

# Debate on AI and Coding Integration in Indonesian Education: Urgency, Challenges, Prospects

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## Abstract

Technological advancements have significantly reshaped education worldwide, necessitating curriculum adjustments to prepare students for future challenges. In alignment with its "Golden Generation 2045" vision, Indonesia has mandated coding and artificial intelligence (AI) as foundational competencies within primary and secondary school curricula. This initiative is driven by the need to enhance students' digital literacy and equip them with critical skills relevant to the evolving job market. **Aims:** This study examines the urgency, challenges, and prospects of integrating coding and AI into Indonesia's education system. It explores policy implications, stakeholder involvement, and the nation's preparedness for implementing this transformative curriculum. A qualitative descriptive approach was used, incorporating literature reviews and international benchmarking to analyze Indonesia's readiness for curriculum reform. The study assessed existing infrastructure, teacher capabilities, and potential barriers to implementation. Findings indicate that coding and AI education significantly enhance students' critical thinking, creativity, and problem-solving skills, which are crucial in the digital era. However, significant challenges persist, including disparities in technology access, inadequate infrastructure in rural areas, limited teacher capacity, and socioeconomic inequalities that hinder equitable implementation. Stakeholder collaboration is essential for successful implementation, requiring coordinated efforts from government agencies, educational institutions, and the technology sector. Policy recommendations emphasize strategic investment in teacher training, infrastructure development, and targeted financial support for disadvantaged communities. A flexible and engaging curriculum incorporating gamified and collaborative learning methods is crucial to ensuring widespread accessibility and effectiveness. Despite existing challenges, coding and AI integration present significant opportunities for advancing Indonesia's education system.

**Keywords:** AI Integration, Coding Education, Digital Curriculum, Education Policy, Indonesia



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## Introduction

In the 21st century, technology has become an indispensable tool shaping every aspect of human life, from political and economic to cultural, artistic, and educational. The introduction of technological changes in the educational sphere utterly transformed teaching and learning, with new ways for students to understand and apply knowledge in real-life situations. This global transformation of the job market is an important part of shifting to a digital economy driven by automation, artificial intelligence, and the Internet of Things. According to Nurhayati (2024), many professions in the future will be directly related to these technologies, which require the development of robust digital competencies. Countries worldwide actively embed technological skills such as coding and AI into their curricula to

strengthen their economic standing in the global market (Al Aidhi et al., 2024). As a developing nation, Indonesia strives to keep pace with these advancements by prioritizing integrating technology into its education system.

Currently, serious attempts are being made by the present administration to realign Indonesian education policy with what is happening in the world. The most recent, of course, is a proposed integration of coding and AI as core competencies into primary and secondary school curricula. This policy aligns with Government Regulation No. 4 of 2022, emphasizing that students should be equipped with knowledge and skills to attain independence in life and lifelong learning. These reforms are further inspired by Indonesia's vision of becoming a globally competitive country by 2045, referred to as the "Golden Generation 2045." In order to achieve this dream, the national education system must rise to the challenge and prepare students with digital competencies to be more competitive in the fast-changing world.

This is indeed the global shift toward digital literacy, already being showcased by countries such as Singapore and India, where coding and AI have become part of the school curriculum (CNN Indonesia, 2024a). For instance, Singapore incorporates computational thinking into primary school as a compulsory subject through which problem-solving and logical reasoning are developed by using coding. Similarly, India has incorporated AI and machine learning into its secondary education system to prepare students more aptly for the challenges of a technology-based economy. These international comparisons show how coding and AI education might revolutionize national educational systems and create a digitally literate workforce able to handle the complexities of the digital age. Meanwhile, the indications of urgency for similar reforms in Indonesia come hand-in-hand with pilot programs, such as "Kecil-kecil Main Coding," that introduce digital literacy at a very tender age, showcasing ways technology-driven educational reforms could empower students (Tempo.co, 2024). These efforts remain localized and seriously limited in scope, proving the dire need for a cohesive and inclusive national strategy. This is especially urgent considering that Generation Y and Z, who dominate Indonesia's current school-age population, are digital natives (Santoso et al., 2018).

