Vol. 7, No. 2 (2023) 143-158 ISSN: 2597-4866
Indonesian Journal of Primary Education

The Use of AI (Artificial Intelligence) in Education (Literature Review)

Riki Nuryadin*, Marlina

Indonesian University of Education*
SMKN 4 Banjar – Jawa Barat
Corresponding author: riki.nuryadin@upi.edu, marlina.nuryadin@gmail.com

Submitted/Received 11 July 2023; First Revised 20 July 2023; Accepted 6 August 2023
First Available Online 1 December 2023; Publication Date 1 December 2023

Abstract

The use of artificial intelligence (AI) in education has become a topic of increasing interest in recent decades. AI has experienced rapid development and has been implemented in various aspects of education, such as adaptive learning, school administration, and increasing educational accessibility. While the potential benefits offered by AI are very promising, their implementation also faces challenges that need to be overcome. This research aims to investigate the development and use of AI in education, as well as the challenges faced in adopting and implementing it. Through a comprehensive literature review, this study evaluates the positive impact of AI in increasing learning effectiveness, providing learning experiences tailored to individual needs, and speeding up the educational administration process. However, challenges were also identified in the application of AI in education. These challenges include student data privacy issues, loss of human interaction, and the changing role of teachers in the AI era. In addition, there are also financial and infrastructural constraints that can hinder the adoption of AI in public schools. The articles cited in this research discuss various solutions that can be implemented to overcome this challenge. The conclusions in this study highlight the importance of supporting the implementation of AI in education by ensuring supportive policies, adequate preparation, and a better understanding of the use of AI by educators. In addition, it is also necessary to develop a curriculum that is adaptive and in accordance with industrial developments. By addressing these challenges, the application of AI in education has the potential to change the way we learn and teach, creating a more inclusive, efficient and quality education

Keywords: Artificial Intelligence; Education; Indonesia; Literature Review.

INTRODUCTION

The use of artificial intelligence (AI) in learning has been an interesting and rapidly growing topic in recent years, the history of using AI in learning has a long history and continues to evolve over time. In the 1950s and 1960s, at the beginning of AI development, researchers began efforts to develop computer programmes that could simulate human learning abilities. An example is a computer programme called Logic Theorist, developed by Allen Newell and Herbert A. Simon in 1955 (Anyoha, 2017). This programme can solve mathematical problems using symbolic problem solving techniques. Up to the 2010s and beyond, advances in computing, digital technology, and data collection have accelerated the use of AI in learning. Learning methods in deep neural networks and deep learning became a major focus. Using big data and advanced processing techniques, AI can recognise complex patterns, gain deeper understanding, and provide accurate predictions .

The utilization of artificial intelligence (AI) in education brings about considerable advantages. However, there are polemics related to artificial intelligence (AI) in education that have become a debated topic in various environments. Here are a few instances of debates associated with the application of AI in the educational context:

1. Dependence on Technology: One of the main polemics is the concern that over-reliance on AI could replace the

role of teachers and human interaction in the classroom. Some argue that the valuable human interaction in learning cannot be completely replaced by technology.

2. Inequality of Access: The use of AI in education can create access gaps, especially in countries with different levels of technology and infrastructure. Not all students or schools have equal access to AI technologies, which can increase educational disparities.
3. Loss of Humanity: Detractors frequently point out that the integration of AI in education has the potential to diminish the direct teaching of human values, empathy, and social sensitivity by educators. Learning experiences centered around technology may struggle to offer a comprehensive and humanized approach to education.
4. Data Privacy and Security: Data Privacy and security concerns pose significant challenges in the implementation of AI in education. Strong measures are essential to safeguard students' personal information and prevent any misuse of the data collected by AI systems during the collection and utilization of student data.
5. Bias and Discrimination: AI systems are prone to bias and discrimination if not carefully developed and implemented. If the algorithms used by AI systems do not take diversity and inclusion into account, then their use in education may reinforce existing disparities and inequalities.

These polemics emphasises the importance of developing and implementing AI in education that is ethical, inclusive, and responsible. A good AI education should combine the advantages of technology with the important role of teachers and benefit all students without increasing the access gap or reducing the human aspect of the learning process.

Nye (Nye, 2015) discusses the use of intelligent tutoring systems in the context of developing countries, in the article Nye presents an overview of some of the problems faced in implementing intelligent learning technologies in resource-limited educational environments. The discussion addresses a challenge concerning the constrained internet access and dependence on the web when implementing Intelligent Tutoring Systems (ITS) in classrooms within developing countries. The article concludes that classrooms in these nations may find web-dependent ITS less suitable. Nevertheless, the effectiveness of web-based ITS can still be achieved beyond the school environment if there is well-organized management of their data usage. The article also mentions several approaches, such as the "well" model, Learning Vans, and other approaches that can mitigate these problems.

Primary school teachers in Indonesia have mixed perceptions of online learning during the pandemic. Some teachers recognise the potential of online learning in maintaining educational continuity while others face challenges in implementing it. Some of the factors that influence teachers' perceptions include limited access to technology, readiness and competence in using online learning platforms, and challenges in maintaining social interaction and student engagement in distance learning (Rasmitadila et al., 2020) .

The study by Dwivedi (Dwivedi et al., 2020) explores the transformative impact of the pandemic on various aspects of education, work and personal life. The authors discuss how the pandemic has accelerated the adoption of digital technologies and remote working practices, forcing organisations and individuals to adapt to new ways of managing information. They analyse emerging challenges and opportunities in areas such as online education, remote collaboration, digital healthcare, and the use of artificial intelligence and data analytics in the pandemic response.

