

Exploring the Integration of Artificial Intelligence in Primary Education: A Systematic Literature Review (2020–2024)

Maharani Revenaya,^{1*}
Bambang Subali,²
Ellianawati³

^{1,2,3} Primary Education,
Universitas Negeri Semarang,
Indonesia

*Correspondence author:
mrevenaya@students.unnes.ac.id

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Abstract

Artificial intelligence (AI) is increasingly transforming primary education by enabling adaptive, personalized, and interactive learning. This study presents a systematic literature review (SLR) of 54 Scopus-indexed articles published between 2020 and 2024 to explore trends, applications, benefits, and challenges of AI integration in primary education. The review followed PRISMA 2020 guidelines and combined bibliometric and thematic analyses. Biblioshiny was applied to examine publication trends and contributing countries, while VOSviewer visualized keyword co-occurrence and thematic clusters. Results indicate steady growth in research, with China, the United States, and Europe leading contributions. Nine categories of AI applications were identified, particularly machine learning, deep learning, and natural language processing. Reported benefits include personalization, improved engagement, inclusive education support, teacher efficiency, and digital literacy development. However, significant challenges remain, such as limited infrastructure, insufficient teacher readiness, financial constraints, and concerns over children's data privacy. The study concludes that while AI holds strong potential to enhance primary education, successful implementation depends on ecosystem readiness, equitable access, and ethical safeguards. This review contributes by mapping global research trends, consolidating fragmented evidence, and offering practical insights for educators, policymakers, and researchers.

INTRODUCTION

The rapid development of Artificial Intelligence (AI) technology has opened up opportunities for significant transformation in the field of education, including primary education. At the elementary school level, AI offers the potential to provide a more personalized, adaptive, and interactive learning experience through adaptive learning platforms, intelligent tutoring systems, educational games, and learning analytics that utilize student data. These applications are designed to tailor content and learning pace to the individual needs of students, increase engagement, and support independent learning. Globally, international organizations such as UNESCO (2023) have highlighted AI as a driver of innovation in education, emphasizing its role in promoting inclusive and equitable quality learning. This global discourse underscores the importance of systematically understanding how AI is being implemented at the primary school level.

The implementation of AI in the context of elementary school learning not only focuses on improving student learning outcomes, but also on the efficiency of assessment and professional support for teachers. AI-powered systems are capable of providing real-time feedback, adjusting the level of difficulty of questions, and presenting data-driven insights that help teachers design more targeted pedagogical interventions (Akintolu & Oyekunle, 2025; Sabharwal & Mitra, 2025). In addition, AI-based interactive media—such as educational games and adaptive learning applications—can increase student motivation and engagement, especially in early childhood, which requires visual stimulation and concrete learning experiences (Elantheraiyan et al., 2024; Joshi & Ramnath, 2025). From the teacher's perspective, AI also contributes to reducing administrative workload and supports differentiated instruction, enabling educators to focus more on higher-order teaching activities and socio-emotional support.

However, the adoption of AI at the elementary school level presents policymakers, practitioners, and researchers with a number of substantive challenges. Ethical and privacy issues are of particular concern because the sensitive data of children, behavior patterns, and learning profiles collected by AI systems must be strictly protected to prevent misuse and privacy violations (Elantheraiyan et al., 2024; Laukyte, 2024). Other challenges include limitations in technological infrastructure in some school contexts, access gaps that have the potential to widen the digital divide, and the need to develop teachers' capacity to be able to utilize and integrate AI tools pedagogically (Joshi & Ramnath, 2025; Mohebi, 2025; Rajput, 2025). In addition, socio-economic disparities and regional differences in digital readiness often determine whether AI can be implemented effectively, raising concerns about educational equity.

Relevant recent empirical studies from 2020–2024 show that research focuses on several main themes: (1) the development and evaluation of adaptive learning

systems and intelligent tutoring systems that target personalized learning; (2) studies on the impact of AI on learning outcomes and teaching practices; (3) analysis of ethics, privacy, and regulation of AI use in school environments; and (4) research on teacher professionalization related to AI literacy and pedagogical skills in utilizing this technology (Abdulmunem, 2023; Akintolu & Oyekunle, 2025; Elantheraiyan et al., 2024; Joshi & Ramnath, 2025; Mohebi, 2025). These findings illustrate the direction of academic attention, which is oriented towards the effectiveness of technology as well as its social and policy implications.