Integrating coding and AI into Indonesia's educational curriculum faces enormous challenges. Disparities in infrastructure, such as those experienced in rural and remote areas, hinder equal access to digital education (Sajida & Ranjani, 2020). Most schools lack essential technological resources like internet connections and devices, contributing to the digital divide and affecting students from underprivileged regions. Readiness on the part of educators also remains a key obstacle. Coding and AI are specialized knowledge and pedagogical skills that most teachers currently lack. According to Lestari et al. (2023), one of Indonesia's most significant barriers to curriculum reform is the lack of comprehensive teacher training programs in digital competencies. Unless much-needed investments in teacher development are made, integration risks being ineffective or non-viable.

Existing research underscores the transformative potential of coding and AI education in fostering critical thinking, creativity, and problem-solving skills (CNN Indonesia, 2024).

However, most studies are based on contexts in developed nations with established digital infrastructures, leaving a gap in understanding the unique challenges developing countries like Indonesia face. Maritsa et al. (2021) showed that successful digital education initiatives require, among other things, a relevant infrastructure, coherence in policy, and teacher capacity. Yet, comprehensive analyses of different stakeholders' roles and concrete strategies through which such challenges may be overcome remain scarce in Indonesia. The study is intended to fill this lacuna by mapping the urgency, challenges, and prospects of coding and AI education within an Indonesian context.

Integrating coding and AI into the curriculum is a strategic move to making Indonesia a digital education powerhouse, not merely a policy initiative. This will assist the country in nurturing a generation of digitally empowered youth, enhance its competitiveness globally, and enable it to meaningfully participate in the global knowledge economy. This initiative mainly grapples with important issues regarding infrastructure disparity, teacher readiness, and multi-stakeholder engagement. It also seeks to provide policymakers and educators with evidence-based recommendations to incorporate coding and AI education in Indonesia successfully. Responding to these challenges would allow the country to build a generation of digital literates capable of tackling the complexities of the digital era and realizing the vision of "Golden Generation 2045."

## Method

This study employs a qualitative descriptive approach, focusing on a comprehensive literature review to analyze the importance of integrating coding and artificial intelligence (AI) into Indonesia's primary and secondary school curricula. A literature review was chosen as the primary method to systematically collect, analyze, and synthesize relevant scholarly articles, policy documents, and credible reports, following some previous studies (Muluk et al., 2023; Sukardi & Sajida, 2023). This approach enables an in-depth understanding of global and local contexts, facilitating a critical evaluation of how coding and AI integration aligns with Indonesia's educational and technological landscape. The data sources for this study include peer-reviewed journal articles, official government publications, and reputable online resources. These sources were selected to ensure the reliability and validity of the findings. By analyzing existing knowledge and frameworks, this study aims to offer evidence-based recommendations that can inform policy design and promote the successful implementation of digital education reforms in Indonesia.

## Result and Discussion

### A. The Urgency of Coding and AI Education

The economy is changing so fast due to technological advancement that different skill sets are at play to penetrate the modern workforce. Among these crucial skills, coding and artificial intelligence (AI) remain vital in equipping people to stay afloat and thrive within the digital world. Coding, a sequence of instructions that a computer can understand and execute acts as a bridge between human creativity and machine employability (Kelly et al., 2023). It

enables individuals to create software applications, automate processes, and solve intricate problems. In terms of education, coding nurtures creative thinking, collaboration, and communication skills, laying a foundation for lifelong learning and adaptability in the modern competitive worldwide arena (Santoni, Prasvita & Adrezo, 2021).

