

Student-facing conversational AI in primary classrooms: Should it be allowed?

Responsible
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Abstract

Purpose – This paper examines the opportunities and risks associated with student-facing conversational artificial intelligence (AI) in primary education. It aims to evaluate how large language models (LLMs) can support personalised learning while identifying developmental, pedagogical and ethical challenges. Rather than treating benefits and risks as discrete factors, the study conceptualises AI as a socio-technical intervention that reshapes relationships between learners, teachers and knowledge.

Design/methodology/approach – The paper adopts a conceptual and theory-driven approach, synthesising current literature on AI in education, pedagogical theories and emerging practices in primary classrooms. The analysis is structured through a tension-oriented synthesis, identifying points of alignment and misalignment between AI affordances and core learning processes in primary classrooms. Based on this synthesis, the study develops a set of guiding principles grounded in developmental and educational considerations.

Findings – Conversational AI offers significant benefits, including personalised learning support, immediate feedback and reduced teacher workload. However, risks include cognitive offloading, overreliance on AI, misalignment with curriculum goals and ethical concerns such as bias and privacy. The analysis suggests that these are not independent challenges but reflect underlying tensions between technological capabilities and pedagogical requirements.

Research limitations/implications – The study is conceptual and lacks empirical validation. Future research should focus on longitudinal and classroom-based studies to assess the actual impact of AI on primary learners' cognitive and social development. The paper highlights the need for interdisciplinary research bridging education, AI and developmental psychology.

Practical implications – The study proposes a set of guiding principles derived from the identified tensions, emphasising teacher-mediated interaction, developmental calibration of AI use, transparency, curriculum alignment, privacy protection and equity considerations. These principles provide a structured basis for integrating AI in ways that support learning processes while mitigating potential risks.

Social implications – The adoption of AI in primary education raises concerns about equity, access and digital divides. Without careful implementation, AI may reinforce existing inequalities. Promoting critical AI literacy and ethical awareness among young learners is essential to prepare them for responsible participation in an AI-driven society.

Originality/value – This paper contributes a developmentally informed, tension-based conceptual framework for understanding student-facing AI in primary education. By reframing commonly identified opportunities and risks as interrelated tensions, it offers a more analytically grounded basis for guiding AI integration beyond descriptive or normative approaches.

Keywords Student-facing AI, Primary education, Pedagogical guidance, Critical AI literacy, Developmentally appropriate technology

Paper type General review

1. Introduction

LLMs and conversational AI systems (e.g. ChatGPT, Google Gemini and Microsoft Copilot) have rapidly transformed how people access and interact with information (Sethi *et al.*, 2025). These AI systems, built on deep learning architectures (Goodfellow, 2016; LeCun *et al.*, 2015), are designed to generate fluent, human-like text in response to prompts, enabling applications that range from creative writing and coding assistance to personalised tutoring and homework help. Their adoption across society has been swift, supported by the convenience and



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accessibility of conversational interfaces that can respond to users immediately (Sublime and Renna, 2024; Yan *et al.*, 2024).

The influence of LLMs on education has been particularly pronounced. Students increasingly use conversational AI to support writing tasks (Demiröz and Ertürk, 2025; Usher and Amzalag, 2025), clarify concepts (Black and Tomlinson, 2025; El Fathi *et al.*, 2025), and seek homework assistance (Estaphan *et al.*, 2025; Turós *et al.*, 2025), often outside formal school settings. Literature indicates that LLM use is widespread among learners and that many students integrate these tools into their study routines, albeit with varying degrees of critical engagement and oversight (Hassan *et al.*, 2025; Rana *et al.*, 2025; Shahzad *et al.*, 2025b; Sublime and Renna, 2024). Studies conducted in K-12 and higher education contexts suggest potential benefits such as personalised responses to learners' questions (Guizani *et al.*, 2025; Vaccaro *et al.*, 2025; Zheng *et al.*, 2025), increased engagement with learning tasks (Narreddy *et al.*, 2025; Ravi *et al.*, 2025; Wu *et al.*, 2024), and opportunities to explore topics at students' own pace (Afifi, 2024; Senechal *et al.*, 2023). These affordances align with longstanding educational goals of learner differentiation and support for diverse learning styles.