Atmojo's (Atmojo & Nugroho, 2020) paper delves into the challenges and instructional practices associated with learning English as a

foreign language (EFL) online in Indonesia during the COVID-19 pandemic. The article elucidates the impact of the pandemic on English language education in Indonesia, prompting a transition to online learning. The author outlines various online teaching activities, including the utilization of digital platforms, interactive media, and mobile applications for English language learning. Additionally, the article highlights the obstacles faced by both teachers and students in adapting to online education, such as restricted internet access, limited devices, and challenges in sustaining direct interaction between teachers and students.

The advent of Industry 4.0 has significantly impacted the field of education, ushering in new business avenues, job opportunities, and professions that were previously inconceivable (Ghufron, 2018). However, this transformative phase also poses a threat to certain lines of business, professions, and jobs, as artificial intelligence machines and robots have the potential to replace human roles. Industry 4.0 represents a technological revolution that brings about a shift in the scale, scope, complexity, and transformation of human activities compared to previous experiences. Notably, the deployment of artificial intelligence (AI) and the substitution of human labor with robots are distinctive features of this revolution. The challenges and opportunities presented by Industry 4.0 stimulate innovation and creativity in vocational education. It becomes imperative for the government to reassess the alignment between vocational education and employment, effectively addressing the changes, challenges, and opportunities brought about by the industrial era 4.0. Vocational education should be characterized by an orientation towards individual performance in the workplace, a focus on psychomotor, affective, and cognitive aspects, and adaptability to the evolving dynamics of the professional landscape.

Based on the background presented above, the problem formulations that can be identified are:

1. What effects does the utilization of artificial intelligence (AI) have on the learning process??
2. What are the polemics associated with the use of AI in education?
3. How does limited access and dependence on technology affect the implementation of AI in education in developing countries?
4. What are the perceptions and challenges faced by educators in Indonesia regarding online learning?
5. How does the industrial revolution 4.0 and the use of artificial intelligence (AI) affect education, especially vocational education?

By formulating these issues, readers can focus more on relevant topics and understand the issues related to the use of artificial intelligence in education and its impact in different contexts.

The research objectives based on the problem formulation above are as follows:

1. To investigate the impact of using artificial intelligence (AI) in learning, both in terms of learning effectiveness, improved learning outcomes, and changes in learning methods.
2. To analyse the polemics associated with the use of AI in education, such as technology dependency, inequality of access, loss of humanity, data privacy and security, as well as bias and discrimination, in order to identify challenges and potential solutions in the implementation of AI in education.
3. To study the access limitations and technology dependency that affect the implementation of AI in education in developing countries, and seek approaches or solutions that can mitigate these problems.
4. To analyse the perceptions and challenges faced by educators in Indonesia regarding online learning, and find ways to improve the quality of online learning implementation.
5. To investigate how the industrial revolution 4.0 and the use of artificial intelligence (AI) affect the world of

education, particularly vocational education, and seek relevant approaches in responding to the changes, challenges and opportunities that arise.

With clear research objectives, researchers can collect relevant data and information, analyse the findings, and contribute new knowledge in the use of artificial intelligence in education and a deeper understanding of its impact.

RESEARCH METHODS

The research method used is literature review. The literature review research method is used to collect, review, and analyse literature that is relevant and related to the research topic. This method aims to reorder and synthesise existing knowledge from various published sources.

According to Hart (Hart, 2018), literature review is a systematic process involving the collection, evaluation, and synthesis of information relevant to a particular research topic. The purpose of the literature review is to understand and describe the development of research that has been done before, identify gaps in knowledge that still exist, and compile a solid theoretical foundation for the research being conducted.

In this study, the data collection technique was carried out in several stages, first determining the topic and problem, second conducting a literature search using the Scopus and Google Scholar databases with the keywords Artificial Intelligence, Education, and Indonesia. The next step is to analyse and interpret the data or literature found.

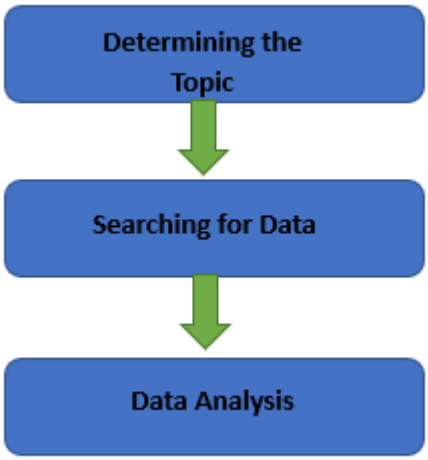

Figure 1
Stages of the research method

According to Okoli & Schabram (Okoli & Schabram, 2012), literature review is a systematic, explicit and reproducible method by identifying, evaluating and synthesizing works resulting from previous research. The following, in table form, is a list of articles and research that are relevant to writing a literature review regarding the use of AI (Artificial Intelligence) in Education in Indonesia:

