

ARTIFICIAL INTELLIGENCE IN HIGHER EDUCATION: A LITERATURE REVIEW ON BRIDGING THE DIGITAL DIVIDE AMONG COLLEGE STUDENTS IN INDONESIA

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ABSTRACT

The digital divide remains a significant challenge in higher education, especially in developing countries like Indonesia. In this case, the gap in access to technology and digital literacy affects students' academic success. This study explores the role of Artificial Intelligence (AI) in bridging the digital divide among students in Indonesia. This study aims to identify the role of AI and its effectiveness in improving access to educational resources, improving digital literacy, and promoting an equitable learning environment, especially in Indonesia. The method used in this study is a descriptive literature review of existing research from 2015 to 2024, focusing on studies related to AI in education, digital equity, and higher education in Indonesia. The results show that AI applications, such as learning platforms, adaptive learning technologies, and online tutoring systems, have the potential to reduce the educational gap, especially in Indonesia. However, the effectiveness of these technologies depends on factors such as infrastructure availability, digital literacy levels, and support from stakeholders. This review shows that although AI offers a promising solution to bridge the digital divide, a multi-faceted approach is still needed to integrate policy interventions, capacity building, and community engagement. In this case, stakeholders in higher education in Indonesia must be able to prioritize the role of AI to improve digital equality and support inclusive academic growth.

Keywords: *artificial intelligence, higher education, literacy, digital divide*

BACKGROUND

The development of technology has brought significant changes in the world of education. In this digital era, all areas of life cannot be separated from technology because they are in accordance with the development of the times. According to data from the Central Statistics Agency (BPS) from the results of the 2022 National Socio-Economic Survey (SUSENAS), 66.48% of Indonesia's population had accessed the internet in 2022 and 62.10% in 2021. The high use of the internet shows the openness of information and the rapid acceptance of society towards technological developments and changes towards more sophisticated information. The number of mobile phone users is also growing rapidly. In 2022, it was recorded that 67.88% of the population in Indonesia had a mobile phone. This figure has increased when compared to the conditions in 2021 which reached 65.87% (Badan Pusat Statistik, 2023). The development of technology in the field of education can provide many benefits for educators and students in facilitating the learning process. However, the development of technology also has negative impacts that need to be considered. (Rohani & Kurniawati, 2024). With increasingly sophisticated technological innovations, those who focus on education must also be able to keep up with and follow existing technological advances. In education, the internet is used to facilitate the

education process. However, in reality, there are still many students who do not have an adequate understanding of digital literacy due to limited access, thus creating a digital divide among students.

Educational innovation with technology has changed the way of teaching and learning at various levels of education. The digitalization of education has a basis that is in line with the mandate of Pancasila and the Constitution of the Unitary State of the Republic of Indonesia (UUD NKRI) 1945, namely in Law (UU) Number 20 of 2003 concerning the National Education System and Article 12 of Law Number 39 of 1999 concerning Human Rights (HAM) which states that everyone has the right to protection for their personal development, to obtain education, to educate themselves, and to improve their quality of life (Cristiana, 2021). The implementation of artificial intelligence in the context of learning has provided the initial foundation for a major change in the approach to learning (Merentek et al., 2023). Artificial intelligence (AI) implemented in the field of education is a system designed to improve the education and learning process to achieve maximum results (Elgy, 2024). Through AI-based platforms, learning can be tailored to the needs and abilities of students, including those in remote areas with limited access to technology. AI-based applications such as adaptive learning systems can adjust learning content to the speed of the available internet connection (Wardani et al., 2024). This allows students to continue to receive quality education without relying on expensive technological infrastructure. The use of features owned by AI can have great potential to bridge the digital divide and strengthen the inclusiveness of education throughout Indonesia. The existence of digital innovations such as e-learning and online learning platforms can expand access to education and allow the teaching and learning process to take place flexibly without limitations of space and time, especially with the presence of AI (Zahra & Arifin, 2024).

