

A Systematic Literature Review with Bibliometric Meta-Analysis of AI Technology Adoption in Education

Maran Chanthiran¹, Abu Bakar Ibrahim^{2*}, Mohd Hishamuddin Abdul Rahman³,
S. Kumar⁴ & Rahul Vishwanath Dandage⁵

^{1,2,3}Department of Computing, Faculty of Art, Computing and Creative Industry, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak, MALAYSIA

⁴Department of Economics, Manonmaniam Sundaranar University, Tirunelveli, State of Tamilnadu, INDIA

⁵MIT World Peace University, Pune Maharashtra, INDIA

*Corresponding author: abubakar.ibrahim@fskik.upsi.edu.my

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Abstract

Education has undergone various developments and changes according to the current world circulation and the development of technology and science. Moreover, Covid-19 has emphasized the significance of technology in education. The use of technology in education increases collaboration among students and helps in academic achievement. The use of Artificial Intelligent (AI) has become a trend in 21st-century education in providing learning aids that are technological and digital. The purpose of this systematic survey is to identify peer-reviewed literature on the adoption of Artificial Intelligent (AI) in education among educators. Scopus, Web of Science, and IEEE citation databases are used in the data-gathering phase. PRISMA approach and keyword search were extracted and analyzed. This bibliographic data of articles published in the journals over the seven years were extracted. VOS viewer was used to analyzing the data contained in all journals. The findings show that studies are showing the use and acceptance of Ai technology in education. It also shows that using this technology has a positive effect on mastering a subject among students. However, there is still room to optimize its usability in education, which is currently in the 4.0 education shift in line with the development of the Industrial Revolution (IR) 4.0.

Keywords: Artificial Intelligence, Bibliometric, Meta-Analysis, Systematic Literature Review, Technology adoption

INTRODUCTION

The Industrial Revolution 4.0 has incorporated technological elements to create a gap in physical, digital, and biological environments [1]. Advances in artificial intelligence are moving to the present, and it has already brought many benefits in various fields, including the field of education. The area of education today faces technological challenges. The current concept of education is indirectly closely related to the development of new technologies, especially artificial intelligence [2]. Teaching and learning techniques have also changed from conventional to technology-based methods to adapt to the situation. Developments in artificial intelligence are seen to provide opportunities and challenges to the future to teaching and learning methods [3].

The use of artificial intelligence applications in teaching and learning activities is ubiquitous as it can profoundly impact students and instructors. The nature of learning is how we interact with the

environment. Computer-based methods that can solve problems and act like human thinking are most appropriately used today [4]. Yet, in a given situation, machines cannot replace fundamental human thinking abilities. The engine is the result of human ingenuity alone. The human mind cannot be inherited from the machine except by its descendants only [1].

However, integrating methods and approaches according to changing trends in the world of technology by using the latest techniques such as Internet of Things (IoT) and Artificial Intelligent (AI) in education can lead to heutagogy education [5, 6, 7]. The heutagogy learning approach allows students to choose learning methods according to suitability by physically addressing the needs of the teacher [8]. Directly, this is very helpful for students to access learning even if education stagnates during the pandemic.