Table 1
Relevant previous research

No.	Author	Result
1	Anutariya, C. (2020)	This article provides insights into how needs-orientated curriculum development can be done in the field of data science and artificial intelligence. Through case studies in Indonesia, Sri Lanka, and Thailand
2	Atmojo (2020)	This article explains how the COVID-19 pandemic has affected English language learning in Indonesia and fuelled the shift to online learning.
3	Butler, D., Leahy, M., Twining, P., Akcan, S., Brunton, J., Chtouki, Y., … Weis, S. (2018)	The use of ICT in education is strongly linked to the pedagogical orientation of teachers, and research has shown that computer-based interventions are more effective when combined with constructivist approaches to teaching.
4	Celik, I., Dindar, M.,	This article recognises the increasing interest in teachers'

	Muukkonen, H., & (2022)	use of AI and highlights the need for further research to better understand teachers' use of AI.
5	Chen, Z., Zhang, J., Jiang, X., Hu, Z., Han, X., Xu, M., V, S., & Vivekananda, G.N. (2020)	The review revealed a growing interest in using AI for educational purposes. The author highlights that AI has made significant contributions in improving learning effectiveness, providing personalised learning experiences, and assisting in the development of adaptive curricula.
6	Dwivedi YK, Hughes DL, Coombs C et al (2020)	The pandemic has accelerated the adoption of digital technologies and remote working practices, forcing organisations and individuals to adapt to new ways of managing information. They analyse the emerging challenges and opportunities in areas such as online education, remote collaboration, digital healthcare, and the use of artificial intelligence and data analytics in pandemic response.
7	Fauzi, Irviani, R., Muslihudin, M., Satria, F., Huda, M., Kamenez, N. V., & Maseleno, A. (2019)	This article explains that artificial intelligence has brought significant changes in various aspects of life, including in the field of education.
8	Ghufron, G., (2018, September)	One of the unique features of this revolution is the application of artificial intelligence (AI) and the use of robots to replace human labour. Industry 4.0 challenges and opportunities drive innovation and creation in vocational education
9	Halili, S. H. (2019).	The use of technology in education requires collaborative efforts from all stakeholders. Cooperation between the government, educational institutions and the technology industry is important to optimise the use of technology in the educational context.
10	Jokhan, A., Chand, A. A., Singh, V., & Mamun, K. A.	Increasing reliance on digital resources in higher education, accelerated by technological advances and digitisation of
	(2022)	learning materials.
11	Kahn, K. (2018)	Children are able to develop understanding and skills in AI programming through the use of Snap
12	L. Hastini, R. Fahmi, and H. Lukito (2020)	The use of technology in learning can play an important role in improving human literacy in Generation Z in Indonesia
13	Machmud, M. T. (2021)	This research highlights the role of ICT in strengthening education and teaching, as well as the government's efforts to implement educational technology in their education system.
14	Mangera, E., Supratno, H., & Suyatno. (2023)	The results of this study reveal a close relationship between transhumanism and artificial intelligence in improving the learning process in higher education.
15	Mijwil, M. M., Aggarwal, K., & Mutar, D. S. (2022)	Artificial intelligence can assist teachers in developing their skills, disseminating subject matter to students, communicating with them, and evaluating their performance through a series of exams.
16	Nye, B.D (2015).	This research provides insights into the use and development of Intelligent Tutor Systems in developing countries
17	Rasmitadila, Rusi Rusmiati Aliyyah, Reza Rachmadtullah, Achmad Samsudin, Ernawulan Syaodih, Muhammad Nurtanto, Anna Riana Suryanti Tambunan. (2020)	Some of the factors that influence teachers' perceptions of online learning include limited access to technology, readiness and competence in using online learning platforms, and challenges in maintaining social interaction and student engagement in distance learning.
18	Salam, S., Jianqiu, Z., Pathan, Z. H., & Lei, W. (2017)	Schools face challenges in integrating ICT in schools such as lack of funding, hardware and software costs, outdated curriculum, interruption of electricity supply, internet connection, and lack of ICT-based teacher training.
19	Sartika, F., Ritonga, M., Lahmi, A., Rasyid, A., & Febriani, S. R.	The conclusion of this study is the need for special attention from various parties, especially in the conditions of the Covid-19 pandemic which

	(2021)	requires activities to be carried out online, to pay attention to areas with limited internet access.
20	Sudira, P. (2019)	Vocational education curricula can no longer be linear and mono disciplinary. An open, multi disciplinary and trans disciplinary curriculum covering a wide range of skills is required.
21	Yusriadi, Y. (2023)	Governments can utilise AI in public services, especially in complex policy making in a changing environment that impacts economic, social and environmental fundamentals.

RESULTS AND DISCUSSION

Literature Review

a. Artificial Intellegence

Artificial Intelligence (AI) is a field of computer science concerned with the development of computer systems capable of performing tasks that normally require human intelligence. According to McCarthy (Mccarthy, 2007), one of the founders of AI, AI is the science and engineering that deals with creating intelligent machines, especially intelligent computer programs. Russell and Norvig (Russell & Norvig, 2010) define AI as "a field of computer science concerned with the creation of computer systems that can do things that would require intelligence if done by humans.

In the 1950s and 1960s, the main focus in AI was on developing computer programs that could perform tasks such as natural language processing, problem solving, and chess playing. At that time, the development of AI had progressed quite significantly, but was still limited in the capabilities and complexity of the tasks that could be handled.

In the 1970s and 1980s, AI experienced a period known as the “AI winter” as research in the field experienced a decline in interest and financial support. Researchers face challenges in dealing with the complexity of more realistic tasks and difficulties in dealing with problems such as uncertainty and incomplete knowledge. However, in the 1990s, developments in computer technology and advances in algorithms and modeling gave a new impetus to the development of AI. Research in the fields of artificial neural networks, fuzzy logic, and genetic algorithms is becoming a major trend in AI development. Since the 2000s, rapid advances in computer technology, the availability of large data, and the development of machine learning methods have triggered an explosion in AI development. Machine learning methods such as artificial neural networks, deep learning, and statistical learning algorithms have achieved impressive results in facial recognition, voice recognition, language translation, and strategy games.

