

# Integration of AI and Coding in Indonesia's New Curriculum: A Literature Review

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## ABSTRACT

The integration of Artificial Intelligence (AI) and programming (coding) into Indonesia's new curriculum reflects the nation's effort to prepare students for the realities of the 21st century, including digital literacy, computational thinking, and problem-solving skills. Although the policy direction signals meaningful progress, its implementation in schools is still uncertain, especially regarding teacher readiness and the availability of supporting resources. This study explores how AI, Computational Thinking (CT), and coding are positioned within Indonesia's curriculum policy and examines the extent to which these competencies can be translated into real classroom practice. Using a narrative literature review, this study analyzes journal articles, policy reports, and key curriculum documents to map both policy intentions and on-the-ground challenges. The review shows that CT has begun to appear in schools through simple activities, including unplugged methods and educational games. In contrast, coding is still introduced only at a basic level, and AI has not yet emerged as a structured component of classroom instruction. Persistent challenges include limited technological infrastructure, varied levels of teacher competence, and the absence of clear operational guidelines. These findings suggest that, while the integration of AI and coding aligns with future skill demands, implementation must be gradual and realistic. CT offers the most feasible starting point before schools progress toward more advanced AI and coding learning. Strengthened teacher training, more equitable access to digital resources, and the development of step-by-step instructional guidelines are essential to support the effective integration of digital competencies in schools.

**Keywords:** *Artificial Intelligence (AI), Coding, Computational Thinking, Curriculum Integration, Indonesia's New Curriculum*

## 1. INTRODUCTION

The rapid advancement of digital technologies has reshaped the competencies required in the twenty-first century, prompting education systems worldwide to redesign their curricula to include digital literacy, Computational Thinking (CT), and introductory programming. A growing body of international research shows that introducing CT at early grade levels can strengthen students' reasoning, problem-solving, and readiness for more advanced skills such as coding and Artificial Intelligence (AI) literacy (Karakainen et al., 2021; Seow, 2020; Kim & Kim, 2019). Computational Thinking has long been recognized as a core problem-solving framework for young learners (Brennan & Resnick, 2012). Wing (2006) positioned CT as a universal cognitive skill that extends beyond computer science, which later shaped global curriculum reforms. CT also provides a conceptual foundation for the development of coding and algorithmic reasoning (Grover & Pea, 2013).

In response to these global developments, Indonesia has introduced AI and coding into its new national curriculum through *Peraturan Menteri Pendidikan Dasar dan Menengah Nomor 13 Tahun 2025*, supported by the *Naskah Akademik Mata Pelajaran Coding dan Kecerdasan Buatan*. These policy documents signal the government's commitment to enhancing students' digital competencies and encourage flexible implementation, including unplugged learning approaches, to accommodate variations in school resources and teacher readiness. Recent data indicate that disparities in digital infrastructure remain a major challenge in Indonesia. According to the Ministry of Education, only around 62% of schools have stable internet access, with significant gaps between urban and rural areas. This condition highlights the structural barriers that may hinder the effective implementation of AI and coding education across diverse educational contexts. Several scholars also note that programming activities can significantly strengthen students' CT skills when designed appropriately (Lye & Koh, 2014). Despite this progressive policy direction, the extent of actual readiness among schools and teachers remains unclear. Internationally, countries such as Singapore have implemented structured progression models for AI and coding integration (Ministry of Education, 2020). Existing studies continue to highlight disparities in digital infrastructure, uneven teacher competencies, and significant differences in institutional capacity across regions (Suryani, 2022; Putra & Dewi, 2023).

However, current literature has not yet provided a comprehensive analysis that explicitly connects Indonesia's new curriculum directives with real conditions in classroom practice. Most existing studies focus on isolated aspect such as teacher readiness, digital infrastructure gaps, or small-scale CT and coding initiatives without examining how these elements align with the expectations set in national policy. Unlike countries that implement structured, phased models beginning with CT and progressing to AI and coding, Indonesia does not yet have an evidence-based roadmap adapted to its contextual challenges. This absence of an integrated progression framework represents a clear research gap.

