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Artificial Intelligence in Education: Bibliometric and Systematic Literature Review from 2019 – 2024

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ABSTRACT
In the industrial age of 5.0, technology can be used to make it easier for humans to do their everyday work. The development of information technology today is proven by the emergence of artificial intelligence (AI). Research related to AI in the field of education to this day still continues to be studied and researched. Therefore, there is a need for a literary study to find out the trends of research on artificial intelligence in the field of education in order to facilitate further researchers in determining the themes of their research. This research aims to collect, identify, evaluate, analyze, interpret, and conclude similar research that deals with artificial intelligence in education. The research method uses library study with bibliometric analysis and SLR techniques. The results of this research are divided into four sections according to the research questions studied in 98 articles relevant to research topics. The four components are the benefits of AI, the application of artificial intelligence, the positive and negative impacts of AI, and the challenges to be faced with AI.

Keywords:
Artificial Intelligence; Education; Bibliometric; Systematic Literature Review

INTRODUCTION

In line with the core of the independent curriculum, which is “free learning," it is more flexible and gives teachers access to teaching as well as the opportunity for students to be more interactive in the learning process. Rahayu dkk., (2022) explains that the focus of independent learning is the freedom and creativity of students in thinking, so that the existence of this curriculum can provide an opportunity for students to study quietly, relaxed, enjoyable, and according to the interests or talents of each student. In accordance with this, it is expected that independent learning can be used as a pleasant development of learning for teachers or students. (Ainia, 2020).

One of the innovations in learning is the use of information and communication technology. According to Lestari (2018), science is evolving from day to day, thus driving the creation of new technologies with various innovations that can facilitate human work. Besides, these developments can be one of the proofs of the progress of the times. Today's flooding technology is already in the digital phase, where all human activities are filled with existing technology (Indarta dkk., 2022). Thus, man will be more able to perform his duties, and man will always interact with the machine through a command.

In the industrial age of 5.0, technology can be used to make it easier for humans to do their everyday work. Today's advances in information technology are demonstrated by the emergence of artificial intelligence. Sabron and Lubis (2021) explained that artificial intelligence is a computer system that can assist humans by performing tasks that require human intelligence. This new technology performs all

of these tasks by first analyzing the data already in the system. This technology reads, analyzes, and then gives humans answers to a problem that's happening.

This technology is being used in many fields, including education. Artificial intelligence in education integrates media as well as methods from various sciences, such as computer science, to help address educational problems. One example of the application of artificial intelligence in the field of education is the development of intelligent problem-solving systems to help facilitate the learning process of teaching in the classroom (Feng & Law, 2021). Syaflin (2022) argues that technology in education is one of the hot topics to discuss. Thus, in order to provide an advanced and innovative education, teachers are required to be intelligent and adaptive when using technology in the learning process. Therefore, the role of the teacher is of paramount importance to the choice of methods and media used in the learning process.

Research related to the application of artificial intelligence in the field of education to this day is still being studied and researched. Therefore, it is imperative that there is a study of the literature to know the trends of research on artificial intelligence in education in order to be able to provide facilities to further researchers in determining the themes of their research. This research has the purpose of helping identify the research trends in artificial intelligence in education with the help of the application VOSViewer for its analysis process.

After obtaining research trends on artificial intelligence in the field of education, it is expected that the results of this research can be a reference for other researchers to define the research themes, especially those related to artificial intelligence in the area of education. In addition, the results of these trends also sparked the curiosity to conduct a systematic literature review (SLR) related to artificial intelligence. The search with the SLR technique aims to find out and explore in detail the research trends related to artificial intelligence in the field of education.

In order to achieve the goal of the research, which is to know the research trends and also answer in detail about the many studies on artificial intelligence in the field of education, there are three formula problems that raise the presence of research questions (RQs) in the research. This RQ helps gather the information needed in the process of analyzing articles relevant to the research topic.

1. (RQ1): What are the benefits of artificial intelligence in education?
2. (RQ2): How is the application of artificial intelligence in education?
3. (RQ3): What is the impact of artificial intelligence in education?
4. (RQ4): What's the challenge with this artificial intelligence?

METHOD

The study uses a library survey method with bibliometric and SLR analysis techniques. Bibliometric analysis is used to look at research trends related to artificial intelligence in the field of education. With this technique of analysis, it can be seen whether research topics are often discussed and studied in previous research, so that future research is renewed research. After obtaining results on research trends, the results at that stage will then be re-analyzed with SLR techniques to identify research gaps, evaluate, and interpret research trend findings from collected articles. The article is then analyzed and selected by eliminating articles that cannot answer research questions, or using this technique called RQ. This RQ is determined after looking at the results of research trends in the process of bibliometric analysis. This RQ represents some problems in the research and is often used as a topic in previous research. A detailed explanation of the stages of this study will be presented in the following sub-chapters:

1. Research Data Search and Retrieval Strategy

Research with bibliometric techniques and also SLR has different stages from the study of ordinary literature. This technique requires a systematic strategy and phases that are carried out smoothly. Starting from the phase of data search, analysis, elimination, and also the final conclusion. The initial stage in a study is the search for data sources on a given topic. The search for this research data is done by searching through the Publish or Perish application. The searched data are research articles that are indexed by Scopus, Google Scholar, or Crossref. In this search process, data is searched using keywords. Keywords entered are “artificial intelligence,” “artificially intelligent," and "education." The year range of data used in this study is limited to 2019–2024, or coincident with the last five years. This is done so that the data used are the latest articles that have been frequently discussed in recent years.

