

Conceptualizing Artificial Intelligence in the Indonesian Education Systems and Reciprocity with AI-Based Curriculum

^{1,*}Nurwahyu Alamsyah, ²Dale Neal 

1 Department of Information Technology, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia
2 Department of Information Management, National Taiwan University of Science and Technology, Taiwan

* Corresponding Author: nurwahyu.alamsyah@umy.ac.id

Abstract: This study employs a Systematic Literature Review (SLR) to analyze the curriculum challenges in Indonesia and explore the potential AI-driven solutions to improve the education systems. The findings reveal that conventional teaching methods, lack of project-based learning (PBL), limited technology integration, and rigid learning approaches are among the most critical issues, leading to low student engagement and an imbalance between hard and soft skills. To address these challenges, AI technologies such as adaptive learning, formative assessments, and AI-powered virtual classrooms can be integrated to enhance personalized and competency-based learning. The findings suggest that by adopting AI-driven strategies, Indonesia can modernize its curriculum, enhance educational effectiveness, and align with global standards. This study contributes to evidence-based policymaking by offering insights into AI adoption in education and proposing a roadmap for a technology-integrated, student-centered learning system.



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1. Introduction

Artificial Intelligence (AI) offers transformative potential for education in Indonesia, a country with vast geographical and demographic diversity. AI-powered systems can address the challenges of accessibility and inclusivity in education, particularly in remote and underserved regions [1]. Tools such as adaptive learning platforms and AI-driven tutors personalize learning experiences by analyzing student behavior, progress, and preferences. For example, in online education systems like Moodle, AI algorithms can tailor course recommendations, monitor engagement, and provide immediate feedback, ensuring that each learner receives support aligned with their unique needs. This is critical for bridging the educational gap between urban and rural areas, where disparities in teacher availability and resources remain significant [2].

Moreover, AI facilitates the automation of administrative tasks in educational institutions [13,14,15], enabling teachers and administrators to focus more on teaching and innovation. For instance, AI can streamline grading, attendance tracking, and curriculum management, significantly reducing workload and improving efficiency. In Indonesia, where student-to-teacher ratios can be high in public schools, these systems can alleviate administrative burdens and allow educators to dedicate more time to personalized instruction. Furthermore, AI-based tools for plagiarism detection and performance analytics enhance academic integrity and help educators identify learning patterns that can inform pedagogical strategies [3].

AI's potential to integrate with the broader goals of Indonesia's digital transformation, such as the "Making Indonesia 4.0" initiative, positions it as a key enabler of educational advancement. The use of AI-driven language processing tools can also play

a significant role in promoting bilingual and multilingual education, reflecting Indonesia's linguistic diversity. However, the integration of AI in education requires addressing challenges such as digital infrastructure disparities, ethical concerns about data privacy, and the need for specialized teacher training. By fostering collaboration between policymakers, educators, and technology developers, Indonesia can harness AI to create a more equitable, efficient, and innovative education system, contributing to the nation's long-term socio-economic development [4].

While the integration of Artificial Intelligence (AI) in education holds transformative potential [16,17,18], it also presents significant challenges that must be addressed to ensure equitable and effective adoption. One of the primary challenges is the digital divide, which is particularly pronounced in regions with limited access to reliable internet and technological infrastructure. This issue is critical in countries like Indonesia, where rural and remote areas often lack the resources needed to implement AI-based educational tools. Without bridging this gap, the benefits of AI in education risk being concentrated in urban and well-funded institutions, exacerbating existing educational inequalities. Another major challenge is data privacy and ethical concerns [5].

AI systems in education rely on vast amounts of data to deliver personalized learning experiences and optimize administrative processes [19,20]. However, the collection and storage of sensitive student and institutional data raise concerns about data security, potential misuse, and compliance with ethical standards. Clear regulations and frameworks are needed to ensure that AI technologies are implemented responsibly, safeguarding the rights and privacy of all stakeholders involved. Finally, the lack of preparedness among educators and administrators poses a barrier to the effective use of AI in education [5].

Many teachers and staff may not possess the necessary skills or confidence to integrate AI tools into their workflows, leading to underutilization or resistance to adoption. Additionally, there is a risk that over-reliance on AI tools, such as generative AI, could impact students' critical thinking and problem-solving skills if not used appropriately. Addressing these challenges requires comprehensive training programs for educators, a balanced approach to AI integration, and collaborative efforts to create an inclusive and supportive environment for all educational stakeholders [4].