Therefore, this study conducts a narrative literature review of curriculum policy documents, national research, and international models of digital competency development. The purpose is to analyze how AI, CT, and coding are positioned within Indonesia's curriculum; synthesize national and global evidence on their implementation; and propose a realistic, staged approach that aligns policy aspirations with school-level realities. Through this analysis, CT is positioned as a foundational competency, with AI and coding envisioned as sequential skills that must be introduced gradually and contextually.

To address this gap, this study seeks to align national curriculum expectations with practical realities in schools, focusing on how digital competencies can be

implemented progressively based on readiness and context rather than through a uniform nationwide mandate.

The objectives of this study are to:

1. Analyze how Computational Thinking (CT), coding, and Artificial Intelligence (AI) are positioned within Indonesia's latest curriculum reform documents.
2. Identify contextual factors and implementation challenges faced by schools, particularly related to teacher readiness and digital infrastructure.
3. Propose a staged integration approach suitable for Indonesian basic education settings.

Based on these objectives, this study is guided by the following research questions:

1. How are CT, coding, and AI conceptualized within Indonesia's new curriculum policy documents?
2. What existing conditions in schools (teacher competence, infrastructure, resources) support or hinder their implementation?
3. What phased implementation model could realistically guide the integration of CT, coding, and AI in Indonesian classrooms?

## **2. METHODOLOGY**

This study employed a qualitative narrative literature review to explore how Computational Thinking (CT), coding, and Artificial Intelligence (AI) are positioned in Indonesia's new curriculum and how these policy directions relate to the realities of school implementation. A narrative review was considered appropriate because it allows for a flexible yet systematic synthesis of diverse written sources, ranging from curriculum regulations to academic publications, without the rigid procedural requirements found in systematic reviews.

### **2.1 Research Design**

The research followed an interpretive narrative literature review design. This approach made it possible to examine how CT, coding, and AI are conceptualized across different documents and to compare these ideas with international practices. Each document was reviewed for its purpose, key arguments, methodological approach (when available), and relevance to curriculum development and implementation.

### **2.2. Participants of the Study**

Because this research is a document-based literature review, there were no human participants involved in the study. The term "participants" in this context refers to the documents included in the review. Sources included peer-reviewed journal

articles, national curriculum regulations, government policy papers, research reports, and academic publications related to CT, coding, and AI.

Only documents that (1) clearly discussed digital competencies in primary or secondary education, and (2) came from credible academic or institutional sources were included. Materials without clear authorship, credibility, or relevance were excluded.

### **2.3. Instruments**

To organize the narrative review process, three simple instruments were used:

1. Screening Checklist

Used to assess whether a document matched the topic focus (CT, coding, AI) and education level.

2. Quality Assessment Notes

Used to review the clarity, reliability, and usefulness of each document. Instead of strict scoring, this instrument provided reflective notes to judge whether a document was appropriate for deeper analysis.

3. Data Extraction Table

Used to record important information including author, year of publication, context, methodology, main findings, policy relevance, and implications for Indonesia.

These instruments helped keep the review systematic while still maintaining the flexibility characteristic of narrative reviews.

### **2.4. Data Analysis Techniques**

The data were analyzed using thematic analysis, which aligns naturally with a narrative literature review. The analysis involved four steps:

1. Reading and Familiarization

All selected documents were read closely to understand their main ideas and arguments.

2. Initial Coding

Key statements related to CT, coding, AI, curriculum directions, and implementation challenges were identified and coded.

3. Theme Development

Codes were grouped into broader themes such as policy orientation, school practices, barriers, and international models.

4. Synthesis

The themes were combined to produce a comprehensive interpretation of Indonesia's current position and to outline realistic pathways for integrating CT, coding, and AI in stages.

This process allowed the researcher to connect insights across documents and identify gaps that remain in policy and practice. The reviewed literature consisted of 15

sources published between 2019 and 2025, drawn from academic journals, national policy documents, and institutional reports related to CT, coding, digital literacy, and AI in basic and secondary education. The selection prioritised works that discussed both conceptual frameworks and practical classroom implementation. Sources were collected through Google Scholar, policy repositories, and institutional archives. Materials lacking clear authorship or direct relevance were excluded. Thematic analysis enabled the synthesis of recurring patterns across policy direction, school readiness, and international practices, allowing the findings to be interpreted contextually rather than generalised statistically.