However, literature that focuses specifically on primary education is still relatively scattered and not yet fully comprehensive. Many studies are conceptual or focused on prototype development without long-term evaluation in real classrooms; while systematic and comparative field studies—especially those considering different regional contexts, infrastructure, and socio-economic conditions—are still limited (Alsohaimi et al., 2025; W. L. Wong, 2025). Another gap is the limited empirical evidence on the long-term impact of AI on the cognitive and non-cognitive development of primary school children, as well as the lack of evidence-based practice guidelines that can be used by teachers and policymakers in the context of primary schools. Furthermore, while bibliometric studies on AI in education exist, few reviews have exclusively synthesized evidence from Scopus-indexed literature with a focus on the primary education level, leaving a fragmented understanding of the field.

Based on observations of these research themes and practical challenges, a systematic review synthesizing evidence from Scopus-indexed publications during the period 2020–2024 is needed. A systematic literature review focusing on this time frame allows for mapping publication trends (RQ1), classifying the forms of AI applications used in elementary schools (RQ2), identifying the main reported benefits (RQ3), tracing implementation challenges and obstacles (RQ4). These research questions are presented explicitly as follows:

1. What are the publication trends related to AI in primary education from 2020–2024?
2. What types of AI applications have been implemented in primary education contexts?
3. What benefits of AI integration are most frequently reported in the literature?
4. What challenges and barriers are identified in implementing AI in primary schools?

Such a review is important to (a) summarize findings scattered throughout the Scopus literature, (b) assess the quality and focus of existing evidence, and (c) provide practical recommendations and further research that can help schools, teachers, and policymakers utilize AI ethically, effectively, and fairly. Thus, this study

aims to fill this knowledge gap through a systematic review of Scopus-indexed studies (2020–2024). The results of this review are expected to contribute empirically and conceptually to understanding the status of AI integration in primary education, offer a summary of the benefits and risks that need to be considered, and guide research and policy priorities focused on the responsible and inclusive use of AI in primary schools.

METHODS

This study employed a systematic literature review (SLR) to synthesize evidence on the integration of artificial intelligence (AI) in primary education from 2020–2024. The review followed the PRISMA 2020 protocol (Page et al., 2021) and SLR procedures outlined by Kitchenham & Brereton (2013) to ensure transparency and reproducibility.

Data were retrieved from Scopus, chosen for its extensive coverage of education and technology research. The final query combined AI- and education-related terms using Boolean operators, limited to English, peer-reviewed, and final publications (2020–2024). The search (10 September 2025) yielded 245 records. The final query was:

Table 1. Scopus Query

```
( TITLE-ABS-KEY( "artificial intelligence" OR "AI" OR "machine learning" OR "deep learning" OR
"intelligent tutoring" OR "adaptive learning" )
AND TITLE-ABS-KEY( "primary school" OR "primary education" OR "elementary school" OR
"elementary education" ) )
AND PUBYEAR > 2019 AND PUBYEAR < 2025
AND ( LIMIT-TO( DOCTYPE, "ar" ) OR LIMIT-TO( DOCTYPE, "re" ) OR LIMIT-TO( DOCTYPE, "cp" ) )
AND ( LIMIT-TO( SRCTYPE, "j" ) OR LIMIT-TO( SRCTYPE, "p" ) )
AND ( LIMIT-TO( PUBSTAGE, "final" ) )
AND ( LIMIT-TO( LANGUAGE, "English" ) )
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For clarity and transparency, the inclusion and exclusion criteria are summarized in Table 1.

Table 2. Inclusion and Exclusion Criteria

No	Inclusion Criteria	Exclusion Criteria
1	Peer-reviewed articles or conference papers	Studies on secondary or higher education
2	Focus on primary/elementary education	Opinion pieces, editorials, non-academic sources
3	Application/integration of AI in learning context	Publications before 2020 or non-English

Studies were included if they were peer-reviewed, focused on primary/elementary education, and addressed AI in learning; and excluded if they concerned higher education, non-academic content, or non-English/pre-2020 works. After screening in Rayyan, 54 studies met inclusion criteria.

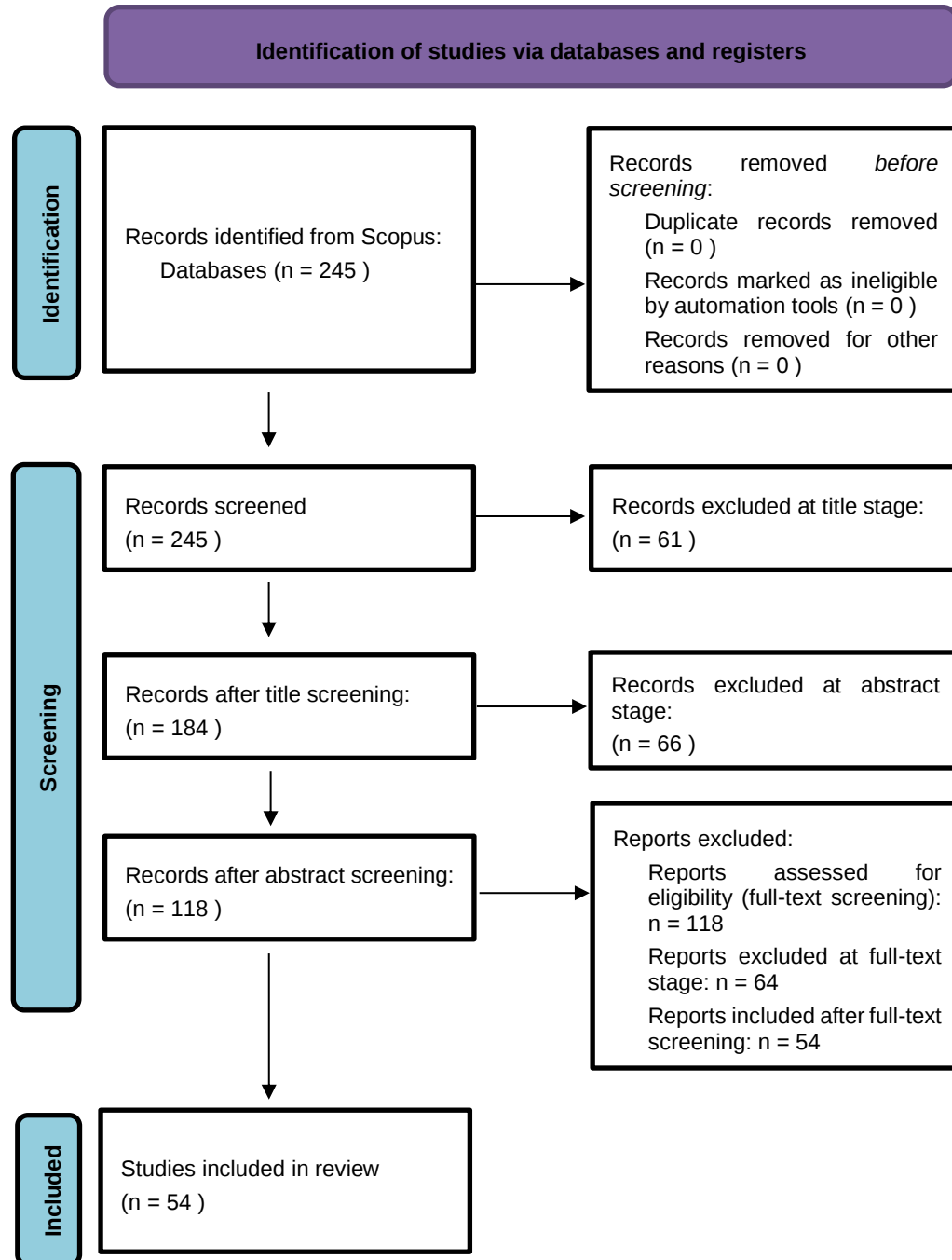


Figure 1. PRISMA Framework

Source: PRISMA Framework

Data extraction covered bibliographic details, AI applications, benefits, and challenges. Analyses combined bibliometric mapping (Biblioshiny, VOSviewer) and thematic coding (Braun & Clarke, 2006). Reliability was ensured through systematic

screening, intercoder checks, and triangulation of bibliometric and thematic findings.

RESULTS AND DISCUSSION

1. Publication Trends on AI in Primary Education (2020–2024)

The following publication presents an analysis of trends in the field of artificial intelligence in primary education during the period 2020–2024. A bibliometric analysis of Scopus-indexed publications from 2020 to 2024 reveals significant insights into the development and dissemination of research on the integration of artificial intelligence (AI) in primary education. A total of 54 studies satisfied the inclusion criteria, enabling an in-depth evaluation of the evolution of scholarly interest in this field over the past five years.

The initial and most salient observation is the consistent escalation in the publication output throughout the review period. In 2020, the number of documents published remained low, indicative of the nascent stage of research on the application of AI to primary education. This figure exhibited a modest increase in 2021, subsequently reaching a nearly twofold growth in 2022, and maintaining a steady upward trajectory in 2023. The year 2024 marked a sharp increase, representing the peak in the dataset and accounting for the largest proportion of total publications. This upward trajectory demonstrates not only a growing scholarly recognition of AI as a transformative force in early education but also the broader momentum of AI research within the educational technology domain. The consistent annual growth in this field is also indicative of policy-level encouragement and global funding priorities that increasingly highlight digitalization and AI in the education sector.

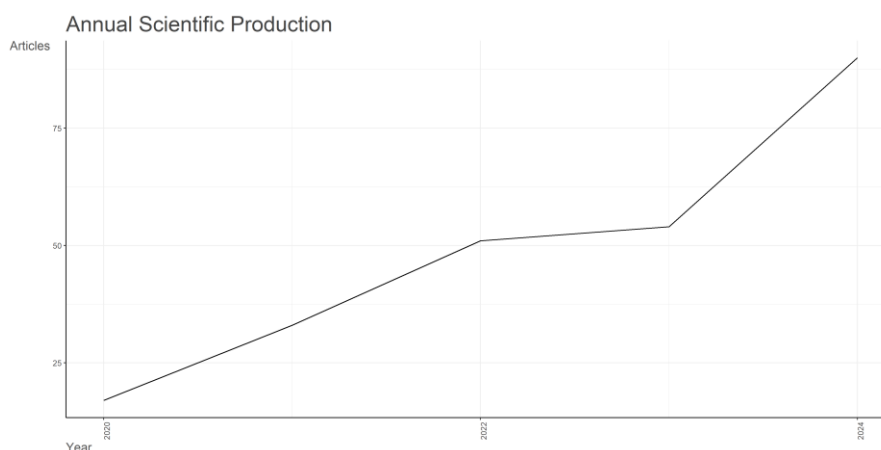


Figure 2. Documents by Years

Source: Bibliometix

The majority of publications during this period were journal articles (86.5%), complemented by conference papers (11.4%) and a small proportion of review

articles (2%). This preponderance of empirical articles signifies that the field remains in an exploratory and application-oriented phase, with scholars prioritising case studies, pilot implementations, and the evaluation of prototypes over meta-analyses or conceptual reviews. The relatively low proportion of review articles also suggests that comprehensive syntheses of existing evidence are still limited, which reinforces the need for systematic literature reviews such as the present study.