In recent years, AI has also experienced significant developments in areas such as autonomous cars, robotics, natural language processing, and object recognition in images and videos. This success is driven by a combination of advances in computer technology, more powerful computing capabilities, and increasingly sophisticated machine learning methods. The history of AI development continues, and today AI is one of the most exciting and rapidly growing areas of research and development in the world of technology. AI has infiltrated various aspects of our lives and is having a significant impact. Let's look at current uses of AI in narrative form: Imagine a world where you can talk to an intelligent virtual assistant. When you wake up in the morning, you ask the assistant to give you the latest weather and news information. When you go to work, autonomous cars with AI technology help you get to your destination safely and efficiently. At work, you work closely with AI colleagues who are able to analyze big data and provide valuable insights. These AI systems help identify patterns and trends that

are invisible to humans, allowing companies to make smarter and more strategic decisions.

When you watch a movie or series on a streaming platform, you are introduced to a variety of content recommendations tailored to your interests and preferences. This is all thanks to a recommendation system that uses AI to analyze audience preferences and habits. In the health sector, AI helps doctors in the diagnosis and treatment of patients. Using AI technology, doctors can analyze patient medical data, look for patterns that humans may not detect, and provide better treatment recommendations. In the manufacturing industry, robots with artificial intelligence are used to carry out repetitive tasks with high accuracy and more efficient speed. They can operate machines, monitor product quality, and perform other tasks with greater precision than humans. On a more personal level, voice recognition and facial recognition applications using AI technology allow you to unlock your phone or access your accounts easily and securely. This technology is also used in security, with surveillance cameras capable of detecting suspicious activity or recognizing individuals' faces. In conclusion, AI has created significant changes in various aspects of our lives. From personal assistants to job automation, object recognition to recommendation systems, AI has enriched our experiences with intelligent and adaptive technology.

Governments can leverage AI in public services, especially in complex policymaking in an environment that is constantly changing and impacts economic, social and environmental fundamentals. One example of using AI is through chatbot development. Chatbots are applications that can absorb knowledge, such as human nature, so that computers can interpret communications with users. Chatbots can reduce barriers to face-to-face and telephone services by enabling the implementation of online activities, thereby increasing access and engagement of communities who may not use other digital channels. Chatbots have been implemented in various institutions, including education, e-commerce, and business. In the world of education, especially at universities, chatbots are very useful in answering questions from students and prospective students (Yusriadi et al., 2023) .

b. AI Technology in Education

AI in the world of education has brought significant changes. Imagine a school where students can learn in the most effective way for them individually, teachers can better identify students' learning needs, and the evaluation process is more efficient. Here's how AI has changed the way we learn and teach. Not only in learning, AI is also used in school administration. For example, learning management systems use AI to organize lesson schedules, monitor student attendance, and manage student data. This helps speed up the administrative process and frees up time for teachers to focus on teaching. Apart from that, AI is also used to increase educational accessibility. With the help of AI technology, students with special needs can get a learning experience tailored to their needs. AI can provide voice or text-based assistance to help students with learning disabilities, so they can follow lessons better. In the increasingly advanced world of education, AI provides great potential to improve the quality and efficiency of the learning process. With the help of AI, the student learning experience becomes more personalized, assessments become more objective, and administrative processes become more efficient. The implementation of AI in education opens the door to an innovative and inclusive educational future.

Mahmud (Machmud et al., 2021) discusses developments and policies for

implementing educational technology in ASEAN countries. This research was conducted through a literature review and comparative analysis regarding educational technology developments and policies in ASEAN countries. This study selected countries to be reviewed based on the Information and Communication Technology (ICT) Index among ASEAN countries, namely Singapore (highest ranking), Thailand and Indonesia (middle ranking), and Myanmar (lowest ranking). The results show that most countries are focused on improving network capabilities to support online learning, and policies in each country show similarities in improving technology equality for learners. Singapore shows the implementation of more advanced technology, such as the wider application of Artificial Intelligence in classroom activities, while the use of Artificial Intelligence (AI) in Thailand and Indonesia is still in the development stage.

The use of artificial intelligence (AI) in the learning process has positive implications in achieving an effective learning process. Although AI cannot replace the role of teachers, this technology can help teachers' work and produce best practices in the world of education (Mangera et al., 2023). In the implementation of artificial intelligence, there are several aspects that support learning, such as the Intelligent Tutoring System (ITS), Smart Virtual Mentor (SMV), Voice Assistant (VA), Automatic Assessment (AA), and Self-Study (SS). Intelligent Tutor System (ITS) or Intelligent Virtual Mentor (SMV) provides flexibility for students to apply their skills through assignments or exercises in certain lessons interactively. SMV is an artificial intelligence technology that is currently widely applied in various educational technology platforms, especially online.

The implementation of artificial intelligence in the learning process has great potential to increase the efficiency and effectiveness of learning. This technology can help teachers prepare and present learning materials, provide feedback to students, and automate several administrative tasks in the learning process. However, it is important to remember that the teacher's role is still important in directing and accompanying students in the learning process.

