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A Review of Artificial Intelligence in Education: A Bibliometrics Analysis Using VOS Viewer

Sehrish Amjad
Research Scholar
Greenwich University, Karachi, Pakistan
sehrish.amjad1947@gmail.com

Dr. Khurram Khan Alwi
Assistant Professor
Department of Teacher Education
Federal Urdu University Arts Science and Technology
skhurumkhan@gmail.com; skhurumkhan@fuuast.edu.pk;

Abstract

In the last several years, artificial intelligence in education (AIED) has grown tremendously. In order to support and concentrate on these developments, it is essential to learn about the current state of innovations and how they are developing. This paper explores the different aspects of AI, how it will be innovative in the classroom, and What applications of AI in education are possible in the future. This bibliometric analysis of the current literature related to education and student performance within the scope of artificial intelligence technologies. The comprehensive analysis results of this study in the Scopus database demonstrate that publications based on AI and education have increased in recent years. The analysis of countries showed that China had the most articles (78), followed by the United States with 67 articles. Artificial intelligence use in education can greatly improve ways of teaching and learning, but it also brings up significant ethical concerns that need to be properly explored. The article emphasizes the need for further analysis of the ethical concerns surrounding the use of artificial intelligence in the classroom.

Keywords: Artificial Intelligence, Student Performance, Bibliometrics Analysis

Introduction

Artificial intelligence is setting the educational landscape ablaze with innovation, offering exciting possibilities for personalized learning, automated tasks, and data-driven insights. This review delves into the transformative potential of AI in education, examining its applications, benefits, and challenges in shaping the future of learning. In the last twenty years, technology has grown rapidly and played an important part in human life. Every aspect of life is integrated with the advancement of technology. According to UNESCO (2019), artificial intelligence (AI) has the potential to improve teaching and learning methods, solve some of the largest issues facing education today, and hasten the achievement of SDG 4.). The most recent advancement of technology is AI (Artificial intelligence), which is grabbing fast in all aspects of life, whether it is

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household, business, education, etc. It is an automated machine that thinks with programmed data and information. According to Rodríguez-Hernández et al. (2021), artificial intelligence (AI) applications have grown ever more important in our daily activities. During the pandemic, educators and students have gone through tough situations all over the world as they were not prepared for technology integration in the classroom.

The role of AI in education is becoming stronger day by day, and the way of learning has been transformed continuously. In the beginning, most of the negative thoughts were shared by artificial intelligence. Still, the acceptance of new technology is recognized, and there are different ways in which student performance can be enhanced with the latest technologies of artificial intelligence. After the development of technology, the integration of artificial intelligence in the classroom faces new challenges. Researchers are increasingly focusing more on education-oriented pedagogy, cognitive development, and humanistic principles in addition to technology-oriented intelligent tutoring systems and robotics (Luan et al., 2020). Artificial intelligence (AI) has a wide range of applications in online education (Anderson et al., 1985; 2016; Roll et al., 2018; Seo et al., 2020b; Vanlehn, 2011). AI facilitates educators in solving students' problems in different discussion forums, and in that way, instructors save valuable time. (Goel& Polepeddi,2016).

Despite the surging interest and rapid evolution of Artificial Intelligence in education, there still needs to be comprehensive overviews that synthesize the field's research landscape. While numerous individual studies explore specific applications or the implications of artificial intelligence on academia, a holistic understanding of the study patterns, leading authors, influential publications, and emerging themes still need to be included. More systematic reviews and bibliometric studies are needed to offer a comprehensive overview of the topic despite the growing interest in AI-powered education. These require a thorough and organized synthesis of the body of knowledge regarding a certain issue. Researchers identify, assess, and summarize research findings from various studies according to a set process. By looking into the trends, patterns, and potential uses of AI for educational research, this study aims to close this gap.

This gap hinders our ability to identify research gaps, prioritize future research directions, and effectively translate research findings into practical classroom applications. A bibliometric analysis offers a robust and objective methodology to address this gap. By systematically analyzing a large corpus of research publications on AI in education, the study uncovers hidden patterns, identifies influential work, and maps the evolution of the field over time. This data-driven methodology highlights potential fields for further investigation and provides useful details for the present situation of AI in education research worldwide. This research investigates ways to facilitate the use of artificial

intelligence tools in the classroom and improve students' ease of learning. Thus, the study paper takes a broad approach to examine the different aspects of artificial intelligence, how it will be innovative in the classroom, and what its future opportunities for use in learning are.

Research Questions

The research questions that follow are intended to be investigated in this study:

1. Which countries contribute significantly to artificial intelligence and co-authorship patterns by authors in educational research?
2. What are the most influential publications, journals, and research clusters shaping Artificial intelligence in education discourse?
3. What are the key themes, emerging trends, and potential research gaps within Artificial intelligence in education research?

Research Objectives

To provide a detailed and data-driven overview of the artificial intelligence research landscape in academia, as well as forthcoming research directions and practical applications.

Literature Review

The Genesis and Evolution of Artificial Intelligence (AI)

Alan Turing was a scientist and mathematician who developed the idea of artificial intelligence (AI). In 1950, Turing presented the eminent Turing Test as a basis for understanding the machine's ability to show intelligent behavior identical to that of a human. Artificial intelligence refers to a set of procedures used in coding that enable machines to activate human intelligence and carry out certain logical activities, like storing facts, rules, and conclusions in memory. Since these programs carry out certain mental functions and skills in a particular way, building computer machines is an important job that demands a certain level of intellect and mental capacities when conducted by a person (Hassan, 2019).

