Analysis of Publication Trends on Artificial Intelligence in Education: A Systematic Literature Review

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Abstract. Artificial Intelligence (AI) is a field of study in computer science that aims to build machines with intelligence like humans. AI-based technology is currently quite advanced and is used in many industries, including education. The application of AI in education is considered to have great potential to improve the quality of the learning process and student learning experiences. Therefore, this research was conducted to determine the trends, impact, and application of AI in the world of research (journal). A literature review study (SLR) with bibliometric analysis was used to determine the development of publications regarding AI in the last 10 years (2014-2023). The Scopus database was chosen as a tool for collecting article data. In the collection process the terms "Artificial Intelligence" AND "E-Learning" AND "Intelligence Learning" were used as search terms. Based on the research results, it was found that research on AI is a topic that has great potential for research, especially in 2023. Apart from that, the application of AI in the world of education also has a very positive impact, especially in helping to improve students' understanding. The application of AI in education is also supported by various machine learning algorithms and data mining techniques. Although the publishing trends of AI in education have been thoroughly discussed in this research, more research is needed on AI in education to thoroughly explore the functions, benefits, and impact of AI in education.

Keywords: Artificial Intelligence, Machine Learning, Smart Learning.

1 Introduction

Technology that continues to develop causes the use of artificial intelligence (AI) in education to become increasingly significant. This change involves the use of AI in the learning process, evaluation, curriculum adjustments, and more. Artificial Intelligence has become a driving force in educational transformation. AI is a computer program designed to imitate human intelligence, including decision-making abilities, logic, and other characteristics of intelligence [1]. In general, the main goal of AI is to make computers and other machines capable of thinking, learning, and behaving like humans, so they can make intelligent decisions, solve problems, and adapt to various situations.

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In the field of education and teaching, AI has the potential to increase the efficiency, accessibility and effectiveness of learning [2]. Apart from that, another potential of AI in learning is that it can provide the potential to improve the quality of teaching and learning by providing a more personalized approach, curriculum adjustments and careful feedback [3].

In recent years, the number of scientific publications related to the use of AI in education has increased significantly. It covers a wide range of topics, such as the use of chatbots in education, data analysis for adaptive learning, and AI evaluation of student performance. Several studies that discuss AI in the world of education include research conducted [4] regarding the evolution and revolution of AI in education, research conducted [5] regarding the vision, challenges, roles and problems of using AI in education, research conducted [6] regarding the future prospects of AI in education, research conducted [7] regarding the ethical principles of using AI in education, and research conducted [8] regarding the application of AI in education, especially in schools.

Even though much AI research has been carried out by previous researchers, there is still no research discussing the trends, influence, and application of AI in education using bibliometric analysis methods. Therefore, this research was conducted to analyze the development trend of research regarding AI, determine the influence of AI in the world of education, and find out what kind of AI is being applied in the world of education. It is hoped that this research will provide knowledge and provide ideas regarding research topics for researchers, especially those who will conduct research on AI.

2 Study Literature

2.1 Previous Research

Several researchers have conducted review studies on AI technology [9-11]. The first research is research conducted [9] which identified the impact of the industrial and digital (information) revolution on all aspects of society, life, companies, and employment. A significant competitive advantage will continue to be gained for those who make extensive use of the Internet and are willing to take entrepreneurial risks to turn innovative products/services into worldwide commercial success stories [9]. The biggest challenge facing society and companies is to harness the benefits of AI technology, providing huge opportunities for new products/services and massive productivity increases, while avoiding the dangers and losses in terms of rising unemployment and greater wealth gaps.

The second research is research conducted [10] who identified the role of AI as a decisive technology to analyze, prepare us for the prevention and fight against COVID-19 (Coronavirus) and other pandemics. AI technology plays an important role in detecting case clusters and predicting the impact of the COVID-19 virus or other viruses in the future by collecting and analyzing all previous data [11].

The third research is research conducted [11] identified the phenomenon of artificial intelligence (AI) technology and the contribution of AI to knowledge-based marketing in B2B. AI systems can be used in combination with any or all of the basic elements to help B2B marketers turn data into information and ultimately various types of knowledge: customer knowledge, user knowledge, and other external market knowledge [11]. These activities promise to help B2B companies become more market-oriented, particularly by enabling companies to create, organize and apply knowledge about customers, users, and other external market forces.