LITERATURE REVIEW

Education has undergone various developments and changes according to the currents of world circulation and the development of technology and science [6]. In line with that, education has become one of the key components that ensure the country's human capital formation. Thus, it is the country's duty in designing an education system that makes students seek education from every place inhabited at any time [7]. In line with that, application development by combining the latest technological elements such as AI can bring students closer to teaching activities [8]. The use of technology in education helps in bridging the gap between students. In particular, students with low levels of proficiency are able to communicate with excellent students. The heutagogy approach became a solution to the problem of gaps that existed due to the Covid-19 pandemic [9]. This heutagogy approach gives students the freedom to determine how to access learning without relying on the teacher alone [11]. The heutagogy approach makes the educator play a role as a facilitator or controller of the learning process. The heutagogy approach emphasizes that learners decide on the media to access learning activities. In the Covid-19 pandemic phase, students able to determine which technological media they want to use to access education. This situation has increased the use of technology among students. Artificial intelligence as a technological element has enormous processing capabilities, including adaptive behaviours, such as sensor insertion and other stuff, that allow it to have human-like cognitive and functional abilities, and indeed, that enhance computer-human interaction [10, 14]. Artificial intelligence is a rapidly evolving domain of technology capable of changing every aspect of social interaction [12]. Artificial intelligence contains future educational development trends [2]. The development of education from academic education to knowledge education is an inevitable trend [12]. Education now focuses on imparting knowledge based on one's abilities, with the enrichment of human knowledge systems and increased knowledge accumulation. Much of the knowledge needed to be learned and mastered in the past is now common knowledge [13]. The role of artificial intelligence becomes an inevitable aspect of education. The practice of Intelligent Tutoring System (ITS), Virtual Mentor, Voice Assistant, Smart Content, Automatic Assessment, Personalized Learning, and Educational Games are among the artificial intelligence technologies frequently used in education. Such knowledge is fundamental to measuring educational development. This situation indicates the practice of a future-oriented education system. So, technologies like artificial intelligence leads to the education of the future.

SIGNIFICANCE AND OBJECTIVE

The UNESCO Annual Education Report [13] peels back that these difficulties in accepting artificial intelligence in the school environment are inherent due to the challenges experienced in identifying the elements that need to be absorbed from this technology. According to [14], artificial intelligence can help promote collaborative learning. One of the most compelling aspects of computer-supported collaborative learning is found in situations where students are not physically in the exact location. This gives students variable choices as to how far and where they want to study. With applications developed with artificial intelligence techniques such as machine learning and superficial text processing, AI systems monitor discussion groups, thus providing teachers with information on discussion and student support to guide student engagement and learning [12]. So, this systematic survey is to identify peer-reviewed literature on

the field of artificial intelligence in education through the Scopus, Web of Science and IEEE database. Below is the research question to be answered in this SLR:

- What the current state of the publication on the artificial intelligence in education?
- What the current citation patterns of publication on the artificial intelligence in education?
- Which themes involving publication on the artificial intelligence in education?
- What the area involving publication on the artificial intelligence in education?

MATERIAL AND METHOD

A systematic literature review is desirable for research on this topic. PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) and Bibliometric analysis have been applied to answer the research questions. PRISMA method used to shortlist and selects the 1983 works from Scopus, Web of Science and IEEE databases with explicit inclusion and exclusion criteria as below:

Table 1 Inclusion and Exclusion Criteria

Inclusion	Exclusion
The article period of 2017 to 2021	Duplicate article with same author and topic removed
The article focusses on artificial intelligence in education	Artificial intelligence in other areas than education is excluded in this analysis.
Article, conference paper and review paper only were analysed in this study.	Other type publication excluded.
English language papers only analysed in this study.	Other than English language excluded.

Analysis of keywords

A total of five sets of keywords were used in determining the study through the Scopus database, the Web of Science and IEEE. The primary keyword used is Artificial intelligence and education. While the secondary keywords used are self-learning and machine learning. The keywords used in this bibliometric analysis regarding Artificial intelligence and model are depicted in Table 2, in which the set of keywords are used with “AND” or “OR” operator.

Table 2 List of Keywords

Keywords set	Keywords
Keywords_Set1	“Artificial intelligence” OR “Education” OR “Artificial intelligence in Education”
Keywords_Set2	“Self-learning” OR “self-centred learning”
Keywords_Set3	“machine” OR “learning” OR “machine learning”
Keywords_Set4	“predictor” OR “education” OR “challenge”
Keywords_Set5	“education” OR “teaching tool” OR “trend”