Artificial intelligence (AI) is the analysis of human intelligence used by technology, which includes functions like the acquisition of knowledge, solving problems, observation, and making decisions. AI systems, which stand for artificial intelligence, attempt to replicate thinking abilities typically linked with human intellect, resulting in the creation of smart machines capable of operating

difficult tasks independently. Intelligence is the analytical aspect that gives the ability to accomplish objectives in the real world. Artificial intelligence (AI) is the field of science and engineering that develops intelligent digital programs as well as machines (McCarthy, 2007). The initial Artificial Intelligence study was created by (McCulloch and Pitts, 1943). McCarthy first applied artificial intelligence in 1956 (Russell & Norvig, 2010). Applications for artificial intelligence include advanced systems, artificial intelligence for vision, speech recognition, linguistic comprehension, reasoning groups, and playing games (McCarthy, 2007). AI technology assists individuals with child development and medical treatment. It assists users in finding relevant and correct information on the internet (Li and Du, 2017).

The evolution of artificial intelligence from Gödel to the present (Wolfgang,2017)

Table 01: Evolution of Artificial Intelligence

Date	Description
1931	Kurt Gödel of Austria established that all logical statements in first-order predicate theory may be derived (Gödel, 1931).
1937	Alan Turing used the problem of halting to show the limits of computers with intelligence (Turing, 1937).
1943	McCulloch and Pitts developed neural systems and found the link with conceptual reasoning.
1950	Alan Turing developed intelligence in computers with Turing testing and wrote about automated learning and algorithmic genetics (Turing, 1950).
1951	Marvin Minsky created a system known as a neural network machine.
1955	Arthur Samuel (IBM) developed an automatic control system application that excelled over its original developer.
1956	McCarthy planned a discussion at Dartmouth College. Here, the concept of Artificial Intelligence originated. Newell and Simon of Carnegie Mellon University (CMU) introduced Logic Researchers, a pioneering symbol-processing programming program (Newell et al., 1957).
1958	McCarthy designed the high-level programming language LISP at the Massachusetts College of Technologies (MIT).
1959	Gelernter (IBM) created the Geometry Theorem Prover.
1961	(GPS), created by Newell and Simon, mimics human intelligence (Newell & Simon, 1961).
1963	McCarthy established the Artificial Intelligence Lab at Stanford University.
1965	Robinson developed a solution mathematics for predicate logical reasoning (Robinson, 1965).
1966	Weizenbaum's program, Eliza conducted a natural language dialogue with people (Weizenbaum, 1966)
1969	In their book called Perceptrons, Minsky and Papert showed that the perceptron, a very simple neural network, can represent only linear functions (Minsky & Papert, 1969).
1972	French physicist Alain Colmerauer created the logic of the programming language PROLOG.
1976	Shortliffe and Buchanan created MYCIN, a specialized framework for the diagnosis of infectious illnesses that allows for uncertainties.
1981	Japan developed the "Fifth Generation Project" at an expensive rate to create a strong PROLOG machine.
1986	Rumelhart, Hinton, and Sejnowski, among others, have contributed to the rebirth of artificial intelligence. (Rumelhart et al., 1986)
1990	(Pearl, 1988), (Cheeseman, 1985), Whittaker, and Spiegelhalter introduced the concept of probability into AI via Bayesian structures.
1992	Tesauros' TD-gammon application highlighted the benefits of learning by repetition.
1993	The global RoboCup program aims to develop independent-playing robots.

1995	Vapnik created support vector machines, which are based on the concept of statistical learning.
1997	Deep Blue, IBM's chess computer, defeated chess world champion Gary Kasparov in the first international RoboCup tournament held in Japan.
2003	The RoboCup robots displayed exceptionally what Artificial Intelligence and robotics might achieve.
2006	Service robotics is emerging as an important field of study in artificial intelligence (AI).
2009	In the beginning, Google's autonomous vehicle traveled on a California highway.
2010	Autonomous machines have started to acquire knowledge to improve their behavior.
2011	IBM's "Watson" defeated two human competitors on the national television game program "Jeopardy!" Watson understands regular speech and can respond quickly to complicated queries.
2016	Google DeepMind's Go system AlphaGo (Silver et al., 2016) overcame the European champion 5:0 in January and Korean Lee Sedol, one of the planet's finest Go players, 4:1 in March. Hanson Robotics (Artificial Intelligence) produced a humanoid robot named Sophia.
2017	The social networking site's Facebook AI Research team taught two "dialog agents" (virtual assistants) to talk with one another in order to learn how to discuss (artificial intelligence).
2018	Ali Baba's (Chinese Technology Group) language processing artificial intellect outperformed human intellect on the Stanford reading and comprehension test.
2020	Microsoft released their Turing Natural Language Generation (T-NLG), which was then the "biggest model of language" (Intelligence and Semantics)

Artificial Intelligence's Definition:

Artificial Intelligence is a growing field of computer science that studies the structure of human intelligence through applications and systems. The goal of this science is to create systems that function like expert minds, resembling human cognitive processes and motor and mental abilities like deductive reasoning, simulation, and rapid thinking.

According to Makkawi (2018), artificial intelligence is a discipline of science that allows machines to think in ways similar to those of humans. Specifically, it involves the development of computer programs that mimic human mental processes like reasoning, analysis, and reaction time.

The ultimate objective of intelligence-based systems is to create smart learning structures that can produce specialized expertise and discover novel ideas (Abuzakiyeh, 2018).

Artificial Intelligence's Features:

According to Ehab (2018), artificial intelligence is a collection of computer applications and systems designed to carry out cognitive tasks more swiftly and correctly than a person's brain.

1. The ability to learn: Artificial intelligence can acquire data, apply principles to it, and correctly categorize it.

2. The ability to gather, transform, and link data to produce information, which facilitates the extensive sharing of information.

3. It supports decisions based on data analysis since it provides evidence alongside techniques that accomplish specific objectives.

4. Is capable of resolving issues inside organizations because it is based on impartial evaluation and accurate responses. It also gives officials transparent information by offering numerous rapid solutions for issues that are challenging for people to examine.