Documents by subject area

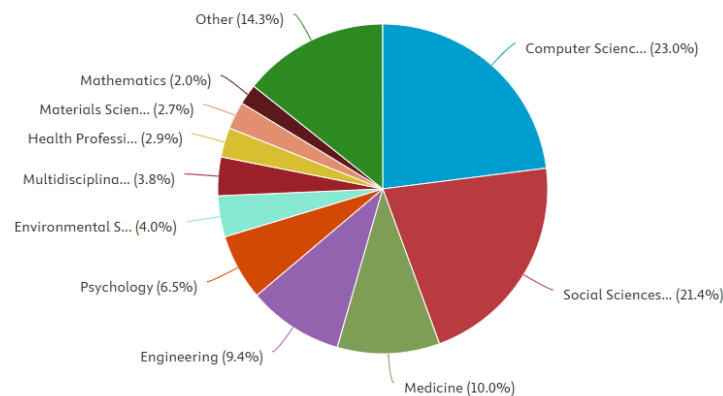


Figure 3. Documents by Subject Area

Source: Scopus analysis

The analysis of subject areas highlights the strongly interdisciplinary character of this research domain. The publications were most frequently indexed under computer science (23%) and social sciences (21.4%), thus emphasising the dual orientation of this field: technical development on the one hand and pedagogical application on the other. Other relevant subject areas include medicine (10%), engineering (9.4%), and psychology (6.5%). This disciplinary spread demonstrates that AI in primary education is not confined to technology development but also extends to questions of learning psychology, child development, teacher practices, and educational policy. The integration of these disciplines suggests that addressing AI in schools necessitates an integrative approach, synthesising technical innovation with socio-pedagogical considerations.

Country Scientific Production

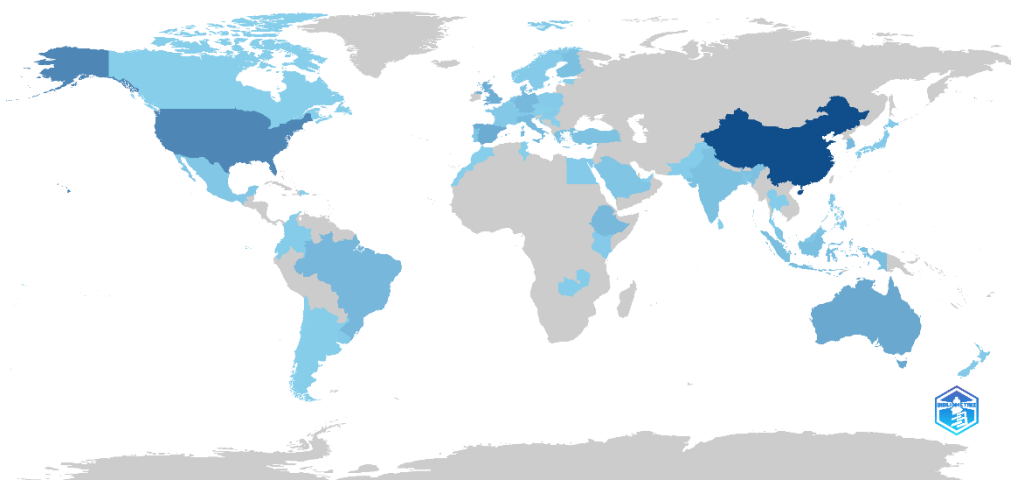


Figure 4. Documents by Country or Territory

Source: Bibliometrix

A geographical analysis reveals a highly uneven distribution of research activity. China emerged as the most prolific nation, contributing the largest number of documents and attaining the highest citation counts (surpassing 900 citations), thereby signifying both volume and impact. The United States was the second-highest ranking nation in terms of publication output, with European countries such as Spain, the United Kingdom, Germany, and Australia following closely behind. Collectively, these nations embody the crux of research endeavours in this domain, thereby indicating that the exploration of AI in education is predominantly occurring in high-income contexts characterised by the presence of well-established digital infrastructures. This prompts further inquiries into the implications for equity in research representation and the generalisability of findings from these contexts to lower-income regions, where infrastructural challenges are more pronounced.

At the institutional level, the leading contributions were provided by Tsinghua University, the Chinese University of Hong Kong, University College London, the University of Melbourne, and OsloMet. These institutions embody a convergence of Asian and Western leadership in the domain of AI education scholarship, thereby signifying an escalating global collaboration. An analysis of funding agencies corroborates this trend. The National Natural Science Foundation of China emerged as the most significant sponsor, followed by the European Union's Horizon 2020 programme and the U.S. National Science Foundation. This finding underscores the strategic prioritisation of AI research in education by state-level and supranational bodies as part of broader digital transformation agendas.

When considered as a whole, the results indicate a rapidly expanding and globally distributed research field that is characterised by interdisciplinarity,

empirical orientation, and concentrated leadership in technologically advanced regions. The marked increase in publications towards 2024 indicates that the topic is gaining traction and may soon transition into a more mature research phase, where synthesis studies, comparative analyses, and long-term evaluations will assume greater significance. Moreover, the considerable influence of national and international funding bodies suggests that future research directions will probably continue to align with digital policy frameworks, such as AI strategies launched by UNESCO, the European Commission, and Asian governments.

The publication trends from 2020 to 2024 demonstrate that the field of research concerning artificial intelligence in primary education has evolved into a vibrant and increasingly globalised domain. The phenomenon under scrutiny is typified by steady growth, cross-disciplinary integration, concentration in technologically advanced countries, and significant reliance on strategic funding support. This evolving landscape underscores both the opportunities and the challenges of developing a robust evidence base to guide the responsible implementation of AI in primary schooling worldwide.