2.2 Artificial Intelligence (AI)

Artificial intelligence (AI) is a field of computer science that focuses on creating intelligent machines that can perform tasks that usually require human intelligence [12]. AI involves developing algorithms and models that enable machines to learn from data, reason, and make decisions. AI covers a variety of subfields, including machine learning (ML), natural language processing (NLP), computer vision, and robotics. AI technology is increasingly being used across industries, including retail, healthcare, finance, and transportation, to automate processes, increase efficiency, and improve decision making.

Meanwhile, AI is a concept that refers to the development of computer systems that can perform tasks that usually require human intelligence [13]. AI technology aims to simulate human cognitive abilities, such as problem solving, pattern recognition, and natural language processing. It has the potential to revolutionize a variety of fields, including education, health, finance, and transportation, by automating processes, increasing efficiency, and enabling new capabilities. AI is a rapidly developing field that continues to advance and expand its applications across various domains.

AI is a field of computer science that focuses on creating intelligent machines capable of performing tasks that usually require human intelligence [14]. AI covers a variety of subfields, including machine learning, natural language processing, computer vision, and robotics. By leveraging AI techniques, researchers and developers aim to build systems that can understand, understand, and interact with the world like humans.

3 Method

The method used in this research is systematic literature with bibliometric analysis. There are several stages carried out in this research, starting from data collection, data identification by screening and filtering the articles that have been collected, bibliometric analysis, and visualizing the results of the analysis. The steps of this research are depicted in Fig. 1.

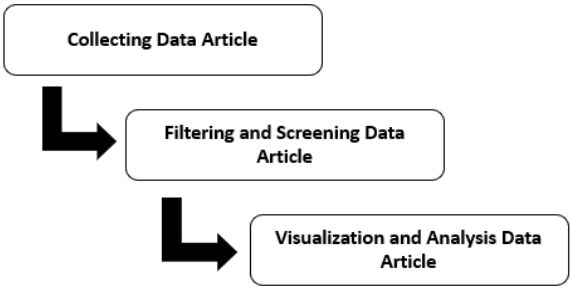

Fig. 1. Research steps.

Collecting article data is the first step in conducting literature research using bibliometric analysis. Scopus indexed article data is collected at this stage. Collection of article data based on article title, abstract and keywords. The terms used when collecting article data are "Artificial Intelligence" AND "E-Learning" AND "Intelligence Learning". From the results of article data collection, 36 documents were obtained. At this stage, articles are also screened directly on the Scopus.com website. Articles in languages other than English and not published in journals or conferences are selected at this stage. The results of the selection resulted in the number of articles from initially being 36 documents being reduced to 31 documents. After the selection is complete, the collected research article data is then saved in various document formats (*.csv, .bip, *.ris). *.csv format documents will be analyzed with the Microsoft Excel number processing application. Documents in the .bip format will be analyzed using the R Studio application and finally documents in the (*.ris) format will be analyzed using the VOSviewer application.

The second step is identifying article data. Research articles collected at the data collection stage will then be identified by document screening and filtering. At this stage, data screening is carried out by paying attention to the title of the article. Articles with irrelevant titles will be removed. After carrying out the article data identification stage, the result was that the article data used for the research was 20 articles.

The third step is data analysis and mapping. The research articles were then analyzed using Microsoft Excel and R Studio. The R Studio application is used to find authors, countries, and affiliates who are productive and have many publications. Meanwhile, VOSviewer is used as a search results data mapping application. Apart from that, VOSviewer is also used to visualize article data and analyze research trends. In this research, two types of visualization were used, namely network visualization and overlay visualization.

Even though only two visualizations were used in this research, mapping using VOSviewer can produce three types of visualization, namely network visualization, which is used to find out how the relationship between several topics or dominant words that appear from the articles reviewed [15], overlay visualization can see an overlay of certain information based on dominant topics or words [16], and density visualization makes it easier to describe the level of popularity of a topic or word that appears from the articles collected [17].

4 Results and Discussion

4.1 Research trends regarding Artificial intelligence (AI)

Development of publications per year. Fig. 2 shows research trends related to AI in education based on the volume of publications published each year. Based on related articles indexed by Scopus which discuss AI in the world of education, publication data was obtained from 2014 - 2023. In 2014-2016, the number of documents relating to research in this field was still absent (0 documents). However, in 2017 there was one publication (3.22%) regarding AI. However, in the following year, namely 2018-2020, the number of publications regarding AI returned to 0. The number of publications regarding AI began to increase in 2021 - now. In 2021 the number of publications regarding this field was 3 documents (9.67%). This number experienced a significant increase in the following year, namely 2022 where there were 13 documents (41.93%) published and indexed by Scopus and in 2023 (starting from October 2023) there were 14 documents (45.16%) published in Scopus indexed journals.