5. Artificial intelligence is extremely reliable because it is not liable to external factors or memory. It analyzes and aims to imitate human reasoning through computational processes. As a result, stability is a relative concept.

6. Since artificial intelligence has the potential to save money and time, intelligence is defined as a person's skills. Artificial intelligence programs and systems are equipped with technology that enables them to perform certain jobs more quickly and accurately.

The Diverse Applications of Artificial Intelligence

In a review of concepts study published in 2018, Fahimirad et al. examined the rise of artificial intelligence within the classroom and its application to the teaching and learning processes. It is a burning issue about how artificial intelligence impacts the classroom. AI can be used in the classroom for different purposes, for example, to assess the student's performance with AI tools; using AI tools helps teachers enhance their teaching pedagogies and, on the other hand, supports the management of educational institutes. It looked at how emerging technologies affect education, how schools are teaching, and how students are learning. The following areas were mentioned by it as places where AI can be integrated into an educational setting:

- AI tutors providing additional student help.
- Automated grading
- AI tracking and monitoring of feedback for teachers and students.
- The differentiation of roles (Artificial intelligence and education) creates an impartial atmosphere for students to experiment.
- AI as a facilitator to coach struggling learners
- AI-enabled learning describes how artificial intelligence (AI) may be used to monitor, record, assess, and teach learners.

In Covid-19, most of the developing countries needed more time to be ready for the sudden change in the implementation of technology in the

classroom. Artificial intelligence (AI) technology implementation in educational systems has brought about a lot of attention and discussion in the past decade. Studies on Artificial Intelligence in Education (AIED) have been growing in the last few years, so efforts are required to accept the status of trends and their development to assist and focus these directions (Prahani, Rizki, Jatmiko, Suprapto & Tan, 2022). Teachers are at the center of this discussion because their viewpoints and methods have a significant influence on how Artificial Intelligence is implemented and used in the classroom. The systemized connection of AI to academia will allow countries to address some of the main challenges in education today, innovate learning and its practices, and help boost progression toward growth and sustainability goals (Ghazi, 2021).

There are many wonderful and varied applications for artificial intelligence, and the study discusses a few of these below in the context of education.

1. Artificial intelligence supports and helps the educational process by making it easier to perform academic and managerial duties. It is regarded as an amazing accomplishment for its ability to arrange files, streamline the reference process, organize every learning domain, and meet the highest standards for performance (Turbot, 2017).

2. It makes data analysis and interpretation challenging for instructors to perform, for instance, in questions with multiple answers, regardless of the volume of the data. By computing specific algorithms, artificial intelligence systems analyze students' responses more extensively to determine their challenges, which can require more time and effort from educators (Hayek, 2018).

3. Education fundamentals should be automated because teachers have much work to do when developing, reviewing, and revising questions, not to mention resolving learners' mistakes and assessing each student's response on their own. Thanks to a computerized installation, artificial intelligence (Hayek, 2018) accurately completes these tasks with less time and effort.

4. Supports learners globally and at all times: Artificial intelligence technology, like a smartphone outfitted with a smart learning approach, enables students to access information at any time and from any location, as well as a variety of educational resources. They can also locate databases that suit their needs and quicken the learning process, thereby fortifying their foundational knowledge (Virou, M. & Alepis, E, 2005).

5. The efficient computational algebra system has many options for AI applications that assist learners in learning the principles of algebra, certain equations and symbolic processes. This allows learners to utilize the digital pencil and accessible instructions to compute, contributing to the instructional value of smart algebra. Alternatively, data, acquire, and so on commands assist with algebraic calculations. According to McArthur and Bishay (2005), artificial intelligence has demonstrated its efficacy and success in assisting students with their algebraic learning.

Smart Teaching System

The Smart Teaching System (ITS) is a computer-based learning program. Students independently learn through an AI tutoring system without the interaction of humans. Every student has a different intelligence level. AI can help different types of intelligence levels, from easy to difficult strategies. The innovative education framework was given to a group of learners of all ages to test and see its impact on influenced them. According to Alhabbash et al. (2016), the setting up of an intelligent Instructional System (ITS) for instructing English grammar will help individuals learn the language more quickly and easily. The method addresses all aspects of English grammar and generates a variety of questions for students to complete for a particular subject.

Artificial Intelligence Open AI tool Chat GPT

Chatbots have been available since the 1960s when Weizenbaum (1966) created ELIZA, a psychotherapeutic chatbot. It has grown significantly since ELIZA. 10. Son et al. Other significant chatbots belong to ALICE and CleverBot. Browser-based chatbots have been around for several years and frequently become part of messaging systems like Facebook Messenger to provide instant messaging. Chatbots can also have similar human features with socially life-like traits, which can emotionally involve individuals in the interaction by using text, audio, and other visual indicators. These days, chatbots employ strategies such as NLP, pattern identification, and machine translation using neural machines to achieve their aims (Huang et al., 2018; Smutny & Schreiberova, 2020). Chat GPT will be an amazing tool for brainstorming ideas. Teachers can use that as a warm-up activity in their lesson plans, and students then come up with more ideas. Teachers can ask open-handed questions, and students can approach new ideas. This chatbot can help learners improve their creative skills and bring ideas that will help them fulfill their writing objectives.

Game-Based Learning

González (2016) examined the impact of personalized gamification on intelligent tutorial systems in their study published in the International Journal of Engineering Education. The research underscores the significance of

individualized gamified elements in bolstering student engagement, offering insights into the effectiveness of this approach for enhancing educational experiences. This study contributes to the ongoing discourse on the integration of gamification and personalization in the context of instructional technology. Game-based learning would become a helpful tool, especially for those students who can learn through interactive game activities. Kahoot! is the most widely used gaming platform for online learning. In a matrix comparison of several game platforms, such as Kahoot!, Quizizz, Quizalize, Socrative, and Riddle, Melissa (Pilakowski, 2015) demonstrated that an extended period of gamification during lectures had no less of an impact on students' engagement (Ab Rahman et al., 2019). Students will love studying using this engaging and fascinating game.