One of the core advantages of teaching coding early is its enhancement of cognitive abilities. In contrast with traditional rote-learning methods, coding cultivates logic, systematic thinking, and problem-solving. Such skills are developed using plugged (computer-based) and unplugged (non-computer-based) approaches. Unplugged activities such as formulating algorithms on paper or using physical objects to mimic coding logic provide a delightful and stimulating learning environment for the young. They make coding education more accessible, ensuring these key skills are cultivated before students move on to more sophisticated digital tools. As worded by Intern (2020), some fun interactions while introducing coding reduce fear among students and build their resilience and growth mindset in dealing with difficulties. The importance of coding education in building self-esteem cannot be ignored. For a child of 7-12 years old, the ability to grasp coding skills and build simple programs gives him/her substantial inner satisfaction. Indeed, this accomplishment helps them develop the faith that they can solve problems and deal with several challenges. As such, coding teaches one to be patient, persistent, and brave enough to try new things. While students debug their programs and learn from errors, they build resilience skills that can be applied outside the classroom to many other areas of life and work.

Complementing the many advantages of coding, AI education can change the mode of teaching and learning (Crompton & Burke, 2023). AI enables personalized learning by studying the data contained in individual students' learning styles, levels of understanding, and preferences. Based on factors such as assessment performance, AI adaptation learning will adjust lesson difficulty and speed by each student's capacity so that they can find the right balance of challenge without losing interest in the topic. This amount of personalization achieves the best possible learning outcome while allowing for the detection and support of students with gaps in understanding so that targeted intervention can be provided.

Countries worldwide have recognized the transformative potential of coding and AI education, embedding these subjects into their school curricula. In Singapore, teaching coding has been compulsory for primary students since 2020 as an integral part of computational thinking. The government's Code for Fun initiative, developed by the Ministry of Education and the Infocomm Media Development Authority (IMDA), provides students with hands-on experience in coding and basic AI concepts. Initially introduced as an elective in 2014, the program has evolved to include cybersecurity topics, reflecting the expanding relevance of digital literacy in the global economy. Similarly, India has embraced technology education by incorporating computer science and AI into its primary and secondary curricula, aiming to prepare students for a future dominated by digital innovation.

In promoting coding and AI education throughout the nation, several interest groups, such as the Persatuan Guru Republik Indonesia (PGRI), have recognized the importance of coding and

AI education. It amplifies the necessity of beginning the subject in elementary school, as it develops skills like critical thinking and logical reasoning. According to Unifah Rosyidi, Chair of PGRI, education in AI and coding should not exclusively entail computer-based tasks but instead focus on computational thinking and problem-solving, accomplished through developmentally appropriate means. Such an approach provides students with a full-fledged cognitive basis on which to build ulterior technical skills such as programming. Rosyidi further states that integrating these subjects into the curriculum can promote students' numeracy and literacy skills-building for mathematics as it relates to the overall educational targets and national development strategy.

The enterprising of coding and AI introduces classroom learning that conforms to the purpose of Indonesia's "Golden Generation 2045." This national agenda reiterates that young Indonesians must possess specific skills to compete globally while contributing to the economic and technological growth of the nation. Projects like the Chromebook in East Java sent early signals that the local governments had started an initiative to integrate digital tools into educational activities. Although these initiatives are commendable, they evoke the urgent need for a disentangled strategy called upon at the national level to guarantee equal share and consistent application. Coding and AI education are increasingly urgent due to technological change and the widening digital divide. Underserved students may be left behind without proactive measures, creating more significant imbalances. Offering coding and AI education is decisive in equalizing opportunity and preparing all students to participate in the digital economy. The urgency of this situation demands intervention now in Indonesia, where infrastructure and technology access disparity is a significant barrier to achieving educational equity.

Moreover, innovation is a global economic commodity, and coding and AI education foster this important trait. They engage the students in activities requiring creative problem-solving and critical thinking, skills that the market will call innovators who address complex challenges. As the economies move from mere automation to a comprehensive digitalization of technology, the call for coding and AI experts will keep increasing. Hence, the incorporation of the two subjects into Indonesia's teaching landscape becomes not just an academic problem but a strategic developmental necessity.