After the search process is completed, the next step is to analyze it with bibliometric techniques so that research trends can be identified and, from these trends, research questions or RQs can be determined. The data obtained is then converted first to the format “RIS” and then entered into the VOSViewer application to be readable and analyzed. Once incorporated into the application, there will be some research trends discussing artificial intelligence in the field of education. After that, the data is analyzed to determine research questions based on the topics most discussed or on the trends of the research. After defining the RQ, enter the selection stage.

The first stage of selection is the stage in which articles gathered and contained on artificial intelligence in the field of education are examined and analyzed to then go into the first elimination process. The elimination process of the first article is based on the title of the article as well as the terms of the writing and publication of the article. The first elimination is done by eliminating articles that have titles that do not correspond to the research topic, i.e., based on research RQ. Then, in the selection of this one, it also eliminates articles that are not published in journals or proceedings and also eliminates articles published under the year 2019. Since this is a literary study, articles using the same method are also eliminated.

After the process of selection one is completed, the article successfully passes the stage and proceeds to the selection two process. The article is reviewed and analyzed based on the outside of the article. The selection process is carried out by scanning several sections of the article, starting with keywords, abstracts, and also the conclusions of the research. All of those sections should cover the research topic of artificial intelligence in the field of education. When the selection process is two, the article that does not match the selection basis two will be removed again and not followed to be included in the subsequent process.

The third selection process is the final selection process of the data source search phase. At this stage, articles that pass selection two are reviewed and analyzed based on the interior of the article or the contents of the article. All articles that are collected and pass several stages of selection are then reviewed to see whether they are relevant to the research topic or not. The quality determination of articles that pass the selection phase is guided by quality assessment (QA). A detailed description of QA in research will be explained in the following sub-chapters.

2. *Quality Assessment*

QA is a guideline for article selection based on research issues present in the RQ. The following is the QA that aims to answer the research question and get a conclusion:

a. Does the article provide information about artificial intelligence in the field of education? (It's a research topic.)
b. Does the article provide information about the benefits of artificial intelligence in education? (is the answer from RQ1)
c. Does the article provide information on how to apply artificial intelligence to education? (is the answer from RQ2)
d. Does the article provide information about the impact of artificial intelligence in education? (is the answer from RQ3)
e. Does the article provide information about the challenges of artificial intelligence in education? (is the answer from RQ4)

An article can be said to have passed the third selection if it is selected and is one of the answers to the QA. This QA rating system has two choices: "Yes" or "No," but cannot choose both. For the answer "yes," it has a value of one, and for "no," it is zero. Whereas an article that cannot answer any of the provisions of QA will be eliminated and not used.

The final step of the research is the withdrawal of conclusions from all stages of the process of analyzing the research source data. Articles that pass several stages of selection will be research materials that are further researched and analyzed to obtain research conclusions that will be found and become research results. The results of the study will display one-by-one answers to the research question, which is the RQ that has been determined in the early stages. Hopefully, with these two advanced analyses, a satisfactory conclusion is obtained and can be used as a recommendation for future researchers.

RESULTS AND DISCUSSION

Based on a number of previously defined selection criteria, as many as 2005 of these articles are research populations obtained on searches in three index journals. Once identified, filtered, and selected, there are 98 articles that can be used as samples of research. Here are the results of each step of the research:

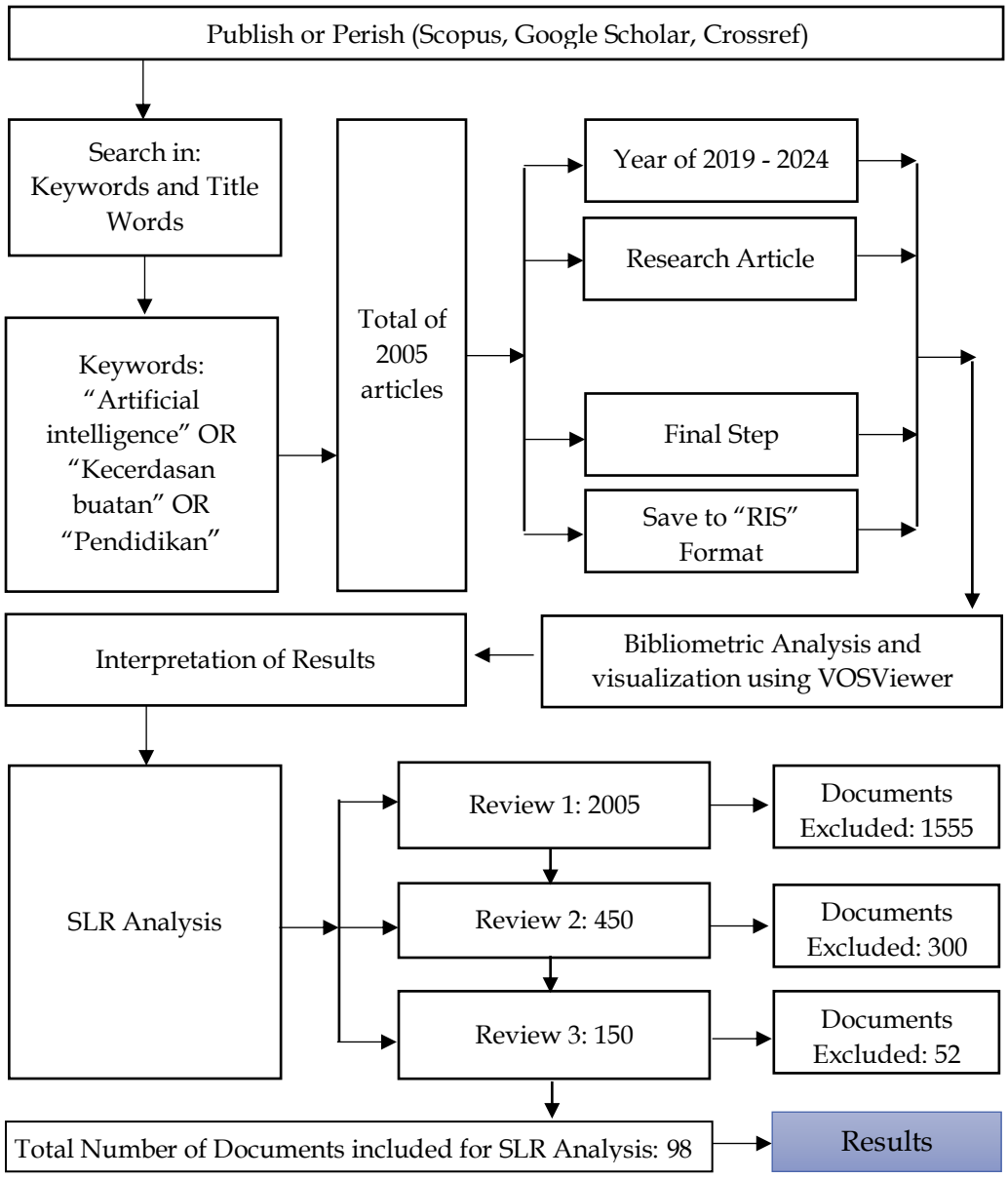

Figure 1. Articles collected in each process

The search for research data produced a 2005 aggregate article. This article is a search from Scopus, Google Scholar, and also Crossref. These articles appear with the use of keywords that have been entered according to the research topic and also based on the range of the year of publication of the article, which is 2019–2024. Thus, articles that do not match research topics and are published before 2019 will be automatically selected and not used. Details of the data search results are shown in Table 1. Each outcome of this study will be explained in detail in the following sub-chapter.

Table 1. Article Search Results

Log Index	Number of Articles	Citation
Scopus	7	97
Google Scholar	998	11676
Crossref	1000	195
Total	**2005**	

1. Data Search and Classification

The search and classification of data is an early stage in the research process. Searching is a very important process and requires a high level of rigor. This data search is a process of searching for articles that are relevant to research topics. It's the stage that determines how much and how valid the results of the research are. At this stage, articles are searched from several journal indexes and then collected into one. The collected articles are then used as material to determine the RQ in research. The data is converted to the "RIS" format and then entered into the VOSViewer application to identify what trends or research topics are popular and continue to be studied to date. From this research trend, some research questions arise. Figure 2 shows the results of the research trend.

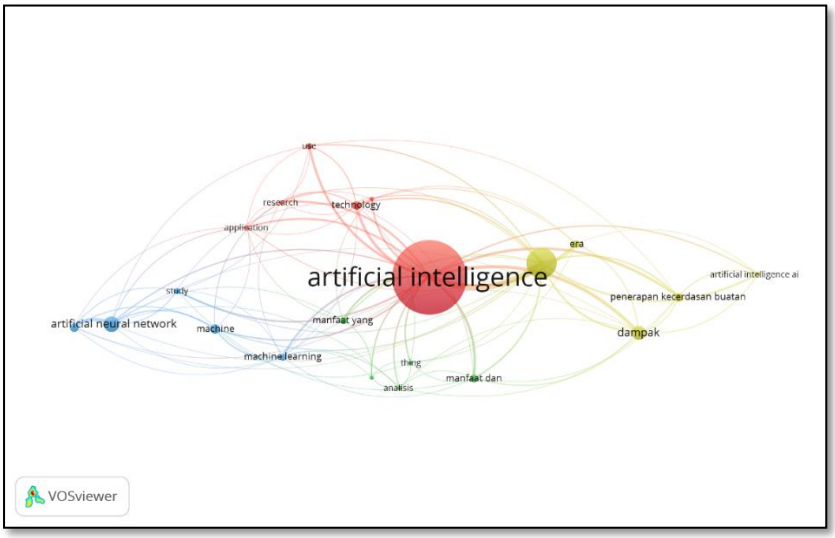

Figure 2. Network Visualization to Artificial Intelligence in Education

A network structure analysis is done to find out the relationship between article trends. The identification result, according to Figure 2, is that there are many discussions related to artificial intelligence. Some of the most frequently studied are

the benefits of artificial intelligence, the application of artificial intelligence, and the impact of the existence of artificial intelligence. With the help of this bibliometric analysis, we found as many as four research clusters and as many as 21 items that are the research trends on artificial intelligence in the field of education. The large and small size of the circle in Figure 2 indicates how much, or at least, the topic is frequently studied. Thus, it can be concluded that artificial intelligence is indeed a popular research topic for discussion and study. After looking at the research data and identifying it, the research question arose, which was an RQ about some trends studied by some people.