Based on the results that have been explained, AI is currently very popular as a research topic. The reason AI is widely used by researchers as a research topic is because:

1. AI has enormous potential to change various aspects of life, one of which is in the field of education.
2. Technological developments are increasingly rapid day by day, causing the need for research that can increase understanding and knowledge.
3. Market demand is one of the strong reasons why AI is widely used as a research topic. Many companies and industries continue to look for ways to leverage AI to increase efficiency, productivity, and competitiveness.

Therefore, AI will become a research subject that is widely used, especially in 2022 and 2023. However, it should be noted that no matter how sophisticated the technology is, technology will still not completely replace the human (i.e., teacher) skills needed in the educational context.

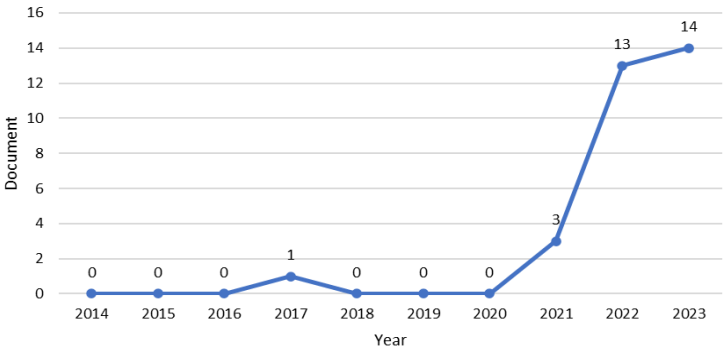

Fig. 2. Development of publications per year.

Document by subject area. From the results of data collection from articles indexed by Scopus, several subject areas were obtained which are often used by researchers. The subject area in question is shown in Fig. 3. Based on Fig. 3, computer science is a field of science that is widely associated with artificial intelligence (AI) research. The number of publications regarding AI in the field of computer science is 26 documents. This number is very high compared to the number of publications in other fields. Such as mathematics with a total of 10 documents, social science with a total of 9, engineering with a total of 8 documents, energy, and decision science with a total of 7 documents each, physics, and astronomy with a total of 4 documents, medicine, and materials science each with a total of 2 documents, and for other fields there is only 1 document.

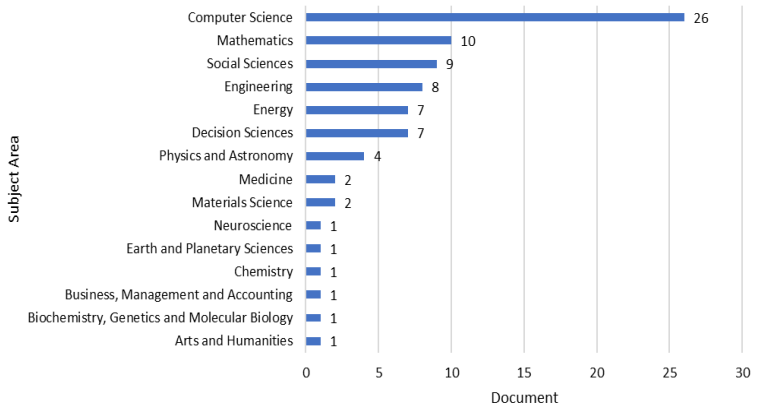

Fig. 3. Research subjects in published articles on AI.

Document by Country. Apart from subject areas, this research also analyzes countries that publish a lot of research related to AI. From the results obtained as seen in Fig. 4, India, the United States, and Spain rank in the top 3 most productive countries conducting research related to AI with each country having the number of studies of 9 (India), 8 (US), and 3 (Spain) documents from 2014-2023. Based on Fig. 4, there are 22 countries that actively play a role in making publications related to AI. These countries are India (9 documents), US (8 documents), Spain (3 documents), UK (2 documents), Taiwan (2 documents), Germany (2 documents), United Arab Emirates (1 document), Ukraine (1 document), Sweden (1 document), Sri Lanka (1 document), Singapore (1 document), Portugal (1 document), Peru (1 document), Noway (1 document), Mexico (1 document), Lebanon (1 document), Jordan (1 document), Italy (1 document), Ecuador (1 document), China (1 document), Australia (1 document), and Algeria (1 document).