2. Literature Review

The evolution of computer and information communication technologies has been a remarkable journey, marked by constant innovation and progress. At the forefront of this advancement stands artificial intelligence, a concept that has transformed from science fiction into a tangible reality. Artificial intelligence, which gives computers the capacity to carry out almost human-like tasks, is the result of the convergence of computers, information communication technology advancements, machinery, and computer-related technologies. AI has revolutionized numerous industries, from healthcare to finance, entertainment to transportation. It harnesses the power of algorithms and data to learn, adapt, and make decisions autonomously, thereby augmenting human capabilities and transforming the way we work, communicate, and live. As AI continues to evolve, it holds the promise of unlocking unprecedented opportunities and solving complex challenges, shaping the future of society and technology in profound ways [6].

Artificial Intelligence has become a pivotal force in the modern world, with its influence permeating numerous aspects of our daily lives. It is transforming industries, enhancing productivity, and making our lives more convenient. AI's ability to learn, interpret, and apply complex information can help advance medicine, agriculture, energy systems, environmental sciences, and other areas of knowledge. As demonstrated by its numerous pragmatic applications, artificial intelligence, including autonomous robots and brain transplants, may indeed benefit humanity [7].

The 2022 Programme for International Student Assessment (PISA) survey results indicate that Indonesia ranked 69th out of 80 participating countries, with a total score of 1,108. Although this ranking shows improvement compared to 2018, when Indonesia ranked 73rd out of 78 countries, the average scores in reading literacy, mathematics, and science remain significantly below international standards. In contrast, Singapore secured the top position with a total score of 1,679, highlighting a substantial gap in education quality between the two nations. One of the primary reasons for the educational disparity between Indonesia and Singapore lies in the differences in their education systems. Singapore adopts a STEM-oriented curriculum (Science, Technology, Engineering, and Mathematics) with a strong emphasis on conceptual understanding from an early age. Additionally, the use of English as the primary language of instruction enhances students' access to global knowledge resources. The Singaporean government prioritizes teacher quality, allocating significant funding for training and competency development. In contrast, Indonesia continues to face challenges related to education accessibility, teacher capacity enhancement, and curriculum alignment with modern industry demands [8].

Table 1. Level of AI Technologies for Education

Level of Technology	AI Tools for Classroom	AI Technologies
Automatable Tasks	AI-powered grading, automated feedback, and fact-checking tools	Machine Learning, Optical Character Recognition (OCR)
Augmentable Tasks	Performance analytics, adaptive learning, AI-driven content creation	Big Data Analytics, Natural Language Processing (NLP)
Lower Automation Potential	Virtual collaboration platforms, student training, classroom organization	Human-AI Interaction, Cognitive Computing

Table 1 explains AI’s Role in Educational Tasks and categorizes AI applications in education based on their level of automation, distinguishing between automatable tasks, augmentable tasks, and tasks with lower automation potential. Automatable tasks include grading, fact-checking, and compiling resources, where AI can fully replace manual effort, improving efficiency and reducing teacher workload [9]. Augmentable tasks, such as performance analytics, adaptive learning, and AI-driven content creation, allow AI to assist educators by providing insights and automating repetitive processes while still requiring human oversight. Tasks with lower automation potential, like lesson planning, student engagement, and organizing classroom activities, rely on human expertise, decision-making, and interaction, making AI a supportive rather than a replacing tool. By leveraging machine learning, natural language processing (NLP), and big data analytics, AI enhances education while ensuring that critical aspects of teaching remain human-centered [10].

3. Methodology

The research methodology employed in this study follows the Systematic Literature Review (SLR) approach. This method is widely used in information technology (IT) research as it facilitates the identification of technological trends, the evaluation of existing approaches, and the discovery of research gaps objectively and systematically. The SLR methodology in IT was first introduced by Barbara Kitchenham [11], who adapted the concept from Archie Cochrane (1972), initially developed for medical research, to be applied in a more structured way within software engineering and IT studies. Subsequent researchers, including Budgen, Brereton, and Zhang, further expanded its application to various technological domains, such as artificial intelligence, information systems, and cybersecurity, making it a fundamental method in evidence-based IT research. Figure 1 illustrates the phases of the SLR process. The first phase is planning, which aims to establish a systematic research methodology. This phase begins with the identification of the review

need, where researchers determine the primary reason for conducting an SLR, such as understanding technological trends or evaluating the effectiveness of a particular method in IT. Next, a review protocol is developed, defining the research questions, literature search strategy, and inclusion/exclusion criteria to ensure only relevant studies are considered. To maintain research reliability and minimize bias, the established protocol is validated by experts before proceeding to the data extraction and analysis phase.

