



ARTIFICIAL INTELLIGENCE & EDUCATION

How Prepared is the Indonesian Education
System in Embracing New Technologies



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Introduction

In everyday life, we cannot ignore how technology has become an integral variable in current societal activities. In recent years, technology has experienced rapid development, particularly with the emergence of Artificial Intelligence (AI), which has fundamentally transformed almost every aspect of society. For instance, when ChatGPT was introduced by OpenAI in 2022, this technology not only captured the spotlight in the tech world but also sparked widespread discussions about AI's new capabilities as a natural language processing chatbot.

One of the most striking aspects of this artificial intelligence is its ability to automate tasks traditionally performed by human thought. With the support of programs and technologies associated with artificial intelligence, we can see decision-making processes, problem-solving, human language understanding, and even the processing of unstructured data efficiently, resembling human intelligence levels. Artificial intelligence is now widely accepted and used in various fields and situations, opening doors to various innovations that were previously difficult to attain.

Artificial intelligence technology has evolved from computer technology to smart online education, with embedded computer systems able to independently or collaboratively perform instructional tasks such as humanoid robots and web-based chatbots. The advancements in artificial intelligence have introduced new features, functions, and appearances in various aspects of social, economic, and cultural life, including education.³

At a time when education is undergoing global fermentation, the presence of artificial intelligence as a new technology has become an integral part of educational development in industrialized countries, especially in digital education. Digital learning games, online tutorials, and virtual courses are concrete examples of how technology has enriched the learning experience, especially since the Covid-19 pandemic forced the adoption of digital technology as the primary medium in the teaching-learning process.⁴



With the current advancement of artificial intelligence technology, there is great potential to provide customizable learning, dynamic assessments, and varied interactions in the learning experience. This phenomenon is also driven by companies focusing on digital educational services, often referred to as Edtech (Educational Technology) companies, which support learning with the latest technology interventions.



This transformation is reshaping the education landscape with a digital foundation that has become the new norm since 2021, where nearly 90 percent of students worldwide, or around 1.6 billion children, rely on educational software or digital resources for their education access. However, this rapid transformation has forced educational institutions to embrace digitalization, and adapting to this digitalization brings complex challenges, particularly regarding the implementation of artificial intelligence as the latest digital resource.

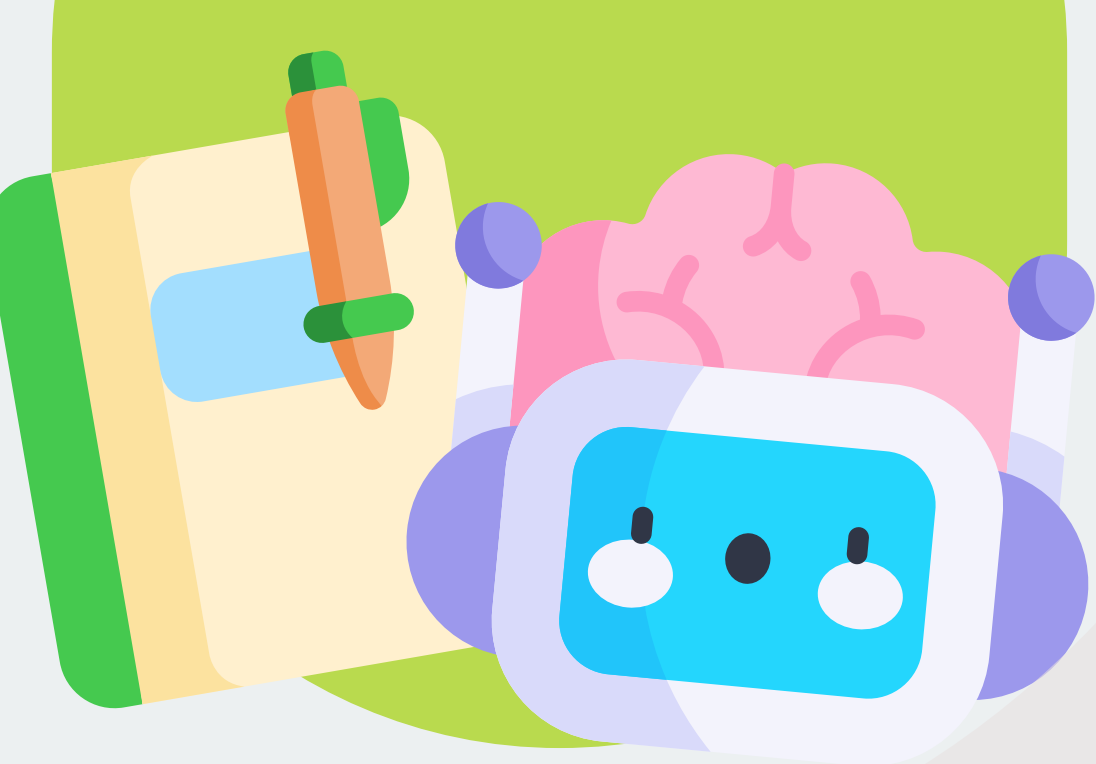
In any case, the use of artificial intelligence in shaping the teaching-learning experience will bring new challenges to the education system, both technically and socially, that have never existed before. As highlighted in the UNESCO Global Education Monitoring Report 2023, these new tools can provide valuable personalized support for students and teachers.⁸ However, this also raises questions about digital divides and the dominance of large corporations involved in the education sector.