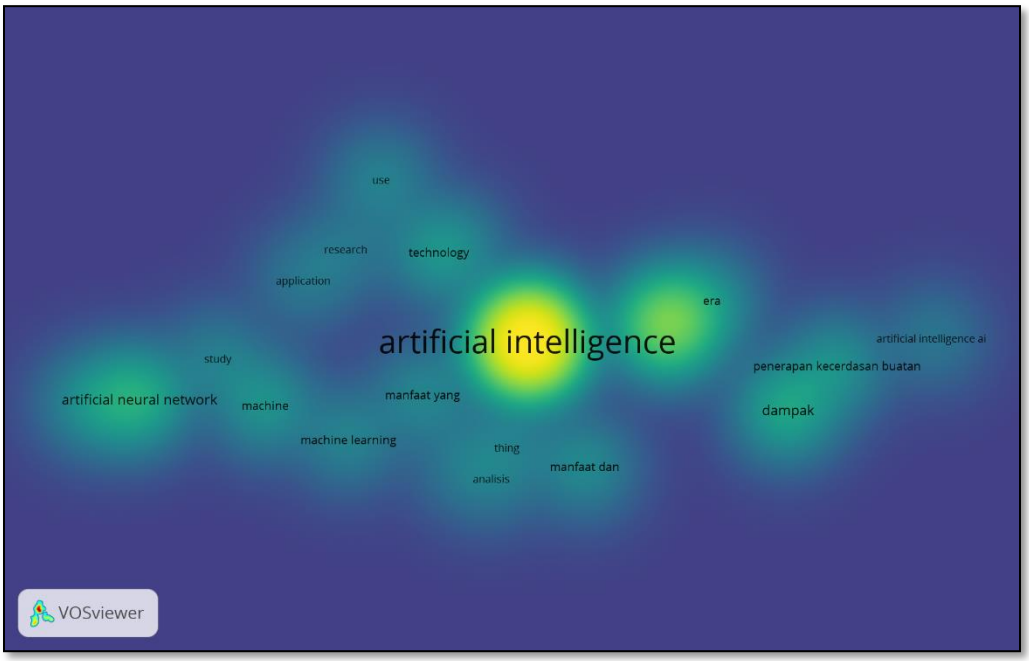

Figure 3. Density Visualization to Artificial Intelligence in Education

Figure 3 shows that artificial intelligence, benefits, applications, and impacts are in the middle of the picture. This proves that artificial intelligence is indeed a topic that is frequently used and studied. It can also be seen from the color that the topic shines the brightest among the others, and the spread of the structure of the web is immense. Thus, the RQ that forms out of this research is the three topics.

2. Analysis and Discussion Test Trial

Articles that pass several stages of research are then analyzed and identified. Figure 4 shows the number of articles obtained at each stage. From there, it is known that each stage of the study has a rather significant elimination process. It can be seen from the early stages when the 2005 article was found and eliminated in Review 1, so that the article passed only 450 articles. Then, at the time of entry into Review 2, only 150 articles were considered eligible for Review 2. At this second stage, the article was analyzed according to abstracts, keywords, and conclusions. Besides, the writing format of the article is also seen before entering the final selection phase, which is based on the entire article content. Then, in the final phase, the article was re-analyzed

based on the QA. Of the 150 articles, only 98 were considered eligible and could escape the QC. An explanation of the results and analysis of each problem formula and the results of the answers from the RQ are described in the next sub-chapter.

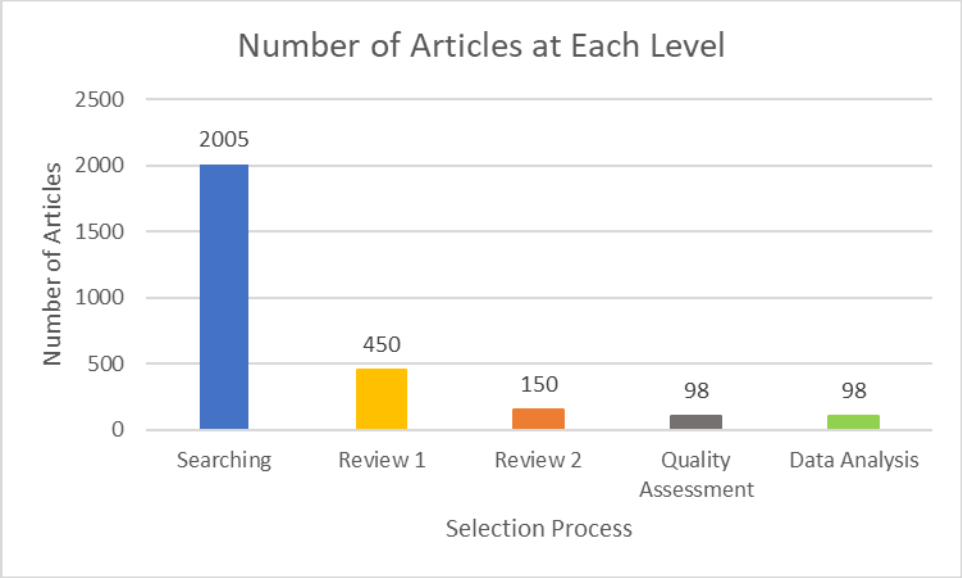

Figure 4. Number of Articles at Each Level

Based on the results of the analysis, the answers are obtained from the RQ presented in the following tables.