The results of a case study conducted by Anutariya (Anutariya, 2020) show that developing a needs-based curriculum is very important in preparing graduates who are competent and relevant to market demand. Through a deep understanding of the needs of industry and society, curricula can be designed taking into account the competencies, skills and knowledge required in the fields of data science and artificial intelligence. This article provides insight into how need-oriented curriculum development can be done in the fields of data science and artificial intelligence. Through case studies in Indonesia, Sri Lanka, and Thailand, this article presents concrete examples of how curriculum development can be adapted to local and regional needs.

Research conducted by Kahn (Kahn et al., 2018) aims to understand children's abilities in learning and using AI programming by using a block programming language that is easier to understand and implement. This research was conducted in the context of a developing country, where access to technology and education is sometimes limited. The results of this research show that children are able to develop understanding and skills in AI programming through the use of Snap!. They can create simple programs involving basic AI concepts such as pattern recognition, logic, and decision making. This research provides insight into the potential use of block programming languages in AI education for children in developing countries. By using

methods that are easier to understand and implement, children can learn and engage in AI programming, which can improve their skills in technology and open up opportunities for a better future.

An article written by Hastini (Hastini et al., 2020) states that Generation Z has a high dependence on smartphones and social media. They tend to be more comfortable communicating online than face to face. However, Generation Z is less able to analyze and utilize the information they obtain critically. Their attention span is also short, only about 8 seconds. Even though there are developments in learning methods using technology such as e-learning, blended learning, and online-learning, this research shows that the use of technology in learning has not been able to significantly increase human literacy in Generation Z. They still have difficulty communicating directly and have high dependency on technology.

Halili's (Hajar Halili, 2019) article presents a review of the use of technology in the Malaysian higher education system, especially in the application of artificial intelligence, big data, and QR codes for educational purposes. One conclusion that can be drawn is that the use of technology in education has experienced significant progress. Technologies such as artificial intelligence, big data, and QR codes have been applied in educational contexts to improve learning processes and efficiency. In addition, this article shows that the use of these technologies has the potential to change the educational paradigm. A more personalized and adaptive learning approach can be realized through the use of artificial intelligence. The use of big data in education can also help make more effective decisions in designing curriculum and learning strategies. Another conclusion is that the use of technology in education requires collaborative efforts from all stakeholders.

Result and Discussion

Artificial Intelligence (AI) as a field of computer science is concerned with the development of computer systems capable of performing tasks that require human intelligence. In the 1970s and 1980s, AI experienced a period of declining interest and financial support known as the “AI winter.” In the 1990s, developments in computer technology and algorithms helped revive AI development. Since the 2000s, advances in computer technology, the availability of big data, and machine learning methods have fueled an explosion in AI development. AI has been used in areas such as autonomous cars, robotics, natural language processing, and object recognition in images and videos.

AI has brought significant changes in learning and teaching. AI is used in effective individual learning, school administration, and increasing educational accessibility. AI can provide learning experiences tailored to student needs, monitor student attendance, and speed up administrative processes. The implementation of AI in education opens up opportunities for an innovative and inclusive educational future. Another study discusses educational technology implementation policies in ASEAN countries, which shows that most countries focus on increasing network capabilities to support online learning. Other articles also highlight the development of needs-based curricula in the fields of data science and artificial intelligence as a way to address challenges in the industry.

The use of AI in education not only provides benefits for students, but also for teachers and educational institutions. In this case, AI can help teachers plan the curriculum, evaluate student performance automatically, and provide relevant feedback. Educational institutions can also use AI to manage student data, analyze learning trends, and improve administrative efficiency.

However, the application of AI in education also faces challenges. Some of the challenges that need to be addressed include student data privacy, concerns about losing human interaction, and uncertainty about the role of teachers in the AI era. Overall, AI has great potential to change the way we learn and teach. With proper use, AI can provide a more personalized learning experience, help students reach their full potential, and improve overall educational efficiency.

The article written by Chen(X. Chen et al., 2022) discusses the use of artificial intelligence (AI) technology in education over the last two decades. The results of the review reveal a growing interest in using AI for educational purposes. The authors highlight that AI has made significant contributions in improving learning effectiveness, providing personalized learning experiences, and helping in the development of adaptive curricula. The use of AI has also played a role in providing more accurate and timely feedback to students, as well as supporting teachers in managing learning more efficiently. Overall, this article shows that the use of AI in education has experienced significant development over the last two decades and has great potential in improving the quality of learning. However, there is still work to be done to ensure implementation is effective, sustainable and appropriate to diverse educational needs.

Salam (Salam et al., 2017) in his article shows that lack of funding for the education sector is the main obstacle in implementing ICT in public schools. Additionally, cost of hardware/software, outdated curriculum, disruption of power supply/internet connection, and lack of ICT-based teacher training are the major obstacles hindering ICT integration in public schools in Pakistan. The conclusion of this article is that Pakistan faces challenges in integrating ICT in public schools. Problems such as lack of funding, hardware/software costs, outdated curriculum, disruption of electricity supply/internet connection, and lack of ICT-based teacher training are the main obstacles to ICT implementation. Steps need to be taken by policy makers and education officials to overcome these barriers and ensure the provision of adequate ICT resources in public schools.