Ultimately, the increased application of artificial intelligence in education demands an interdisciplinary approach. While most studies on artificial intelligence are still predominantly conducted in the STEM (Science, Technology, Engineering, and Mathematics) fields.⁹ Some recent studies highlight the lack of educational and social approaches in the study of artificial intelligence in education and its implementation in context-based and locally grounded settings.

Examining the contextuality of Artificial Intelligence practice in education needs to understand each country's regulation on it. For instance, the adaptation of artificial intelligence in Indonesia's education. That topic has become a growing development focus. The Ministry of Communication and Information Technology (Kemkominfo) as an accelerator, facilitator, and regulator of Indonesia's digital transformation, through the National AI Strategy 2020-2045, actively supports the development of artificial intelligence practices to enhance societal well-being.¹⁰ Likewise, the Ministry of Education, Culture, Research, and Technology (Kemendikbud Ristek) has supported the development of artificial intelligence in the education system in Indonesia.¹¹

However, with the revolutionary potential of artificial intelligence to change how students learn and teachers teach, both at the primary and tertiary levels globally, it raises the question of whether the education system in Indonesia is ready to adopt artificial intelligence in a national context.

Therefore, this paper aims to explore the forms of support, challenges, and realities present in the dynamics of the education system in Indonesia in integrating artificial intelligence into the education landscape.



Artificial Intelligence Innovation in Education Development

In the realm of education, Artificial Intelligence (AI) technology significantly contributes to how students learn, how teachers teach, and even how the education system itself is formed and evolved.¹² Started in the 1950's, we can see AI development in the education sector. Some education leaders and figures, such as Sal Khan, the founder of Khan Academy, an online education platform that provides various personalized learning materials, embrace this change with great enthusiasm. Khan believes that artificial intelligence has tremendous potential to bring about unprecedented positive transformations in the education system¹³