Table 2. Category of benefits of artificial intelligence in education

Indicator	Article	Total
Learning Personalization	(Ali et al., 2023; Angkasawan et al., 2023; Arly et al., 2023; Cahyaningrum, 2023; Firdaus et al., 2023; Gusli et al., 2023; Komarudin et al., 2024; Luthfiyyah et al., 2024; Mambu et al., 2023; Muarif et al., 2023; Nadila & Septiaji, 2023; Niza Tadzkiratun Nafisah et al., 2024; Oktavianus et al., 2023; Palupi Kusumaningtyas et al., 2023; Pertiwi, Bara, et al., 2023; Pertiwi, Sappebua, et al., 2023; Putri et al., 2023; Saputra et al., 2023; Suharmawan, 2023; Suryokta et al., 2023; Susanto, 2023; Tsabitah Zain Mumtaz et al., 2023)	22
Increased Efficiency	(Afrita, 2023; Akhyar et al., 2023; Anas & Zakir, 2024; Arly et al., 2023; Cahyaningrum, 2023; Fauziyati, 2023; Fitriani et al., 2024; Gusli et al., 2023; Komarudin et al., 2024; Mambu et al., 2023; Mustika et al., 2024; Pertiwi, Bara, et al., 2023; Rifky, 2024; Rosa et al., 2023; Sudirman et al., 2022; Suryokta et al., 2023; Zakaria et al., 2023)	17
Improving the quality and effectiveness of learning	(Abidin, 2023; Afrita, 2023; Akhyar et al., 2023; Amelia et al., 2022; Anas & Zakir, 2024; Anggraini et al., 2024; Bukhori et al., 2024; Fauziyati, 2023; Firdaus et al., 2023; Fitriani et al., 2024; Gusli et al., 2023; H.I.A, 2023; Hasni et al., 2023; Jayawardana, 2023; Karyadi, 2023;	38

Indicator	Article	Total
	Komarudin et al., 2024; Mambu et al., 2023; Maufidhoh & Maghfirah, 2023; Muarif et al., 2023; Mulianingsih et al., 2020; Mustika et al., 2024; Mutaqin et al., 2023; Nailus & Hasanudin, 2023; Nita et al., 2023; Patty et al., 2023; Pertiwi, Bara, et al., 2023; Prastiwi & Pujiawati, 2019; Puspitasari et al., 2020; Putri et al., 2023; Rifky, 2024; Rochmawati et al., 2023; Salmi & Setiyanti, 2023; Saputra et al., 2023; Selvina et al., 2023; Subowo et al., 2022; Susanto, 2023; Syahira et al., 2023; Zakaria et al., 2023)	
Accessibility	(Anas & Zakir, 2024; Angkasawan et al., 2023; Bukhori et al., 2024; Nailus & Hasanudin, 2023; Rochmawati et al., 2023; Suharmawan, 2023; Zakaria et al., 2023)	7
Enhanced Classroom Surveillance and Administration	(Akhyar et al., 2023; Angkasawan et al., 2023; Firdaus et al., 2023; Gusli et al., 2023; Isma et al., 2023; Komarudin et al., 2024; Mambu et al., 2023; Nailus & Hasanudin, 2023; Serdianus & Saputra, 2023; Soegiarto et al., 2023; Subiyantoro et al., 2023)	11
Digital Skills Development	(Abdullah et al., 2024; Gusli et al., 2023; Hikmawati et al., 2023; Jayawardana, 2023; Rochmawati et al., 2023; Salmi & Setiyanti, 2023)	6
Creating Active and Interactive Learning	(Kuncara et al., 2024; Muhammad Yahya et al., 2023; Mustika et al., 2024; Nadila & Septiaji, 2023; Nailus & Hasanudin, 2023; Pertiwi, Bara, et al., 2023; Pertiwi, Sappebua, et al., 2023; Rosa et al., 2023; Sari, 2023; Sarinda et al., 2023; Sholihatin et al., 2023; Suharmawan, 2023; Susanto, 2023)	13
Improve student learning experience and motivation	(Naila et al., 2023; Nurachmy Sahnir et al., 2023; Pertiwi, Sappebua, et al., 2023; Sari, 2023; Subakti, 2024)	5

Source: Processed from Research Results Data, 2024.

3. RQ1: The benefits of artificial intelligence in education

The problem formula in RQ1 discusses the benefits of artificial intelligence in education. Table 2 shows the classification of each category of benefits of artificial intelligence (AI). This category is obtained from the results of the analysis of each article that passes several selections. Based on the results of the selection, the answer to the RQ1 problem is about the benefits of artificial intelligence in the field of education.

