



Research on the Transformation of Teaching and Learning Methods in Primary School Mathematics Classrooms Enabled by Artificial Intelligence

Yuqing Yuan^{ID}

School of Education Science, Qingdao University, Qingdao, 266071, China

yuanyuqing@qdu.edu.cn

Abstract. Artificial intelligence (AI) offers transformative potential for primary school mathematics education through personalized learning and intelligent teaching support. However, challenges such as insufficient AI-aligned resources, teachers' low technical literacy, and students' over-reliance on technology hinder effective implementation. This study proposes actionable strategies—including tiered resource development, teacher capacity-building frameworks, and student autonomy scaffolding—to guide AI integration while balancing pedagogical and ethical considerations.

Keywords: Artificial Intelligence; Primary School Classroom Teaching; Learning Model Change; Teaching Resources; Technical Literacy.

1 Introduction

1.1 Background of AI in Education

In the digital age, artificial intelligence (AI) has become an important force in many industries, including education. The fast development of technologies like machine learning, natural language processing, and computer vision has created new opportunities for educational changes. AI-driven educational tools can look at a lot of student data, helping to understand each student's learning patterns and needs. In higher education, AI is used for personalized learning platforms, smart tutoring systems, and automatic assessments.

In primary education, AI is slowly becoming more popular. Primary schools, which are the start of a student's learning journey, are looking for ways to improve teaching and meet the different needs of young students. AI has the ability to change traditional teaching methods, making learning more interesting, interactive, and personal.

1.2 The Significance of AI Empowering Primary School Teaching

The significance of AI empowering primary school teaching is multifaceted. From a theoretical perspective, it enriches educational theory by exploring the intersection of

AI technology and early education, and helps develop new educational models and frameworks that are more in line with the characteristics of young learners. At the practical level, for teachers, AI provides intelligent teaching support, such as real-time feedback on student performance, automatic lesson preparation, and targeted teaching suggestions. For students, it provides a personalized learning experience.

1.3 Research Objectives and Questions

This study aims to explore effective AI integration strategies in primary mathematics classrooms, addressing:

1. Current challenges in AI resource alignment and teacher training.
2. Methods to develop curriculum-compliant AI tools.
3. Strategies to balance technology reliance and critical thinking.

2 Literature Review: AI in Primary Education

2.1 Applications of AI in Education

Recent advancements in artificial intelligence (AI) have significantly reshaped educational practices, particularly in personalized learning and adaptive instruction. Studies demonstrate that AI-driven tools, such as intelligent tutoring systems (ITS), enhance student engagement by dynamically adjusting content complexity based on real-time performance metrics [1]. For instance, natural language processing (NLP) applications facilitate language acquisition through interactive dialogue systems, enabling tailored feedback for primary school learners [2]. Additionally, AI-powered analytics platforms enable educators to identify learning gaps and predict academic outcomes, thereby optimizing curriculum design [8].

Beyond individualized learning, gamified AI environments have been shown to improve problem-solving skills in mathematics by combining adaptive algorithms with motivational elements [4]. These systems align with constructivist pedagogical approaches, fostering active participation and self-regulated learning [10]. However, disparities in AI adoption persist across regions, influenced by infrastructural readiness and resource allocation [3]. For example, OECD (2022) highlights that only 35% of schools in low-income regions have access to AI tools, compared to 82% in high-income areas, exacerbating educational inequity.

Critical challenges also emerge in ethical and cultural dimensions. Chen et al. argue that AI-driven primary education risks reducing human interaction, potentially undermining socio-emotional development—a concern particularly salient in collectivist cultures where teacher-student relationships are central.

2.2 Transformations in Primary School Teaching and Learning Modes

AI technologies are redefining traditional teacher-centered models by promoting hybrid pedagogies that blend online and offline interactions. For example, flipped classrooms

augmented by AI recommendation systems allow students to pre-learn foundational concepts through curated digital content, freeing classroom time for collaborative activities [5]. Teachers utilize generative AI tools to create multilingual resources, accommodating diverse linguistic backgrounds within heterogeneous classrooms [9].

Nevertheless, tensions exist between AI's efficiency and the preservation of holistic education. While AI can automate routine tasks like grading [1], over-reliance on technology may marginalize creative and critical thinking skills. Khan emphasizes that AI scaffolding must transition students from dependency to autonomy, a balance yet to be systematically addressed in primary education [10].

2.3 Research Gaps and Motivation

Existing literature predominantly focuses on higher education, with limited empirical studies on AI's integration in primary schools [8]. Key gaps include:

1. Teacher Training: Few studies explore scalable strategies for improving educators' AI literacy, especially in resource-constrained settings [9].

2. Curriculum Alignment: Only 40% of AI tools align with national primary education standards, often prioritizing rote learning over critical competencies [7].

3. Ethical Frameworks: Current AI systems lack robust safeguards for minors' data privacy and cultural adaptability [4][6].

This study addresses these gaps by proposing actionable strategies for AI integration, grounded in both pedagogical theory and empirical evidence from diverse primary school contexts.