Table 1. AI Innovation in Education¹⁴

Time Period	Key Innovation
1950s-1960s 	Early Research: The term “Artificial Intelligence” was invented, which refers to developing early natural language processing programs such as ELIZA. Also, the first Intelligent Tutoring System (ITS) known as “SAINT” was made.
1970s-1980s 	System Formation: Big progress happened during this time, like Judea Pearl creating Bayesian networks to understand cause-effect, and starting the International Journal of Artificial Intelligence in Education.
1990s-2000s 	Machine Learning and NLP Advancements: Important things were achieved in machine learning and NLP. Online courses called MOOCs became popular. Many beneficial apps using AI to learn language, like Rosetta Stone Language Learning Software, Turnitin, and ALEKS, were introduced.
2010s 	Chatbots Emergence: This was a time when we got much better at making computers write like humans, using models like GPT-2 and GPT-3. Technologies like DALL-E and Stable Diffusion let us make images from text. AI tutoring systems like Mika are showing good outcomes, and chatbots are getting more common to help people learn languages.
2020s 	Popularization of AI: In this time, AI became highly accessible, especially generative AI tools. This has been highly beneficial in streamlining administrative tasks and learning experiences in various educational contexts.

In practice, the use of artificial intelligence is still in its early adoption stages, which can be utilized by teachers and students in educational institutions. Some examples of contextualization of artificial intelligence include the use of AI technology as a virtual assistant to reduce teachers' workload, such as AI-based educational games, adaptive learning platforms, and chatbots to support learning material exploration.¹⁵ Artificial intelligence can act as an instructional assistant capable of human-like communication and assisting in explaining difficult learning concepts to students as smart tutors.¹⁶

Moreover, this artificial intelligence model can also support personalized learning for students with disabilities and provide translations for those learning foreign languages.¹⁷ Furthermore, artificial intelligence can handle administrative tasks such as curriculum planning, material creation, worksheet design, quiz development, and production of high-quality academic teaching resources.¹⁸ With this potential, artificial intelligence has the capability to reduce the time spent by teachers on administrative tasks, allowing them to focus more on their primary tasks, namely teaching and supporting students' optimal development.

However, some other education figures warn that the use of artificial intelligence also brings potential risks such as spreading misinformation or misleading information, facilitating cheating in educational institutions, and violating individuals' privacy boundaries.¹⁹

Although reports indicate that artificial intelligence provides assurance to enhance education comprehensively at all levels by providing extensive personalization, comprehensive education is a goal that teachers aim for in the development of their students' knowledge and skills.^{20 21} One of the challenges related to this concerns the role of teachers. The risk of mechanizing the learning experience is that artificial intelligence can automate teachers' roles such as formulating lesson plans, preparing materials, assessing assignments, and providing real-time feedback to students.²² As explained by American writer Audrey Watters in her book "Teaching Machines," although teachers may not be entirely replaceable by technology, there is a possibility that artificial intelligence can change the dynamics of the relationship between teachers and students, and shift the focus of teaching from humanistic aspects to mechanical aspects.²³





Implementation of Artificial Intelligence in the Education Sector in Indonesia

In recent times, the education landscape has been evolving rapidly, with artificial intelligence being considered a transformative force that can provide significant benefits to education. Tools and platforms facilitated by artificial intelligence not only face challenges but also offer benefits in providing personalized learning experiences. Users of artificial intelligence can identify individual strengths and weaknesses and adjust content according to the pace of student learning.²⁴ However, to harness the full potential of artificial intelligence, users, in this case, teachers and students, need to be equipped with the necessary knowledge and skills. In many developed countries, teachers actively integrate artificial intelligence into their teaching methods, demonstrating readiness to adapt to change.²⁵ However, the situation is somewhat different in Indonesia.

The Minister of Education, Culture, Research, and Technology, Nadiem Makarim, has advocated for the simultaneous development of artificial intelligence and character intelligence for education stakeholders in Indonesia.²⁶ In this advocacy, Makarim highlights that artificial intelligence has the potential to help overcome administrative tasks that are usually the main burden for teachers during the teaching process.²⁷ The application of artificial intelligence as a supporting technology in education is expected to simplify these tasks and free up time for teachers to focus more on the core aspects of teaching. Furthermore, Makarim also emphasizes the importance for students in academic settings to develop not only intellectual intelligence but also character intelligence with technological interventions, so that students are better prepared to face future challenges with innovative ideas and solutions.