For Indonesia, coding and AI represent an essential linchpin in future-oriented curricula targeting the empowerment of students with the modern skills to negotiate and succeed in the digital realm. By sharpening students' truly cognitive and creative abilities, these subjects create the foundation for a resilient, innovative, and competitive generation internationally. The experiences learned from other countries, especially Singapore and India, can serve as valuable lessons for Indonesia as it undertakes this journey. Through strategic planning, stakeholder collaboration, and equitable resource allocation, Indonesia can ensure that coding and AI education become transformative in achieving its educational and developmental aspirations. The urgency of this initiative cannot be overstated, as it holds the

potential to redefine not only how students learn but also how they contribute to the nation's progress in an increasingly digital world.

## **B. Stakeholder Roles in Coding and AI Implementation**

With coding and AI education being charioteers to the goal of turning Indonesia into a global digital superpower, an ambitious project of this magnitude demands the concerted engagement of many stakeholders from government, education, and the private sector. According to Muchlas, Special Staff for the Ministry of Primary and Secondary Education, coding and AI should be integrated into the national curriculum after careful understanding and strategy. He stated that children must be taught to classify information and to know themselves through simple yet effective pedagogical methods. In support of this, the World Economic Forum predicts that AI will be the eighth most common technology adopted by organizations worldwide between 2023 and 2027, with an estimated adoption rate of 74.9% (Nurjolis, 2024). This figure speaks volumes about the importance of AI for future industries and the pressing need for Indonesia to equip its youth for these developments.

The Indonesian government has made substantial efforts to introduce coding and AI programs into the education system. However, job hindrances persist, including resource allocation, infrastructure development, and teacher readiness. The mandate of the National Education System states that all national-level curricula must consider region-specific contexts to ensure sustainability. Such stipulations call upon the stakeholders to fortify institutional systems and manage the risk of the challenges involved in changing a primary and secondary education system. The integration process requires large financial investments, especially in infrastructure, to bridge the gap in educational facilities in urban and rural areas. The transformation of public services in e-Government is directed at the implementation of flexible governance, so that in the era of disruption, agile governance is needed as a necessity in facing the country's existential crisis (Dewi & Suardana, 2023). Many regions still lack access to technology and reliable internet, posing significant barriers to equitable education delivery (Pratama, A.Y. et al., 2022). Strengthening policies to ensure sustainable education, particularly in coding and AI, is thus a critical priority.

Digitalization efforts in Indonesia have gained momentum, driven by institutional commitments to sustainable education. The Ministry of Education, Culture, Research, and Technology (Mendikbudristek) reported during a parliamentary session on January 24, 2023, that 71,991 formal schools had received ICT infrastructure support through a dedicated physical allocation fund since 2020 (Arifa, F.N., 2023). Additionally, 1,253,074 ICT devices were distributed to facilitate digital education in schools. The government's implementation of phased coding and AI education aligns with this broader digitalization agenda. Priority will be given to schools with adequate facilities to ensure effective learning and curriculum customization tailored to the developmental stages of primary and secondary students. This strategic approach underscores the need for technical and infrastructural readiness to enable students to access and excel in digital learning environments.

