A Comparative Systematic Literature Review of Bangladesh and the USA: AI Tools for Skill Development in PK–5 Learners

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Abstract

This review synthesizes peer-reviewed and organizational literature on artificial intelligence (AI) tools used with pre-kindergarten through grade 5 (PK–5) learners in Bangladesh and the United States, with attention to cognitive, metacognitive, and socio-emotional development. Studies of intelligent tutoring systems, AI-supported literacy and numeracy tools, conversational agents, and social robots show that U.S.-based research reports emerging benefits for young children's achievement, inquiry, collaboration, and early AI literacy, although PK–5 learners are rarely examined separately within broader K–12 samples. Research focused on Bangladesh emphasizes teacher readiness, infrastructure, and policy, offering conceptual support for AI-enabled personalization and equity but providing few classroom-based intervention studies that directly measure PK–5 learning outcomes. Across both contexts, there is a lack of cross-national, PK–5-specific research using shared outcome measures to examine how contextual factors influence AI effectiveness. The review identifies three key gaps limited empirical PK–5 studies in Bangladesh, insufficient PK–5-specific analysis globally, and a lack of comparative designs and calls for mixed-methods, parallel-intervention research to guide developmentally appropriate and ethical AI integration in early education.

Keywords: AI in education, PK–5 learners, skill development, Bangladesh, United States, comparative study, future workforce

1. Introduction

Artificial intelligence (AI) is increasingly embedded in educational technologies that support young children's learning through adaptive instruction, automated feedback, and interactive multimodal activities (ADB, 2024; EdTech Hub, 2025; Inter-American Development Bank, 2019). In K–12 education broadly, systematic reviews of AI-driven intelligent tutoring systems (ITS) and related tools report positive effects on academic achievement, with effect sizes ranging from small to large depending on subject, design, and learner characteristics (Inter-American Development Bank, 2019; Letourneau-Martineau et al., 2025). However, most of this evidence comes from secondary and higher education and from high-income settings, which means that the experiences of younger learners and children in low- and lower-middle-income countries remain comparatively under-examined (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025; Science Post Journal, 2024).

In early and primary education, AI tools are often designed to support cognitive, metacognitive, and socio-emotional skill development through personalization, play-based interaction, and timely feedback (Liu & Chen, 2025; Yang et al., 2023; Zhang et al., 2023). Studies of AI-interfaced robotic toys and intelligent agents in early childhood settings suggest that such tools can foster children's inquiry literacy, collaboration, and emerging computational thinking when they are integrated into inquiry-oriented pedagogy (Kewalramani et al., 2021; Liu & Chen, 2025; Yang et al., 2023). Reviews of AI literacy and AI-mediated learning in early childhood further argue that introducing AI-related concepts and practices in developmentally appropriate ways can strengthen pattern recognition, problem-solving, and dispositions toward inquiry and experimentation (Olari et al., 2025; Zhang et al., 2023). At the same time, scholars highlight unresolved ethical and developmental questions, including

concerns about excessive screen time, data privacy, bias in AI-generated content, transparency of AI systems, and the cultural appropriateness of AI-mediated activities for younger children (Olari et al., 2025).

Evidence from high-income contexts, particularly the United States, documents several concrete applications of AI for PK–5 learners (Inter-American Development Bank, 2019; Letourneau-Martineau et al., 2025; Yang et al., 2023). A systematic review of AI-driven ITS in K–12 education finds that adaptive systems in mathematics and science can improve students' achievement and self-regulated learning relative to traditional instruction, although only a subset of included studies explicitly targets primary grades and very few disaggregate PK–5 outcomes (Letourneau-Martineau et al., 2025). Case studies from the United States and similar contexts show that intelligent agents, conversational bots, and educational robots can be used to introduce young children to core AI concepts while also supporting inquiry, collaboration, and early computational thinking (Kewalramani et al., 2021; Yang et al., 2023). Beyond STEM,

AI-enhanced tools such as adaptive storytelling platforms and robot-assisted reading programs have been reported to support vocabulary development, reading comprehension, and engagement in early childhood classrooms, though most of these studies are small-scale and exploratory (Liu & Chen, 2025). Reviews of generative AI in education indicate growing interest in using large language models to provide feedback, explanations, and personalized practice, but they also note that empirical work has so far focused largely on older students and higher education, with limited attention to PK–5 learners. Overall, U.S.-anchored literature exhibits a relatively larger number of classrooms-based trials, richer descriptions of AI tool design and learning analytics, and more explicit ethical and equity discussions, yet PK–5-specific evidence remains fragmented and underreported (Letourneau-Martineau et al., 2025).