Additionally, the government also supports Edtech startups in Indonesia that are developing artificial intelligence-based systems to improve students' basic understanding. Companies like Zenius Education have introduced a new feature called ZenCore, which uses artificial intelligence to enhance users' basic understanding of mathematics, verbal logic, and English.²⁸ This system utilizes artificial intelligence to provide an adaptive learning

ecosystem with hundreds of thousands of questions to train skills tailored to each user's level of understanding. This feature adopts gamification concepts aimed at increasing user engagement through score achievements, making learning activities more enjoyable. The gamification approach in digital education has been successful in improving students' average grades by up to 34.75% and performance improvement by 89.45% compared to students receiving conventional materials only.²⁹



Similarly, the government has announced a national strategy for the development of artificial intelligence, ensuring that progress in this technology will be safe and provide significant benefits to all parties. These steps demonstrate the Indonesian government's commitment to advancing this high-tech field more evenly and sustainably in the education sector.



What about Indonesia's readiness at present?

Although the use of technology in learning has been positively responded to by many parties in Indonesia, challenges that hinder the government's digital transformation goals in education have not been fully resolved. Indonesia, like other developing countries, still faces challenges in ensuring that all education stakeholders, including teachers and students, are ready to integrate with artificial intelligence.³⁰ One of the biggest obstacles is the digital divide.

The disparity in access to Information and Communication Technology (ICT), particularly internet access, still starkly contrasts between teachers and students in various urban and rural areas in Indonesia.³¹ Moreover, the internet penetration rate in Indonesia is still relatively low compared to many other Southeast Asian countries.³² Even the majority of teachers and students in Indonesia still face difficulties in accessing the required technology and internet connections, especially in adopting artificial intelligence, which requires high understanding and skills, creating an imbalance in educational opportunities.