Table 2 shows that there are several benefits of artificial intelligence, including:

- **Learning Personalization**
  AI enables the adaptation of learning for each student based on their individual abilities, learning styles, and needs, increasing learning effectiveness. So with this AI, students are free to pursue learning by adjusting their time and needs.
- **Increased Efficiency**
  With the automation of administrative tasks and data analysis, AI helps reduce the workload of teachers, enabling them to focus more on teaching and interacting with students. Moreover, with this AI, student learning becomes more efficient because students do not have to bother when they want to find out about something.
- **Improving the quality and effectiveness of learning**
  By providing more detailed and accurate feedback to teachers about student performance and their teaching methods, AI helps improve the quality of teaching and learning. Students will be able to compare and adapt their learning so that the learning process can be continuously improved.
- **Accessibility**
  Through an AI-supported online learning platform, education can be accessed more easily by students from a wide range of backgrounds and geographical locations, opening the door to inclusive education.
- **Enhanced Class Surveillance and Administration**
  Artificial intelligence systems can help educational institutions monitor student performance more effectively, detect performance patterns that may require intervention, and better manage student performance data. Student fraud will be more easily detected, thus enabling students to learn in order. Moreover, administrative data is easier to monitor.
- **Digital skills development**
  Using AI technology in learning helps students develop digital skills that are critical in today's digital age. The more advanced technology allows students to be able to grow anyway. Students can learn a variety of things with AI, so they will not only play a role as users but also as developers.
- **Create active and interactive learning**
  The meaning of the AI function to create active and interactive learning is that artificial intelligence is used to develop learning environments that involve students actively in the learning process and interact with the learning material.
- **Improve student learning experience and motivation**
  The meaning of AI serving to enhance the learning experience and motivation of students is that artificial intelligence (AI) is used to create learning experiences that are exciting, challenging, and motivate students to learn better. With the variety of features offered by AI, students who usually only learn through methods and media that are common will feel interested and try to understand the subject matter. Students will be more motivated when learning using AI.

Thus, it can be concluded that AI is very useful in the learning process of students. AI provides many benefits in the field of education. Therefore, there is a need for the development of the use of AI and also the modification of learning with the help of AI.

Table 3. Category Applications of artificial intelligence in education

Indicator	Article	Total
Learning Personalization	(Afrita, 2023; Astutik et al., 2023; Fauziyati, 2023; Firdaus et al., 2023; Hakim et al., 2024; Hasni et al., 2023; Karyadi, 2023; Marlin et al., 2023; Muarif et al., 2023; Oktavianus et al., 2023; Putri et al., 2023; Rifky, 2024; Rubini & Herwinsyah, 2023; Sarinda et al., 2023; Suryokta et al., 2023; Yahya et al., 2023; Yulianti et al., 2023; Yustiasari Liriwati, 2023; Zakaria et al., 2023)	19
Virtual Tutor	(Afandi & Kurnia, 2023; Afrita, 2023; Astagisa et al., 2022; Fauziyati, 2023; Gusli et al., 2023; Ilfi & Manaf, 2024; Karyadi, 2023; Nafisah et al., 2024; Nurachmy Sahnir et al., 2023; Oktavianus et al., 2023; Saputra et al., 2023; Supriadi et al., 2022; Suryokta et al., 2023; Yulianti et al., 2023)	14
Learning Surveillance	(Afrita, 2023; Nurachmy Sahnir et al., 2023; Oktavianus et al., 2023)	3
Learning Assistant	(Fitriani et al., 2024; Gusli et al., 2023; Hakim et al., 2024; Hasni et al., 2023; Hikmawati et al., 2023; Putri et al., 2023; Sarinda et al., 2023; Supriadi et al., 2022; Supriyadi, 2022; Suryokta et al., 2023)	10
Learning Facilities	(Abdullah et al., 2024; Afandi & Kurnia, 2023; Akhyar et al., 2023; Ali et al., 2023; Amelia et al., 2022; Anas & Zakir, 2024; Anggraini et al., 2024; Arip Nurahman & Pandu Pribadi, 2022; Fauziyati, 2023; Gusli et al., 2023; Jayawardana, 2023; Marlin et al., 2023; Maufidhoh & Maghfirah, 2023; Muarif et al., 2023; Mumtaz et al., 2023; Mustika et al., 2024; Mutaqin et al., 2023; Nadila & Septiaji, 2023; Oktavianus et al., 2023; Putri et al., 2023; Rochmah, 2023; Sappaile et al., 2024; Serdianus & Saputra, 2023; Suharmawan, 2023; Suryokta et al., 2023; Trisna et al., 2020; Wicaksono & Sembiring, 2023; Yulianti et al., 2023)	28
Automatic Assessment	(Arly et al., 2023; Astutik et al., 2023; Fitriani et al., 2024; Gusli et al., 2023; Hakim et al., 2024; Hikmawati et al., 2023; Ilfi & Manaf, 2024; Karyadi, 2023; Nafisah et al., 2024; Oktavianus et al., 2023; Prasetyo, 2022; Sudirman et al., 2022)	12
Voice assistant	(Astagisa et al., 2022; Astutik et al., 2023; Fauziyati, 2023; Gusli et al., 2023; Ilfi & Manaf, 2024; Nafisah et al., 2024; Nita et al., 2023; Saputra et al., 2023; Sarinda et al., 2023; Supriadi et al., 2022)	10

Source: Processed from Research Results Data, 2024.

4. RQ2: Applications of artificial intelligence in education

The second problem is to discuss the application of artificial intelligence in education. Table 3 shows the classification of some of these applications. Here's a more detailed explanation.