Collaboration among stakeholders is vital to successfully implementing coding and AI education. The government plays a central role in fostering partnerships and mobilizing resources, while private sector entities and non-governmental organizations contribute through expertise, funding, and technological innovation (Sajida & Kusumasari, 2023a, 2023b). The initiative proposed by Vice President Gibran Rakabuming Raka highlights the importance of collaborative efforts in preparing a digitally literate "Golden Generation" that can compete globally (CNN Indonesia, 2024b). The Indonesian government has expressed its commitment to working with various stakeholders to enhance technical readiness and provide comprehensive training for teachers tasked with delivering coding and AI education. Beyond technology, the policy aims to cultivate creative and innovative mindsets, bolster digital literacy, and equip students to address the challenges of globalization effectively. The involvement of key stakeholders is pivotal in guaranteeing the long-term success of coding and AI education. These stakeholders include:

### **1. Ministry of Communication and Information Technology (Kominfo)**

Kominfo is instrumental in developing the technological infrastructure necessary for education, including internet connectivity and related resources. Besides that, the ministry also conducts digital literacy training for students, teachers, and the general community to enhance the productive use of technology. By providing the opportunity for such training, the ministry ensures that all stakeholders can benefit from the various digital tools.

### **2. The Ministry of Education, Culture, Research, and Technology (Kemendikbudristek)**

This ministry is responsible for an essential function integrating coding, AI, and digital literacy measures into the national curriculum. It must also ensure that these digital education programs are implemented effectively, aligning with the stated objectives of the national educational system. This would entail the development of comprehensive curricula that respond to the needs of the students and, in this way, empower teachers to implement them.

### **3. Local Government and Education Offices**

The local government and the Local schools and offices are closer to the schools and have an important role in implementing the policies. Here, these agencies organize continuous professional development for teachers to ensure the effective integration of technology into the classroom. The local governments must also ensure that relevant technological resources, including computer and Internet connectivity, are provided in schools to facilitate digital learning.

### **4. Teachers and Educational Staff**

Teachers serve as the frontline implementers of coding and AI education. They must possess advanced technical skills along with pedagogy relevant to the developmental stages of the students in order to teach these subjects efficiently. This requires continuous professional development and support from educational institutions and policymakers.

Teachers also play a critical role in fostering students' interest and confidence in technology by designing engaging and accessible learning materials. Clear communication, resource allocation, and accountability mechanisms must support the strategic involvement of these stakeholders. Indeed, policymakers must ensure all stakeholders understand their roles and responsibilities, thus sharing ownership and commitment to the initiative's success. Moreover, the integration of coding and AI into the curriculum must proceed based on evidence-based intervention theories and best practices, extending some lessons from Singapore and India. These countries have managed to integrate aspects of computational thinking and digital literacy into their education, which are important lessons for Indonesia.

While Indonesia advances in digitalizing education, it becomes necessary that gaps and challenges are holistically addressed. Stakeholders must collaborate so that all students enjoy the benefits of coding and AI education, regardless of geography or socioeconomic orientation. By embracing an inclusive perspective toward digital education, Indonesia will bring forth a generation of students who are not just digitally literate but also able to innovate and contribute toward the economic and technological development of the country.

### C. Prospect for Future

Incorporating technology-based competencies, especially coding and artificial intelligence (AI), in adjusting to the fast-changing realm of information technology has become essential. As more and more things revolve around digital tools and systems, the speed and competence in using such technologies shall not be a matter of choice but an absolute necessity. Although ill infrastructure and economic disparities may be there, digital education in Indonesia has the potential to mark the advancement of the whole country and nurture a new generation that is skillful, innovative, and competitive. The benefits of teaching coding and AI within the educational curriculum of Indonesia are far-reaching and transformative.

Firstly, digital literacy will be greatly enhanced through the teaching of coding and AI. Martin (2005) describes digital literacy as comprising the awareness, attitudes, and skills required to effectively use digital tools and facilities. Developing these skills is critical for effectively utilizing AI tools and understanding their ethical and practical implications (Karroum & Elshaiekh, 2023). Coding and AI should be integrated into the primary and secondary syllabus so that learners will be encouraged to develop a deeper understanding of technology at an early stage. The knowledge becomes the foundation that enables students to get by in a technology-infested world with nurtured critical and problem-solving skills. Most importantly, introducing these concepts must be done in a manner and level of complexity appropriate to the student's developmental stages so that the learning experience is fun yet achievable.