### **3. RESULTS AND DISCUSSION**

The narrative review produced several key findings regarding the positioning and implementation of Computational Thinking (CT), coding, and Artificial Intelligence (AI) in Indonesia's newest curriculum reform. This section discusses these findings by connecting them with relevant theories, national conditions, and international experiences.

#### **3.1 Policy Orientation on CT, AI, and coding**

The review indicates that Indonesia's most recent curriculum reform formally highlights Computational Thinking (CT), coding, and Artificial Intelligence (AI) as key digital competencies for twenty-first century learning. Policy documents such as *Permendikdasmen No. 13 of 2025* and the *Academic Paper for Coding and Artificial Intelligence* present CT as the conceptual foundation on which AI and coding literacy should be built. These documents also encourage flexible implementation approaches, including unplugged activities, to accommodate the diverse conditions of Indonesian schools.

Although the policy direction is clearly articulated, the curriculum still provides high-level conceptual guidance without specifying detailed competency progressions, instructional models, or assessment criteria. This lack of operational clarity results in highly varied interpretations of policy expectations, as schools and teachers attempt to implement the competencies based on their own understanding and available resources.

Despite the strong policy vision, the curriculum still offers broad conceptual directions without providing detailed operational guidance. Recent studies also highlight the need for practical, teacher-friendly models to support implementation at the classroom level (Khosibah et al., 2025). There are no explicit learning progressions, structured instructional models, or standardized assessment frameworks for CT, coding, or AI integration. As a result, schools interpret these expectations in different ways, leading to varied and inconsistent implementations across regions. Further

details are elaborated in the Academic Paper on Coding and Artificial Intelligence, which provides conceptual guidelines for competency development.

### **3.2 Classroom Implementation: CT, AI, and Coding Practices**

Implementation across Indonesian schools is uneven. CT is the most commonly practiced competency, introduced through low-tech, hands-on activities such as sequencing tasks, pattern-based games, puzzles, and basic problem-solving exercises. These activities are feasible because they do not require digital devices or advanced infrastructure. The variation in teachers' competencies is largely influenced by unequal access to professional development opportunities, limited exposure to computational thinking and AI-related pedagogy, and the absence of standardized national guidelines. Many teachers rely on self-directed learning or short-term training programs, which often lack continuity and practical classroom application. As a result, the implementation of AI and coding remains fragmented and highly dependent on individual teacher initiative rather than systemic support.

In contrast, coding is typically introduced through extracurricular programs, limited pilot initiatives, or collaborations with external organizations. AI education is almost entirely absent from formal classroom instruction. Schools face several limitations, including inadequate digital devices, unstable internet access, and teachers' limited confidence in teaching programming or AI-related concepts.

This pattern aligns with international research indicating that infrastructure and teacher preparedness are the strongest predictors of successful digital literacy implementation

### **3.3 Barriers and Challenges**

The literature consistently identifies several challenges that hinder the effective implementation of CT, coding, and AI in Indonesian schools. These challenges appear across different regions and school types, indicating systemic issues rather than isolated cases. The main barriers that emerge from the reviewed sources include the following:

1. Infrastructural disparities

Many schools lack sufficient devices, laboratories, and stable internet access, making AI and coding difficult to implement.

2. Variations in teacher competence

Teachers show different levels of digital literacy and pedagogical readiness. Low confidence in teaching coding or AI remains a common issue, as reflected in national studies.

### 3. Lack of operational guidance

Although the curriculum highlights CT, coding, and AI as key competencies, it does not provide detailed teaching models or step-by-step implementation guidance. This gap leaves teachers without practical resources to translate policy into classroom practice.

These challenges collectively illustrate the gap between policy expectations and school-level readiness. Limited infrastructure restricts opportunities for meaningful AI and coding activities, uneven teacher competence reduces instructional quality, and the absence of practical curriculum guidance makes implementation inconsistent across settings. Several Indonesian studies point out that teacher capacity-building remains one of the most urgent needs for digital learning implementation (Chaniago et al., 2025). Classroom observations show that CT can be introduced effectively through unplugged activities, but scaling these practices requires better support (Isharyadi, 2023).