However, the use of LLMs in primary education also raises significant developmental and pedagogical concerns (Shahzad *et al.*, 2025b; Yan *et al.*, 2024). Because primary students are still acquiring foundational skills in literacy, reasoning, and metacognition, there is a risk that unstructured access to AI responses may encourage overreliance on AI-generated content and reduce opportunities for independent problem-solving. Research has documented how LLMs can produce superficially fluent but inaccurate or misleading information, a phenomenon known as "hallucination", which can misinform learners who lack the expertise to detect errors (Ador *et al.*, 2025; Idris *et al.*, 2024; Mustaffa *et al.*, 2025). Overreliance on such outputs may erode critical thinking and evaluation skills, abilities that are essential for deeper learning and that educators strive to cultivate in early schooling (Kosmyrna *et al.*, 2025; Sublime and Renna, 2024).

In addition to cognitive risks, concerns about data privacy, equity, transparency, and ethical use complicate the adoption of conversational AI in primary classrooms (Alawneh *et al.*, 2024; Waiganjo and Mutemaringa, 2025). LLMs are often developed and deployed by commercial providers with proprietary data practices, creating challenges in safeguarding young learners' personal information and ensuring equitable access to technology (Yan *et al.*, 2024). These issues underscore the importance of contextualising LLM use within robust pedagogical frameworks and age-appropriate safeguards.

Against this backdrop, this paper contributes to the growing body of work on AI in education by moving beyond descriptive accounts of opportunities and risks toward a more analytically integrated perspective on student-facing conversational AI in primary classrooms. While existing literature has extensively documented concerns such as cognitive offloading, bias, and data privacy, these issues are often treated in isolation. In contrast, this study conceptualises conversational AI as a relational and socio-technical intervention that reshapes interactions between learners, teachers, and knowledge. By synthesising insights from developmental theory, pedagogical research, and AI studies, the paper develops a set of guiding principles derived from underlying tensions between these domains. In doing so, it offers a theoretically grounded framework that not only explains how AI may disrupt or support learning processes but also translates these insights into structured considerations for responsible integration in primary education contexts.

While examples from specific jurisdictions are referenced to illustrate policy and implementation challenges, this paper adopts a global perspective on the integration of student-facing conversational AI in primary education. Given the rapid but uneven adoption of AI technologies across education systems, insights are drawn from multiple international contexts, including Australia, the European Union (EU), the United States (US), and the United Kingdom (UK), to ensure broader applicability of the proposed framework and analysis (Holmes *et al.*, 2019; Miao *et al.*, 2021).

2. Methodology

This study adopts a conceptual and theory-driven approach to examine the implications of student-facing conversational AI in primary education. Conceptual research is appropriate in emerging domains where empirical evidence is still limited but where theoretical integration is necessary to guide future inquiry and practice (Jaakkola, 2020).

The paper is informed by a structured and purposive review of interdisciplinary literature, drawing from three primary domains: (1) AI in education, particularly research on large language models and generative AI; (2) developmental psychology, including cognitive and socio-emotional development in primary-aged children; and (3) pedagogical theory, with emphasis on scaffolding, differentiated instruction, and classroom interaction. Sources were selected based on their relevance, recency, and theoretical contribution, with priority given to peer-reviewed journal articles, major academic reports, and widely cited foundational works. Specifically, the review engaged foundational developmental works including Piaget (1969), Vygotsky (1978), and subsequent cognitive-development literature including Goswami (2019) and Siegler (2014), alongside major scholarship on AI in education (Holmes *et al.*, 2019; Kasneci *et al.*, 2023; Luckin and Holmes, 2016). Priority was given to peer-reviewed publications published between 2020 and 2026 addressing generative AI, large language models, developmental learning processes, educational technology, and policy governance. Sources were included where they contributed conceptual, pedagogical, developmental, or ethical insights relevant to student-facing AI in primary education.

The analytical process followed an iterative and comparative conceptual synthesis. First, key constructs were identified within each domain, including developmental constraints (e.g. cognitive readiness, scaffolding), pedagogical practices (e.g. differentiation, inquiry-based learning), and technological affordances associated with conversational AI. Second, these constructs were examined comparatively to identify points of alignment and tension across domains. For instance, the capacity of AI to provide immediate responses was considered alongside pedagogical emphasis on productive struggle, while personalised content generation was analysed in relation to curriculum coherence and sequencing.

Third, the analysis focused on how these tensions manifest within primary classroom contexts, particularly where the operational logic of AI systems may not align with established principles of learning and development. Rather than treating opportunities and risks as independent categories, this approach conceptualises them as interrelated dynamics, where potential benefits may simultaneously introduce new constraints or trade-offs.