Technology in the current digital era continues to develop. Artificial Intelligence (AI) has emerged as a new product that can help various sectors of human life. AI is a technological innovation designed with artificial intelligence that imitates human cognitive abilities such as learning, logical thinking, and decision making so that it can carry out complex tasks independently and efficiently (Chen et al., 2020). Artificial intelligence like this can help make the education process more efficient through personalized learning that is tailored to the individual needs of students. With advanced data analysis capabilities, AI is able to identify students' strengths and weaknesses and present more effective and adaptive teaching materials and methods (Hasnah et al., 2023). AI provides virtual tutors who can provide intensive learning assistance to students so that they get more flexible personal assistance. The automated assessment system by AI also increases efficiency in learning evaluation which allows teachers to provide faster and more accurate feedback. One of the areas that is increasingly affected by this progress is Education. The development of an AI-powered Virtual Learning Environment (VLE) can help students bridge the digital divide by providing personalized feedback and recommendations. By using this AI-powered VLE, students can improve their learning outcomes and increase their engagement in more flexible online courses (Laksito & Wibowo, 2023). Overall, recent research suggests that large learning objects and VLEs continue to be valuable tools for enhancing teaching and learning in a variety of contexts (Khairany et al., 2024). The integration of new technologies such as AI into these tools also opens up new possibilities for customized and adaptive learning experiences.

Integration of technology in the learning process is the key to improving the quality of education in an era of rapid technological development (Patty & Lekatompessy, 2024). As previous relevant research by Yufei et al (2020) which explains that artificial intelligence in this case can increase the efficiency and effectiveness of learning. Research by Afrita (2023) which explains the advantages of AI to help the learning process using the AI tutor system, Chatboot, student engagement analysis system and other types. To improve the quality of education, there needs to be artificial intelligence technology and its benefits in the field of education, so that students can have a more adaptive, personal learning experience, and focus on individual needs both to improve their abilities and intelligence (Karyadi, 2023). Such as the application of AI applications in higher education which can be classified into four main areas: profiling and prediction, intelligent tutoring systems, assessment and evaluation, and adaptive systems, all of which support a more personalized and efficient learning process (Richter et al., 2019).

The digital divide regarding the understanding of artificial intelligence (AI) and the limited access to technology and the internet by students hinders its use in supporting more inclusive and efficient learning in higher education. This study aims to analyze the potential of AI applications in bridging the digital divide and increasing the inclusiveness of education in Indonesia and find solutions that can be implemented to ensure optimal use of AI in supporting the learning process of students.

RESEARCH METHOD

The research method chosen for this study is the Descriptive Literature Review method. This approach involves the analysis and synthesis of relevant literature to gain in-depth insights into, the methodology used will include a detailed analysis of relevant and high-quality literature in the field. This study uses literature spanning 2015-2024, which covers several topics that we will present, including the use of learning platforms with AI, adaptive learning with AI, and online tutoring systems. The first step in this study is to identify and collect appropriate reading materials, including scientific journals, review articles, textbooks, and other publications that cover various aspects of AI in higher education (Sari et al., 2024)

RESEARCH FINDINGS

The Potential of AI in Bridging the Digital Divide in Higher Education

Artificial intelligence (AI) is a technological development that was first developed by John McCarthy at the 1956 Dartmouth conference. According to McCarthy (2007), Artificial intelligence is the study of how to make computers capable of performing tasks that can only be done by humans by creating models of human thought and behavior through algorithms and computer programs (Shamaya et al., 2023). AI can be an effective tool in supporting learning with its personal and adaptive approach system. The results of the study show that AI applications, such as learning platforms, adaptive learning technologies, and online tutoring systems, have the potential to reduce the educational gap, especially in Indonesia.

Learning Platform

A learning platform is a digital platform used to run a system according to a program plan that has been created (Wibawa, 2021). Learning using AI can be found on several digital learning platforms. Digital platforms are programs that can support the success of online learning (Assidiqi & Sumarni, 2020). There are several platforms that can be used in implementing online learning, including the use of e-learning platforms such as Google Classroom, Microsoft Team and remedial gamification approaches that can help students learn better (Risnawati et al., 2023). This platform has the ability to increase engagement and motivation to learn, improve accessibility of learning materials, expand student-teacher collaboration, and increase active student participation. The use of several digital learning platforms can be beneficial for students in higher education, especially in Indonesia, which can potentially reduce the educational gap in Indonesia.