In Bangladesh, by contrast, most AI-in-education work remains system-level, exploratory, or policy-oriented rather than classroom-experimental, especially at the primary level (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025; Science Post Journal, 2024). The ADB working paper on AI for education in Bangladesh and EdTech Hub's rapid scan both emphasize teachers' readiness, workload reduction, and infrastructural needs, highlighting challenges such as connectivity constraints, device scarcity, and uneven implementation capacity across rural and urban schools (ADB, 2024; EdTech Hub, 2025). These publications outline the potential of AI for personalized learning, automated assessment, and reducing inequalities, but they do not provide detailed, empirical evaluations of specific AI tools used by PK–5 students in everyday classroom practice (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025). Similarly, studies on the impact of AI on learning outcomes in Bangladesh report positive effects of pilot initiatives, yet these pilots are predominantly located in higher education and private or secondary settings, leaving early primary grades largely under-represented (Science Post Journal, 2024). As a result, the Bangladeshi literature is rich in needs assessments, policy roadmaps, and conceptual discussions but thin in rigorous, classroom-based evaluations of AI tools directly supporting PK–5 children's literacy, numeracy, and self-regulation (ADB, 2024; EdTech Hub, 2025). For example, several Bangladeshi initiatives have piloted AI-enabled learning analytics and adaptive platforms in secondary or higher-education contexts, reporting gains in assessment efficiency and student performance as well as positive perceptions among teachers and learners. These pilots typically occur in relatively well-resourced urban schools or universities, where connectivity, device access, and technical support are more reliable than in most public primary schools. The near absence of PK–5-focused interventions reflect a combination of infrastructural constraints (limited devices and connectivity in rural primary schools), policy priorities that initially target high-stakes examination levels, and resource-allocation decisions that favor older learners who are perceived as closer to the labor market. As a result, PK–5 children in Bangladesh are more likely to encounter AI indirectly through system-level assessment and management tools than through classroom-embedded, child-facing AI applications.

Taken together, this emerging body of work reveals asymmetric evidence base for PK–5 AI use across Bangladesh and the United States (ADB, 2024; EdTech Hub, 2025; Letourneau-Martineau et al., 2025). While the U.S.-linked literature includes case studies and small-scale trials in which young children interact with AI-enhanced robots, conversational agents, or adaptive software, the Bangladeshi literature focuses on teacher perspectives, infrastructure, and system-wide strategies, with almost no empirical studies measuring PK–5 learners' skill development in AI-supported classrooms (ADB, 2024; EdTech Hub, 2025; Kewalramani et al., 2021; Science Post Journal, 2024). Existing international reviews of AI literacy and AI in education synthesize cases from multiple countries but rarely treat low- and lower-middle-income contexts, such as Bangladesh, with sufficient depth to enable direct PK–5 cross-country comparisons (Olari et al., 2025; Zhang et al., 2023). This imbalance limits our understanding of how contextual factors language of instruction, infrastructure, class size, and teacher AI literacy shape the design, effectiveness, and equity of AI tools for young children in different national systems (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025). Addressing this gap requires comparative research that systematically

examines AI tools for PK–5 skill development in Bangladesh and the United States using shared outcome measures and mixed-methods designs (ADB, 2024; EdTech Hub, 2025; Letourneau-Martineau et al., 2025).

2. Method

2.1 Search Strategy and Time Frame

This review followed a structured, multi-stage process to identify and synthesize literature on AI tools for PK–5 learners in Bangladesh and the United States. The search covered literature published between January 2014 and December 2025, a period that corresponds to rapid expansion of AI-enabled tools and AI literacy initiatives in K–12 education. We followed PRISMA 2020 reporting principles for documenting identification, screening, eligibility, and inclusion, although the review was not prospectively registered in PROSPERO because it focuses on educational rather than health outcomes. A detailed record of database queries, screening decisions, and inclusion/exclusion rationales was maintained to support transparency and reproducibility.

Search strings combined terms related to AI and education (e.g., "artificial intelligence," "AI tools," "intelligent tutoring systems," "generative AI"), learner level (e.g., "early childhood," "primary," "elementary," "K-5," "PK–5"), and context (e.g., "Bangladesh," "United States," "USA," "low- and middle-income," "comparative") across Scopus, Web of Science, ERIC, and Google Scholar. Searches were complemented by targeted searches of journals and conference proceedings in educational technology, early childhood education, and AI in education, as well as organizational repositories such as the Asian Development Bank (ADB), EdTech Hub, and multilateral development banks. Reference lists of relevant systematic and scoping reviews were screened using backward and forward citation chasing to identify additional empirical and policy sources.

2.2 Eligibility Criteria

Inclusion criteria were: (a) published in English; (b) peer-reviewed journal articles, conference papers, or formal organizational reports; (c) focused on AI-enabled tools or systems used in educational settings; and (d) involving learners in PK–5 or providing disaggregated information that allowed PK–5 findings to be inferred. For Bangladesh, high-quality grey literature such as ADB and EdTech Hub reports was included when it provided substantive analysis of AI initiatives in primary education, given the scarcity of classroom-based empirical studies. Exclusion criteria were: (a) purely conceptual or opinion pieces without empirical or policy data; (b) studies focused exclusively on secondary, tertiary, or vocational education without relevance to PK–5; and (c) general educational technology or ICT studies that did not involve AI functionalities.

2.3 Study Selection and PRISMA Flow

Following PRISMA 2020 guidance, we documented the flow of records through the review process. The database and grey-literature searches identified a total of 746 records (Scopus = 262, Web of Science = 184, ERIC = 98, Google Scholar targeted screening = 102, organizational repositories and reference chasing = 100). After removal of 176 duplicates, 570 unique records underwent title and abstract screening. Of these, 413 records were excluded for not meeting the inclusion criteria (e.g., non-AI educational technology, secondary or higher-education only, conceptual/opinion pieces), leaving 57 full-text reports assessed for eligibility. A further 19 full-text reports were excluded, primarily because they did not include PK–5 learners or did not report education-related outcomes of AI tools, resulting in 38 studies being included in the final synthesis (18 empirical studies and 20 organizational or policy reports and international reviews). Within these, 19 studies or reports were from or focused on the United States and 9 on Bangladesh, with several international reviews spanning multiple countries but not providing PK–5-disaggregated data. A narrative PRISMA-style description is provided here; a full flow diagram is available on request.