Finally, the guiding principles presented in Section 7 were developed as analytical responses to these tensions, rather than as prescriptive recommendations. Each principle reflects an attempt to reconcile competing demands between developmental appropriateness, pedagogical intent, and technological capability. In this sense, the study adopts a theory-driven, tension-oriented synthesis, enabling a more structured understanding of how student-facing AI can be integrated in ways that are both educationally meaningful and developmentally appropriate.

3. Primary classroom context

Primary education encompasses the formative years of learning, typically involving children aged 5 to 12, during which foundational cognitive, social-emotional, and literacy skills are established (Bourne, 2004; Horster, 2011). Understanding these developmental characteristics is essential when evaluating the appropriateness of student-facing AI tools, including LLMs, in classroom settings. Figure 1 presents the multiple factors that may shape the effective use of AI in primary classrooms.

3.1 Cognitive development

Primary learners are commonly situated within Piaget's preoperational and concrete operational stages (Piaget, 1969). The preoperational stage is characterised by emerging

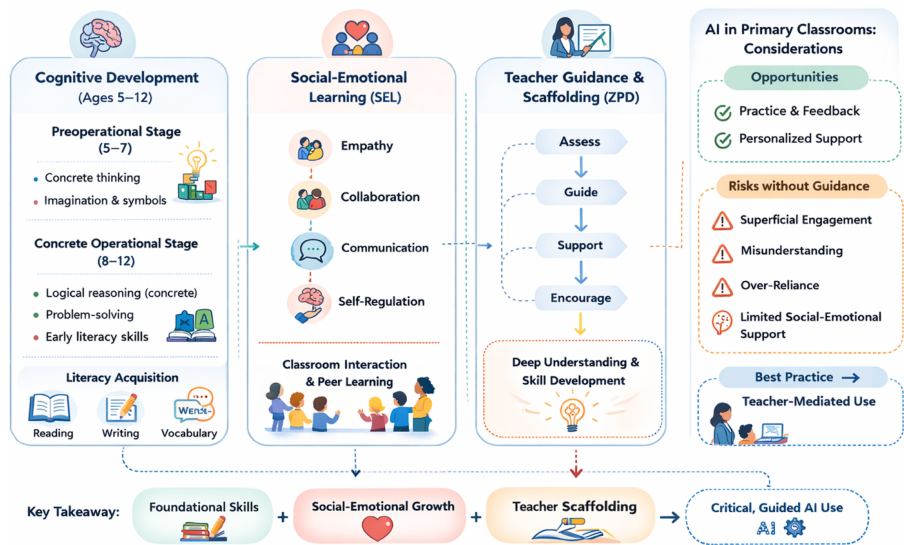


Figure 1. Primary classroom factors shaping safe and effective use of student-facing AI. Source: Authors' conceptualisation based on literature synthesis

symbolic thinking and language development, while the concrete operational stage involves increasing logical reasoning about familiar and observable situations. These stages have traditionally been used to explain how children process information and solve problems during the primary years.

The Piaget framework is further elaborated by post-Piagetian theorists such as Case (2013) and Fisher (1998). While this stage-based perspective continues to inform curriculum design, it has been increasingly critiqued for presenting cognitive development as linear and uniform. Contemporary research instead emphasises that children's reasoning abilities are highly contingent on task structure, prior knowledge, and instructional scaffolding (Goswami, 2019; Siegler, 2014).

This perspective challenges the common assumption that primary students are not ready to engage with AI-generated content because they are still developing abstract reasoning skills. In this context, abstract thinking refers to the ability to evaluate ideas, explanations, and possibilities that are not directly observable or tied to immediate experience. Research suggests that children's capabilities vary considerably depending on the task, their prior knowledge, and the support available to them (Goswami, 2019; Siegler, 2014). Consequently, the challenge is not simply that AI can produce complex responses, but whether those responses are presented in ways that match learners' developmental needs.

A similar tension emerges in discussions of literacy development. Foundational skills such as reading comprehension, vocabulary acquisition, and writing fluency are still consolidating during primary education (Cunningham and Stanovich, 2001; Hayes, 2025). Concerns that AI-generated text may encourage superficial engagement (Kasneci *et al.*, 2023; Kuru and Eryaman, 2025) are well-founded, yet they implicitly assume a passive learner. While concerns about superficial engagement focus on whether students actively process AI-generated information, a separate issue is the linguistic complexity of AI outputs. AI can expose learners to richer vocabulary and more advanced language structures, which may support literacy development when accompanied by appropriate teacher guidance. The educational challenge is therefore twofold: ensuring that students engage meaningfully with content while also ensuring that the complexity of AI-generated language remains developmentally appropriate.