Second, coding and AI promote critical thinking and problem-solving skills. Therefore, in addition to being in mathematics, coding involves logic, algorithms, and reasoning processes that contribute to a student's cognitive development. This aligns with Tjahyanti et

al. (2022), who observed that AI technology could be a personalized assistant for students to explore problem-solving methods more interactively and innovatively. By approaching real-life problems and working them out through the lens of computational thinking, students gain much-needed and admired skills in the world market. Collaboration with AI enhances students' innovation and creativity as they learn coding for developing digital artifacts such as websites, applications, games, and simple programs (Lee et al., 2021). Integrating AI toolkits into the teaching/learning process helps set unique opportunities for students to appreciate and understand technologies to solve practical challenges. For example, students can simulate real-world scenarios through an AI-powered platform to test and refine their AI-generated solutions. This fosters an innovative mindset where students can think beyond conventional boundaries and develop new solutions to contemporary challenges.

Moreover, A broad range of characteristics is nurtured through AI and coding education by AI and coding education, and those subjects also help develop soft skills. These subjects themselves require a high degree of teamwork, collaboration, and communication, as students often work in groups on projects and exchange ideas. Such activities build mutual respect for different ideas, conflict resolution, and collaboration towards common goals. Experiences would develop values like perseverance, adaptability, and resilience—anything from the basic traits to skills paramount for maneuvering the complexities of the contemporary world.

In terms of longer-term benefits, once coding and AI are instituted into the curriculum, actual implementation becomes secondary in importance compared to Indonesia's larger national goals actualization of a Golden Generation 2045 vision of creating a generation of Indonesians who are well-informed, technology-wise competent, and globally competitive. With coding and AI introduced in the curriculum, Indonesia would further accelerate the realization of this vision, allowing students to be poised for success in a fast-changing world economy. In addition, the proposal also fosters nation-building by providing an avenue for technological and economic resilience, which shall significantly contribute to the adaptation possibilities in the face of future disruptive forces or opportunities.

The other opportunity for coding and AI education is that it can help bridge the present rifts of inequity and establish inclusivity. Indonesia can bridge the digital divide and ensure that its citizens can meaningfully participate in the digital economy by ensuring access to these transformative skills for students from different backgrounds. Nonetheless, this would require concerted efforts to equalize access to resources, infrastructure, and teacher training, focusing on disadvantaged and rural areas. Other interventions – such as technology devices and internet service support – would be critically important, as well as collaborating with private stakeholders to secure equitable opportunities for all students. Coding and AI, when included in the curriculum, create a tremendous opportunity for Indonesia to align itself with global standards and best practices. These subjects have previously made their way into the education systems of countries like Singapore and India, earning testimony in favor of the positive effects of integrating computational thinking and digital literacy. These nations stand

as models for Indonesia to draw into curriculum design, teacher training, and resource allocation. With the lessons learned from these nations, Indonesia can adapt and popularly implement contextually relevant strategies.

## Conclusion

The inclusion of a programming and AI education course in the curriculum systems of Indonesia is a pivotal paradigm-shifting step to arm a generation with the requisite abilities that are elemental in today's Golden Generation 2045, able to sustain this momentum of coding and AI for critical thinking, creativity, and problem-solving. Addressing these challenges- infrastructure, teacher readiness, and economic inequalities- will require stakeholder collaboration in government, educational institutions, and the private sector. Strategic investment in training, curriculum development, and equitable resource distribution should be upheld. Qualitative in nature and dependent on the existing literature, the study adopts an approach that does not cover the strategies to overcome the challenges faced in implementing these kinds of studies. Future investigations may open new avenues for empirical research across various contexts with a longitudinal approach studying the effects of coding and AI education and looking into alternative ways to teach inclusively in keeping with engagement. Filling these coding and AI education gaps in Indonesia will not only push the nation further, but also help bridge the digital divide at the national level in preparation for a highly competitive global workforce.

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