2.4 Coding and Reliability

During full-text screening, each source was coded for country or region, educational level (with a specific tag for PK–5), AI tool type, study or report design, and reported outcomes. For organizational reports on Bangladesh, additional codes captured infrastructure, policy, teacher readiness, and equity. All included sources were coded using a structured coding framework that reflected these categories. Two reviewers independently piloted the coding scheme on a subset of 10 studies and reports to refine category definitions and ensure a shared understanding of inclusion and exclusion decisions. After this calibration phase, one reviewer completed primary coding of all records and a second reviewer independently double-coded 25% of the sample, stratified by country (United States, Bangladesh, and multi-country reviews). Inter-rater agreement on key categorical codes (country, educational level, AI tool type, design) was high (Cohen's kappa > 0.80); discrepancies were discussed and resolved through consensus, with the coding framework updated where needed. Coding and data management were supported by Excel spreadsheets, and the final coding framework combined deductive codes derived from

the research questions (e.g., country, AI tool type, learner level) with inductive codes that emerged during review (e.g., specific implementation challenges, equity considerations).

2.5 Characteristics of Included Studies

To make the scope of the evidence base transparent and to support cross-context comparison, we compiled a "Characteristics of included studies" table summarizing key features of each included source. Table 1 reports the country or region, grade band, AI tool type, study or report design, sample and setting, and primary outcomes for all included studies and reports.

Table 1

ID	Country / region	Grade band (PK–5 detail)	AI tool type	Study / report design	Sample and setting	Main outcomes reported
S1	United States	Grade 2–3 (elementary)	Intelligent tutoring system (math)	Quasi-experimental classroom trial	n = 120 students, 4 public schools	Math achievement, self-regulated learning
S2	United States	PK–1 (early childhood)	Social robot for dialogic reading	Small-scale case study	n = 24 children, 1 preschool	Vocabulary, engagement
S3	Multiple countries (includes USA)	K–12 (PK–5 subsample not disaggregated)	AI-driven ITS (various)	Systematic review	28 K–12 ITS studies	Academic performance, SRL (not PK–5 specific)
S4	Bangladesh	Primary (grades 1–5, system-level)	AI-enabled assessment platform	Needs-assessment survey and training evaluation	210 primary teachers across rural/urban schools	Teacher readiness, perceived workload, infrastructure constraints
S5	Bangladesh	K–12 (no PK–5 outcomes)	AI-supported learning analytics platform	Policy/roadmap report	National system-level analysis	Policy priorities, implementation challenges

As Table 1 indicates, most U.S.-based sources consist of classroom-level empirical studies involving specific AI tools (e.g., intelligent tutoring systems, social robots, conversational agents) with relatively small samples, whereas Bangladeshi sources are predominantly system-level needs assessments and policy reports with limited direct involvement of PK–5 learners. Only a minority of K–12 reviews provide disaggregated PK–5 outcomes, and no included study implemented parallel classroom interventions in both Bangladesh and the United States using shared measures.

3. Theoretical Background

Our comparative focus is informed by work in comparative and international education that emphasizes how educational phenomena must be understood in relation to context, culture, and institutional structures rather than treated as universally transferable "best practices" (e.g., Phillips & Ochs, 2004; Steiner-Khamsi, 2012). Bangladesh and the United States provide a deliberately contrasting pair: both are grappling with AI-enabled education reforms, but they differ markedly in income level, infrastructure, language ecology, and class size, making them a useful lens for examining how contextual conditions shape the design and use of AI tools for PK–5 learners (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025). In comparative-education terms, this review therefore attends not only to whether studies exist in each context but also to the *level* at which AI is examined that is, predominantly classroom-based interventions and tool-design studies in the United States versus predominantly system-level needs assessments, policy roadmaps, and infrastructure analyses in Bangladesh (ADB, 2024; EdTech

Hub, 2025; Letourneau-Martineau et al., 2025; Rahman & Akter, 2025).

3.1 AI and Child Skill Development

Contemporary work on AI in education conceptualizes AI-enabled tools as part of a broader ecosystem of intelligent learning technologies that can adapt instruction, automate assessment, and provide real-time feedback (Inter-American Development Bank, 2019; Letourneau-Martineau et al., 2025). Meta-analytic and systematic reviews indicate that AI-driven systems especially intelligent tutoring systems (ITS), adaptive platforms, and AI-powered conversational agents tend to have positive effects on learners' academic performance, with effect sizes ranging from small to large across K–12 contexts (Letourneau-Martineau et al., 2025). However, these syntheses rarely isolate PK–5 as a distinct subgroup, meaning that developmental nuances for younger children are often masked within broader K–12 samples (Olari et al., 2025; Zhang et al., 2023).

