTAR, Singapore	2	319	159.50	0.69	2	100.00	7
2	S.C.H. Ho	Singapore Management University	2	319	159.50	0.69	2	100.00	7
3	J. Wang	University of Chicago, USA	2	319	159.50	0.69	2	100.00	7
4	M.A. Al-Masani	Kyung Hee University, South Korea	2	716	358.00	1.56	0	0.00	13
5	M.A. Antari	Kyung Hee University, South Korea	2	716	358.00	1.56	0	0.00	13
6	M.T. Choi	Sungkyunkwan University, South Korea	2	716	358.00	1.56	0	0.00	13
7	S.M. Han	Kyung Hee University, South Korea	2	716	358.00	1.56	0	0.00	13
8	T.S. Kim	Kyung Hee University, South Korea	2	716	358.00	1.56	0	0.00	13
9	M. Loey	Benha University, Egypt	2	432	216.00	0.94	2	100.00	4
		Total of 9 authors	18	4969	276.06	1.20	8	44.44	90
		Global total	100	22970	229.70	1.00			
		Share of top 9 authors in global total	18.0	21.63					

(TP: Total Publications; TC: Total Citations; CPP: Citations Per Publication; RCI: Relative Citation Index; ICP: International Collaborative Papers; TLS: Total Link Strength).

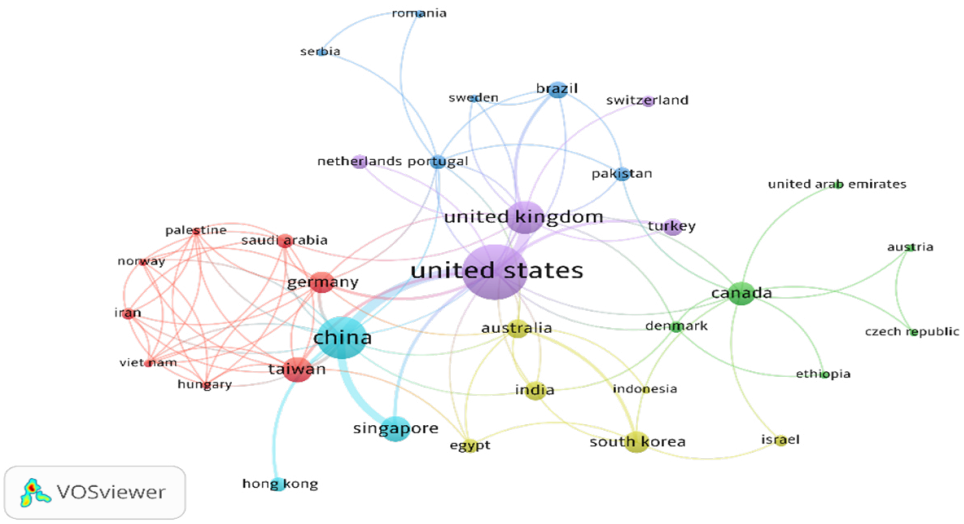

Figure 2: Co-authorship network map among 34 countries.