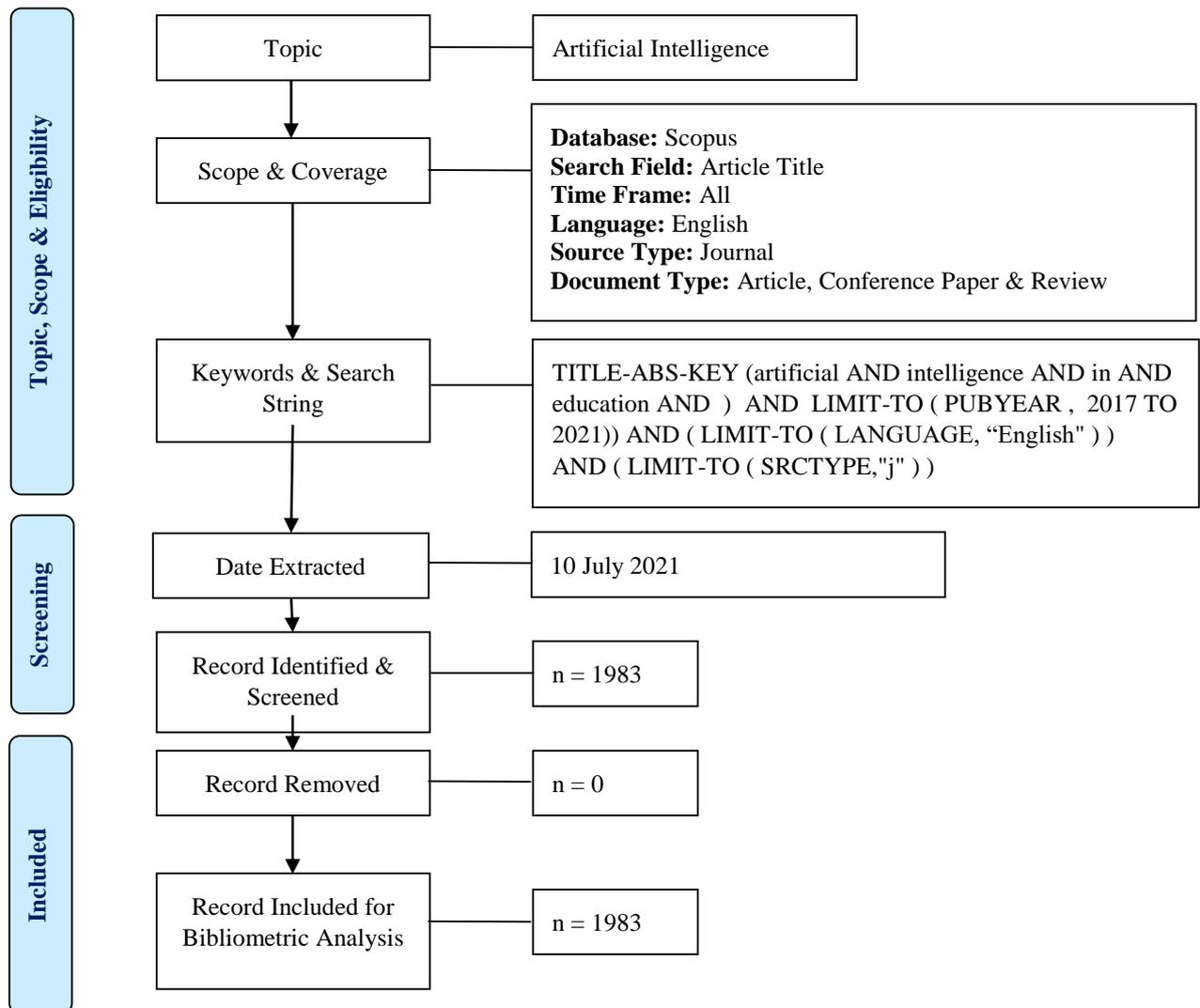


Figure 1 PRISMA flowchart for systematic review of artificial intelligence

RESULT AND DISCUSSION

To address the research questions created in the previous section, the study of this paper utilized the accompanying parts of scholarly works. A total of 1983 articles were analysed in this bibliometric and SLR based on Scopus, WOS and IEEE databases. VOSViewer was used to analyse and answer the objectives of the study. The analysis was conducted to identify the frequency of publication of studies in artificial intelligence in Education. Among the aspects identified are publications issued from 2017 to 2021. Next, subject area and publication trends are also analysed in this literature review.