Artificial Intelligence Microsoft Tool Copilot

A limited amount of research has been conducted on the use of copilot tools in education, especially in developing countries. Nowadays, a question has arisen in everyone's mind about how these tools will be useful for us. There are two schools of thought. One believes that the study can use these tools to make student learning more innovative, and at the same time, teachers can also benefit from increased effectiveness. On the other hand, the other school of thought believes that these tools would not be helpful for students and could even be used as cheating tools.

KhanmigoGPT-4 Learning Tool

A pilot program for Khanmigo, a GPT-4 powered customized version of ChatGPT technological advances intended to function as an online tutor for students, was introduced by Khan Academy in March 2023. Sal Khan, the owner of the volunteer educational resource Khan Academy, claims that Khanmigo serves as a tutor and advisor for students rather than assigning homework. Khanmigo will follow the Socratic learning strategy. According to Sal Khan, this application is a learning resource. The most fascinating part of this application is that it is available in more than 50 languages.

The Academic Essay feedback tool from Khan Academy, Khanmigo, can offer detailed and useful feedback on a student's essay. This can include timely and beneficial advice on how to format an opening, set a suitable tone for academic writing, and develop and bolster essay points. Instructors co-wrote lesson plans, lesson hooks, and exit tickets using Khanmigo. Students could find assistance in math, physics, and the humanities by using Khanmigo.

Language Learning App Duolingo and Babble

Babble and Duolingo are language learning applications that provide learners with a gateway to the experience of learning different languages. An application called Duolingo is available for free and offers English language lessons. Learners are encouraged by gamification aspects such as levels, patterns, and scores. Reading, writing, speaking, and listening exercises are all included, along with social engagement and fast responses. Duolingo is a free Android application (there is also an online version), and it is currently the most prominent in the learning level on Google Play. Studies have indicated significant rises in language skills as a result of utilizing the app. The software then asks the student if they already know anything about the language, and if so, it gives them a test to determine their placement. If a student is unfamiliar with language acquisition, they should begin with the foundation level.

It provides a wide range of activities where students can practice through activities, same-time feedback, and pronunciation practice. However, using this learning application in the classroom has some limitations, like a certain level of attention from an instructor. It may focus more on initial language patterns and avoid those learners who need advanced-level instructions. Language learning applications have both advantages and disadvantages. However, it depends on the teacher how to utilize them in the classroom and make this application effective for their learners.

Challenges for the Application of Artificial Intelligence in Education

Artificial intelligence may simplify things for both educators and learners, but multiple obstacles remain that limit its potential to reliably and successfully assist education. The negative aspects include price, security, ethical principles, inability to be explained, or dependence on reliable data. These restrictions may make artificial intelligence too expensive for its advantages or even dangerous by violating privacy, which may make it unfeasible, unsafe, or unattractive to apply artificial intelligence.

1. The primary concern about artificial intelligence in academics is to safeguard against fraudulent use of data. There are no proper regulations in the quickly expanding profession. The first comprehensive set of AI regulations was the European Union’s AI Act in 2023 (EU AI Act: first regulation on artificial intelligence, 2023). Experts need to be hired to develop proper guidelines to protect users of artificial intelligence.

2. AI requires data; its efficiency depends on the amount and quality of data available. Inaccurate data or particular values are disproportionately represented, and AI may spread and strengthen negative prejudices. Systems

must be created to detect any biases or incorrect AI outputs (Khan et al., 2023).

3. With the growing popularity of artificial intelligence tools, many reliable options have become expensive, often requiring monthly or yearly subscriptions. This makes these tools less accessible to everyone.

4. Artificial intelligence can lead to decreased human interaction, and humans may lose their critical thinking skills as students and educators become too dependent on these systems.

5. Artificial intelligence has the potential to be a very useful tool if applied effectively. Some human-AI partnerships collapse, according to Holstein et al., because humans need more expertise or the AI needs to develop effectively, making it impossible for human to use the AI (2019). Because it is new and unexplored, learners, as well as teachers, will require practice and instruction in order to use it effectively. Teachers and students could only spend time attempting to adjust to the technology if they were trained. It would be comical if educators and students spent more time studying how to use educational AI than actually teaching or learning. After all, the purpose of educational AI is to aid education.

Methodology

Stage 1: Search Criteria

Bibliometrics is the systematic organizing and assessment of the bibliographic data taken from academic publications. It includes the quantitative evaluation of written works, including books and articles, to determine their relevance and influence in an area of interest. This field of study uses a variety of measures to evaluate the effectiveness and distribution of academic findings, such as authorship patterns, publication numbers, and citation analysis.

The systematic management and evaluation of bibliographic data gathered through scholarly works is known as bibliometrics. A researcher has selected bibliometrics for search criteria because the technique offers an unbiased structure to guide finding and selecting good research publications. Bibliometric indicators assist scholars in assessing the effect, credibility, and relevancy of scientific literature. This guarantees that the chosen works are both relevant to the study's subject matter and acknowledged for their contribution to the field. The study itself intends to depend on research-related scientific literature. The chosen papers for this study were found by using search engine key phrases, such as "artificial intelligence" and "student performance."

Table 01: Search Criteria

Theme	Search Terms
Artificial Intelligence	Artificial Intelligence
Context	Student Performance

Stage 2: Data Base Selection

A crucial first step in any research project is choosing the right database. Scopus is the primary database that will be used for this study. This decision is supported by other strong arguments, such as the large volume of journal articles it holds and its adherence to strict, uniform standards for article indexing. One of the main features of Scopus is its broad coverage of peer-reviewed literature. One of the largest abstract and citation databases available contains a wide range of scholarly journals from many areas. Because of its wide range of sources, Scopus is especially useful for research that crosses disciplinary boundaries or requires a comprehensive understanding of a particular subject. Scopus makes it easier to conduct thorough literature studies by giving users access to a vast number of high-quality, peer-reviewed papers. This guarantees that researchers may find and use the most recent and pertinent research in their work.