Research findings by Sartika (Sartika et al., 2021) show that local governments in low internet areas have not planned adequately to support online learning during the pandemic. Implementing online learning in these areas requires different preparations and faces various difficulties, such as the high cost of online learning, weak WiFi signals, and frequent power outages. As a result, pupils and students in areas with minimal internet have to struggle to find certain locations that have internet access, often having to travel by motorbike for 15 minutes to reach an affordable location with signal coverage. The conclusion of this research is that special attention is needed from various parties, especially in the Covid-19 pandemic conditions which require activities to be carried out online, to pay attention to areas with limited internet access.

Celik (Celik et al., 2022) discusses developments in the use of artificial intelligence (AI) by teachers in the field of education and identifies gaps and recommendations for future research. This article acknowledges the increasing interest in teachers' use of AI and highlights the need for further research to better understand teachers' use of AI. The authors propose that as AI becomes more popular in education, there will likely be an increase in research focused on teachers' use of AI in teaching. AI-based systems in education often do not fully exploit the potential of multimodal data. This article highlights the importance of investigating the use of AI in the education of prospective

teachers, leveraging multimodal data in AI-based systems, involving teachers in the development of AI systems, and addressing the limitations and challenges of AI in education. The findings contribute to the understanding of the potential impact of AI in teaching and learning and encourage multidisciplinary collaboration among stakeholders to improve the development and implementation of AI systems in education.

The introduction of ICT in the learning environment does not directly bring about changes in pedagogical practice. The use of ICT in education is closely related to the pedagogical orientation of teachers, and research has shown that computer-based interventions are more effective when combined with constructivist approaches to teaching. Butler (Butler et al., 2018) discusses the complexities of teaching and learning through the use of ICT (Information and Communication Technology), this article highlights that the use of ICT in Irish schools is still largely at a technological literacy level, indicating the need to address the pedagogical orientation of teachers. The Digital Strategy for Schools in Ireland aims to encourage a constructivist pedagogical orientation in teachers, thereby enabling students to gain in-depth knowledge and apply it to real-world problems. To support this, the article emphasizes the importance of developing appropriate professional learning models for teachers.

In the era of industrial revolution 4.0, there have been massive changes in the way of work and work systems in various industrial sectors, including extraction, manufacturing, assembly, marketing, distribution and service. Industrial automation supported by artificial intelligence (AI), virtual reality (VR), augmented reality (AR), and the Internet of Things (IoT) enables production and service systems to become more intelligent and humanistic. Revolutionary changes in industrial systems and work processes drastically affect the need for job competencies and skills. In responding to the Industrial Revolution 4.0, a big leap is needed in preparing the skills of the workforce to follow the revolutionary changes in the industry. The vocational education curriculum can no longer be linear and monodisciplinary. An open, multidisciplinary and transdisciplinary curriculum is needed that covers a variety of skills (Sudira, 2019). The application of the Cyber-Physical Production System (CPPS) in industry 4.0 changes industrial systems and ways of working towards a smart industry in producing products and services that are smart, fast, careful and satisfying. This change has a direct impact on the vocational education system. The role of vocational education in the industrial era 4.0 can be seen from the basic function of Vocational Education itself. The main goal of vocational education is to prepare graduates for work. Changes in the production system in Industry 4.0 which implements CPPS are an important point in adjusting the content of the vocational education curriculum. The role of vocational education in industrial automation 4.0 is as a provider of competent workforce in the implementation of CPPS in accordance with the concept of matching between individuals and jobs as the basis for developing vocational education programs.

The article written by Fauzi (Fauzi et al., 2019) discusses the educational revolution through artificial intelligence with a fuzzy multiple attribute decision making approach to determine the best vocational high school. This article explains that artificial intelligence has brought significant changes in various aspects of life, including in the field of education. In an educational context, artificial intelligence can be used to optimize the decision-making process in selecting the best vocational high school. This is important

because choosing the right school will affect the quality of education and career preparation of students in the future.

Chen (Z. Chen et al., 2020) research discusses education 4.0 which uses artificial intelligence to analyze student performance. Education 4.0 leverages technology such as data analysis and artificial intelligence to understand and improve student performance. In this context, this article focuses on the use of artificial intelligence to perform student performance analysis. The method used in this research involves collecting student performance data, including grades, attendance, and participation in learning activities. The research results show that the approach of using artificial intelligence in analyzing student performance provides significant benefits.

Jokhan, Chand, & Mamun (Jokhan et al., 2022) in their research explored the growing trend of digital resource consumption in higher education institutions and the potential role of artificial intelligence (AI) in informing decisions regarding student performance. This study emphasizes the increasing reliance on digital resources in higher education, which is increasingly accelerated by advances in technology and the digitization of learning materials. Researchers identified AI as a potential solution to overcome these challenges. They highlight the role of AI in collecting and analyzing data about students' use of digital resources, enabling the identification of patterns, trends and correlations that can inform decision-making regarding student performance.

Mijwil (Mijwil et al., 2022) discuss the role of artificial intelligence in creating a modern educational environment. The article states that artificial intelligence can help teachers develop their skills, disseminate learning materials to students, communicate with them, and evaluate their performance through a series of tests. Additionally, artificial intelligence also allows teachers to create content that suits their students' needs while ensuring learning, sharing opinions, asking questions, and discussing answers. This article also emphasizes the importance of teacher awareness of artificial intelligence applications and how to interact with these technologies, as well as their impact on students. Apart from that, the government is also advised to provide productive technology to teachers to support their work, set standards that serve the e-learning sector, and organize more training and workshops needed to spread the culture of artificial intelligence and e-learning, and how it contributes to development of a new generation capable of serving the country now and in the future.