2. Types of AI Applications Integrated in Primary Education

A systematic review of 54 studies indicates that the application of artificial intelligence (AI) in primary education is highly diverse, with nine main categories. Machine learning (ML) (26 studies) and deep learning (DL) (13 studies) are the most prevalent, with applications including prediction of learning outcomes, detection of difficulties, and automated assessments (Akintolu & Oyekunle, 2025; Elantheraiyan et al., 2024). These developments signify a transition towards a data-driven approach to personalisation, despite the emergence of concerns regarding bias, fairness, and infrastructural limitations (Mohebi, 2025; Rajput, 2025).

Table 3. Types of AI Applications in Primary Education (2020–2024)

No	AI Application Type	Example	Frequency (n=54)
1	Machine Learning	Prediction of academic performance, adaptive quizzes	26
2	Deep Learning	Image recognition, automated assessment	13
3	NLP / Generative AI (e.g., ChatGPT)	Writing support, Q&A systems, conversational agents	8
4	Adaptive Learning Systems	Personalized content, dynamic difficulty adjustment	5
5	Educational Data Mining & Learning Analytics	Learning dashboards, predictive insights for teachers	4
6	Computational Thinking Tools	Block-based programming, AI literacy curricula	6
7	Robotics & Intelligent Tutoring Systems (ITS)	Humanoid robots, AI tutors for math and reading	3

8	Ensemble/Hybrid Learning Models	XGBoost, Random Forest for student modeling	4
9	Computer Vision	Automated handwriting and visual assessment	2

A total of eight studies have been conducted which demonstrate the efficacy of natural language processing (NLP) and generative AI, such as ChatGPT, in the fields of literacy, question-and-answering, and interactive tutoring (Joshi & Ramnath, 2025). This technology supports interaction-based learning in accordance with Vygotsky's theory, but it has been argued that it may encourage dependence and the spread of inaccurate information (Laukyte, 2024).

Five studies examine adaptive learning systems that adjust content and difficulty levels in real-time, particularly in mathematics and reading (W. L. Wong, 2025). Four other studies examine educational data mining and learning analytics that assist teachers through predictive dashboards, although the effectiveness of these tools depends on teachers' data literacy (Alsohaimi et al., 2025).

AI is also studied as learning content through the medium of computational thinking (CT) and AI literacy curricula (6 studies), which aim to foster problem-solving skills from an early age (Elantheraiyan et al., 2024). However, the long-term evidence is still limited (Laukyte, 2024). Furthermore, robotics and intelligent tutoring systems (three studies) have been demonstrated to enhance students' emotional engagement (Abdulmunem, 2023), whilst computer vision (two studies) is employed for handwriting recognition and classroom monitoring, although the technology is still in its experimental stage.

It is evident that AI applications function within three principal domains. The three key elements of this project are as follows: firstly, the provision of support for teachers through the personalisation and analysis of data; secondly, the increase in student engagement through the utilisation of natural language processing (NLP), generative artificial intelligence (AI), and robotics; and thirdly, the updating of the curriculum through the strengthening of digital literacy and computational thinking. Nevertheless, challenges pertaining to ethics, sustainability, teacher preparedness, and contextual discrepancies persist (W. L. Wong, 2025). It is recommended that future research place greater emphasis on cross-context comparisons, long-term evaluation of AI literacy, and ethical integration frameworks that protect children while encouraging innovation.

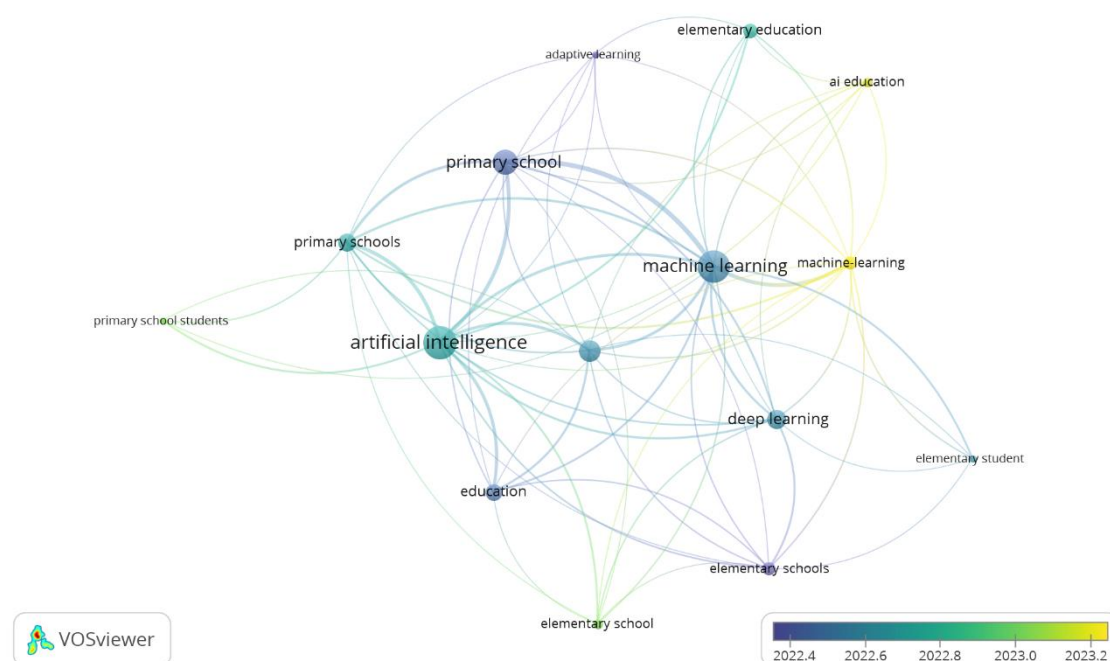


Figure 6. Overlay visualization of keyword co-occurrence

Source: VOSviewer