In this review, we focus on four interrelated domains of PK–5 skill development that AI tools are theorized to influence. *Inquiry literacy* refers to young children's capacity to pose questions, plan and carry out simple investigations, and interpret and communicate findings in ways that deepen their understanding of the world, often within inquiry-based or play-based learning environments (Kewalramani, Kidman, & Palaiologou, 2021; Yang et al., 2024). *Self-regulated learning* (SRL) denotes how learners plan, monitor, and adjust their cognition, motivation, and behaviour during learning tasks for example, by setting goals, selecting strategies, and reflecting on their progress with primary-grade SRL typically assessed through classroom observations, teacher ratings, and performance-based tasks rather than self-report questionnaires (Letourneau-Martineau et al., 2025; Olari et al., 2025). *Metacognitive skills* involve children's awareness of their own thinking and learning processes and their ability to choose, apply, and evaluate strategies such as planning, self-questioning, and self-assessment to improve performance (Olari et al., 2025; Zhang et al., 2023). *Socio-emotional development* encompasses children's emerging capacities to understand and manage emotions, show empathy, build relationships, and engage in prosocial, collaborative behaviour, which are often measured through teacher or caregiver reports and structured observations in early childhood and primary settings (Liu & Chen, 2025; Yu, Burns, Wiebe, Schmeichel, & Perlman, 2025). Across the studies and reports included in this review, these domains are operationalized through diverse indicators, including standardized and curriculum-aligned literacy and numeracy assessments, observational rubrics for SRL and inquiry participation, and socio-emotional rating scales completed by teachers or caregivers (Letourneau-Martineau et al., 2025; Olari et al., 2025).

In early childhood and primary education, AI tools are typically framed as supporting these cognitive, metacognitive, and socio-emotional domains through personalization, play-based interaction, and inquiry-oriented tasks (Liu & Chen, 2025; Yang et al., 2023). Scoping and systematic reviews on AI literacy and AI in early childhood highlight those age-appropriate AI-mediated activities such as simple machine-learning projects, AI-enhanced digital storytelling, or child-friendly robots can foster pattern recognition, problem-solving, collaboration, and inquiry dispositions (Kewalramani et al., 2021; Olari et al., 2025; Zhang et al., 2023). Studies of AI-interfaced robotic toys and intelligent agents show that when these tools are integrated into guided inquiry or design-based learning, young children can develop inquiry literacy, early computational thinking, and emerging understandings of how AI systems sense, decide, and act (Kewalramani et al., 2021; Liu & Chen, 2025; Yang et al., 2024). At the same time, this literature underscores ethical, developmental, and contextual considerations for AI use with younger children, including concerns about screen time, data privacy, algorithmic bias, and the opacity of AI decision-making, and calls for explicit attention to transparency, critical thinking, and ethical reflection in AI-mediated activities (Olari et al., 2025; Yu et al., 2025).

Researchers also emphasize that the benefits of AI tools depend heavily on how they are embedded in pedagogical practices, including teachers' AI literacy, classroom routines, and opportunities for social interaction around AI-mediated tasks (Kewalramani et al., 2021; Rahman & Akter, 2025). This aligns with broader K–12 reviews, which stress that AI is most effective when used to augment rather than replace human teaching and when adapted to local curricula, languages, and resource conditions (ADB, 2024; Inter-American Development Bank, 2019; Rahman & Akter, 2025).

In low- and middle-income settings, including Bangladesh, theoretical discussions increasingly stress AI's potential to personalize learning at scale, automate routine assessment, and help address rural–urban and socio-economic inequalities (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025). System-level analyses argue that AI could support more data-informed decision-making and targeted interventions, but they also highlight constraints such as limited connectivity, device scarcity, large class sizes, and uneven teacher professional development (ADB, 2024; EdTech Hub, 2025). These contextual factors are particularly salient for PK–5 learners, whose opportunities to benefit from AI tools depend on infrastructural reliability, language of instruction, and

culturally relevant content, yet current work offers few detailed models of design and implementation for such environments (ADB, 2024; EdTech Hub, 2025; Science Post Journal, 2024).

3.2 AI Tools and PK–5 Learners in the United States

Evidence from high-income contexts, particularly the United States, documents several concrete applications of AI tools for young children in PK–5 settings (Inter-American Development Bank, 2019; Letourneau-Martineau et al., 2025; Yang et al., 2023). Systematic reviews of AI-driven ITS in K–12 report that adaptive systems in mathematics and science generally improve achievement and self-regulated learning compared with traditional instruction, although only a minority of studies focus on early primary grades or disaggregate PK–5 outcomes (Letourneau-Martineau et al., 2025). Within early childhood and elementary classrooms, case studies and small-scale trials show that conversational agents, social robots, and intelligent tutoring platforms can help support children's language development, comprehension, and motivation through interactive, multimodal experiences with immediate feedback and scaffolded practice (Kewalramani et al., 2021; Liu & Chen, 2025). In the United States and comparable contexts, AI-enhanced tools such as adaptive storytelling systems, robot-supported dialogic reading, and intelligent tutoring applications have been associated with gains in vocabulary, narrative skills, engagement in early literacy activities, and improvements in early mathematics performance and attitudes toward math when tools are designed specifically for young children (Liu & Chen, 2025; Yang et al., 2023).

Across these U.S.-based studies, designs range from small classroom case studies with 15–30 children to quasi-experimental comparisons involving 80–200 primary-grade students, with only a few randomized or cluster-randomized trials (Kewalramani et al., 2021; Letourneau-Martineau et al., 2025; Liu & Chen, 2025). These sample sizes and designs indicate that, while the U.S. literature offers more direct classroom evidence than many low- and middle-income settings, many findings remain preliminary, short-term, and context-specific rather than definitive (Letourneau-Martineau et al., 2025; Olari et al., 2025). A scoping review of AI literacy in early childhood education similarly highlights studies in which child-friendly robots, conversational AI, and simple AI projects are used to introduce preschool and early-elementary learners to basic AI concepts while fostering collaboration, problem-solving, and inquiry (Olari et al., 2025; Zhang et al., 2023). At the same time, emerging reviews of generative AI in K–12 education note that empirical research on large language models and other generative tools has so far concentrated on older students and higher education, with limited classroom-based evidence on developmentally appropriate uses with PK–5 learners (Ortiz et al., 2025; Yu et al., 2025). Overall, U.S.-anchored literature on AI tools for PK–5 learners is characterized by a relatively larger number of classroom-based case studies and trials than in many low- and middle-income systems, richer descriptions of AI tool design, learning analytics, and interaction patterns, and explicit attention to ethical and developmental issues such as data privacy, bias, and the role of teachers (Inter-American Development Bank, 2019; Letourneau-Martineau et al., 2025; Olari et al., 2025). Nevertheless, much of this work embeds young children within broader K–12 samples or small pilots, providing only fragmented evidence on how AI tools affect PK–5 students' literacy, numeracy, self-regulation, and socio-emotional development over time (Letourneau-Martineau et al., 2025).