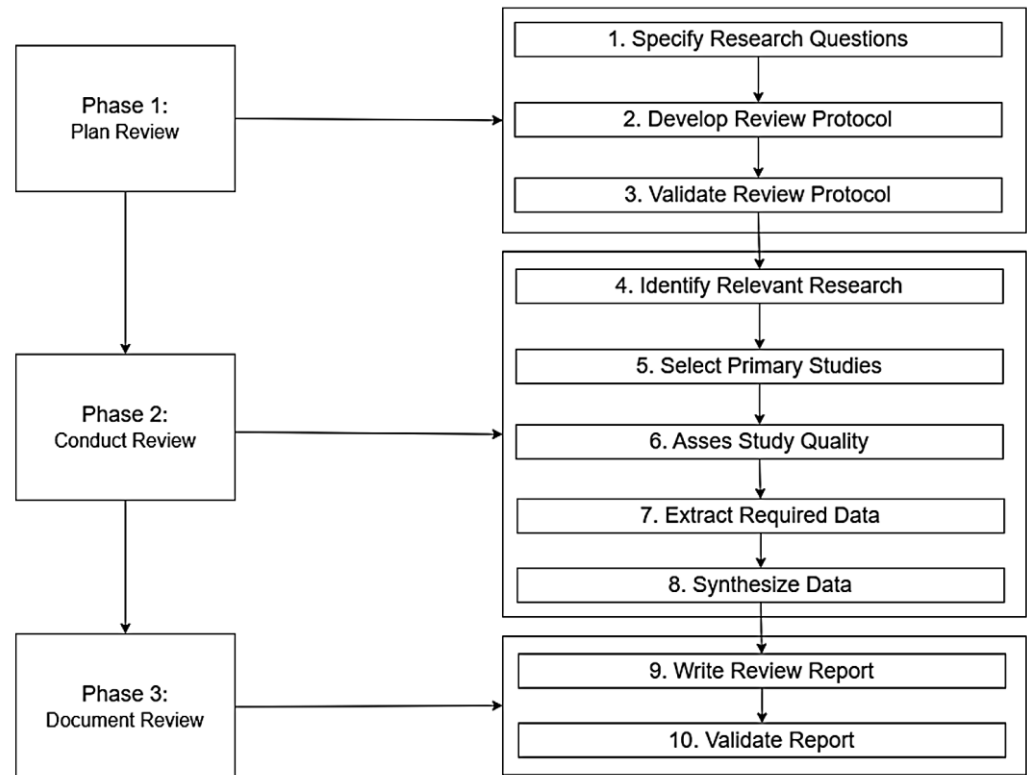


Figure 1. A phase of literature review

After the planning phase, the next step in the Systematic Literature Review (SLR) process is the systematic study search, which follows the established protocol. The first step involves selecting data sources, such as IEEE Xplore, ACM Digital Library, Scopus, and SpringerLink, to ensure access to high-quality literature. A search query is then formulated using keywords and Boolean operators to retrieve the most relevant studies. The initial screening process filters studies based on titles and abstracts, followed by an in-depth screening through full-text reading to confirm alignment with the research topic. Once the selected studies pass the screening phase, they undergo data extraction for systematic comparison. Key information, including research objectives, methodology, and findings, is extracted and categorized based on primary themes or research trends. A critical appraisal is then conducted to evaluate the methodological quality and validity of the included studies. This analysis aims to identify research gaps and validate the most significant findings in the field of Information Technology (IT). The final phase involves report synthesis, where results are presented in tables or graphical visualizations to highlight research trends and patterns. A discussion follows to connect findings with research questions and assess the study's contribution to IT advancements. The report concludes with a summary of key findings and recommendations, outlining suggestions for future research directions [12].

4. Result and Discussion

Result of this study, we separate AI and AI-based curriculum into two levels. Figure 2 visualizes the urgency of various curriculum challenges in Indonesia, highlighting key issues that require immediate attention. Conventional teaching methods remain one of the most pressing problems, as traditional, teacher-centered approaches limit student engagement and critical thinking development. Similarly, the lack of project-based learning (PBL) prevents students from acquiring hands-on problem-solving skills, which are essential for adapting to real-world challenges.