3.2 Social-emotional learning

Social-emotional learning (SEL) refers to the development of skills such as self-awareness, self-regulation, empathy, relationship building, and responsible decision-making (Durlak *et al.*, 2011). Primary classrooms are not solely cognitive environments but also key sites for social-emotional development, where skills such as empathy, collaboration, and self-regulation are cultivated through structured interpersonal interaction (Durlak *et al.*, 2011; Willis, 2016; Zins, 2004). This dimension is often invoked to argue that AI cannot replicate the relational dynamics of teaching. While this claim is broadly valid, it risks becoming reductive if it treats social-emotional learning as entirely incompatible with technological mediation.

Emerging research suggests that some AI systems can identify indicators of student emotions or engagement from patterns in language, behaviour, or interaction data (Javed, e Zehra, Ullah and Naveed, 2025; Kim *et al.*, 2018). This means AI may be able to recognise when a learner appears confused, frustrated, or disengaged. However, recognising emotional cues is different from understanding the broader social and classroom context in which those emotions occur. Effective social-emotional learning requires judgement, empathy, and relationship-building, which remain primarily human responsibilities within classroom environments.

Thus, the limitation of student-facing AI is not merely that it lacks emotional intelligence, but that it operates outside the social fabric of the classroom, where meaning is co-constructed through interaction (Durlak *et al.*, 2011; Henriksen *et al.*, 2025). This raises a more nuanced concern: AI may not replace social learning, but it may reconfigure the balance between individualised interaction and collective classroom engagement, with unclear implications for developmental outcomes.

3.3 Teacher guidance and scaffolding

In educational contexts, scaffolding refers to the temporary support provided by a teacher or more knowledgeable other that helps learners complete tasks they could not yet perform independently. The importance of scaffolding in primary education is strongly grounded in Lev Vygotsky's concept of the Zone of Proximal Development (ZPD), which positions learning as a socially mediated process requiring adaptive support (Vygotsky, 1978). Subsequent work has emphasised that effective scaffolding involves continuous calibration based on learner feedback, task complexity, and evolving competence (Van de Pol, Volman and Beishuizen, 2010; Wood *et al.*, 1976; Xi and Lantolf, 2021).

In contrast, critiques of LLMs often characterise them as providing static or uniform support (Luckin and Holmes, 2016; Tabarsi *et al.*, 2025). While this critique captures an important limitation, it risks oversimplifying the nature of AI interaction. LLMs are, in fact, responsive to prompts and can generate differentiated outputs; however, their limitation lies in the absence of pedagogical intentionality. Unlike teachers, they do not possess an internal model of the learner, nor can they strategically regulate assistance to preserve productive struggle (Holmes *et al.*, 2019; Kasneci *et al.*, 2023; Luckin and Holmes, 2016).

This distinction reframes the issue. The problem is not simply that AI cannot scaffold, but that it is structurally oriented toward resolution rather than learning progression. Effective scaffolding often involves withholding answers, prompting reflection, and encouraging error-driven learning, processes that are not naturally aligned with LLM design (Van de Pol *et al.*, 2010; Wood *et al.*, 1976). Consequently, the integration of AI risks shifting learning from iterative meaning-making to answer optimisation, unless carefully mediated by educators.

3.4 Distinction from adult or secondary education contexts

The application of AI in education is frequently generalised across age groups, yet such generalisations obscure critical developmental differences. Older learners typically demonstrate more advanced metacognitive awareness, enabling them to evaluate, regulate, and strategically use external cognitive supports (Flavell, 1999; Sodian, 2014). This underpins

arguments that AI can function as a productivity-enhancing tool in secondary or adult education (Karamuk, 2025). However, extending this logic to primary contexts is problematic. Younger learners are still developing the cognitive frameworks required for critical evaluation, source verification, and self-regulated learning. As a result, they are more susceptible to uncritical acceptance of AI-generated outputs, particularly in the absence of explicit instructional guidance.

Moreover, the pedagogical goals of primary education differ fundamentally from those of later stages. The emphasis is not on efficiency or task completion, but on the development of foundational skills, learning habits, and cognitive resilience (Durlak et al., 2011; Hayes, 2025). From this perspective, the risk of AI is not merely misuse, but premature optimisation, where the process of learning is bypassed in favour of immediate outcomes.