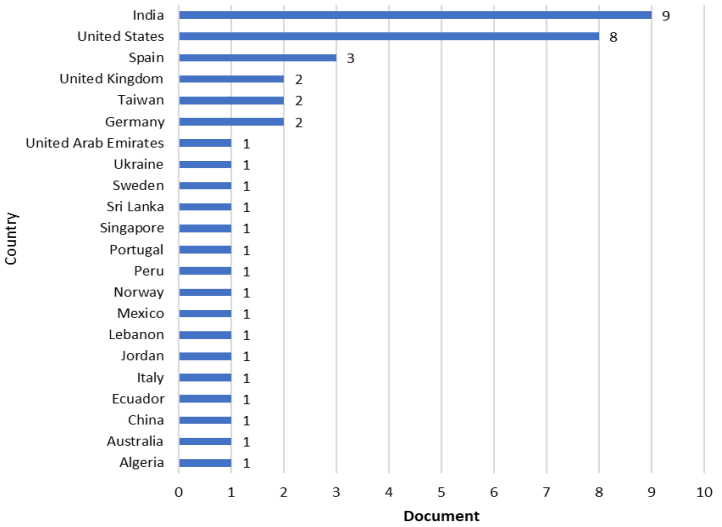

Fig. 4. Productive countries publish publications about AI.

Document by Author. Different countries and subject areas, publications about AI are written by various authors and from different countries. Fig. 5 shows the 15 most productive authors writing scientific papers about AI and published in several journals/conferences indexed by Scopus. From Fig. 5, all authors have the same number of publications, namely 1 document from 2014-2023. For the names of writers who are included in the top 15 most productive writers, namely Abbas, A., Abu-Shanab, S. A., Achrya, R., Akram, B., Al Ameri, W. S., Al Awadhi, K., Alam, A., Alzu'bi, S., Anand, M., and Ar, A. Y.

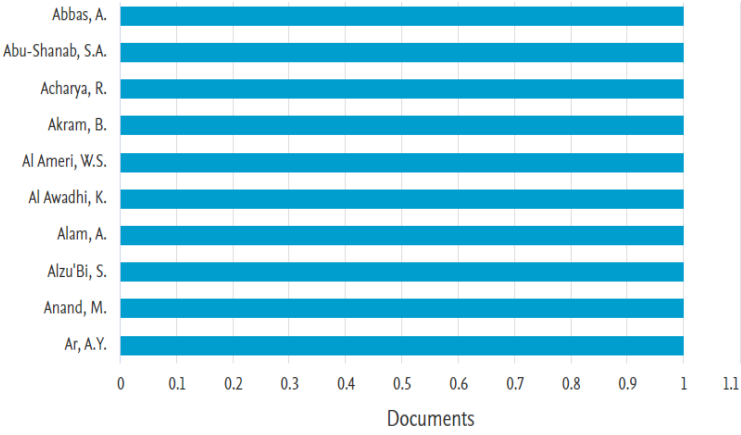

Fig. 5. Fifteen authors with the most research on AI.

Network Visualization by VOSviewer. The results of the co-occurrence analysis are shown in the network visualization analysis shown in Fig. 6. The network visualization is represented by nodes and edges that are connected to each other. The nodes represented by circles can be publications, journals, researchers, or keywords while edges indicate relationships between pairs of nodes. Apart from showing the relationship between pairs of nodes, edges also show the strength of that relationship. The strength indicated by the edge is represented by the distance. The closer the distance between one node and another node indicates the higher the relationship between the nodes. Mapping and clustering are complementary things. Mapping can be used to get a detailed picture of the structure of a network, while clustering is used to get insight or an overview of bibliometric groupings. In Fig. 6, each circle represents a frequently occurring term. These terms are taken from the title and abstract of an article. The size of the circle indicates the number of publications that are related to that term, both in the title and abstract of the article. The larger the size of the circle, the greater the number of articles that are relevant to that keyword or term. From the results of the analysis, it was found that 31 articles could be grouped into 3 clusters with a total of 19 items. Each of the three clusters can be identified based on their color. Table 1 shows a more detailed explanation regarding cluster division.

Table 1. Cluster network visualization classification.