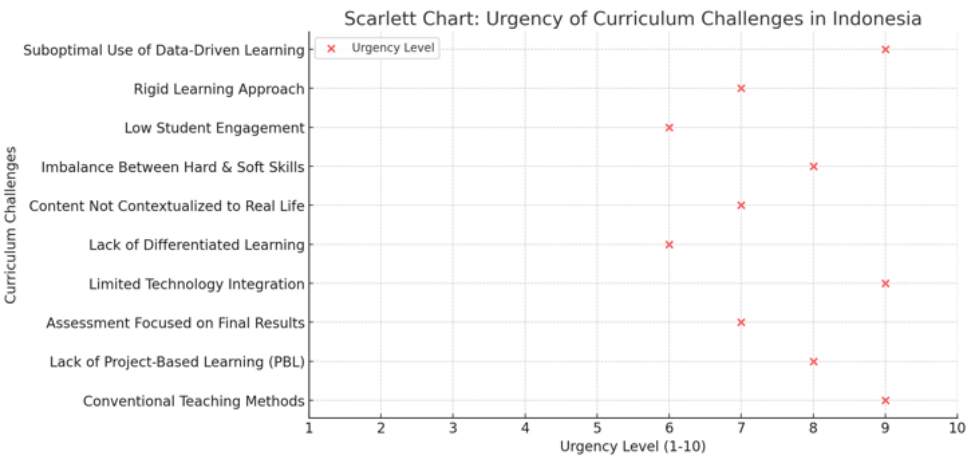


Figure 2. Urgency of Curriculum Challenges in Indonesia

Limited integration of technology in education also poses a significant barrier, as many institutions still rely on outdated teaching methods rather than leveraging digital tools to enhance the learning experience. Other important issues include rigid learning approaches and suboptimal use of data-driven learning, which hinder the adaptability of the curriculum to students’ needs. The imbalance between hard and soft skills further exacerbates the gap between education and workforce requirements, leaving graduates unprepared for modern job markets. Additionally, low student engagement and lack of contextualized content make learning less relevant and practical, reducing overall educational effectiveness. Addressing these challenges requires a more flexible and technology-driven curriculum, incorporating AI-powered personalized learning and adaptive assessments to better cater to student needs.

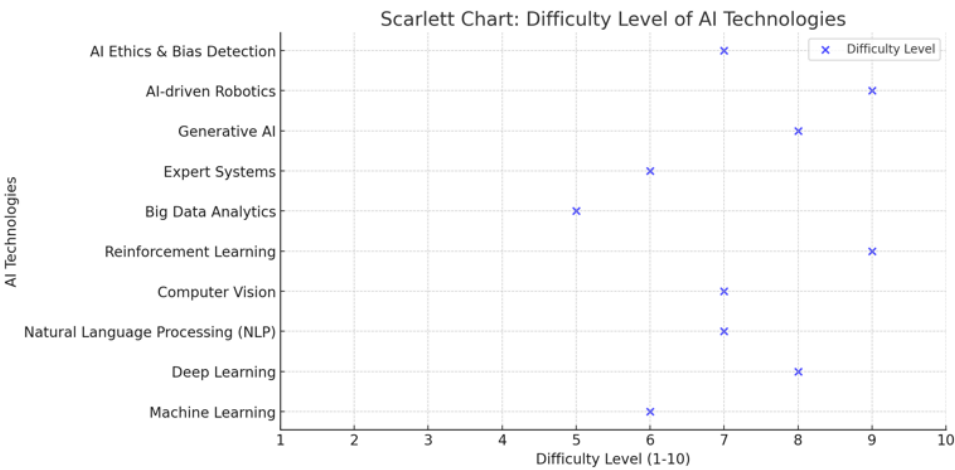


Figure 3: Difficulty level of AI Technologies Adoption

Figure 3 illustrates the difficulty level of various AI technologies, providing insights into their complexity and implementation feasibility. Reinforcement Learning and AI-driven Robotics rank among the most difficult technologies to implement, requiring sophisticated computational models, large datasets, and advanced processing power. These technologies are primarily used in automation, self-learning systems, and robotics, making them highly valuable but challenging to integrate into mainstream education. On the other hand, Machine Learning and Deep Learning fall within the medium-high difficulty range but are widely used in AI-driven education systems, helping to create adaptive learning platforms that personalize content based on student progress. Technologies with moderate difficulty levels, such as Natural Language Processing (NLP), Big Data Analytics, and Expert Systems, are already being applied in various education sectors globally. NLP is used in chatbots and AI tutors, enhancing interaction in online learning, while Big Data Analytics helps analyze student performance trends for better curriculum planning. Generative AI and AI Ethics & Bias Detection also play an increasingly important role in ensuring that AI-driven education systems are ethical and fair. This chart serves as a strategic guide for policymakers and educational institutions in choosing the most feasible AI technologies to integrate into the Indonesian education system while considering their complexity and impact.