4. Opportunities of student-facing conversational AI

The integration of conversational AI into education more broadly is frequently framed in terms of transformative potential, particularly in relation to personalisation, engagement, and instructional efficiency (Holmes et al., 2019; Luckin and Holmes, 2016). These claims are increasingly being extended to primary education settings. However, such claims often rest on idealised assumptions about implementation, overlooking the pedagogical conditions under which these benefits are realised, or undermined. Rather than treating these opportunities as inherent properties of AI, a more critical perspective positions them as contingent outcomes shaped by instructional design, teacher mediation, and learner characteristics.

4.1 Enhancing differentiated learning

Differentiated instruction is a core principle of primary education, aimed at addressing the diverse needs, abilities, and interests of learners (Goyibova et al., 2025; Tomlinson, 2017). Conversational AI is often presented as particularly well-suited to this task, given its ability to generate tailored prompts aligned with students' literacy levels and conceptual understanding (Akgun and Greenhow, 2022; Kasneci et al., 2023; Kuru and Eryaman, 2025). For instance, AI systems can simplify texts for struggling readers while offering extensions for more advanced learners (Lin et al., 2025), thereby appearing to operationalise differentiation at scale.

Yet, this apparent strength invites closer consideration. While AI can generate varied content, the extent to which this constitutes meaningful pedagogical differentiation, as opposed to surface-level variation, remains open to question. Differentiation, as traditionally conceptualised, involves not only adapting content but aligning it with learning goals, prior knowledge, and misconceptions. In this sense, AI may expand the capacity for differentiation, but its effectiveness still depends on how teachers integrate and validate these outputs within structured instruction.

Moreover, although personalised learning combined with feedback has been shown to enhance engagement and achievement (Babu et al., 2025; Pane et al., 2016; Tariq, 2025), it is not the presence of personalisation alone that drives these outcomes, but its alignment with pedagogical intent. AI, therefore, can support differentiation, but does not, in itself, guarantee its quality. Whether LLMs can deliver durable differentiation at scale in primary settings, rather than superficial responsiveness, remains an open empirical question.

4.2 Supporting self-directed inquiry

Primary education increasingly emphasises opportunities for curiosity-driven learning, where students ask questions and explore topics of interest (Abdelghani et al., 2022; Council, 2000). Conversational AI appears to support this goal by enabling students to pose

questions and receive immediate, adaptive responses (Navas Bonilla *et al.*, 2025). Unlike static resources (e.g. textbooks or worksheets), AI can respond dynamically to follow-up questions, potentially sustaining engagement and encouraging exploration.

At the same time, the assumption that access to immediate answers naturally fosters inquiry warrants some caution. Inquiry-based learning involves not only asking questions, but also evaluating information, comparing perspectives, and reflecting on responses. While AI facilitates the questioning process, it does not inherently ensure that these deeper inquiry skills are developed.

Nevertheless, research suggests that when used in a guided manner, AI can support the development of inquiry skills such as hypothesis generation and information comparison (Luckin and Holmes, 2016). This indicates that the value of AI lies less in its responsiveness alone, and more in how that responsiveness is structured within learning activities. In this sense, AI can create a low-stakes environment for exploration, but its effectiveness depends on whether interactions encourage active engagement rather than passive reception.

4.3 Assisting writing and editing skills

Writing development in primary education is widely understood as an iterative and complex process involving idea generation, structuring, and revision (Becker, 2006; Graham and Perin, 2007). Conversational AI can contribute to this process by providing examples of sentence structures, suggesting vocabulary alternatives, and identifying grammatical errors (Demiröz and Ertürk, 2025; Yang, 2025). Such support may help students recognise language patterns and develop awareness of stylistic conventions.

However, this support also raises questions about the balance between assistance and independence. While AI-generated feedback can reinforce learning, there is a risk that students may rely on suggestions without fully engaging in the cognitive processes underlying writing. This concern aligns with broader discussions about overreliance on AI tools in educational contexts (Idris *et al.*, 2024; Kosmyna *et al.*, 2025).

At the same time, research on writing interventions highlights the importance of repeated practice and feedback in improving fluency and accuracy (Khezrlou, 2020; Moore, 2021; Underwood and Tregidgo, 2006). From this perspective, AI can serve as a supplementary tool that extends opportunities for guided practice. The key issue, therefore, is not whether AI supports writing, but how it is used to complement rather than replace the learner's active involvement in the writing process.

4.4 Reducing teacher workload

Primary teachers face significant demands related to repetitive instructional tasks, including marking, providing feedback, and preparing differentiated materials (Ballet and Kelchtermans, 2009; Stauffer and Mason, 2013). Conversational AI has been proposed as a means of alleviating these pressures by handling routine queries, generating examples, and supporting practice activities (Kirk, 2025).