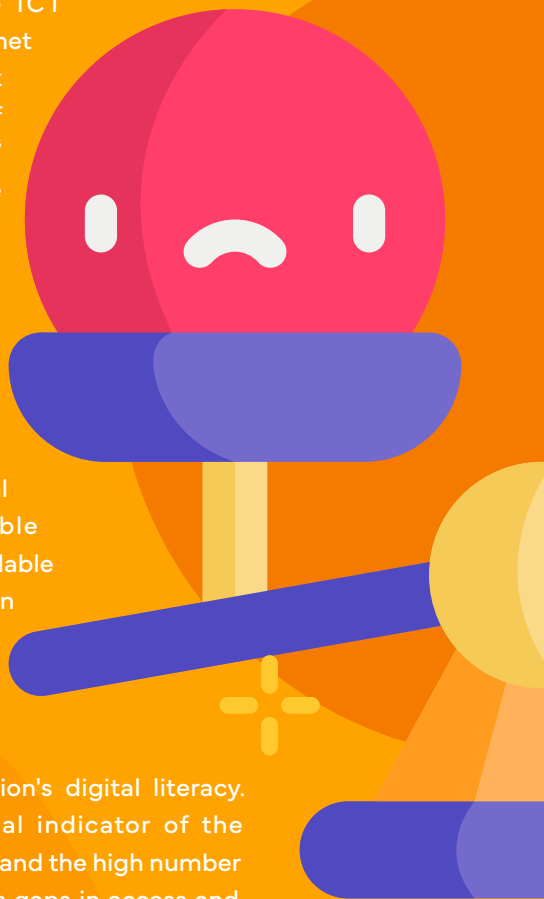


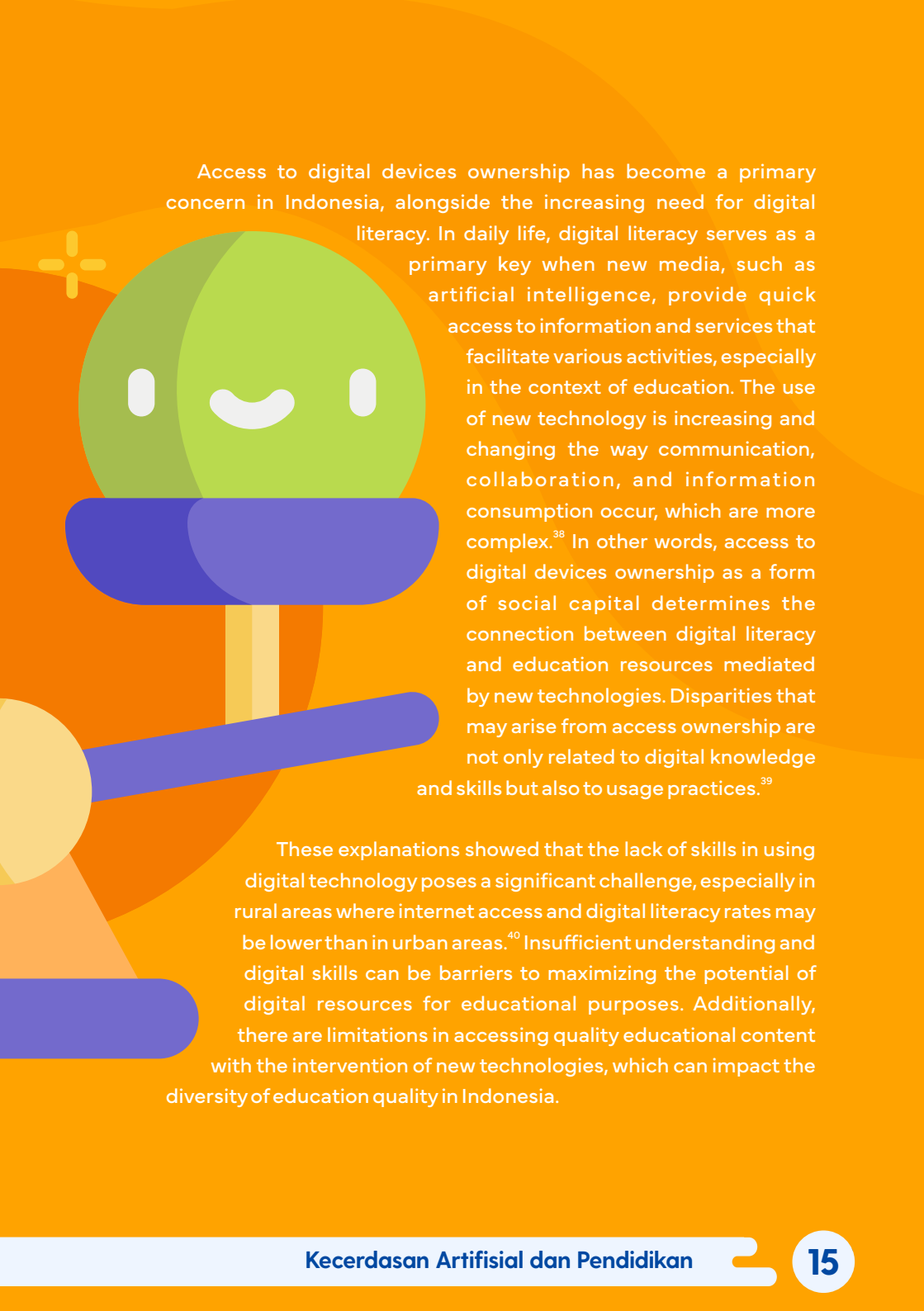
Although there has been an increase, there are still disparities in access and digital divides between urban and rural areas. Based on data from the Central Bureau of Statistics (BPS) from the 2022 Susenas Survey, it shows that 67.88 percent of Indonesia's population already has mobile phones and 66.48 percent of the population has used the internet, an increase from the previous year.³³ This increase in internet usage has occurred across all regions of Indonesia, both in urban and rural areas. Demographically, in urban areas, the percentage of internet usage in 2022 was 74.16 percent, up from 71.81 percent, while in rural areas, it increased from around 49.30 percent to 55.92 percent in the same period.³⁴ The weaknesses of the internet network in rural areas and the high cost of internet data are still major obstacles. Moreover, a comparison between provinces shows that the highest percentage of internet usage is in DKI Jakarta with a value of 84.65 percent, while Papua Province has the lowest percentage, around 26.32 percent.³⁵ The focus of ICT infrastructure development is still centralized on the island of Java, while other provinces still have significant disparities in signal reception when conducting digital activities.