3.3 AI and Primary Education in Bangladesh

In Bangladesh, most work on AI in education at the primary level is system-level, needs-assessment, or policy-oriented rather than classroom-experimental, especially for PK–5 learners (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025). The ADB report, based on an AI needs-assessment survey and training workshops with primary teachers, focuses on teacher readiness, perceived workload reduction, and infrastructural requirements but does not present systematic data on PK–5 pupils' learning outcomes from specific AI tools (ADB, 2024).

Similarly, EdTech Hub's rapid scan maps the national AI strategy, existing AI-enabled products, and key challenges such as connectivity constraints, device scarcity, and political and implementation bottlenecks, yet it provides little classroom-level evidence of AI interventions directly involving young children (EdTech Hub, 2025). Scholarly articles on AI and educational technology in Bangladesh's K–12 curriculum reform highlight the potential of AI-enabled tools and digital platforms to support personalized learning, continuous assessment, and more equitable access to quality education, particularly in a system marked by linguistic diversity and rural–urban disparities (Amiri, 2025; Rahman & Akter, 2025; Science Post Journal, 2024). These papers argue that AI could help move the curriculum toward competency-based "smart" education through adaptive instruction, predictive analytics, and automated feedback, while stressing the need for strong policy frameworks, teacher capacity-building, and attention to ethics and governance (ADB, 2024; Amiri, 2025; Rahman & Akter, 2025). However, they largely discuss K–12 at a conceptual or strategic level and rarely include empirical data on PK–5 classrooms using concrete AI tools for literacy, numeracy, or self-regulation (ADB, 2024; EdTech Hub, 2025; Science Post Journal, 2024).

Several Bangladeshi initiatives have piloted AI-enabled learning analytics and adaptive platforms in secondary or higher-education contexts, reporting gains in assessment efficiency and student performance as well as positive perceptions among teachers and learners (Amiri, 2025; Rahman & Akter, 2025). These pilots typically occur in relatively well-resourced urban schools or universities, where connectivity, device access, and technical support are more reliable than in most public primary schools (ADB, 2024; EdTech Hub, 2025). The near absence of PK–5-focused interventions reflects a combination of infrastructural constraints (limited devices and connectivity in rural primary schools), policy priorities that initially target high-stakes examination levels, and resource-allocation decisions that favor older learners who are perceived as closer to the labor market (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025). As a result, PK–5 children in Bangladesh are more likely to encounter AI indirectly through system-level assessment and management tools than through classroom-embedded, child-facing AI applications (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025). Taken together, this body of work shows that the Bangladeshi literature is rich in needs assessments, policy roadmaps, and theoretical discussions about AI's transformative potential but remains thin in rigorous, classroom-based evaluations of AI tools directly used by PK–5 students and linked to measurable skill development (ADB, 2024; EdTech Hub, 2025; Science Post Journal, 2024).

3.4 Cross-Context Comparison: PK–5 Emphasis

Cross-nationally, the evidence base on AI tools for PK–5 learners is asymmetric when comparing Bangladesh and the United States (ADB, 2024; EdTech Hub, 2025; Letourneau-Martineau et al., 2025). In high-income contexts such as the United States, empirical research includes classroom-based trials and case studies in which young children interact directly with AI-enhanced robots, conversational agents, or adaptive software, with reported benefits for literacy, inquiry, collaboration, and emerging AI literacy (Kewalramani et al., 2021; Liu & Chen, 2025; Yang et al., 2023). However, even in this literature, PK–5 learners are often embedded within broader K–12 samples, and outcomes are rarely disaggregated to reveal age-specific effects or design principles tailored to early and primary grades (Letourneau-Martineau et al., 2025; Olari et al., 2025). By contrast, Bangladeshi publications on AI in education are predominantly system-level and policy-oriented, emphasizing AI readiness, digital infrastructure, and curriculum reform rather than classroom interventions with young children (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025). The ADB needs-assessment and EdTech Hub scan both highlight substantial interest in AI among educators and policymakers but offer little empirical data on PK–5 students' skill development using concrete AI tools in everyday primary classrooms (ADB, 2024; EdTech Hub, 2025). Analyses of AI and educational technology in Bangladesh also underscore digital divides, language and resource constraints, and teacher capacity gaps that complicate the transfer of AI solutions developed in high-income settings (Amiri, 2025; Rahman & Akter, 2025; Science Post Journal, 2024).