The overlay visualization further illustrates the temporal dimension of these developments. Earlier studies (around 2021–2022) were more concentrated on broader terms such as *artificial intelligence* and *education*. In contrast, more recent publications (2022–2023) demonstrate a shift toward applied approaches, particularly *machine learning*, *deep learning*, and *adaptive learning*. This trend suggests a transition from conceptual discussions of AI in education toward the implementation of specific AI techniques to address practical challenges in primary schools.

Overall, the analysis confirms that AI applications in primary education can be categorized into three main types: (1) broad conceptual use of AI in educational settings, (2) technical applications such as machine learning and deep learning, and (3) adaptive learning platforms tailored to primary school contexts.

3. Benefits of AI Integration in Primary Education

A review of 54 Scopus articles published between 2020 and 2024 shows that integrating artificial intelligence (AI) into primary education can be beneficial in cognitive, pedagogical, affective and organisational terms. Eight main themes emerged: personalisation; motivation and engagement; inclusive education support; teacher efficiency; digital literacy development; accessibility; instant feedback; and collaboration and creativity.

Personalisation was found to be the most dominant benefit. Adaptive platforms can be tailored to students' needs in terms of content and difficulty levels, and have been proven to improve literacy (Dai et al., 2023; Mertala et al., 2022; H. Moon et al., 2024; Relmasira et al., 2023; S. Y. Wu & Yang, 2022; Yim, 2024) and mathematics (Li & Noori, 2024; Rumbelow & Coles, 2024; Tian et al., 2022; Wardat et al., 2024) skills, as well as fostering self-efficacy (Mohebi, 2025). These systems also enable teachers to better support a diverse student body.

Motivation can be increased through game-based learning and robotics. For example, robot-based storytelling can strengthen interest in reading (Lin et al., 2021; Pu et al., 2021; C. H. Wu et al., 2022), while gamification applications can extend the learning focus (Faria et al., 2020). Furthermore, adaptive quizzes can encourage exploration (Joshi & Ramnath, 2025).

AI also supports inclusion. Speech-to-text technology assists students with dyslexia (Shalileh et al., 2023), while pronunciation support strengthens second language acquisition (Mertala et al., 2022). Furthermore, predictive analytics can detect learning difficulties at an early stage.

AI reduces administrative burdens, freeing up teachers' time. Real-time dashboards and automated grading allow for greater interaction (Butler & Starkey, 2024). Formative assessment tools generate personalised feedback (Villegas-Ch et al., 2024), while learning analytics strengthen data-driven planning (Akintolu & Oyekunle, 2025).

AI integration also fosters computational thinking and digital literacy from an early age. Students learn to understand algorithms and logic (G. K. W. Wong et al., 2024), develop problem-solving skills through block-based programming (Abar et al., 2021) and prepare for STEM careers (Hughes et al., 2022; Jang et al., 2022).

In terms of accessibility, AI enables flexible learning outside the classroom. Mobile platforms support mathematics (Relmasira et al., 2023) and language learning (Yu et al., 2022). Real-time feedback also improves metacognition and retention (Villegas-Ch et al., 2024).

Furthermore, AI fosters collaboration and creativity through activities such as storytelling with robots (Pont-Niclòs et al., 2024), collaborative problem-solving in mathematics (Benvenuti et al., 2023), and creative exploration with writing assistants (Villegas-Ch et al., 2024).

Overall, AI acts as a pedagogical partner that enriches the learning experience. However, most studies are still short-term and contextual. Future research should therefore focus on longitudinal studies, sustainability and scalability across socioeconomic and cultural contexts.

4. Challenges and Barriers in Implementing AI in Primary Schools