These disparities in access and digital divides pose serious problems that can hinder the implementation of artificial intelligence in education. Some areas or schools may not have adequate infrastructure to support the use of technology in the teaching-learning process. In rural areas, in particular, there are often challenges regarding the availability of incomplete ICT infrastructure, such as limited internet access, unstable network connections, or even the absence of internet access altogether.³⁶ Therefore, inadequate infrastructure inhibits society from accessing artificial intelligence applications or even more basic digital resources as new learning opportunities.

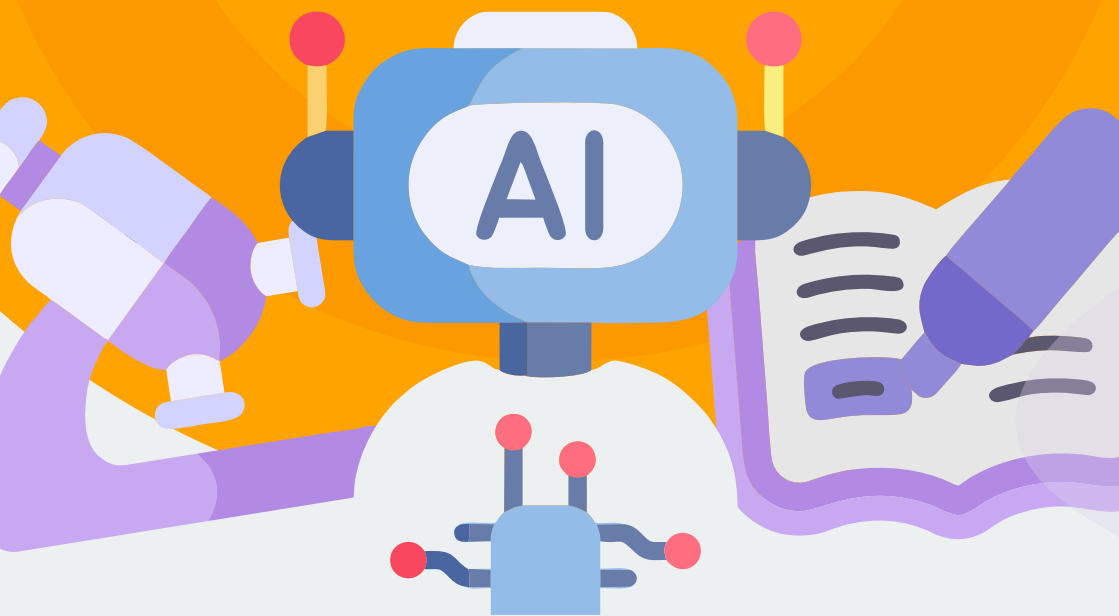
The disparity in household social capital also poses a major barrier to achieving equal educational opportunities. Even with equitable access to education, the role of available resources remains a crucial factor in developing individual skills, which vary depending on the environment in which individuals grow and develop.³⁷ This is reflected in the diverse distribution of the population's digital literacy. Digital literacy serves as a crucial indicator of the effectiveness of students' education, and the high number of people lacking these skills reflects gaps in access and quality of education.