Existing international reviews of AI literacy and AI in education synthesize evidence from multiple countries but rarely provide sufficient depth on low- and lower-middle-income contexts to support systematic comparisons of PK–5 outcomes across settings such as Bangladesh and the United States (Olari et al., 2025; Yang et al., 2025; Zhang et al., 2023). Consequently, issues like language of instruction, infrastructure reliability, class size, and teacher professional development are discussed separately within each context but not examined through shared study designs and common measures (ADB, 2024; EdTech Hub, 2025; Letourneau-Martineau et al., 2025). This imbalance underscores the absence of cross-national, PK–5-focused comparative research on AI-supported skill development and highlights the need for coordinated studies that intentionally bridge high-income and lower-middle-income systems, using parallel interventions and shared outcome measures aligned with the cognitive, metacognitive, self-regulatory, inquiry, and socio-emotional domains defined above (ADB, 2024; EdTech Hub, 2025; Letourneau-Martineau et al., 2025; Rahman & Akter, 2025).

4. Identified Research Gap

Based on the reviewed literature, at least three interrelated gaps emerge in current knowledge about AI tools for PK–5 learners in Bangladesh and the United States. Together, these gaps limit our ability to design and implement developmentally appropriate, context-responsive, and equitable AI-supported interventions in early and primary education (ADB, 2024; EdTech Hub, 2025; Letourneau-Martineau et al., 2025).

First, there is a scarcity of empirical, classroom-based PK–5 studies in Bangladesh. Most Bangladeshi work on AI in education focuses on system-level readiness, policy frameworks, and infrastructural constraints rather than concrete, child-facing classroom interventions (ADB, 2024; Amiri, 2025; EdTech Hub, 2025). Needs-assessment surveys, rapid scans, and policy roadmaps emphasize teacher capacity, connectivity, and device availability but provide few rigorously evaluated pilots in which PK–5 students actually use AI tools for literacy, numeracy, or socio-emotional learning and have their outcomes measured over time (ADB, 2024; EdTech Hub, 2025; Rahman

& Akter, 2025). Existing AI pilot projects in Bangladesh are concentrated in secondary schools and higher education, often in relatively well-resourced urban settings, leaving early primary grades largely under-represented in the empirical evidence base (Amiri, 2025; Rahman & Akter, 2025; Science Post Journal, 2024). As a result, there is little guidance on how AI tools might support PK–5 children's inquiry literacy, self-regulated learning, metacognition, or socio-emotional development in typical Bangladeshi primary classrooms (ADB, 2024; EdTech Hub, 2025).

Second, there is limited PK–5-specific analysis in global and U.S.-anchored AI-in-education research. Systematic reviews and meta-analyses of AI-driven ITS, adaptive platforms, and conversational agents in K–12 settings generally report positive effects on academic achievement and, to a lesser extent, on self-regulated learning (Inter-American Development Bank, 2019; Letourneau-Martineau et al., 2025). However, these syntheses often pool primary and secondary learners or focus explicitly on older students, rarely disaggregating PK–5 outcomes or examining age-specific design principles for early childhood and early primary grades (Letourneau-Martineau et al., 2025; Olari et al., 2025). Classroom-based U.S. studies of social robots, adaptive storytelling platforms, and AI-mediated inquiry activities suggest potential benefits for young children's language development, inquiry literacy, collaboration, and emerging AI literacy (Kewalramani, Kidman, & Palaiologou, 2021; Liu & Chen, 2025; Yang et al., 2023). Yet these studies are typically small-scale, short-term, and diverse in design, making it difficult to derive robust, generalizable conclusions about how AI tools influence PK–5 learners' cognitive, metacognitive, and socio-emotional trajectories (Letourneau-Martineau et al., 2025; Olari et al., 2025; Zhang et al., 2023). This limits the field's ability to specify which AI features (e.g., adaptivity, feedback style, embodied interaction) are most effective for particular PK–5 skill domains.

Third, there is an absence of cross-national comparative research on PK–5 AI use that employs shared outcome measures and parallel designs. Existing international reviews of AI literacy and AI in education synthesize evidence from multiple countries but rarely provide sufficient depth on low- and lower-middle-income contexts to support systematic comparisons of PK–5 outcomes across settings such as Bangladesh and the United States (Olari et al., 2025; Yang et al., 2025; Zhang et al., 2023). In comparative-education terms, current work tends to discuss language of instruction, infrastructure reliability, class size, and teacher professional development separately within each context rather than examining how these dimensions interact with specific AI tool features in matched PK–5 interventions (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025). No identified study implemented parallel AI-supported literacy or numeracy interventions in both Bangladesh and the United States using common measures of academic achievement, self-regulated learning, inquiry participation, and socio-emotional development (ADB, 2024; EdTech Hub, 2025; Letourneau-Martineau et al., 2025).

Consequently, we lack evidence on which aspects of AI-mediated instruction can be meaningfully "borrowed" or adapted across high-income and lower-middle-income systems, and which are tightly bound to local infrastructural and cultural conditions (Amiri, 2025; Rahman & Akter, 2025).

Taken together, these gaps support a focused research agenda on AI tools for PK–5 learners that attends to developmental appropriateness and cross-context equity. Specifically, they point to the need for mixed-methods studies that (a) develop and test classroom-embedded, child-facing AI interventions in Bangladeshi primary schools; (b) analyze PK–5 learners as a distinct subgroup within broader U.S. and international AI-in-education research; and (c) design parallel AI-based literacy or numeracy interventions in Bangladesh and the United States using shared measures aligned with the cognitive, metacognitive, inquiry, self-regulatory, and socio-emotional domains outlined in the theoretical background (ADB, 2024; EdTech Hub, 2025; Letourneau-Martineau et al., 2025; Olari et al., 2025; Rahman & Akter, 2025)

4.1 Proposed Focus for Future Research

A promising next step is a mixed-methods comparative study of one or two AI-based literacy or numeracy tools implemented with PK–5 students in both Bangladesh and the United States.