While this potential is widely acknowledged, it is important to consider how such efficiencies are realised in practice. On one hand, automating routine tasks may enable teachers to focus on higher-order instructional activities, such as facilitating discussions or supporting students with additional needs (D'Mello, 2021). On the other hand, the integration of AI may introduce new responsibilities, including monitoring outputs and ensuring alignment with learning objectives.

This suggests that AI does not simply reduce workload, but may redistribute it, shifting effort from routine execution to oversight and orchestration. Nevertheless, when implemented thoughtfully, this redistribution can enhance instructional quality without diminishing pedagogical control.

4.5 Pedagogical potential and considerations

The pedagogical value of student-facing AI is often framed in terms of its ability to complement teacher-led instruction (Sevilla *et al.*, 2025). These tools can provide personalised input, support skill development, and extend opportunities for practice and exploration (Kakogianni *et al.*, 2025; Nwachukwu *et al.*, 2025). In this sense, they can act as supportive learning tools that augment, rather than replace, classroom teaching (Jing and Mouhong, 2025; Luckin and Holmes, 2016).

However, this complementary role is not inherent, but contingent on implementation. AI outputs must be monitored for accuracy, aligned with curriculum goals, and used in ways that support critical thinking and creativity. Without such considerations, there is a risk that AI may shift learning towards efficiency and task completion at the expense of deeper engagement.

Accordingly, the opportunities of conversational AI should be understood not as fixed advantages, but as context-dependent possibilities, realised through careful pedagogical design and teacher mediation.

5. Risks and concerns of student-facing conversational AI

While student-facing conversational AI presents significant pedagogical opportunities, its integration into primary classrooms is not without risks. These concerns span developmental, pedagogical, ethical, and policy dimensions, reflecting both the unique characteristics of young learners and the broader educational contexts in which AI is deployed. As illustrated in Figure 2, these risks are often discussed separately; however, they frequently intersect in practice, suggesting the need to consider not only individual concerns but also how they interact within classroom settings.

5.1 Developmental risks

5.1.1 Cognitive offloading and reduced problem-solving. One of the most frequently cited developmental concerns is cognitive offloading, where learners rely on AI to generate answers

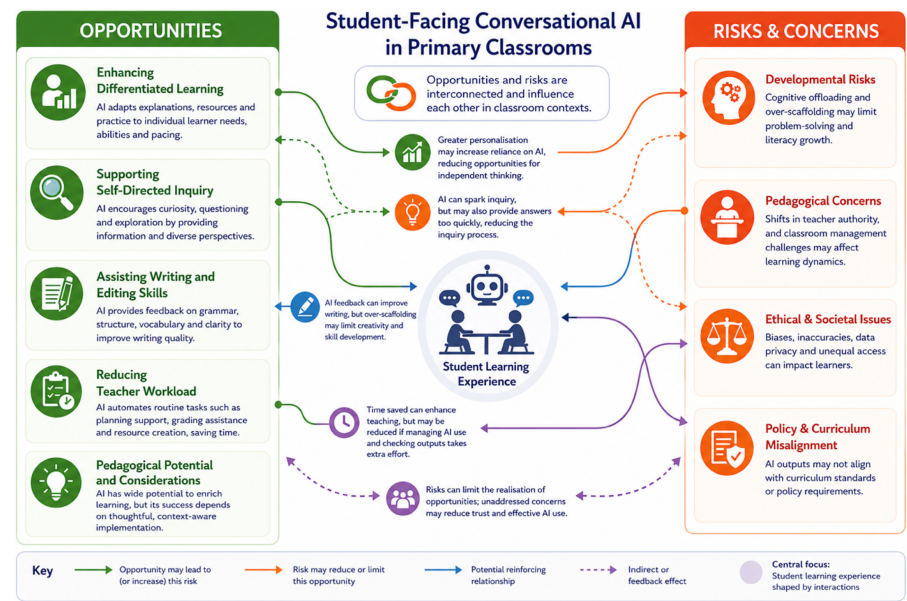


Figure 2. Opportunities, risks and their interconnected relations of student-facing AI in primary classrooms. Source: Authors' conceptualisation based on literature synthesis

rather than engaging in problem-solving processes themselves (Bakar and Tapsoba, 2026; Ko *et al.*, 2026). This concern aligns with established perspectives in cognitive psychology, which emphasise the role of effort, struggle, and iterative practice in strengthening reasoning and metacognitive skills (Bjork and Bjork, 2011; Fisher, 1998; Raximboyevna, 2026).