Current publication state of AI in education

The analysis conducted shows in Table 1 the data of the types of publications published in the database selected from 2017 to 2021 for artificial intelligence. The findings showed that 318 (16.04%) posted were articles, while the publication of conference papers was 1615 (81.44%), and conversely, the publication of review papers was 50 (2.52%).

Table 3 Document Type

Document Type	Total Publications (TP)	Percentage (%)
Article	318	16.04
Conference Paper	1615	81.44
Review	50	2.52
Total	371	100.00

Next, an analysis is conducted to see the publication by trend or landscape of the study is conducted. Findings show for 2017, a total of 2017 studies were published and 568 times referenced in other studies. The average citation value per cited publication for the year was 18.04, and a total of 35 studies recorded the index h , and 90 studies recorded the index value g . Meanwhile, for the year 2018 found that a total of 316 were published. Still, 241 articles in the total number were not referenced, and 22 studies recorded the value of the index h , and 37 studies recorded the value of the index g . The total number of study publications in the three databases showed an increase for 2019 and 2020, which recorded the number of studies of 410 and 403, respectively. However, the number of studies that documented the index h and g decreased for these two years.

Table 4 Year of Publication

Year	TP	NCP	TC	C/P	C/CP	h	g
2017	723	568	10245	14.17	18.04	35	90
2018	316	241	2143	6.78	8.89	22	37
2019	410	243	1219	2.97	5.02	15	23
2020	403	134	509	1.26	3.80	11	15
2021	131	18	41	0.31	2.28	3	4
Total	1983						

Notes: TP =total number of publications; NCP =number of cited publications; TC =total citations; C/P =average citations per publication; C/CP =average citations per cited publication; h = h -index; and g = g -index.

The figure below shows, the study data that recorded the average citation per publication for the year 2020 is 1.26, with the value of the average citation per cited publication is 3.80. Meanwhile, for the years 2021 to July, 131 studies were published in the surveyed database, with a total of 18 unreferenced studies. However, the number of studies referred is 41, with an average citation per publication of 0.31 with an average citation per cited publication value of 2.28. As of July 2021, three studies recorded the index h , and a total of four studies recorded the value of the index g .

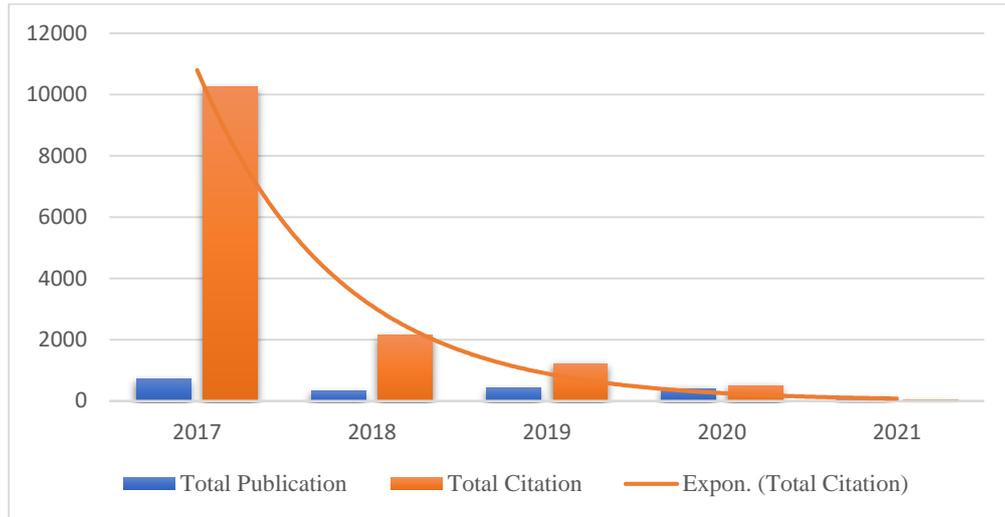


Figure 2 Year of Publication

Next, Table 5 shows the types of published sources of the 1983 studies collected in this review analysis. Among the many studies published are through ACM international conference proceeding series type sources with a total of 875 publications and followed by CEUR workshop proceedings of 77 studies which are 3.88%. Meanwhile, Communications in computer and information science and Procedia computer science were published as many as 70 and 61. The result shows that ACM is the primary source among researchers in artificial intelligence in education.