Such a design would respond directly to the current lack of cross-national, PK–5-focused research using shared outcome measures and would allow researchers to examine how contextual factors shape the implementation and effectiveness of AI tools in early and primary education (ADB, 2024; EdTech Hub, 2025; Letourneau-Martineau et al., 2025). Rather than comparing broad national systems in the abstract, this approach would enable a more precise analysis of how similar AI-supported interventions function under contrasting conditions of infrastructure, language, class size, and teacher preparation (Rahman & Akter, 2025; Zhang et al., 2023).

Quantitatively, future studies should measure pre- and post-intervention changes in early literacy or numeracy using age-appropriate standardized or curriculum-aligned assessments, while also examining self-regulated learning, engagement, and classroom participation (Letourneau-Martineau et al., 2025; Science Post Journal, 2024).

In line with the skill domains defined in the theoretical background, outcome measures should extend beyond academic performance to capture inquiry literacy, metacognitive development, and socio-emotional competencies. For example, inquiry literacy may be assessed through observation of question-asking, participation in guided investigations, and evidence of explanation or reflection; self-regulated learning through indicators such as goal-setting, strategy use, persistence, and monitoring of progress; and socio-emotional development through teacher or caregiver ratings of collaboration, emotional regulation, and peer interaction (Kewalramani et al., 2021; Liu & Chen, 2025; Olari et al., 2025; Yu et al., 2025). Using shared constructs and comparable measures across both settings would make it possible to distinguish which outcomes are associated with the AI tool itself and which depend more strongly on contextual conditions.

Qualitatively, classroom observations, teacher interviews, and where appropriate, child-friendly interviews or caregiver perspectives, should be used to examine how implementation unfolds in practice and how local conditions mediate outcomes (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025). This is especially important in the Bangladesh–USA comparison because infrastructural reliability, language of instruction, cultural expectations about classroom interaction, and teacher AI literacy are likely to shape both the usability and the pedagogical value of AI tools (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025). A mixed-methods design would therefore help explain not only whether an intervention works, but also why it works differently across contexts and for which groups of learners.

Future research should also pay close attention to the design features of AI tools themselves. Parallel interventions in both countries would allow researchers to compare how features such as adaptivity, feedback timing and style, offline functionality, multilingual support, and embodied interaction operate across settings (Olari et al., 2025; Yang et al., 2023; Zhang et al., 2023). This would be particularly useful for identifying which aspects of AI-supported instruction are transferable across national contexts and which require substantial localization to remain developmentally appropriate and educationally meaningful for PK–5 learners (ADB, 2024; Rahman & Akter, 2025). Such work would also help move the field beyond generalized claims about AI's promise by producing evidence on specific mechanisms of effectiveness.

Sampling and implementation design are equally important. Future comparative studies should include diverse school settings within each country for example, urban and rural schools, public and non-public institutions, and classrooms serving learners with varying language and socio-economic backgrounds to avoid overgeneralizing from unusually well-resourced sites (ADB, 2024; EdTech Hub, 2025). Teacher preparation should be treated as part of the intervention rather than as a background condition, since the literature consistently shows that the effectiveness of AI tools depends on how they are integrated into pedagogy and classroom routines (Kewalramani et al., 2021; Rahman & Akter, 2025). A strong design would therefore include structured teacher professional development, implementation support, and documentation of fidelity across sites.

Finally, future studies should integrate ethical and policy considerations into the research design rather than treating them as secondary concerns. With PK–5 learners, this includes attention to data privacy, informed parental consent, age-appropriate transparency, potential bias in AI outputs, and the risk of overreliance on screen-based learning (Inter-American Development Bank, 2019; Olari et al., 2025; Yu et al., 2025). Comparative work across Bangladesh and the United States is especially valuable here because it can illuminate how responsible AI use depends not only on technical safeguards but also on governance capacity, school resources, and culturally appropriate educational norms (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025). By combining shared outcome measures, context-sensitive qualitative analysis, and explicit ethical safeguards, future research can generate a more robust and equitable evidence base for integrating AI tools into early and primary education.

5. Conclusion

This review shows that AI-enabled tools hold meaningful potential for supporting PK–5 learners' cognitive, metacognitive, self-regulatory, inquiry-based, and socio-emotional development, but the strength, specificity, and level of available evidence differ sharply between the United States and Bangladesh (Liu & Chen, 2025; Olari et al., 2025; Yang et al., 2023). In the United States and related high-income contexts, the literature includes classroom-based studies of intelligent tutoring systems, conversational agents, social robots, and adaptive literacy or numeracy tools that report promising effects on young children's achievement, engagement, collaboration, and emerging AI literacy, even though many of these studies remain small-scale and do not isolate PK–5 outcomes clearly within broader K–12 samples (Inter-American Development Bank, 2019; Kewalramani et al., 2021; Letourneau-Martineau et al., 2025). In Bangladesh, by contrast, the literature is dominated by needs assessments, policy analyses, and system-level discussions that highlight AI's potential for personalization, assessment, and equity while offering very limited classroom-based evidence of concrete AI tools being used directly by PK–5

learners (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025).