At the same time, it is worth noting that cognitive offloading is not unique to AI, but has long been associated with educational tools more broadly. The issue, therefore, is not simply that offloading occurs, but whether it displaces core learning processes at a stage where these are still developing. In primary contexts, where foundational skills are being established, immediate access to AI-generated solutions may reduce opportunities for students to plan, reflect, and revise their thinking (Shahzad *et al.*, 2025a; Suryanto *et al.*, 2025). In primary classrooms, where the very purpose of many tasks is to build independent capability, the risk of offloading too early in skill development is substantially greater than in adult learning contexts.

For example, when students use AI to generate responses to writing or problem-solving tasks, there is a possibility that they adopt outputs without fully engaging in the underlying reasoning (Liu *et al.*, 2025). This suggests that while AI can support task completion, it may also, under certain conditions, limit opportunities for deeper cognitive engagement.

5.1.2 Over-scaffolding and literacy development. Closely related is the concern of over-scaffolding, where AI provides support that exceeds the learner's developmental readiness (Solomon Paul Raj *et al.*, 2026). Scaffolding, as conceptualised by Lev Vygotsky (Vygotsky, 1978; Xi and Lantolf, 2021), is most effective when it is carefully calibrated to the learner's current level and gradually withdrawn. However, AI systems tend to provide immediate and often complete assistance, raising questions about whether such support aligns with these principles.

While AI-generated suggestions such as sentence structures or vocabulary corrections can support literacy development, there is also a concern that consistent reliance on such outputs may reduce opportunities for experimentation and independent construction (Ramos-Benitez *et al.*, 2026; Wilson, 2025). This is particularly relevant in early writing development, where practice and error play a central role (Graham and Perin, 2007).

At the same time, it is important to recognise that scaffolding itself is not inherently problematic; rather, the issue lies in its calibration and use. AI may therefore support literacy development when used to reinforce learning, but may hinder it if it substitutes rather than supplements the learner's own efforts (Akao *et al.*, 2025; Aslam *et al.*, 2025).

5.2 Pedagogical concerns

5.2.1 Teacher authority and role. The integration of AI into classrooms also raises questions about teacher authority and the nature of instruction (Tripathi *et al.*, 2025). If AI is perceived by students as a primary or authoritative source of information, it may influence how knowledge is valued and interpreted within the classroom (Jose *et al.*, 2025; Orak, 2025).

However, this does not necessarily imply a direct loss of teacher authority. Rather, it suggests a potential shift in how authority is negotiated, particularly when AI-generated responses appear fluent and confident. Teachers may therefore face challenges in maintaining instructional coherence if students prioritise AI outputs over teacher guidance (Bakar and Tapsoba, 2026; Yin *et al.*, 2025).

This dynamic is especially significant in primary education, where teacher mediation plays a central role in developing critical thinking and reflective learning practices (Durlak *et al.*, 2011; Henriksen *et al.*, 2025; Palmquist *et al.*, 2026). As such, the issue is less about replacement and more about how AI reshapes the relationship between learners, knowledge, and instruction.

5.2.2 Classroom management challenges. In addition to shifts in authority, AI tools may introduce new classroom management challenges. Real-time, individualised interactions can potentially lead to distraction, off-task behaviour, or uneven participation among students (Kayyali, 2026; Southgate *et al.*, 2019).

At the same time, these challenges are not entirely new, as similar concerns have been raised in relation to other digital technologies. What distinguishes AI, however, is its interactive and responsive nature, which may make it more engaging, and therefore potentially more distracting, than static tools.

Teachers must therefore balance the integration of AI with the need to maintain structured, collaborative learning environments (Daher, 2025; Waiganjo and Mutemaringa, 2025). Without clear guidelines and classroom protocols, there is a possibility that AI use may disrupt, rather than support, learning processes (Luckin and Holmes, 2016; Yadav, 2025).

5.3 Ethical and societal issues

5.3.1 Bias and accuracy. Concerns regarding bias and accuracy in LLM outputs are well documented, particularly given their reliance on large, heterogeneous training datasets (Bender *et al.*, 2021; Hadi *et al.*, 2024; Tiwari, 2025). These systems may generate responses that are factually incorrect, incomplete, or influenced by underlying biases.

For primary learners, who may not yet possess strong evaluative skills, such outputs can be particularly problematic. Exposure to inaccurate or biased information may reinforce misconceptions or shape understanding in unintended ways (Danyaro *et al.*, 2025; Elsayed, 2024).

At the same time, these limitations are not always visible to users, as AI-generated responses are often presented in a coherent and authoritative manner. This highlights the importance of critical engagement and oversight, particularly in early educational contexts.