CONCLUSION

Conclusion

The use of artificial intelligence (AI) in education in Indonesia has experienced significant development in recent years. Various efforts have been made to exploit the potential of AI in increasing learning effectiveness, personalizing learning experiences, and developing adaptive curricula. One area where AI has been used in education in Indonesia is in the creation of intelligent learning systems. This system uses AI technology to analyze student data and provide learning recommendations tailored to their individual needs. With this system, students can learn according to their own pace and learning style, thereby increasing learning effectiveness and improving academic achievement. Artificial intelligence can also help teachers in developing their skills, disseminating study materials to students, communicating with them, and evaluating their performance through a series of tests. Additionally, artificial intelligence also enables teachers to create content that suits their students' needs while ensuring learning

However, the use of AI in education in Indonesia also faces challenges. One of them is the availability of adequate infrastructure, especially stable and fast internet access throughout the region. Additionally, challenges remain in integrating AI into existing education systems, including teacher training and awareness of AI's potential to improve learning. To optimize the use of AI in education in Indonesia, there needs to be collaboration between the government, educational institutions and technology companies. Investments in technology infrastructure and teacher training related to AI are needed. Apart from that, there is also a need for policies that support the development and implementation of AI in education, as well as protecting student data privacy. Overall, the use of AI in education in Indonesia has great potential to improve the quality of learning and provide a more personalized and effective learning experience. With continued efforts to overcome challenges and ensure appropriate implementation, the use of AI in education in Indonesia can provide significant benefits for students, teachers and the education system as a whole.

Suggestion

The application of artificial intelligence in education can bring significant benefits. AI can be used to optimize the learning process, provide learning experiences tailored to student needs, and increase the efficiency of school administration, in developing AI-based systems in education, it is important to ensure inclusivity and fairness. Consider concerns about student data privacy, loss of human interaction, and the role of teachers in the AI era. Ensure that the implementation of AI in education respects human values and supports the social interactions that are important in learning.

Further research can be conducted regarding the increasing interest in using AI by teachers. Therefore, further research is needed to better understand teachers' use of AI. Focus research on teachers' use of AI in teaching and the benefits of using multimodal data in AI systems to better understand teaching and learning processes. In facing revolutionary changes in industry and work systems in the Industrial Revolution 4.0 era, it is necessary to update the vocational education curriculum. Ensure that the vocational curriculum is open, multidisciplinary and transdisciplinary to cover various skills that are relevant to the needs of an intelligent and humanistic industry, therefore it is necessary to develop a responsive vocational curriculum. In the digital era, educational institutions need to effectively monitor and analyze students' digital resource consumption patterns. Leverage artificial intelligence (AI) to collect and analyze student digital resource usage data. This will help inform decisions regarding student performance and improve educational outcomes, the use of digital resources in higher education must be optimized. by harnessing the potential of AI in education, addressing emerging challenges, and conducting advanced research, we can optimize the learning experience, improve the quality of education, and prepare students for a smart, sustainable future

BIBLIOGRAPHY

Anutariya, C. (2020). Anutariya, C. (2020). Building a needs-based curriculum in data science and artificial intelligence: Case studies in Indonesia, Sri Lanka, and Thailand. International Symposium on Project Approaches in Engineering Education. *International Symposium on Project Approaches in Engineering Education , Bangkok - Thailand, 26 -28 August 2020* , 97–104.

Anyoha, R. (2017, August 28). *The History of Artificial Intelligence*. Harvard University. sitn.hms.harvard.edu

Atmojo, A. E. P., & Nugroho, A. (2020). EFL Classes Must Go Online! Teaching Activities and Challenges during COVID-19 Pandemic in Indonesia. *Register Journal*, *13*(1), 49–76. https://doi.org/10.18326/rgt.v13i1.49-76

Butler, D., Leahy, M., Twining, P., Akoh, B., Chtouki, Y., Farshadnia, S., Moore, K., Nikolov, R., Pascual, C., Sherman, B., & Valtonen, T. (2018). Education Systems in the Digital Age: The Need for Alignment. *Technology, Knowledge and Learning*, *23*(3), 473–494. https://doi.org/10.1007/s10758-018-9388-6

Celik, I., Dindar, M., Muukkonen, H., & Järvelä, S. (2022). The Promises and Challenges of Artificial Intelligence for Teachers: a Systematic Review of Research. *TechTrends*, *66*(4), 616–630. https://doi.org/10.1007/s11528-022-00715-y

Chen, X., Zou, D., Xie, H., Cheng, G., & Liu, C. (2022). Contributors, Collaborations, Research Topics, Challenges, and Future Directions. *Educational Technology & Society*, *25*(1), 28–47. https://www.jstor.org/stable/48647028

Chen, Z., Zhang, J., Jiang, X., Hu, Z., Han, X., Xu, M., Savitha, V., & Vivekananda, G. N. (2020). Education 4.0 using artificial intelligence for students performance analysis. *Inteligencia Artificial*, *23*(66), 124–137. https://doi.org/10.4114/intartif.vol23iss66pp124-137

Dwivedi, Y. K., Hughes, D. L., Coombs, C., Constantiou, I., Duan, Y., Edwards, J. S., Gupta, B., Lal, B., Misra, S., Prashant, P., Raman, R., Rana, N. P., Sharma, S. K., & Upadhyay, N. (2020). Impact of COVID-19 pandemic on information management research and practice: Transforming education, work and life. *International Journal of Information Management*, *55*. https://doi.org/10.1016/j.ijinfomgt.2020.102211

Fauzi, Irviani, R., Muslihudin, M., Satria, F., Huda, M., Kamenez, N. V, & Maseleno, A. (2019). Revolutionizing Education through Artificial Intelligence: Fuzzy Multiple Attribute Decision Making Approach for Determining the Best Vocational High School. *Applied Mechanics and Materials*, *892*, 234–239. https://doi.org/10.4028/www.scientific.net/AMM.892.234

Ghufron, M. A. (2018). REVOLUSI INDUSTRI 4.0: TANTANGAN, PELUANG DAN SOLUSI BAGI DUNIA PENDIDIKAN. *Seminar Nasional Dan Diskusi Panel Multidisiplin Hasil Penelitian & Pengabdian Kepada Masyaraka*, 332–337.