The analysis of 54 articles reveals that the primary challenges in implementing AI in elementary schools pertain to infrastructural limitations and access to technology (Darmawan et al., 2024). It is evident that a considerable number of elementary schools, particularly in remote regions, encounter challenges due to their limited access to hardware, internet networks, and electricity (Faria et al., 2020; Tabuenca et al., 2024). These limitations act as substantial impediments to the integration of AI-based systems within these educational institutions. This condition is exacerbated by the digital divide between urban and rural schools, resulting in uneven AI adoption (Li & Noori, 2024).

Furthermore, the competence of teaching staff represents a significant challenge. It is evident that the majority of elementary school teachers have not yet attained the level of technological literacy and pedagogical expertise necessary to incorporate AI into their lesson plans. This finding aligns with the observations of Galindo-Domínguez et al., (2024), who emphasised that without ongoing professional development, educators often encounter challenges in effectively utilising AI. This challenge is also related to the limitations of the curriculum and learning content, which do not yet fully accommodate AI literacy-based material, leaving teachers without clear guidelines (Fundi et al., 2024; H. Moon et al., 2024).

Conversely, the financial implications of implementing AI can also act as a significant impediment. The procurement of equipment, software licenses, and maintenance costs require a substantial budget, which is challenging for most public and small private elementary schools to meet (Aslan et al., 2024; Darmawan et al., 2024). The financial constraints experienced by educational institutions frequently result in the implementation of technology being undertaken on a limited scale rather than on a full scale.

Privacy and data ethics issues have also been raised in a number of studies. For instance, (Pont-Niclòs et al., 2024; Uğraş et al., 2024) emphasise the potential risks to student data security when artificial intelligence systems are employed for learning analysis. Butler & Starkey, (2024) concurs with this sentiment, emphasising the importance of specific regulations for protecting children's data in educational settings. This issue is of particular pertinence when considering the vulnerability of elementary school students.

Furthermore, several studies emphasise the risk of dependence on technology, which has the potential to reduce students' critical thinking and problem-solving abilities if AI is used excessively (Horvers et al., 2024). Furthermore, numerous AI applications are constrained by limitations pertaining to language and cultural context. This is evidenced by the absence of comprehensive support from the system for regional languages and local nuances (Mertala et al., 2022).

The challenges identified demonstrate that integrating AI into elementary schools necessitates a comprehensive approach. This approach should include the following: improving teacher capacity, investing in infrastructure, adjusting the curriculum, and establishing clear regulations regarding data use ethics. Consequently, the success of AI implementation is contingent not solely on the technology itself, but also on the readiness of the broader education ecosystem (W. Moon et al., 2024).

CONCLUSION

This systematic review synthesizes 54 Scopus-indexed studies published between 2020 and 2024 on the integration of artificial intelligence (AI) in primary education. The findings yielded several key insights that addressed the four guiding research questions.

First, an analysis of publication trends (RQ1) reveals a steady and significant growth of scholarly interest in AI in primary education, with a notable surge in 2024. The focus of research is predominantly centered in technologically advanced countries, including China, the United States, and several European nations. This concentration is indicative of both substantial financial support for research initiatives and the influence of global digitalization policies. Notwithstanding, studies from developing regions remain limited, thereby raising questions about the global representativeness of current evidence.