Access to digital devices ownership has become a primary concern in Indonesia, alongside the increasing need for digital literacy. In daily life, digital literacy serves as a primary key when new media, such as artificial intelligence, provide quick access to information and services that facilitate various activities, especially in the context of education. The use of new technology is increasing and changing the way communication, collaboration, and information consumption occur, which are more complex.³⁸ In other words, access to digital devices ownership as a form of social capital determines the connection between digital literacy and education resources mediated by new technologies. Disparities that may arise from access ownership are not only related to digital knowledge and skills but also to usage practices.³⁹

These explanations showed that the lack of skills in using digital technology poses a significant challenge, especially in rural areas where internet access and digital literacy rates may be lower than in urban areas.⁴⁰ Insufficient understanding and digital skills can be barriers to maximizing the potential of digital resources for educational purposes. Additionally, there are limitations in accessing quality educational content with the intervention of new technologies, which can impact the diversity of education quality in Indonesia.



Then, what's next?

It cannot be denied that the success of education requires teachers and students to adapt to and proficiently utilize artificial intelligence technology. This indicates that there is still a significant task ahead to improve ownership of access to digital devices and the internet, as well as literacy skills in the education sector. To optimize the use of artificial intelligence in education in Indonesia, collaboration between the government, educational institutions, and technology companies is highly necessary. Investments in technology infrastructure and teacher training related to artificial intelligence are urgent to enhance technology infrastructure, such as widespread internet access in all regions, especially in remote areas.⁴¹ Education about technology and its usage also needs to be enhanced to ensure equal access to technology and fulfill the goals of comprehensive education.

Increasing investment in developing ICT infrastructure in all regions, both urban and rural, is a crucial step in improving equitable access to technology. This includes installing telecommunication towers and fiber

networks, as well as developing alternative connectivity such as wireless networks or satellite technology for areas that are difficult to reach physically.⁴² These decisions can help reduce educational disparities and skills by ensuring that all students in Indonesia have broader access to learning resources available through artificial intelligence technology, which can influence students' opportunities for future success. This includes customizable learning materials, digital library resources, adaptive learning platforms, and more responsive assessments.⁴³ Thus, students across Indonesia will have equal opportunities to develop their potential according to their interests and needs, no longer hindered by limited local resources.

All efforts to reduce access disparities and gaps in Indonesia aim to provide equal opportunities for students to receive comprehensive education, access quality educational resources, and develop their potential optimally in the era of evolving technology. By continuing to strive to address these challenges and ensure proper implementation, the use of artificial intelligence in education in Indonesia has the potential to enhance the quality of learning and provide more personalized and effective learning experiences for students, teachers, and educational institutions as a whole.



Alongside this, educational institutions need to harness the positive potential offered by artificial intelligence while anticipating or mitigating its negative impacts. To support this, UNESCO has played a significant role by publishing its first guidelines in September 2023 for generative artificial intelligence in educational and research environments. The guidelines aim to address potential disruptions arising from the use of artificial intelligence technology by introducing various available technologies and models and identifying important ethical issues, including ethical recommendations and relevant policy measures.⁴⁴ This is expected to help develop cohesive and comprehensive policies to regulate the use of artificial intelligence in education and research primarily, while also exploring long-term implications in both fields.



Conclusion

Overall, education advocates agree that "all-digital" is not the desired final goal in the knowledge delivery process. Student exposure to screens needs to be regulated wisely, and it is important not to overlook the humanistic aspects of the technical aspects of the development of this artificial technology. We cannot assume that technology can replace the role of teachers; the role of teachers in education remains important even though technology has reached an advanced stage, it still cannot be replaced.

Furthermore, in the context of Indonesia, the readiness of teachers to adopt artificial intelligence in education has not yet reached global standards. Challenges such as digital divides, inadequate resources, and limited awareness are significant. These access disparities and digital divides are influenced by several factors, including limited access to technology devices, lack of digital skills, and high socioeconomic disparities

However, the potential benefits of artificial intelligence in education are immense, and Indonesia has the potential to overcome these disparities by investing in infrastructure, providing comprehensive training for teachers, and increasing awareness of the contextual benefits of artificial intelligence. To remain relevant in the global shift towards integrating artificial intelligence into education, Indonesian teachers need to be ready to embrace this technological revolution and empower their students for a future driven by technology that aids in the effectiveness of work in achieving comprehensive educational goals.

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