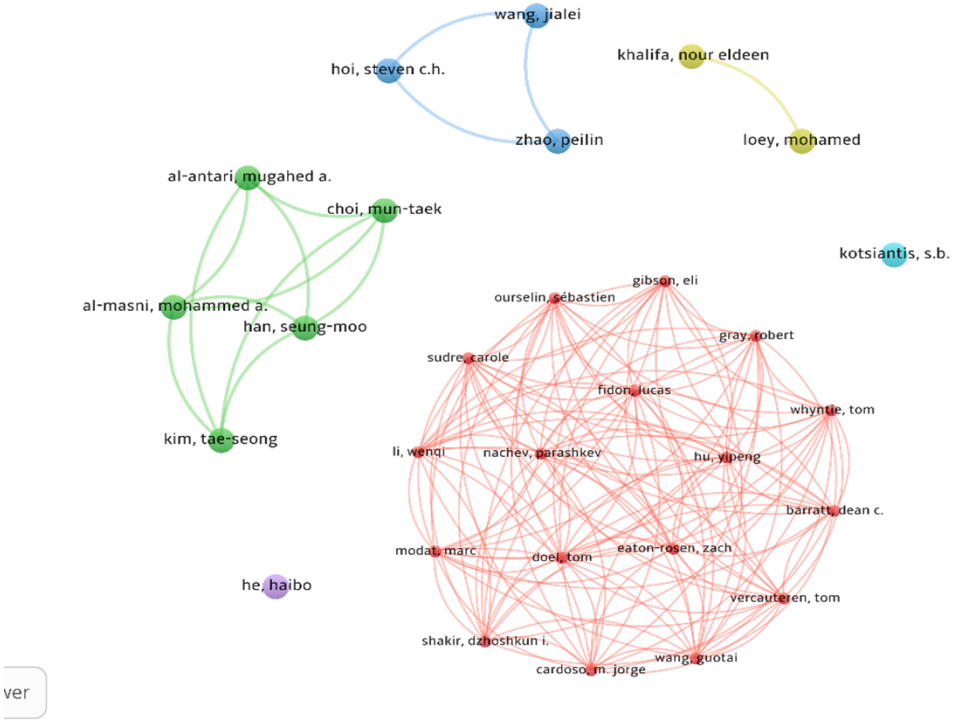

Figure 3: Collaborating network visualization of Top 29 Authors.

immersive technologies (e.g., virtual and augmented reality), and personalized learning systems, as indicated by Putra, Ramadhani and Sandy (2025), presents further avenues for exploration.

Based on the findings and discussions, several recommendations can enhance the progress of AI in distance education (Figure 5). Educational institutions and policymakers should prioritize investment in research and development of AI solutions designed for educational contexts, ensuring that innovations remain sustainable and accessible. Collaborative research partnerships among universities, industry, and governments should be encouraged to facilitate knowledge exchange and advance the development of practical AI applications. Additionally, future AI implementations must focus on ethical considerations and inclusivity to meet diverse learner needs without reinforcing existing educational disparities. Ongoing professional development for educators is essential, equipping them with the skills to effectively integrate AI tools into their teaching practices and enhance pedagogical approaches. Finally, establishing robust monitoring and evaluation frameworks will enable the

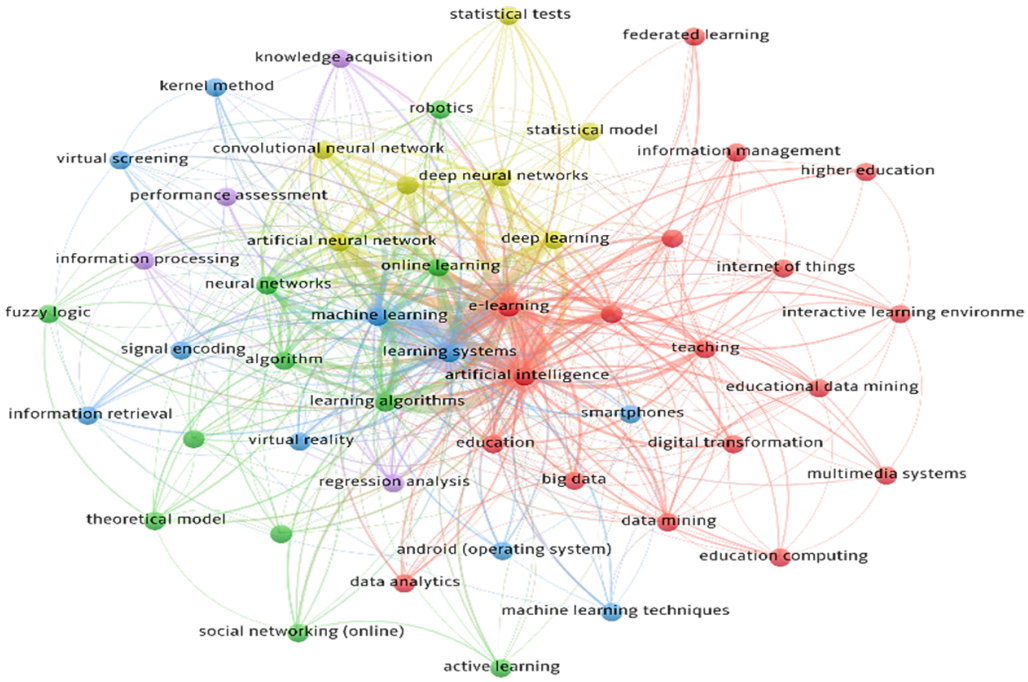

Figure 4: Co-occurrence network of the top 50 keywords.

Table 5: Top 19 journals with two or more papers.