Secondly, the review identifies a wide range of AI applications (RQ2), including machine learning, deep learning, natural language processing, adaptive learning systems, robotics, and educational data mining. These technologies are employed to personalize learning, provide automated assessments, support computational thinking, and enhance engagement through interactive tools. The broad array of applications underscores the potential of AI to function not only as a support tool for educators but also as a learning partner for students.

Thirdly, the review underscores numerous advantages of AI integration (RQ3) across cognitive, pedagogical, affective, and organizational domains. The most frequently reported advantage of personalization of learning was its ability to foster student autonomy, followed by its capacity to promote inclusivity and support for diverse learners, enhance teacher efficiency, and cultivate digital literacy. Additionally, AI has been demonstrated to enhance accessibility, facilitate real-time feedback, and promote collaboration and creativity in classroom settings.

The analysis emphasizes persistent challenges and barriers (RQ4), including infrastructural limitations, the digital divide, insufficient teacher readiness, high implementation costs, and concerns over data ethics and privacy. Furthermore, the presence of cultural and linguistic disparities, in conjunction with the potential pitfalls associated with excessive reliance on technological solutions, underscores

the necessity for meticulous consideration to ensure the equitable and conscientious integration of these innovations.

Moreover, the Government of Indonesia, through the auspices of the Ministry of Primary and Secondary Education (Kemendikdasmen), has embarked on a series of concrete initiatives to integrate artificial intelligence (AI) into primary education. Key measures include the development of a new curriculum that introduces coding and AI as elective subjects, commencing in the 2025–2026 academic year; teacher training programs to enhance pedagogical readiness; and focus group discussions (FGDs) to formulate effective integration strategies. Minister Abdul Mu'ti and Deputy Minister Fajar Riza Ul Haq have emphasized that the objective of these initiatives is to equip young Indonesians with the necessary digital competencies and global competitiveness. The implementation of the AI and coding curriculum is scheduled to occur primarily in Grade 5. The curriculum will emphasize not only programming skills but also computational thinking, problem-solving, and algorithmic logic. The government's efforts to address these disparities include collaborations with educational institutions, communities, and private sectors to ensure an inclusive and equitable digital transformation. Such initiatives are indicative of Indonesia's escalating commitment to cultivating a future-ready generation, one that is adept at leading in the era of technological advancement.

The findings, when considered collectively, indicate that artificial intelligence (AI) possesses the capacity to effect profound and revolutionary change in the domain of primary education. However, the successful implementation of AI in this context is contingent upon the readiness of the broader educational ecosystem. This encompasses investments in infrastructure, teacher professional development, ethical governance, and context-sensitive curriculum integration. Future research should prioritize longitudinal studies, comparative analyses across socio-economic and regional contexts, and the development of evidence-based guidelines to inform practice and policy. Addressing these gaps is imperative for leveraging AI as a tool to support inclusive, equitable, and high-quality primary education.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author(s).

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