Stage 3: Data Collection

Data was imported in May 2024, and to maintain the consistency and accessibility of the research analysis, only English publications were selected. A researcher carefully considered the decision was made to keep the review to English-language publications in order to preserve a grammatically acceptable framework. This decision reduced potential linguistic complications and errors while enabling a more simplified and cohesive analysis of the literature. Furthermore, it guaranteed that the results would be comprehensible to a wide range of scholarly audiences, so augmenting the significance and distribution of the research findings. There were 1,193 in all. Because the study field is dynamic and continuously growing, this vast collection contains a wide variety of scholarly publications, with a substantial emphasis on conference papers. The cautious work of data filtering appears in the selection of 532 articles from an increased number of 1,193 papers. This comprehensive screening ensures that the most relevant and significant studies will be a part of the study. In this collection, conference papers stood out in particular due to their ability to convey innovative research and promote scholarly discussion.

Stage 4: Data Analysis

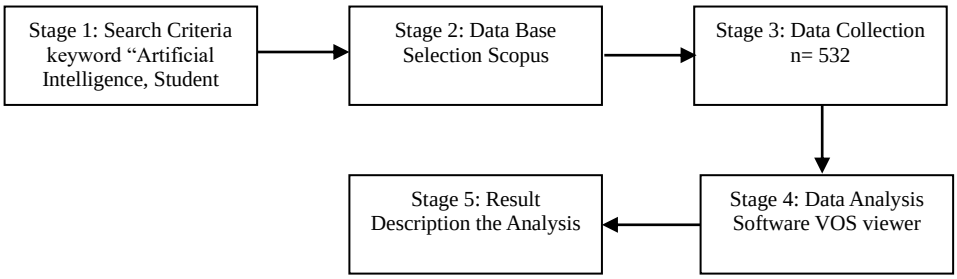
A collection of programs named VOSviewer is used to create and visualize bibliometric networks. These organizations can be formed by citation, bibliographic coupling, co-citation, or co-authorship links and can include journals, researchers, or individual publications. Furthermore, VOSviewer features programs for text mining that may be utilized to generate and visualize co-occurrence networks of relevant terms extracted from a collection of scientific literature. Co-authorships (authors, nations, and organizations), co-citations (authors and references referenced), and co-occurrences (author keywords) have all been analyzed.

Using the VOSviewer 1.6.20 program, these analyses were performed in every situation utilizing the "full count" approach, which yields a score of one representing the author's overall weight (Perianes-Rodriguez et al., 2016). The visualization maps display the findings.

Bibliometric information gathering from Scopus sources. After the network has been established, the data will be examined using the visualization features of VOSviewer. To emphasize certain network features, change the visualization's parameters. Spot areas of study with the density visualization and significant groups with the clustering feature. Scientists can find patterns and insights in scientific literature by conducting thorough bibliometric analysis with VOSviewer.

Stage 5: Result Description

The results set in the investigation were taken from the Scopus database and included PlainText formatted information. Details like the publication year, title, author, journal, citation information, and keywords were included in this data. After 2020, most of the data covered was analyzed using VOSviewer software version 1.6.20. For analysis and the production of visual maps, Van Eck and Waltman's (2010) software tool, VOSviewer, was utilized. The program employed VOS clustering and mapping techniques to accomplish these goals. This method makes the relationship and framework evaluation inside the specified dataset possible.



Analysis

VOSviewer is an innovative software tool that is easily accessible for designing and analyzing bibliometric networks. It was created by the Centre for Science and Technology Studies (CWTS) at Leiden University in the Netherlands. This text refers to version 1.6.20. Maps based on co-authorship, co-occurrence of terms, citation, bibliographic coupling, and co-citation linkages among academic papers can be easily created with VOSviewer. The software is a useful tool for academics conducting bibliometric studies since it can visually depict intricate links understandably. This technique has been discussed by various scholars, including Appio et al. (2016), Fahimnia et al. (2015), and Verma et al. (2023).

VOSviewer Exporting and Analyzing

Researchers gather search result records from the Scopus database before beginning the VOSviewer software analysis process. These records—which could contain author information, keywords, citations, and references—are exported in a plain text file type. Once they are entered into VOSviewer, the program examines these files, creating visual maps. These maps provide insights into the processes and framework of the research field under study and illustrate the links and relationships within the dataset.

Inclusion and exclusion criteria:

The inclusion and exclusion criteria were as set out in the following table. It is important to clarify that this review is primarily based on the Review of Artificial Intelligence and covers different perspectives on AI.

Table 02: Inclusion and Exclusion Criteria

Inclusion	Exclusion
• Must provide Artificial intelligence and student performance • Paper must be included in English Language. • Peer-reviewed journal articles, book chapters, and conference papers were included in the inclusion criteria.	• Not related to Artificial Intelligence • No peer-reviewed journal articles, book chapters, or conference papers were included in the inclusion criteria. • Not in English.