Adaptive Learning

Adaptive learning is a medium whose attributes meet the needs and conditions of learning components (Batubara & Ariani, 2019). Adaptive learning, also referred to as adaptive teaching, refers to the provision of customized learning experiences to meet the different educational or training needs of individuals (Syahputra & Hanum, 2023). Adaptive learning using learning experiences can make students actively participate and engage in learning, so that students gain a good understanding according to their mindset. The use of adaptive learning can create an education system that is able to provide tailored attention to the increasingly diverse number of students in higher education, especially in Indonesia. Adaptive learning optimizes the learning process of each student, identifying what they need to learn so that it has the potential to reduce the educational gap in Indonesia.

Online Tutoring System

A tutoring platform is a place for activities that provide assistance in the form of learning activities for students or parents to achieve maximum academic achievement. An online tutoring system is a place or place to learn in depth with teacher guidance that is carried out online, namely by utilizing several

existing digital platforms. In Indonesia, there have been many online tutoring digital platforms that are most in demand, such as Brain Academy by Ruang Guru, pahamify, Quipper, and Zenius Education (Suryanto et al., 2022). Learning systems using AI technology can help students in dealing with learning difficulties, such as using the Brain Academy application by Ruang Guru which already contains all the facilities needed by students in tutoring. Learning using an online tutoring system can optimize student learning so that it has the potential to reduce the educational gap in Indonesia.

The Impact of the Digital Divide on Academic Achievement

The digital divide has a significant impact on academic achievement. Students who do not have adequate access to technology, such as computers or stable internet, often fall behind in following online learning materials and accessing digital learning resources (Firdaus & Ritonga, 2024). This inequality causes difficulties in obtaining academic learning opportunities such as online courses or research that is already technology-based. As a result, academic inequality is increasingly visible, namely between students who have limited access to technology and students who have full access (Kuhn et al., 2024). These gaps exacerbate inequalities in education and slow overall academic progress.

Digital Literacy: A Key Factor in Technology Utilization

Digital literacy is the ability to use technology and information from digital instruments effectively and efficiently in various contexts, such as academic, career, and daily life (Kurnianingsih et al., 2017). This study shows that in addition to technology access, digital literacy plays an important role in the use of technology for learning purposes (Quraishi et al., 2024). The internet access obtained must also be supported by digital literacy provided to students so that its use can be optimal. Digital literacy helps students not only in understanding and using technological devices, but also in managing information, communicating effectively, and protecting their privacy in the digital world. These skills can lead students to become more skilled in learning online, collaborating with their peers, and overcoming complex academic challenges. Therefore, the development of digital literacy must be one of the priorities in efforts to improve the quality of education and ensure that all students have an equal opportunity to succeed in the digital era (Mozelius et al., 2024).

These limitations in digital literacy cause many students to have difficulty in utilizing technological devices and platforms effectively (Siregar, 2024). Low digital literacy exacerbates the gap among students, where those who are accustomed to using technology have an advantage in online learning, while students who are less skilled in this aspect are left behind in keeping up with developments in technology-based education.

The Role of Stakeholders in Technology Infrastructure Development

The digital divide that impacts students' academic achievement requires the role of stakeholders, including the government, educational institution stakeholders, and the community to realize the development of technological infrastructure. These various parties must work together to ensure equal access to the internet and technological devices throughout the region, especially in areas that are still digitally lagging behind (Baharuddin & Hatta, 2024). Although AI offers a solution to overcome the digital divide, without adequate infrastructure support, efforts to utilize technology such as AI in learning are not easy to realize. Investment in expanding internet networks, technology device subsidy programs, and increasing digital literacy need to be a priority in public policy, in order to create inclusive and equitable access to education for all levels of society.

DISCUSSION

AI, as a form of similar technological development, has the potential to develop and facilitate human work in various activities. AI in the context of higher education environments has the potential to structurally change university administrative services, the field of teaching and learning in higher education presents a very different set of challenges. Artificial intelligence solutions relate to tasks that can be automated, although they cannot yet be considered as solutions for more complex tasks in higher education (Popenici & Kerr, 2017). In addition, according to Ma and Siau (2018), AI in learning in higher education has an impact on 3 things, namely learning platforms, adaptive learning technology, and online tutoring systems.