Table 5 Source Type

Source Title	TP	%
ACM international conference proceeding series	875	15.23%
CEUR workshop proceedings	77	3.88%
Communications in computer and information science	70	3.53%
Procedia computer science	61	3.08%
Proceeding's 6th annual conference on computational science and computational intelligence CSCI 2019	25	1.26%
Lecture notes of the institute for computer sciences social informatics and telecommunications engineering LNICST	23	1.16%
2017 25th signal processing and communications applications conference SIU 2017	17	0.86%
Wiley interdisciplinary reviews data mining and knowledge discovery	15	0.76%
31st AAAI conference on artificial intelligence AAAI 2017	12	0.61%
AAAI 2020 34th AAAI conference on artificial intelligence	12	0.61%
33rd AAAI conference on artificial intelligence AAAI 2019 31st innovative applications of artificial intelligence conference IAAI 2019 and the 9th AAAI symposium on educational advances in artificial intelligence EAAI 2019	11	0.55%
Computers in human behaviour	10	0.50%
Conference on human factors in computing systems proceedings	10	0.50%
Neurocomputing	9	0.45%
International multidisciplinary scientific GeoConference surveying geology and mining ecology management SGEM	8	0.40%
Journal of ambient intelligence and humanized computing	8	0.40%
3rd IEEE international conference on	7	0.35%
Iberian conference on information systems and technologies CISTI	7	0.35%
IJCAI international joint conference on artificial intelligence	7	0.35%
International journal of advanced computer science and applications	7	0.35%

Notes: *TP* total number of publications, *TC* total citations, *SJR* SCImago Journal Rank measures weighted citations received by the source title, *SNIP* Source Normalized Impact per Paper measures actual citations received relative to citations expected for the source title's subject field

Themes and trends of AI in education

Meanwhile, the objective of this review study also emphasizes identifying trends or landscapes of studies conducted in the field of artificial intelligence in education. Table 6 shows the analysis of the subject area of the study conducted in as many as 1983 studies conducted. The table below shows a total of 20 subject areas frequently studied between these five years. In that, many studies were done in the field of computer science, which is 1856 (93.6%), followed by mathematics subjects with a total of 764 (38.53%), and studies in the field of artificial intelligence in the issue of Biochemistry, Genetics and Molecular Biology is 32 (1.61 %). On the other hand, health professions and veterinary subjects were performed once (0.05%). It can be concluded that the subject area of computer science conducted many studies published in the database analysed in this review paper.

Table 6 Subject Area

Subject Area	Total Publications (TP)	Percentage (%)
Agricultural and Biological Sciences	7	0.35%
Arts and Humanities	24	1.21%
Biochemistry, Genetics and Molecular Biology	32	1.61%
Business, Management and Accounting	14	0.71%
Chemical Engineering	12	0.61%
Chemistry	7	0.35%
Computer Science	1856	93.60%
Dentistry	3	0.15%
Earth and Planetary Sciences	29	1.46%
Economics, Econometrics and Finance	5	0.25%
Health Professions	1	0.05%
Immunology and Microbiology	4	0.20%
Mathematics	764	38.53%
Multidisciplinary	24	1.21%
Neuroscience	18	0.91%
Nursing	4	0.20%
Pharmacology, Toxicology and Pharmaceutics	8	0.40%
Physics and Astronomy	11	0.55%
Psychology	21	1.06%
Veterinary	1	0.05%

To further strengthen the findings, an analysis of the title and abstract was also conducted. Results showed 1774 (89.46%) studies used keyword artificial intelligence, followed by Education as much as 774 (39.03%), learning system as much as 723 (36.46%) and while the keyword students were used as many as 462 times (23.30%). Thus, it can be concluded that artificial intelligence and Education are among the main keywords in the study's title.