Cluster	Color	Total Items	Items
1	Red	7	challenge, data, field, machine learning, model, order, and research.
2	Green	7	approach, artificial intelligence, importance, learning, student, study, and use.
3	Blue	5	application, learner, machine, paper, and work

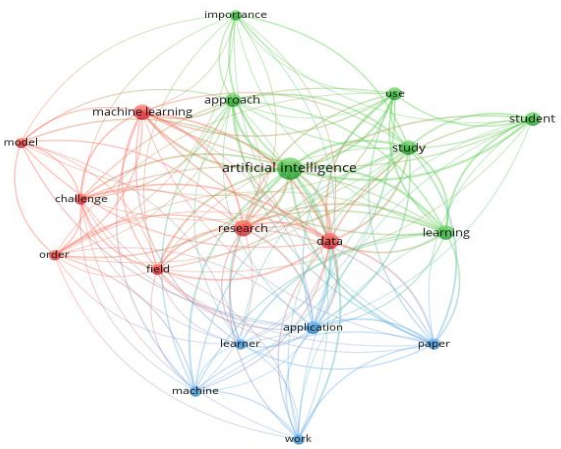

Fig. 6. Network visualization.

After identifying mapping and clustering through network visualization, research trend mapping was then carried out based on the year the article was published. Information obtained from the results of the overlay visualization can be used to detect and identify the sophistication of certain research subjects presented with the overlay visualization as shown in Fig. 7. In this visualization, the color of a node represents a keyword, while the color of the node indicates the year of the article containing the keyword. is published. The darker the color of the node, the longer the topic is discussed in the research. The overlay visualization in Fig. 7 shows that topics related to AI, E-Learning, and Intelligence Learning are topics that have been discussed since 2021. This creates great opportunities for research.

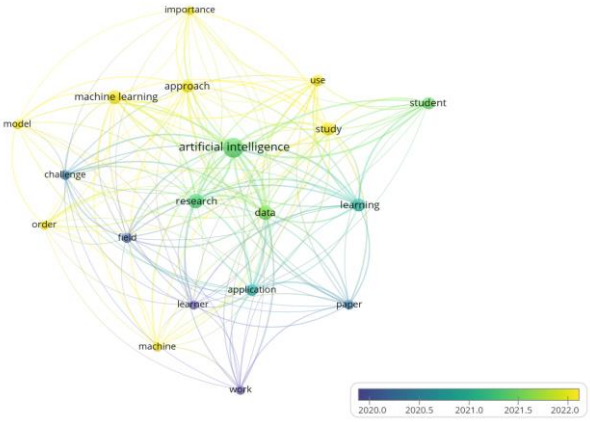

Fig. 7. Overlay visualization.

Specifically, the network visualization form of the term AI is shown in Fig. 8. In Fig. 8, the term artificial intelligence is in cluster 2 which is connected to 18 other terms, including work, machine, learner, application, paper, data, research, field, order, challenge, model, machine learning, approach, importance, use, study, learning, and student. AI has a total link strength of 104 and occurrences of 19.

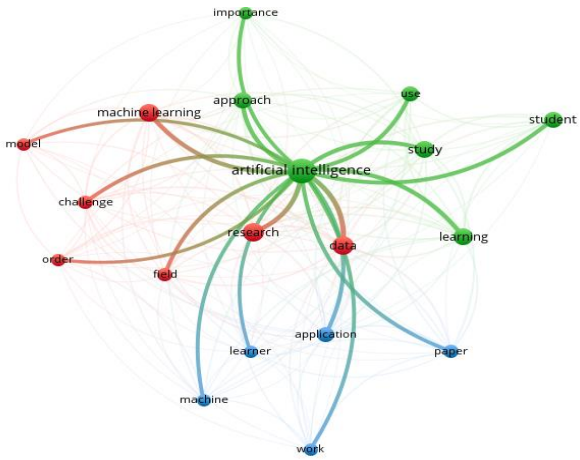

Fig. 8. The relationship between the term artificial intelligence and other terms.

4.2 Application of artificial intelligence in education

Artificial intelligence (AI) can be applied in education in a variety of ways to enhance the learning experience. One way is using AI-powered learning platforms that can personalize the learning process for each student, providing customized content and input [18]. AI can also be used to automate administrative tasks, such as grading and scheduling, freeing up time for teachers to focus on teaching [19]. Additionally, AI can help identify areas where students may be experiencing difficulties and provide targeted interventions to support their learning [20].

In addition, Artificial intelligence (AI) can be applied in education to improve learning experiences and support student engagement [21]. One way to apply AI in education is through the development of AI-based learning environments, such as the AI Play learning environment [21]. This environment allows students to learn AI concepts and practices while creating gaming experiences using AI-based techniques such as machine-generated content, quest-based pathfinding, non-player character reasoning, and natural language processing-based interactions.