3 Theoretical Framework

AI integration in primary education adheres to three principles: (1) pedagogical alignment with curriculum goals, (2) ethical transparency in data usage, and (3) developmental appropriateness for young learners' cognitive stages.

4 Current Status Analysis

4.1 Existing Applications of AI in Primary School Classrooms

This study adopted a mixed research method and surveyed 12 public primary schools in three provinces in eastern China (Shandong, Jiangsu, and Zhejiang), covering 320 teachers and 1,500 students. Data were collected through questionnaires (teachers) and classroom observations (students), and statistical analysis was performed using SPSS 26.0.

4.2 Shortage of AI-based Teaching Resources

As shown in Figure 1, a survey of 12 Chinese primary schools (N=320 teachers, 1,500 students) revealed critical gaps:

- 1. Only 40% of AI resources meet national standards.
- 2. Over 60% of veteran teachers struggle with AI tools.
- 3. Most training programs lack AI integration strategies.

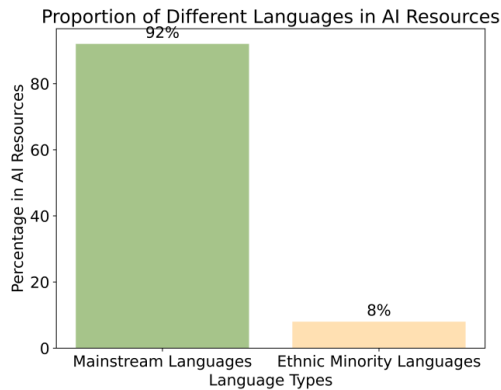


Fig. 1. Proportion of Different Languages in AI Resources

4.3 Current Status of Teachers’ Technological Literacy

A 2024 survey showed a split in teachers' tech skills. As shown in Figure 2:

- 75% of teachers under 35 can use AI tools like digital lesson - planning apps.
- 60% of teachers with over 15 years' experience struggle to interpret AI - system data.

Systematic training gaps still exist, with 67% of professional development programs Also, 70% of professional development programs lack AI - integration strategies. As a result, 68% of classrooms only use AI for basic tasks like grading. As shown in Figure 3.

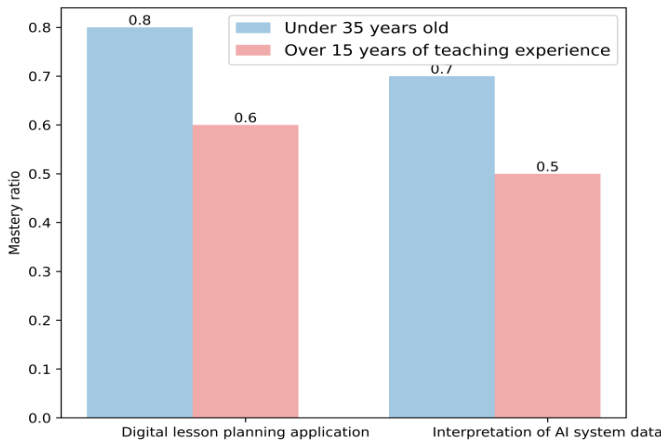


Fig. 2. Mastery ratio of AI tools used by teachers in different teaching - experience groups

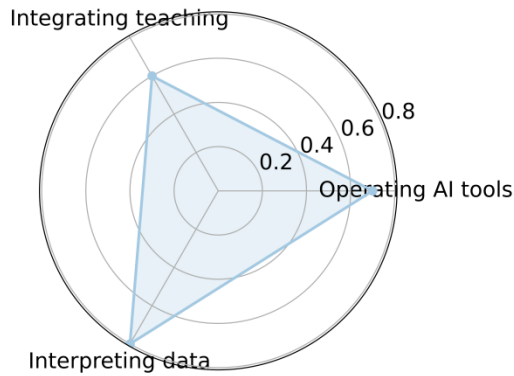


Fig. 3. Teachers ability levels in different AI technology literacy aspects

5 Strategies for AI Transformation

1. **Resource Development:** Modular AI tools aligned with curriculum standards, co-designed by educators and developers.
2. **Teacher Training:** Embed AI literacy in pre-service programs and peer mentorship networks.
3. **Student Autonomy:** Define clear AI usage boundaries (e.g., AI-free zones for critical tasks).

6 Conclusion

The integration of AI in primary education has both potential and challenges. AI-driven tools can personalize teaching and boost student engagement, but adoption is uneven due to a lack of resources and teacher training. Excessive dependence on AI tools could hinder critical thinking development, particularly in tasks requiring independent problem-solving [7]. For systemic reform, curriculum frameworks should incorporate AI literacy, policymakers must ensure equitable access to resources, and teacher training programs need to blend technical skills with teaching strategies. Future studies should explore AI's long-term effects on young learners, cultural adaptability, and teacher-AI collaboration models. Interdisciplinary efforts are essential for ethical and scalable AI integration.

Disclosure of Interests

The authors have no competing interests to declare that are relevant to the content of this article.

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