Learning Platform

A learning platform is a digital platform used to run a system according to a program plan that has been created (Wibawa, 2021). Learning using AI can be found on several digital learning platforms. This AI learning platform works by offering effectiveness and flexibility for its users, namely students and teachers. This platform also allows its users to communicate in two directions in real time, so that distance limitations can be easily solved. Students and teachers can discuss ideas, materials, assignments, in a supportive online learning environment. Other studies have suggested that AI learning platforms contribute directly to improved learning in higher education.. According to Putra et al. (2024), as many as 85% of students stated that access to learning platform materials was easy, accompanied by 80% of teachers confirming that there was an increase in material efficiency. In addition, there is a negative potential that can arise from the AI learning platform. Dependence on technology can occur if it is not balanced with real social interaction. Students still need social and emotional skills in conducting lectures. The role of teachers will also decrease along with the use of learning platforms.

Adaptive Learning

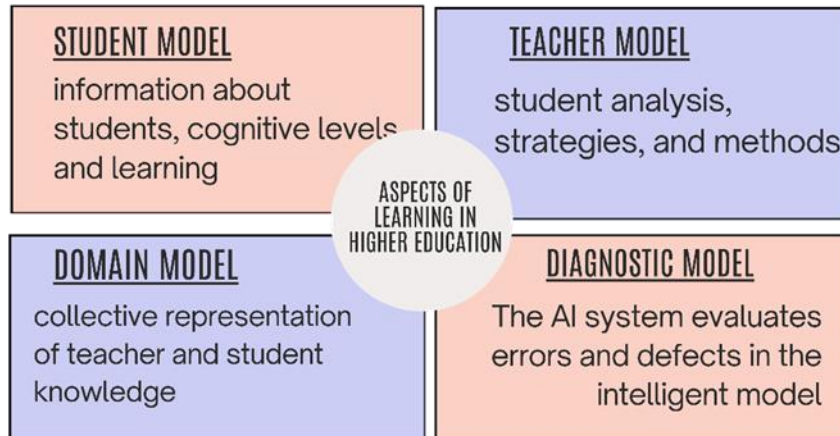
Adaptive learning is a medium whose attributes meet the needs and conditions of learning components (Batubara & Ariani, 2019). Adaptive learning focuses its services on providing specific learning experiences to meet educational needs (Syahputra & Hanum, 2023). Adaptive learning also plays a role in creating a more personal, adaptive and interactive learning atmosphere and experience (How & Hung, 2019). Adaptive learning provides learning navigation and student personal profiles. Learning navigation in this context is how students move from one material to another. Adaptive learning helps teachers to sequence learning materials, add learning instructions and guides, and facilitate access to various learning resources. These profiles can include learning styles, knowledge, background, and other features (Vollmer et al., 2020). Equipped with machine learning algorithms, AI can identify students' learning needs and preferences, providing feedback quickly.

The above according to Muarif (2023) can improve learning effectiveness, optimize student engagement, and increase learning satisfaction. Such systems are in high demand because of their ability to deliver learning content and analysis by actively adapting to the needs and requirements of each student (Almohammadi et al., 2017). Andika et al. (2024) mentioned that there was an increase in student learning outcomes in a college environment with adaptive learning of 8.57%. Research conducted by Nguyen et al. also showed that adaptive systems can help in technical management in lectures, such as organizing undergraduate student studies, exams, managing new student admissions, helping with decision making and Institutional policies (Nguyen et al., 2018).

Even though this system is able to learn the needs of its users, it still requires direction from teachers or system designers to provide instructions related to the learning that will be studied, such as adding context and clarifying concepts (Almohammadi et al., 2017). Therefore, regular maintenance is needed in the use of this adaptive learning system.