Sl. No.	Name of the journal	TP	TC	CPP	IF
1	Computers and Education	6	1326	221.00	4.0
2	IEEE Access	5	728	145.60	3.7
3	Neurocomputing	4	1004	251.00	5.5
4	Expert Systems with Applications	3	1158	386.00	7.6
5	IEEE Transactions on Neural Networks and Learning Systems	3	901	300.33	10.4
6	Medical Physics	3	628	209.33	3.9
7	Education and Information Technologies	3	593	197.67	4.8
8	Artificial Intelligence Review	3	554	184.67	11.7
9	Journal of Computer-Aided Molecular Design	2	1305	652.50	2.9
10	Computer Methods and Programs in Biomedicine	2	838	419.00	5.5
11	Computers in Human Behaviour	2	485	242.50	9.5
12	International Journal of Artificial Intelligence in Education	2	427	213.50	4.7
13	Machine Learning	2	424	212.00	5.8
14	Journal of Machine Learning Research	2	416	208.00	7.0
15	IEEE Journal of Biomedical and Health Informatics	2	329	164.50	7.1
16	Geoderma	2	324	162.00	6.7
17	IEEE Transactions on Systems, Man, and Cybernetics, Part B: Cybernetics	2	303	151.50	6.18
18	Applied Sciences (Switzerland)	2	255	127.50	2.7
19	IEEE Internet of Things Journal	2	237	118.50	9.0
	Total of top 19 journals	52	12235		
	Global total	100	22970		
	Share of top 19 journals in global total	52	53.27		

(TP: Total Publications; TC: Total Citations; CPP: Citations Per Publication; IF: Impact Factor).

Figure 5: Recommendations to enhance the progress of Artificial Intelligence in Distance Education.

continuous refinement of AI technologies in educational settings, improving their effectiveness in serving students.

The integration of AI into medical education and online learning environments has gained significant attention in recent years. Feigerlova *et al.* (2025) highlights the transformative impact of AI on medical training, suggesting that it enhances learning outcomes through personalized approaches. Similarly, Sun *et al.* (2023) emphasize the effectiveness of AI applications in evaluating educational outcomes in medical settings, underscoring the growing importance of incorporating technology into curricula. Adewale *et al.* (2024) focused on how AI can boost student engagement in online learning, suggesting that its use could address challenges faced by educators in maintaining student interest. During the COVID-19 pandemic, Wang *et al.* (2021) and Vaishya *et al.* (2020) examined the critical role AI played in facilitating distance learning, revealing its capacity to adapt educational delivery in unprecedented circumstances. Singh *et al.* (2025) further explored the benefits and challenges of implementing AI in distance learning environments, highlighting the need for educators to embrace these technologies effectively. Vieriu *et al.* (2025) proposed a framework for AI application in academic practices, providing a structured approach to leverage technology in enhancing educational experiences. Finally, Mahafdah *et al.* (2024) demonstrated how these technologies can significantly improve e-learning experiences overall. Collectively, these studies illustrate the rich potential of AI to reshape education while also pointing to areas requiring further exploration to optimize its implementation.

The study provides a holistic view of the research landscape by leveraging multiple analytical tools, including citation analysis and co-authorship networks. The comprehensive nature of the data collected from the Scopus database enables the identification of influential contributions and prevailing trends in the field, which are often overlooked in traditional qualitative reviews. Despite its strengths, the study has certain limitations. The analysis conducted in this study relies solely on the Scopus database for its downloaded records, which may pose a limitation by excluding relevant research indexed in other databases such as PubMed, Web of Science, and Google Scholar (Vaishya *et al.*, 2024). This restricted scope can affect the breadth of the analysis and may result in an incomplete picture of the literature on AI and Distance Education. As a result, important studies that could provide valuable insights and contribute to a more comprehensive understanding of the field might be overlooked, highlighting the need for caution when generalizing the findings and recognizing the potential for additional relevant research that exists outside the chosen database. Moreover, citation practices can be biased; higher citation counts may not necessarily reflect the quality or impact of the research. This could lead to an overemphasis on highly cited papers that may not encapsulate the breadth of innovative work in AI and distance education.

Studying top-cited research papers in the field of AI and Distance Education serves significant theoretical and practical purposes (Vaishya *et al.*, 2024). Theoretically, it maps the knowledge landscape, identifies research gaps, and establishes a credible narrative that guides future investigations. Practically, insights from influential papers inform policy and decision-making for educational institutions, enhance teaching and learning practices through evidence-based strategies, facilitate collaboration and networking among researchers and organizations, and allow institutions to benchmark their performance against leaders in the field (Vaishya *et al.*, 2025). This comprehensive analysis ultimately fosters innovation and improves educational outcomes while guiding future research directions.

CONCLUSION

This bibliometric analysis has provided insights into the significant role of AI in shaping the future of distance education. The findings underscore the necessity for ongoing research and innovation, particularly in light of AI's transformative potential for enhancing learning experiences globally. As AI technologies continue to develop, a thoughtful and collaborative approach must inform their application in education, ensuring that they foster an inclusive and effective learning environment for all students.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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