Results

Contribution by countries

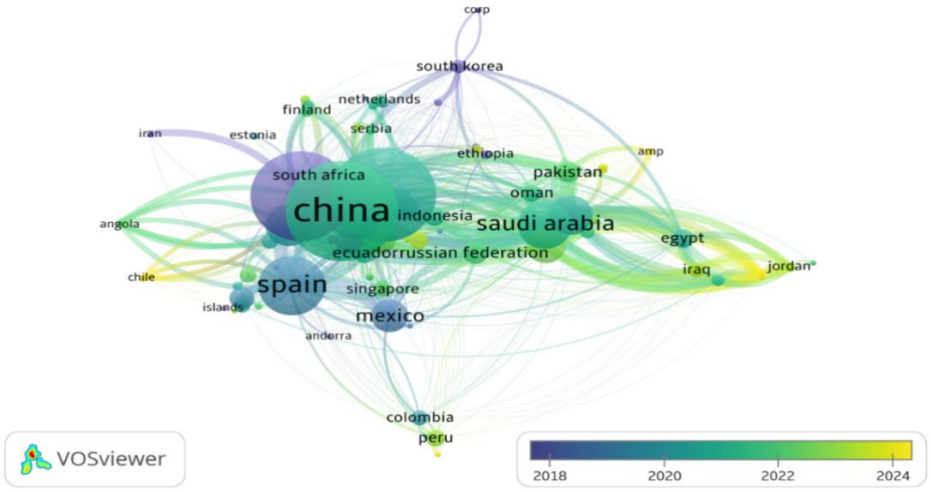
This international pattern of study production offers useful data on the current situation of artificial intelligence in educational studies globally. China leads the world in artificial intelligence productivity in education, with 78 articles. India comes in second with 72, the US with 67, Spain with 38, the UK with 27, Saudi Arabia with 28, Australia with 23, Malaysia with 21, Bangladesh with 5, and Pakistan with 9 articles. According to these data, most of the work was done

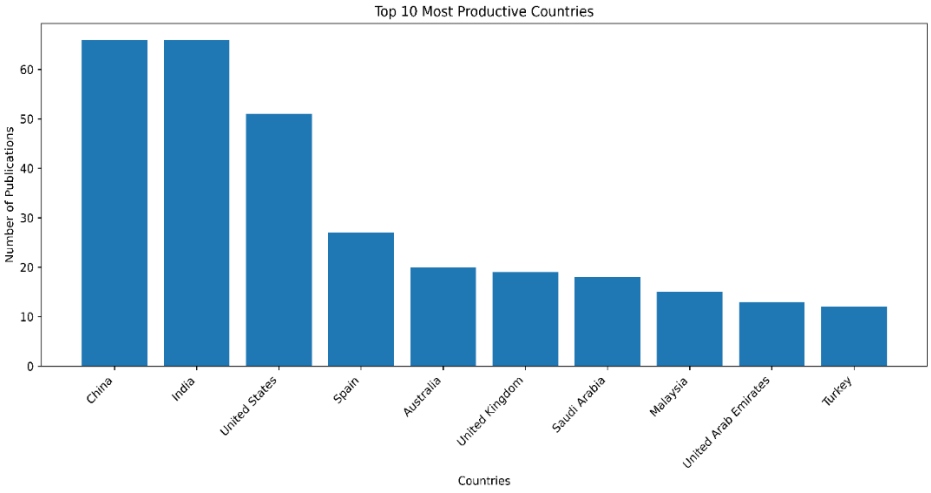
in China. India would be the second country, and after that, the United States has been conducting productive work on related topics. It indicates that these three nations are leading the way in this field of research, maybe as a result of their considerable individuals, economies that are emerging, and expenditures in higher education and technology.

The most productive top ten countries have been shown in the following table.

Table 03: Top 10 Most Productive Countries

S.No	Country	Documents	Citations	Total Link Strength
1	Australia	23	194	10
2	China	78	645	17
3	India	72	361	13
4	Malaysia	21	198	13
5	Russian Federation	10	34	9
6	Saudi Arabia	28	153	10
7	Spain	38	303	9
8	UAE	19	120	8
9	United Kingdom	27	367	11
10	United States	67	884	20



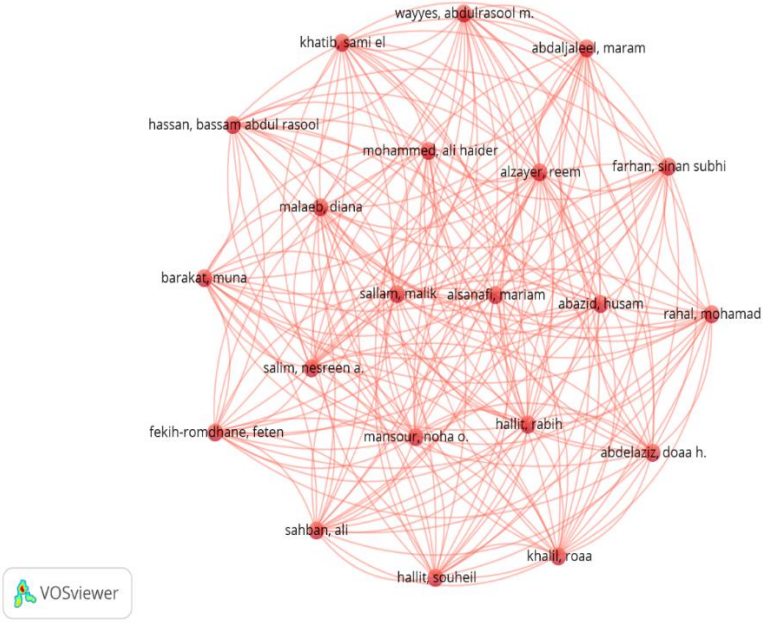


Notably, countries like Spain, Australia, and the United Kingdom belong to the most prosperous 10, suggesting that the study of artificial intelligence and education is an international phenomenon, not just confined to the strongest economies. The Middle East and Southeast Asia are becoming increasingly interested in and investing in artificial intelligence (AI) and education research, as evidenced by the inclusion of Saudi Arabia, Malaysia, and the United Arab Emirates on this list of countries. The diversity of countries included in the top 10 points to a widespread understanding of the value of artificial intelligence in education. This broad interest may result in a wide range of viewpoints and methods for using artificial intelligence (AI) to address educational problems in various academic and cultural environments.