Another way to apply AI in education is by integrating AI learning experiences into interactive game design activities [22]. This approach combines the benefits of game design interventions with AI learning, allowing students to develop their AI literacy while engaging in creative, hands-on activities. By incorporating AI learning into game design, students can gain practical knowledge and skills in AI while growing their interest and understanding of computer science.

Additionally, AI can be used to personalize and adapt educational content to the needs of individual students [23]. Through analysis of student data and learning patterns, AI algorithms can provide personalized recommendations, adaptive assessments, and targeted interventions. This personalized approach can help students learn at their own pace and meet their specific learning needs, ultimately improving their educational outcomes.

4.3 The impact of applying Artificial Intelligence (AI) in education

There are several impacts of using AI in education/learning [18], including:

1. Better Learning Opportunities: Artificial intelligence (AI) in education provides individuals with more concentrated learning opportunities and helps them recognize areas where they may not fully understand a subject. This enables a personalized and adaptive learning experience, allowing students to learn at their own pace and focus on areas that need improvement.
2. Assistance from Instructors: Instructors play a valuable role in the process of assessing student learning outcomes. AI helps instructors fulfill their valuable role throughout the learning journey, guiding and supporting students in their educational endeavors.
3. Automation and Efficiency: AI and machine learning technologies automate certain tasks in education, freeing up time for instructors to focus on more meaningful interactions with students. This automation can simplify administration, assessment and data analysis processes, thereby making education more efficient.
4. Technological Literacy: Integrating AI and machine learning into education helps students develop technological literacy, in line with the implementation of Industry 4.0 initiatives. It prepares students for advanced technology-based projects in the 21st century and equips them with the skills needed in the digital world.
5. Learning during Pandemics: AI has proven to be very useful during disease outbreaks, such as the COVID-19 pandemic. This enables distance learning, providing access to education even in challenging situations. AI-powered systems can personalize the learning experience, track student progress, and offer targeted interventions to support learning continuity.
6. Innovative Learning Models: AI and machine learning enable the development of innovative learning models that motivate students to master new skills. This technology can analyze and organize data, providing insights that enhance the learning experience and improve learning outcomes.
7. Global Scale Research and Development: The importance of AI and machine learning in education is being researched and developed on a global scale. Educational institutions and technology companies are investing in AI to improve learning experiences and outcomes.

Apart from that, Artificial intelligence (AI) has the potential to have a major impact on education by improving the learning experience and providing personalized teaching [21]. By leveraging AI technology, educators can create interactive and engaging learning environments that meet the needs of each student. AI can analyze student data and provide real-time feedback, allowing teachers to identify areas where students may need additional support. Additionally, AI can help automate administrative tasks, giving teachers more time to focus on teaching. Overall, the application of AI in education has the potential to improve student outcomes and make learning more efficient and effective.

5 Conclusion

Based on research results, artificial intelligence (AI) is a field of computer science that is concerned with the development of computer systems that can perform tasks that usually require human intelligence. The application of AI in education offers opportunities to create engaging learning experiences, increase AI literacy, and support student success. By leveraging AI-based technologies and integrating AI learning into educational activities, educators can empower students to develop the knowledge and skills necessary to navigate an increasingly AI-driven world. The application of AI in the world of education also has several positive and negative impacts. The impact of applying artificial intelligence in education includes increasing learning opportunities, providing personalized and adaptive learning experiences, automating administrative tasks, developing technological literacy, supporting learning during the pandemic, encouraging innovative learning models, and encouraging global research and development efforts.

Apart from that, from the research results it was also found that the research trend regarding AI is very high, especially in 2022 and 2023. Judging from the development curve, AI has been in high demand for research since 2021 and continues to increase in the following years, namely 2022 (13 documents) and 2023 (14 documents). This increase in publications cannot be separated from the role of writers who actively conduct research on AI. Several authors who are actively conducting research on AI include Abbas, A., Abu-Shanab, S. A., Achrya, R., Akram, B., Al Ameri, W. S., Al Awadhi, K., Alam, A., Alzu'bi , S., Anand, M., and Ar, A. Y. India, United States, and Spain are the 3 countries that have contributed the most publications on AI with 9, 8, and 3 documents respectively. As for the research subject area itself, AI is widely associated or widely researched, especially in the field of computer science. This is because AI is synonymous with technology, so computer science is a field that is often involved in AI research. From the mapping results, AI is a topic that has a great opportunity to become a research topic.

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