Online Tutoring Learning System

In addition to the above AI developments, this artificial intelligence also produces an online-based tutoring system. The tutoring platform is a place for activities that provide assistance in the form of learning activities to users in order to achieve maximum academic achievement. The system learns what students are learning and recognizes the learning habits of its users (Crompton & Burke, 2023). This online tutoring system uses cognitive intelligence and artificial intelligence to provide and personalize real-time learning experiences (Ma & Siau, 2018). Technology or in this case AI serves as a learning provider or can also replace the role of teachers in learning. There are several aspects of high-level learning within the scope of the learning system, namely as shown in Picture 1 below.

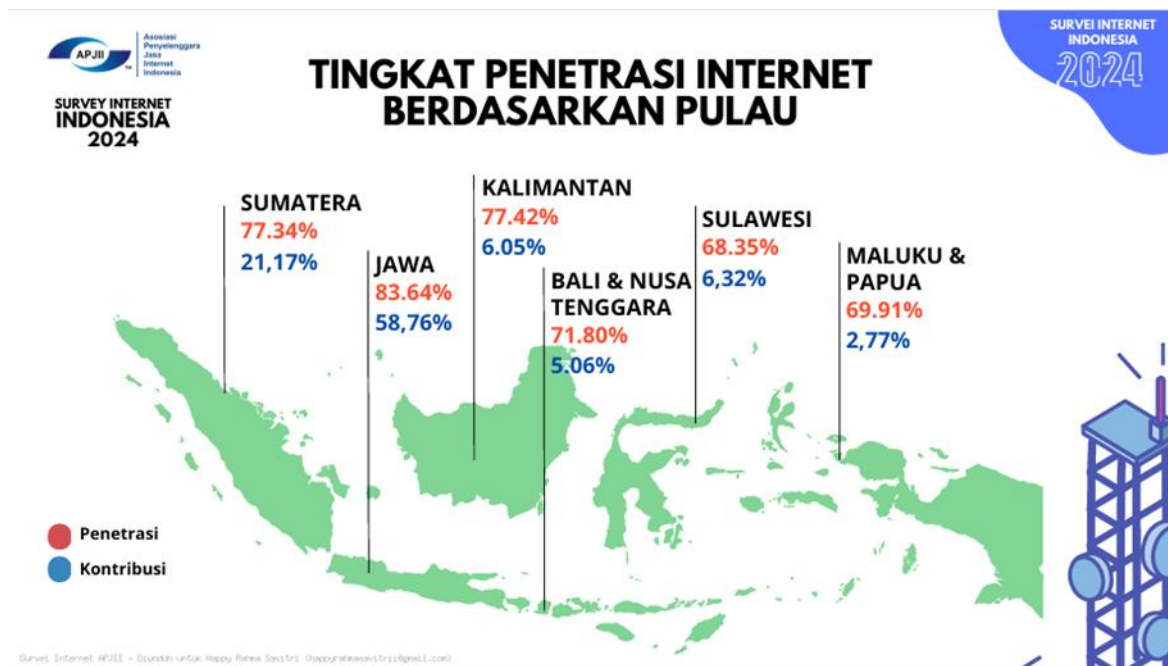


Picture 1. Aspect of learning in higher education

For students, this learning system can explain in more detail and is flexible in terms of place and time when there is material that is not yet understood (Ijaz, 2024). AI is able to recognize the difficulties faced by students so that it can provide suggestions for materials, discussions, and enrichment for learning. Meanwhile, for teachers, they can find out the progress of students' learning in the system, and can change learning strategies based on the needs of the students. Meanwhile, for parents, they can monitor the development of their children's learning systematically (Huang & Chen, 2016).

The Impact of the Digital Divide on Academic Achievement

Digitalization plays an important role, supported by adequate internet access. Digital is the technology that underlies many modern devices and media, while the internet network plays a role in providing access for these devices to connect to each other. According to the Indonesian Internet Service Providers Association (APJII) as shown in Picture 2 below, the number of internet users in Indonesia in 2024 will reach 221,563,479 people out of a total population of 278,696,200 people, with a penetration rate or number of Indonesian internet users reaching 79.5%. Although the number is large, the distribution of internet contributions or also called productivity from the digital technology sector is still centered on the island of Java with a presentation of 58.76%. Followed by Sumatra at 21.17%, and other islands that have a fairly low percentage.