Overall, this bibliometric analysis presents a lively and widely dispersed research sector. Higher education is moving toward more individualized, effective, and based-on-data teaching methods, as seen by the emphasis on artificial intelligence (AI), machine learning, and its practical uses. With participation from established and emerging study communities, the worldwide spread of the study output suggests that the impact of artificial intelligence (AI) on education is a global phenomenon.

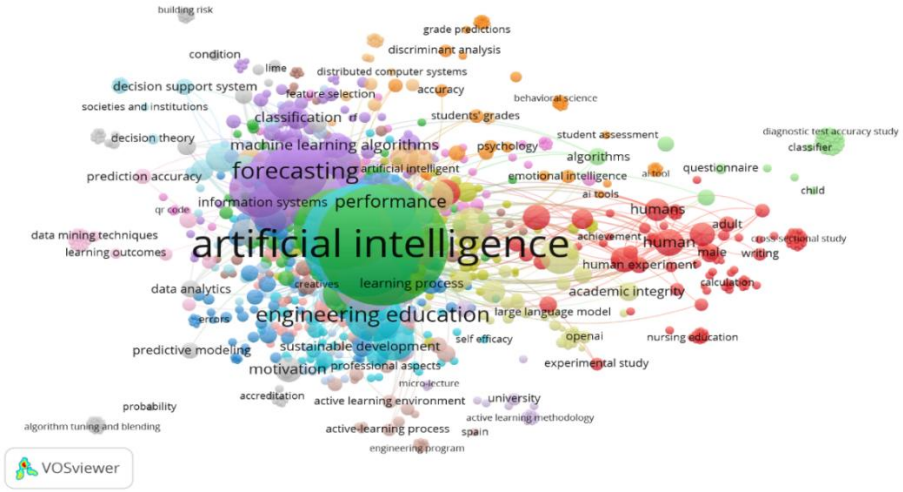
Co-Authorship by Authors

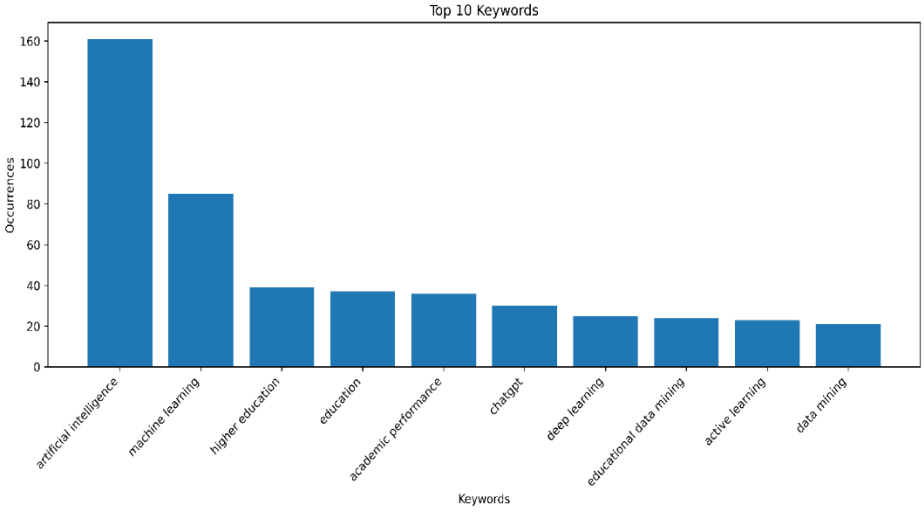
The co-authorship visualization map for authors in VOSviewer illustrates the strength of the collaboration between authors on the topic. The mapping criteria were set to one article per author. A total of 1832 authors were registered, but only 1000 were included in the study. The single color (red) indicates that only one co-authorship group of authors was formed. The distances between the points indicate that there is a relative strength of collaboration, and the small size of the points indicates little production.



Keywords

In the starting process, 3,431 keywords met the threshold, and then a minimum number of occurrences of a keyword was selected, and finally, 1000 keywords were taken in the process. The most repeated word was Artificial Intelligence, which was used (370) times, followed by students (319) times. Other important words were academic performance, learning system, machine learning, and education computing. Keyword visualizations were created of different sizes depending on the frequency of the use of words. Word placement was random, with dominant words placed in the center to increase their visibility as their size increased. This method was created using VOS Viewer. The study of the bibliometric data indicates notable trends in study performance and focus areas connected to artificial intelligence in higher education. The top 10 keywords provide insight into the most prevalent topics in this field:





The distribution of keywords here emphasizes how prevalent machine learning and artificial intelligence are in the field of research. The prominence of phrases like "academic performance," "higher education," and "educational data analysis" suggests that using artificial intelligence (AI) to enhance academic procedures and results is a major priority.

Citation and co-citation analysis

The most highly cited paper was written by Jie XU in 2017, with 156 citations, and published in the IEEE journal. It is a machine-learning approach for tracking and predicting student performance in degree programs.