Artificial intelligence (AI) has several applications in education, including:

- **Personalized Learning**
  Artificial intelligence systems can analyze data on student learning progress and preferences to present learning materials tailored to individual needs. It can improve learning efficiency and ensure that each student gets a learning approach that fits his or her learning style.
- **Virtual Tutor**
  AI applications can act as virtual tutors who provide guidance and explanation to students outside of school hours. They can provide instant answers to questions, explain difficult concepts, and provide direct feedback on student performance.
- **Learning supervision**
  Artificial intelligence systems can be used to monitor online tests and detect fraudulent behavior, such as cheating or using unauthorized material. It helps ensure fairness and integrity in the evaluation process.
- **Learning Assistant**
  AI can be used to help manage administrative tasks such as scheduling, document archiving, and communication with students and parents. This allows educational staff to focus on more student-oriented activities.
- **Learning facilities**
  The meaning of "AI as a learning facility" is that artificial intelligence (AI) is used as a tool or facility that helps in the learning process of students and teachers. In other words, AI does not replace the role of teachers or students but acts as an instrument that supports and enriches the learning experience.
- **Automatic assessment**
  The meaning of "AI can play an automatic judgment role" is that artificial intelligence (AI) can be used to automatically evaluate student performance in a variety of tasks, exams, or jobs. This means AI plays an important role in providing feedback and assessment of student work without the need for direct human intervention.
- **Voice assistant**
  The meaning of "AI as a voice assistant" is that artificial intelligence (AI) is used to enable human interaction with technology through the use of voice or voice commands. In the context of learning or education, AI acting as voice assistants can provide assistance and support to students and teachers in a variety of learning activities.

It is possible to conclude from the above explanation that AI is now applied in various ways in the field of education. As this AI develops, it encourages us to use it in everyday life to facilitate work. Thus, it is expected that the increasing development of this AI can be used by humans in various areas of life.

Table 4. Category Impact of artificial intelligence in education

Category	Indicator	Article	Total
Positive	Improved learning outcomes and student thinking patterns	(Abdullah et al., 2024; Anas & Zakir, 2024; Angkasawan et al., 2023; Arip Nurahman & Pandu Pribadi, 2022; Azizah et al., 2024; Firdaus et al., 2023; Isma et al., 2023; Mahyudi, 2023; Maufidhoh & Maghfirah, 2023; Muarif et al., 2023; Mulianingsih et al., 2020; Mutaqin et al., 2023; Nurachmy Sahnir et al., 2023; Pardamean et al., 2022; Putri et al., 2023; Rante & Irvine, 2019; Rosa et al., 2023; Rubini & Herwinsyah, 2023; Sanhaji & Hizbullah, 2023; Sappaile et al., 2024; Sari, 2023; Sholihatin et al., 2023; Soegiarto et al., 2023; Subiyantoro et al., 2023; Yulianti et al., 2023; Zein, 2023)	26
	Automation Administrative tasks	(Abidin, 2023; Mumtaz et al., 2023)	2
	In-depth Data Analysis	(Nafisah et al., 2024)	1
	Digital Skills Development	(Abidin, 2023; Firdaus et al., 2023; Hanila & Alghaffaru, 2023; Jayawardana, 2023; Rahadiantino, 2022; Rubini & Herwinsyah, 2023; Sarinda et al., 2023)	7
	Improved Education Accessibility	(Abidin, 2023; Amelia et al., 2022; Salsabilla et al., 2023; Sari, 2023; Sarinda et al., 2023)	5
Negative	Dependency on Technology	(Abidin, 2023; Astutik et al., 2023; Bukhori et al., 2024; Fauziyati, 2023; Luthfiyyah et al., 2024; Masrichah, 2023; Mumtaz et al., 2023; Mustika et al., 2024; Sarinda et al., 2023)	9
	Blowjob	(Abidin, 2023; Bukhori et al., 2024; Fauziyati, 2023; Luthfiyyah et al., 2024; Sholihatin et al., 2023)	5
	Privacy and Ethics Concerns	(Afandi & Kurnia, 2023; Firdaus et al., 2023; Masrichah, 2023; Salsabilla et al., 2023)	4
	Lost a job	(Abidin, 2023; Masrichah, 2023)	2

Source: Processed from Research Results Data, 2024.

5. RQ3: Impact of artificial intelligence in education

The problem formula in RQ3 discusses the classification of articles based on the impact of the use of artificial intelligence in education. Table 4 shows the grouping of categories based on the classification results of the articles found. From the above table, we can conclude that there are two categories of positive impact and negative impact. For each of these impacts, there are also some indicators that are included in the positive and negative impacts.

Here are some of the positive impacts that have been felt as a result of the presence of artificial intelligence in the field of education:

- **Improved learning outcomes and student thinking patterns**
  AI is one of the means of improving student learning outcomes and thinking patterns. It means that AI can bring significant positive changes to the way students learn and think. Students will be very helpful and very easy to learn, so student learning results will continue to rise.
- **Automation of administrative tasks**
  AI can automate administrative tasks such as data archiving, scheduling, and monitoring student performance, reducing the workload of teachers and administrative staff.
- **In-depth data analysis**
  By analyzing learning data, AI can provide valuable insights to teachers and school administrators to improve decision-making and identify specific tasks.
- **Digital skills development**
  Using AI technology in learning helps students develop digital skills that are essential for success in the digital age. It means that students can channel their entire interests and talents to become technology developers rather than just users.
- **Enhanced education accessibility**
  Through an AI-supported online learning platform, education is accessible to students from a wide range of backgrounds and geographical locations, opening the door to inclusive education.