Picture 2. Internet penetration rate by island (Source: APJII.or.id)

Development of access to information and technology in Indonesia is still centered on the islands of Java and Bali (Sunandi et al., 2023). In addition, the gap also occurs between cities and suburbs, where the distance between the two areas can certainly be easily accessed. However, development of information access is still uneven. As research by Putra et al (2024) that it is not uncommon for students to encounter internet connection and network stability constraints. Students often encounter learning that is not conducive due to unsupported internet access. This limits students' ability to participate optimally in the digital world, access educational resources, engage in online communication, and utilize digital services (Haniko et al., 2023).

Unequal digital inequality also causes information access to not be comprehensive to every region. Urban areas provide smooth internet networks, so that new information will be more easily conveyed. Students have more access and varied learning options, allowing students to explore learning further. This is not an opportunity that can be obtained by suburban areas or islands outside Java and Bali.

Digital Literacy: A Key Factor in Technology Utilization

Currently, the literacy rate of Indonesian society is still relatively low. Therefore, innovation is needed to improve literacy in Indonesia, especially with the support of increasingly sophisticated technological advances. Students are now not only required to master basic literacy such as reading and writing. In the era of the industrial revolution 4.0, they must also master three types of literacy: data literacy, technology literacy, and human literacy. Mastery of these three literacies is very important to help students face future challenges and become more competitive (Muliani et al., 2021).

In the context of AI integrated learning, it is important to adjust the needs and developments of technology with materials and curriculum development in order to improve the quality of education. According to Puspito (2017), there are nine categories in digital literacy, namely: (a) Ease of access to internet sites and social networks; (b) Multitasking ability; (c) Understanding the difference between privacy areas on social media; (d) Using the correct identity (e) Managing educational publications on social media wisely; (f) Organizing and identifying various content; (g) Innovative in creating content; (h) Selective in using social media; and (i) Being able to share personal ideas or work.

The Role of Stakeholders in Technology Infrastructure Development

The various roles of AI in higher education are a great opportunity if the regulation of AI use can be regulated by the government. According to Putra and Trastuti's research, in early 2018 Indonesia was ranked fourth in readiness to face the Globalization of Education and the Industrial Revolution 4.0, where the Indonesian government wants to create a competent, innovative society that is able to master a skill proficiently. Even so, the impact of the educational revolution felt by developing countries like Indonesia, especially in remote areas or regions, has not been too significant (Putra & Triastuti, 2019).

Until now, the development of AI in higher education is still running consistently even though it has not yet reached its maximum point, so comprehensive development is needed in technical terms. Educational institutions under the auspices of the government are required to improve human quality as users of technology that will be applied in the education system and not only focus on providing information and communication technology. Because improving the quality of education does not only depend on technological sophistication, but also on the sophistication of educators and students in carrying out the educational process. A perfectly integrated system will bring a comprehensive solution to both the Education sector and its continuity with other sectors. This is an important role for policy makers in deciding policies that are right on target, especially technology regulations and in this case AI so that it can be utilized as expected (Popenici & Kerr, 2017).

CONCLUSION

The digital divide experienced by students has triggered inequality in access to education in Indonesia. In the midst of this situation, AI technology has emerged as a potential solution to overcome this problem. However, the integration of AI in education cannot rely solely on technology; it requires appropriate policies, capacity development, and community participation to optimize its use. Digital Literacy plays a crucial role in improving the quality of education. The ability to access, evaluate, and utilize digital information effectively allows students to utilize technology optimally in the learning process. Based on research studies, it shows that several types of AI applications, such as learning

platforms, adaptive learning technologies, and online tutoring systems, have the potential to reduce the education gap, especially in Indonesia. The availability of infrastructure, the level of digital literacy of students, and support from stakeholders greatly influence the effectiveness of this technology. Although Artificial Intelligence (AI) offers a promising solution to bridge the digital divide, a multi-aspect approach is still needed to be able to integrate policy interventions, capacity development, and community involvement. In this case, stakeholders in higher education in Indonesia must work together to prioritize the role of AI to improve digital equality and support the growth of higher education in Indonesia.

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