Hajar Halili, S. (2019). TECHNOLOGICAL ADVANCEMENTS IN EDUCATION 4.0. *The Online Journal of Distance Education and E-Learning*, *7*(1), 63–69. www.tojdel.net

Hart, C. (2018). *Doing a Literature Review: Releasing the Social Science Research Imagination* (Second Edition). University of Chester.

Hastini, L. Y., Fahmi, R., Lukito, H., Program, M., Ilmu, D., & Unand, M. (2020). Apakah Pembelajaran Menggunakan Teknologi dapat Meningkatkan Literasi Manusia pada Generasi Z di Indonesia? *Jurnal Manajemen Informatika (JAMIKA)*, *10*(1), 12–28. https://doi.org/10.34010/jamika.v10i1

Jokhan, A., Chand, A. A., Singh, V., & Mamun, K. A. (2022). Increased Digital Resource Consumption in Higher Educational Institutions and the Artificial Intelligence Role in Informing Decisions Related to Student Performance. *Sustainability (Switzerland)*, *14*(4). https://doi.org/10.3390/su14042377

Kahn, K., Megasari, R., Piantari, E., & Junaeti, E. (2018). AI Programming by Children using Snap! Block Programming in a Developing Country. *Thirteenth European Conference on Technology Enhanced Learning, 11082*.

Machmud, M. T., Widiyan, A. P., & Ramadhani, N. R. (2021). The development and policies of ICT supporting educational technology in Singapore, Thailand, Indonesia, and Myanmar. *International Journal of Evaluation and Research in Education*, *10*(1), 78–85. https://doi.org/10.11591/ijere.v10i1.20786

Mangera, E., Supratno, H., & Suyatno. (2023). Exploring the relationship between Transhumanist and Artificial Intelligence in the Education Context: Particularly Teaching and Learning Process at Tertiary Education. *Pegem Egitim ve Ogretim Dergisi*, *13*(2), 35–44. https://doi.org/10.47750/pegegog.13.02.05

Mccarthy, J. (2007). *WHAT IS ARTIFICIAL INTELLIGENCE?* http://www-formal.stanford.edu/jmc/

Mijwil, M. M., Aggarwal, K., Mutar, D. S., Mansour, N., & Singh, R. S. S. (2022). The Position of Artificial Intelligence in the Future of Education: An Overview. *Asian Journal of Applied Sciences*, *10*(2). https://doi.org/10.24203/ajas.v10i2.6956

Nye, B. D. (2015). Intelligent tutoring systems by and for the developing world: A review of trends and approaches for educational technology in a global context. In *International Journal of Artificial Intelligence in Education* (Vol. 25, Issue 2, pp. 177–203). Springer Science and Business Media, LLC. https://doi.org/10.1007/s40593-014-0028-6

Okoli, C., & Schabram, K. (2012). A Guide to Conducting a Systematic Literature Review of Information Systems Research. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1954824

Rasmitadila, Aliyyah, R. R., Rachmadtullah, R., Samsudin, A., Syaodih, E., Nurtanto, M., & Tambunan, A. R. S. (2020). The perceptions of primary school teachers of online learning during the covid-19 pandemic period: A case study in Indonesia. *Journal of Ethnic and Cultural Studies*, *7*(2), 90–109. https://doi.org/10.29333/ejecs/388

Russell, S. J., & Norvig, P. (2010). *Artificial Intelligence: A Modern Approach* (3rd Ed). Pearson.

Salam, S., Jianqiu, Z., Pathan, Z. H., & Lei, W. (2017). Strategic Barriers in the Effective Integration of ICT in the Public Schools of Pakistan. *ACM International Conference Proceeding Series*, 169–172. https://doi.org/10.1145/3168390.3168422

Sartika, F., Ritonga, M., Lahmi, A., Rasyid, A., & Febriani, S. R. (2021). Online Learning in the Low Internet Area, Planning, Strategies and Problems Faced by Students During the Covid-19 Period. In D. Oliva, S. A. Hassan, & A. Mohamed (Eds.), *Artificial Intelligence*

for COVID-19 (pp. 413–421). Springer International Publishing. https://doi.org/10.1007/978-3-030-69744-0_23

Sudira, P. (2019). The Role of Vocational Education in the Era of Industrial Automation. *Journal of Physics: Conference Series*, *1273*(1). https://doi.org/10.1088/1742-6596/1273/1/012058

Yusriadi, Y., Rusnaedi, Siregar, N. A., Megawati, S., & Sakkir, G. (2023). Implementation of artificial intelligence in Indonesia. *International Journal of Data and Network Science*, *7*(1), 283–294. https://doi.org/10.5267/j.ijdns.2022.10.005