### 3.4 International Models and Lessons Learned

International implementation models demonstrate the effectiveness of phased, scaffolded learning progressions. Countries with successful integration offer clear progression pathways.

- Singapore has introduced CT and coding since 2014 through *Code for Fun* and expanded to AI literacy under its *AI for Students* roadmap (Woo, 2025).
- Finland incorporated CT and programming into its 2016 national curriculum, embedding them across subjects through robotics and project-based learning (Casal-Otero et al., 2023).
- South Korea mandated software education in 2018, starting with CT in primary school and progressing to programming and AI modules in secondary school (Xu & Ouyang, 2022).
- Australia's Digital Technologies Curriculum (2015) integrates CT and coding systematically from Year 1 and introduces data-driven AI concepts in upper grades (Crompton et al., 2023).

Across these systems, shared characteristics include national progression frameworks, extensive teacher training, and abundant curriculum resources (Garzón et al., 2025). The success of these countries reinforces global consensus that digital competency education requires structured scaffolding.

### 3.5 Implications for Indonesia

Based on the findings, a gradual and context-sensitive implementation pathway is essential for Indonesia. Schools vary widely in their infrastructure, teacher readiness, and institutional capacity, which means that integrating CT, coding, and AI must follow

a phased progression rather than a uniform approach. Listiowati (2025) emphasizes that digital competency integration must consider school context to ensure long-term sustainability. A realistic and developmentally appropriate roadmap would consist of the following stages:

1. Strengthen CT as the foundation in early grades.
2. Introduce unplugged and block-based coding progressively.
3. Expand to text-based programming once foundational skills are stable.
4. Introduce basic AI literacy only when coding foundations have been established.

This sequenced approach ensures that students develop the necessary conceptual and technical foundations before engaging with more complex digital competencies. To support this progression, sustained teacher professional development, improved access to digital infrastructure, and clearer instructional guidance are required. These elements will be critical in aligning policy aspirations with the practical realities of school environments across Indonesia. Teacher confidence plays a crucial role in determining whether digital competencies can be integrated effectively at the classroom level (Putra & Dewi, 2023).

#### **4. CONCLUSION**

This study set out to analyze how Computational Thinking (CT), coding, and Artificial Intelligence (AI) are positioned within Indonesia's latest curriculum reform and to consider how these policy intentions correspond with actual conditions in schools. Through a narrative literature review, the study found a clear distinction between the curriculum's ambitious vision and its current level of implementation. CT has begun to find its place in classroom practice because it can be delivered through accessible, low-tech activities. In contrast, coding remains limited in scope, often appearing only through isolated initiatives, and AI has not yet emerged as a structured element of teaching and learning.

The findings underscore a persistent gap between policy aspiration and educational readiness. Many schools continue to grapple with limited technological infrastructure, and teachers vary considerably in their digital competence and pedagogical confidence. Moreover, the curriculum provides high-level direction but lacks the detailed instructional guidance needed to support consistent implementation. When viewed alongside international models that employ phased, well-supported progression frameworks, it becomes evident that Indonesia has yet to develop an operational roadmap that is both contextually realistic and scalable.

To move forward, a gradual and carefully sequenced approach is essential. Strengthening CT as a foundational competency offers the most feasible starting point, after which schools can progressively introduce unplugged and block-based coding, followed by text-based programming and, eventually, age-appropriate AI literacy.

Achieving this vision will require sustained investment in teacher development, equitable access to digital tools, and the creation of clear, practical implementation guidelines. By addressing these areas, Indonesia can bridge the gap between curriculum policy and classroom practice and advance toward a more robust and future-oriented digital education landscape.

In addition to these implications, future research should move beyond policy analysis and begin examining empirical classroom implementation across diverse school contexts. Studies involving lesson design, teacher training models, and classroom-based interventions will be essential to validate phased integration approaches. Pilot projects that compare unplugged, block-based, and text-based programming pathways can also provide practical insights for adapting curriculum expectations to teacher readiness and school infrastructure.

Therefore, this study recommends the development of a national operational guideline to support teachers in implementing AI and coding education in a structured, scalable, and context-sensitive manner. These efforts will help ensure that curriculum reform is supported by evidence from real learning environments rather than policy assumptions alone.

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