Table 2. Curriculum Challenges in Indonesia and Solutions Using AI

Curriculum Challenges in Indonesia	AI Technology Solutions	AI Applications
Conventional Teaching Methods	AI for adaptive and personalized learning	Squirrel AI (China), Century Tech (UK)
Lack of Project-Based Learning (PBL)	AI-driven project-based learning and simulations	Knewton Alta (USA), Coursera AI Labs
Assessment Focused on Final Results	AI-powered formative assessments and automated feedback	Gradescope (USA), Turnitin AI
Limited Technology Integration	AI-powered virtual classrooms and interactive learning	Google Classroom AI, IBM Watson Education
Lack of Differentiated Learning	AI for analyzing student learning styles and recommending materials	DreamBox Learning (USA), Smart Sparrow (Australia)
Content Not Contextualized to Real-Life	AI in contextual learning and augmented reality (AR)	Pearson AI, Labster (Virtual Science Lab)
Imbalance Between Hard & Soft Skills	AI-driven career guidance and soft skills analytics	Skillsoft AI, LinkedIn Learning AI
Low Student Engagement	AI chatbots to enhance student interaction	Duolingo AI Chatbot, ChatGPT for Education
Rigid Learning Approach	AI in flexible, competency-based curriculum systems	OpenAI Codex (Flexible Learning Modules)
Suboptimal Use of Data-Driven Learning	Big Data and AI for student learning pattern analysis	Khan Academy AI, Carnegie Learning AI

Table 2 outlines key curriculum challenges in Indonesia, potential AI technology solutions, and global AI applications that can be leveraged to enhance the education system. Indonesia faces persistent issues such as conventional teaching methods, lack of project-based learning (PBL), limited technology integration, and rigid learning approaches. Many of these challenges stem from outdated instructional strategies, a lack of adaptive learning mechanisms, and insufficient emphasis on real-world applications. Additionally, student engagement remains low, and there is an imbalance between hard and soft skills, leading to graduates who struggle to meet industry demands. To address these challenges, AI-driven solutions such as personalized learning, formative assessments, virtual classrooms, and AI-powered career guidance can be implemented. These technologies enable adaptive learning, automated evaluations, and interactive teaching methods that cater to students' individual needs. Globally, platforms like Squirrel AI, Google Classroom AI, Gradescope, and Khan Academy AI have successfully integrated AI into education, providing real-time feedback, intelligent tutoring, and data-driven insights to improve learning outcomes. By adopting similar AI-driven approaches, Indonesia can create a more dynamic, flexible, and student-centered education system that aligns with global standards.

5. Conclusion

This study categorizes AI and AI-based curriculum into two levels, examining both the urgency of curriculum challenges in Indonesia and the difficulty of adopting AI technologies. The findings reveal that conventional teaching methods, lack of project-based learning (PBL), and limited technology integration are among the most pressing issues hindering education in Indonesia. These challenges result in low student engagement, an imbalance between hard and soft skills, and a disconnect between education and workforce demands. Addressing these issues requires a more adaptive, technology-driven curriculum that integrates AI-powered personalized learning, formative assessments, and interactive digital tools. The study also highlights the complexity of AI technologies, emphasizing that while Machine Learning, NLP, and Big Data Analytics have already been successfully implemented in education, more advanced technologies such as Reinforcement Learning and AI-driven Robotics remain challenging due to their computational and resource-intensive requirements. The strategic implementation of AI in Indonesian education can bridge learning gaps, enhance student engagement, and improve curriculum flexibility. By adopting AI-driven platforms such as Squirrel AI, Google Classroom AI, Gradescope, and Khan Academy AI, Indonesia can modernize its education system to be more dynamic, competency-based, and aligned with global standards. This study underscores the need for a structured approach to AI integration to ensure a future-ready, innovative education system capable of meeting 21st-century learning demands.

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