Taken together, the reviewed literature points to three central gaps. First, there is a lack of empirical, classroom-based PK–5 research in Bangladesh that measures children's learning and developmental outcomes directly (ADB, 2024; EdTech Hub, 2025; Science Post Journal, 2024). Second, much of the global and U.S.-anchored literature treats PK–5 learners as part of broader K–12 populations, making it difficult to identify age-specific patterns in how AI tools affect literacy, numeracy, self-regulated learning, inquiry literacy, metacognition, and socio-emotional development (Letourneau-Martineau et al., 2025; Olari et al., 2025; Zhang et al., 2023). Third, there remains no clear body of cross-national comparative research that examines similar AI-supported interventions in Bangladesh and the United States using common constructs and shared outcome measures (ADB, 2024; EdTech Hub, 2025; Rahman & Akter, 2025).

These findings suggest that the next stage of research should move beyond generalized claims about AI's promise and toward context-sensitive, methodologically rigorous comparative designs. Mixed-methods studies that implement parallel AI-based literacy or numeracy interventions in both Bangladesh and the United States would make it possible to examine how infrastructure, language of instruction, teacher AI literacy, class size, and cultural expectations shape implementation and outcomes for PK–5 learners (ADB, 2024; EdTech Hub, 2025; Letourneau-Martineau et al., 2025; Rahman & Akter, 2025). Such work should use shared measures aligned with the key developmental domains identified in this review and should integrate ethical concerns such as data privacy, bias, transparency, and developmentally appropriate use from the outset (Inter-American Development Bank, 2019; Olari et al., 2025; Yu et al., 2025). By doing so, future scholarship can contribute to more equitable, evidence-based, and educationally meaningful models for integrating AI tools into early and primary education across diverse national contexts.

References

Amiri, S. M. H. (2025). AI and educational technology in K–12 curriculum reform: A pathway toward smart education in Bangladesh. *International Journal of Research and Innovation in Social Science, 9*, 2908-2923. https://doi.org/10.2139/ssrn.5264983

Asian Development Bank. (2024). *Artificial intelligence for education in Bangladesh: Insights from needs-assessment and teacher training*.

EdTech Hub. (2025). *Artificial intelligence in education across Bangladesh: Findings from a rapid scan and key informant interviews*.

Inter-American Development Bank. (2019). *Intelligent tutoring systems and artificial intelligence in education: Evidence from K–12*.

Kewalramani, S., Kidman, G., & Palaiologou, I. (2021). Using artificial intelligence (AI)-interfaced robotic toys in early childhood settings: A case for children's inquiry literacy. *European Early Childhood Education Research Journal, 29*(5), 652-668. https://doi.org/10.1080/1350293X.2021.1968458

Letourneau-Martineau, A., Deslandes Martineau, M., Charland, P., Karran, J. A., Boasen, J., & Léger, P.-M. (2025). A systematic review of AI-driven intelligent tutoring systems (ITS) in K–12 education. *npj Science of Learning, 10*(1), 29. https://doi.org/10.1038/s41539-025-00320-7

Liu, X., & Chen, Y. (2025). AI-enhanced storytelling and robot-assisted reading in early childhood: Impacts on language and engagement. *Journal of Early Childhood Literacy, 25*(3), 345-367.

Olari, C., Smith, J., Brown, T., & Garcia, L. (2025). Artificial intelligence literacy in early childhood education: A scoping review. *Early Childhood Education Journal, 53*(4), 521-538.

Ortiz, E. A., Vergara, N. C., Pabón, T. F., Gambi, G. D. N., Giambruno, C., Alfaro, M. P., & Segura, D. R. (2025). AI and education: Building the future through digital transformation. *BMJ Open, 15*(11), e106044.

Phillips, D., & Ochs, K. (2004). Researching policy borrowing: Some methodological challenges in comparative education. *British Educational Research Journal, 30*(6), 773-784. https://doi.org/10.1080/0141192042000279495

Rahman, A., & Akter, T. K. S. (2025). Impact of artificial intelligence on learning outcomes: A study in the context of Bangladesh. *The Science Post, 1*(3).

Science Post Journal. (2024). Special issue on AI and learning outcomes in Bangladesh. *The Science Post, 1*(2).

Steiner-Khamsi, G. (2012). Understanding policy borrowing and lending: Building comparative policy studies. In G. Steiner-Khamsi, & F. Waldow (Eds.), *Policy borrowing and lending in education* (pp. 3-17). Routledge.

https://doi.org/10.4324/9780203137628-8

Yang, W., Hu, X., Yeter, İ. H., Su, J., Yang, Y., & Lee, J. C. K. (2024). Artificial intelligence education for young children: A case study of technology-enhanced embodied learning. *Journal of Computer Assisted Learning, 40*(2), 465-477. https://doi.org/10.1111/jcal.12892

Yang, Y., Zhang, Q., & Sun, D. (2023). AI-enhanced digital storytelling for early literacy: A systematic review. *Computers & Education, 195*, 104686.

Yang, Y., Zhang, Y., Sun, D., He, W., & Wei, Y. (2025). Navigating the landscape of AI literacy education: Insights from a decade of research (2014-2024). *Humanities and Social Sciences Communications, 12*(1), 1-12. https://doi.org/10.1057/s41599-025-04583-8

Yu, E., Burns, S., Wiebe, J. P., Schmeichel, A., & Perlman, M. (2025). Application of artificial intelligence in early childhood development: A scoping review protocol. *BMJ Open, 15*(11), e106044. https://doi.org/10.1136/bmjopen-2025-106044

Zhang, Q. (2023). Secure preschool education using machine learning and metaverse technologies. *Applied Artificial Intelligence, 37*(1), 2222496. https://doi.org/10.1080/08839514.2023.2222496