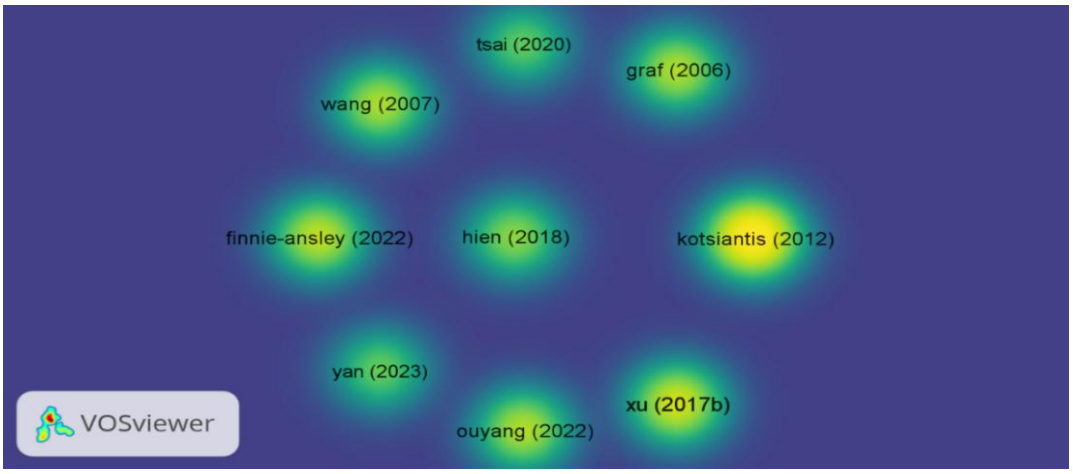


Table 04: Year-wise Citations

Title	Year	Citations
A Machine Learning Approach for Tracking and Predicting Student Performance in Degree Programs	2017	156
Use of machine learning techniques for educational proposes: A decision support system for forecasting students' grades	2012	150
The robots are coming: Exploring the implications of OpenAL codex on introductory programming	2022	136
Artificial intelligence in online higher education: A systematic review of empirical research from 2011 to 2020	2022	124
Forming heterogeneous groups for intelligent collaborative learning systems with ant colony optimization	2006	122

Most Productive Sources (Articles and Total Citations)

The citation analysis begins with the ten main sources that have the largest number of publications in the field of artificial intelligence listed in the Scopus index. Therefore, this analysis focused on tracking the citations and impact of these key publications. Table 2 explains the information.

Table 05: The Top 10 Most Productive Sources

Source	Documents	Citations
Lecture Notes In Computer Science	27	318
Advances In Intelligent Systems And Computing	19	68
Acm International Conference Proceeding Series	17	286
Lecture Notes In Networks And Systems	15	13
Communications In Computer And Information Science	11	29
Education And Information Technologies	9	250
Ieee Access	9	22
International Journal of Engineering Education	7	64

International Journal of Educational Technology In Higher Education	6	176
Sustainability Switzerland	6	72

Table 05 presents information about the most productive journals and publication sources in terms of the number of publications and citations related to the topic. The most productive publication is Lecture Notes in Computer Science, with 27 documents and 318 citations. This was followed by advances in intelligent systems and computing, with 19 papers and 68 citations.

Discussion

It shows that materials discussing artificial intelligence for educational purposes have been published over the past few years. Although the majority of the research articles and papers presented at conferences appeared in 2023 and 2024, the year with the most publications shows that the discipline has advanced in the last few decades. Although most of the articles and conference papers were published in 2023 and 2024, the year with the highest number of publications indicates that the field has been progressive in recent years. The most productive research field in this study is computer science. Artificial intelligence is an integration of computer science. From this approach, these research fields are thought to rank first in Scopus categories. The number of countries showed that China had the most articles (78), followed by the United States with 67 articles.

Co-occurrence analytics is an innovative approach to research that helps to understand and analyze the main ideas and areas of emphasis in a particular field of research. By analyzing the frequency with which certain keywords occur together in different studies, researchers can learn about the prevailing themes and structures in that particular subject. The approach improves in emphasizing high-frequency keywords, which function as indicators for significant concepts and studies in disciplines.

The most highly cited paper was written by Jie XU in 2017, which received 156 citations and was published in the IEEE journal. It is a machine learning methodology for monitoring and forecasting academic achievement in degree programs. The primary objective of this study is to provide a unique machine-learning strategy for forecasting academic achievement in higher education that addresses these critical problems.

Strength And Limitation

Research has certain limitations that need to be noted. Initially, the study's primary reliance on Scopus-indexed articles may lead to a certain level of bias in its findings. This reliance on Scopus-indexed journals limits the study to the content that is available in the Scopus database, even though it offers a wide range of material from a bibliometric perspective, providing insightful information

about sources, authors, countries, documents, and keywords in addition to co-occurrence and co-citation connections. This could have had an effect on the study's overall conclusions since pertinent research that is not indexed in Scopus might have gone unnoticed.

The bibliometric study was further limited to items written in English. Because the research done in other languages was left out, the study might not accurately reflect the worldwide context of the subject. A significant number of publications published in languages other than English may have gone unnoticed, which could distort the findings of the research and interpretation.

It is essential to understand the limitations of the present study and significant bibliometric insights into the research through its analysis of English-language, Scopus-indexed journal articles.

Conclusion And Suggestions for Future Research

This bibliometric analysis of the current literature related to education and student performance within the scope of artificial intelligence technologies. The comprehensive analysis results of this study in the Scopus database demonstrate that publications based on Artificial Intelligence and education have increased in recent years. The results show that China is the most relevant country after the United States. In light of the findings of this study, the number of studies in this field has been a significant topic and has also been discussed at conferences.

The blending of artificial intelligence and academia has had a tremendous impact on the field of education. These frameworks can be enlightened to provide higher intelligence, allowing them to deal with a variety of challenging obstacles such as motivation, emotions, beliefs, morals, and nature.

The advancement of personal desktops, as well as advancements in computing technology, has made AI more prevalent, and its role in a variety of sectors has been apparent. Furthermore, the capacity to combine computer-based technologies with various machines or tools has contributed to the widespread implementation of AI. Furthermore, the research provides an overall review with a VOS viewer visualization, but many aspects of this study should be discussed, including ethical issues. Most universities still do not accept AI in education, and the main reason is cheating. A wide range of studies will be conducted on the ethical issues related to artificial intelligence in education.

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Sehrish Amjad, Research Scholar at Greenwich University, Karachi, Pakistan.

Dr. Khurram Khan Alwi, Assistant Professor in the Department of Teacher Education at the Federal Urdu University of Arts, Science and Technology.