In addition to the positive impact, there is also the negative impact of artificial intelligence in the field of education. Here's the negative impact:

- **Dependency on technology**
  Excessive reliance on AI technology can reduce students' independence and ignore the importance of social interaction in learning. With this technology, students will become accustomed to using AI and tend to be more dependent. Students will look for AI to help with everything they face.
- **Blowjob**
  With AI, encourage students to do everything with AI. It is a form of concern where students will depend on technology to perform tasks that previously required effort, and active involvement can reduce the initiative and ability of students as well as teachers.
- **Privacy and Ethics Concerns**
  The use of AI technology in administration raises concerns about student data privacy and the ethical use of data, including issues such as excessive data collection and unauthorized use.

- **Lost a job**
  Automation by AI can jeopardize administrative jobs, especially administrative ones that tend to be easily replaced by technology. Everything can be done by AI.

The conclusion about the positive and negative impact of the use of AI in education is that artificial intelligence technology has great potential to revolutionize the learning and teaching process. However, its success depends heavily on how it is integrated and used in the education system.

Table 5. Category of challenges of artificial intelligence in education

Indicator	Article	Total
Technology gaps	(Hanila & Alghaffaru, 2023; Jayawardana, 2023; Yulianti et al., 2023; Yustiasari Liriwati, 2023)	4
Precautions Ethics and Privacy	(Afrita, 2023; Akhyar et al., 2023; Angkasawan et al., 2023; Arly et al., 2023; Cahyaningrum, 2023; Firdaus et al., 2023; Fitriani et al., 2024; Hanila & Alghaffaru, 2023; Jayawardana, 2023; Komarudin et al., 2024; Marlin et al., 2023; Masrichah, 2023; Misnawati Misnawati, 2023; Muarif et al., 2023; Mutaqin et al., 2023; Oktavianus et al., 2023; Putri et al., 2023; Rifky, 2024; Rochmawati et al., 2023; Sanhaji & Hizbullah, 2023; Serdianus & Saputra, 2023; Soegiarto et al., 2023; Suharmawan, 2023; Suryokta et al., 2023; Yulianti et al., 2023; Yustiasari Liriwati, 2023; Zakaria et al., 2023; Zein, 2023)	28
Dependency on Technology	(Rochmawati et al., 2023; Suharmawan, 2023; Suryokta et al., 2023)	3
Teacher Training and Skills	(Afrita, 2023; Ali et al., 2023; Angkasawan et al., 2023; Hanila & Alghaffaru, 2023; Jayawardana, 2023; Lubis et al., 2023; Masrichah, 2023; Rochmawati et al., 2023; Suryokta et al., 2023; Zakaria et al., 2023)	10
Implementation Cost	(Suryokta et al., 2023)	1
Access Not Equalized	(Yulianti et al., 2023; Zakaria et al., 2023)	2

Source: Processed from Research Results Data, 2024.

6. RQ4: The challenges that arise as a result of the presence of artificial intelligence in education

The problem formula on RQ4 discusses the classification of articles based on the challenge of anything that arises as a result of the presence of artificial intelligence in education. In Table 5, some indicators obtained from the analysis of several related articles are shown. The various challenges that arise as a result of the existence of artificial intelligence include the following:

- **Technology gaps**
  Not all schools or students have equal access to the technology needed to use AI in learning.
- **Ethics and privacy precautions**
  The use of AI in education raises various ethical questions related to student data privacy, data usage, and algorithm transparency. It is important to ensure that student data is protected and that decisions made by AI can be explained transparently.
- **Dependency on technology**
  Excessive reliance on AI technology can reduce students' ability to think critically, collaborate, and interact socially, which are important aspects of learning.
- **Teacher training and skills**
  Teachers need to be adequately trained to use AI technology in learning. A lack of understanding of how to integrate this technology into their teaching can be an obstacle.
- **Implementation fee**
  Implementing AI technology in education can involve high costs, including software, hardware, training, and technical support costs.
- **Access hasn't been achieved**
  The meaning of "uneven access" as one of the AI challenges is that not all students, teachers, or educational institutions have equal access to artificial intelligence (AI) technology. This can be caused by a variety of factors, including inadequate technological infrastructure, financial constraints, and digital gaps.

The conclusion of the various challenges in the application of AI in education is that although artificial intelligence has great potential to improve the quality and efficiency of learning, there are a number of obstacles that need to be overcome in order for the benefits to be felt evenly and optimally. A careful, inclusive, and planned approach is crucial to ensuring that this technology supports, not impedes, educational goals.

CONCLUSION

The use of artificial intelligence (AI) in education has a significant impact, both positive and negative. Positive impacts include the provision of tailored learning, increased efficiency, broader accessibility of education, and in-depth data analysis. However, there are also negative impacts such as technology gaps, reliance on technology, privacy and ethical concerns, job losses, and resistance to change. While the use of AI can bring many benefits to improving learning and the management of education, serious efforts are needed to address the related challenges, such as technology gaps, ethical and privacy concerns, and excessive reliance on technology. Collaboration between educators, technology developers, policymakers, and other stakeholders is needed to ensure that the use of AI in education has a positive and sustainable impact.

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