Table 7 Author primary keyword

Author Keywords	Total Publication (TP)	Percentage (%)
Artificial Intelligence	1774	89.46%
Education	774	39.03%
Learning Systems	723	36.46%
Students	462	23.30%
Machine Learning	334	16.84%
Engineering Education	308	15.53%
Education Computing	284	14.32%
E-learning	213	10.74%
Learning Algorithms	207	10.44%
Computer Aided Instruction	194	9.78%
Data Mining	186	9.38%
Deep Learning	175	8.83%
Teaching	174	8.77%
Computer Science	128	6.45%
Computers	128	6.45%
Classification (of Information)	123	6.20%
Intelligent Tutoring System	106	5.35%
Natural Language Processing Systems	106	5.35%
Curricula	104	5.24%
Neural Networks	103	5.19%

Visualisation Map

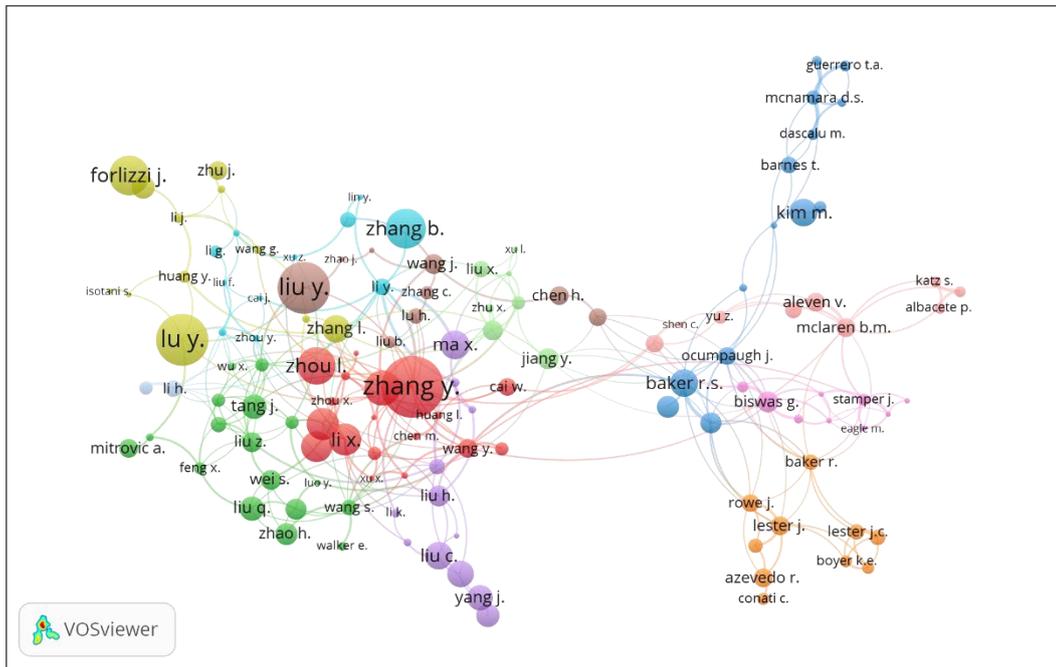


Figure 3. Network visualisation map of the author keywords

most compelling aspects of computer-supported collaborative learning is found in situations where students are not physically in the exact location. With applications developed with artificial intelligence techniques such as machine learning and superficial text processing, artificial intelligence systems monitor discussion groups, thus providing teachers with information on discussion and student support to guide student engagement and education [15]. Finally, [16] stated the potential of artificial intelligence enhances the learning experience among students with disabilities.

CONCLUSION

This review assesses artificial intelligence and its usage in education. The increase in research on artificial intelligence indicates interest in this area of study. This review evaluates the effectiveness and trend of using artificial intelligence. A total of 1983 studies cited from Scopus, Web of Science IEEE were systematically and bibliometrically analysed. The findings conclude that integrating methods and approaches according to the changing trends in the world of technology by using the latest techniques such as artificial intelligence in education can lead to heutagogy education. In line with that, [12] stated that the development of multimedia applications by combining the latest technological elements could bring students closer to teaching activities. The result of applications with technology bridges the gap in technology and bridges all groups of students with educational activities.

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