5.3.2 Data privacy and child protection. Conversational AI systems often collect and process user inputs, raising significant privacy and child protection concerns in primary education contexts (Kurian, 2025; Peinado, 2025). These concerns are governed by diverse regulatory frameworks globally, including the Australian Privacy Principles under the Privacy Act 1988 in Australia (Paltiel, 2023; Paterson, 1998), the General Data Protection Regulation in the EU (Hoofnagle *et al.*, 2019; Voigt and Von dem Bussche, 2017), and child-specific protections such as the Children's Online Privacy Protection Act in the US (Gadbaw, 2016; Steeves and Mačėnaitė, 2022), which impose strict requirements on the collection, processing, and storage of children's data.

Young learners may inadvertently disclose sensitive personal information when interacting with AI systems, while schools and educators often have limited transparency regarding how such data are stored, processed, or reused by AI providers (Huang, 2023; Mienye and Swart, 2025; Regan and Jesse, 2019; Williamson and Eynon, 2020). This asymmetry raises concerns around data governance, accountability, and informed consent, particularly in classroom settings involving minors.

Ensuring compliance with these regulatory frameworks, alongside implementing data minimisation, purpose limitation, and anonymisation strategies, is therefore critical to safeguarding student privacy and maintaining institutional trust in AI-enabled educational environments (D'Mello, 2021; Miao *et al.*, 2021; Paludi, 2024; Pratap and Shukla, 2025).

5.3.3 Equity and access. The digital divide represents another important consideration in the use of AI in education. Access to devices, reliable internet, and AI-enabled platforms varies significantly across contexts, potentially influencing who benefits from AI-supported learning (Rasheed *et al.*, 2025). While AI has the potential to support personalised learning, unequal access may result in disproportionate advantages for some students, thereby reinforcing existing disparities (Hussein *et al.*, 2025; Zoelfakar and Ibrahim, 2026).

Addressing this issue requires not only technological provision but also broader considerations of resource allocation and institutional capacity (Ahmed, 2024; Akpan and Essien, 2025; D'Mello, 2021). In this sense, AI can both mitigate and exacerbate inequality, depending on how it is implemented.

5.4 Policy and curriculum misalignment

5.4.1 Curriculum standards. Student-facing AI outputs may not align with curriculum standards or learning objectives, which vary significantly across educational systems. For example, AI-generated explanations may reflect generalised knowledge that does not align with structured national curricula, such as the NSW Curriculum in Australia, which emphasises sequenced knowledge and explicit learning outcomes (Carter and Buchanan, 2022; Masters, 2019; NSW, 2026), the Common Core State Standards in the US, which define grade-level competencies and benchmarks (Polikoff *et al.*, 2011; Schmidt and Houang, 2012), or the National Curriculum for England, which structures learning through key stages and attainment targets (Priestley *et al.*, 2013). This misalignment can lead to confusion, gaps in learning progression, or reinforcement of concepts at inappropriate developmental levels, thereby limiting the pedagogical effectiveness of AI-supported learning (Holmes *et al.*, 2019; NSW, 2026; Selwyn, 2019).

5.4.2 Lack of clear guidelines. Globally, there remains a lack of consistent policy guidance regarding the integration of AI in primary classrooms (Yeter *et al.*, 2024). While some jurisdictions have begun developing national-level frameworks for AI in education, implementation remains uneven. For instance, the EU emphasises regulatory oversight and ethical AI use (Mahmutovic, 2025), whereas the US adopts a decentralised approach, with policies often determined at district or institutional levels (Kundu and Bej, 2025). UK has introduced guidance focused on responsible AI adoption in schools (Xu *et al.*, 2025), while Australia is developing policies across federal and state levels (Marrone *et al.*, 2025). This variation highlights the absence of unified standards and underscores the need for theoretically grounded, developmentally appropriate frameworks to guide safe and effective AI use in diverse educational contexts (Acara, 2026; D'Mello, 2021; Holmes *et al.*, 2019).

6. Cross-national policy and implementation landscape

The integration of AI in primary education varies significantly across jurisdictions, reflecting divergent regulatory philosophies and governance structures. In the EU, a precautionary, rights-based approach foregrounds data protection, transparency, and accountability through instruments such as the General Data Protection Regulation and the EU AI Act, which shape AI deployment through risk-based classification and stringent requirements for systems involving children (Floridi *et al.*, 2018; Veale and Borgesius, 2021). In contrast, the US adopts a decentralised governance model, where AI integration is determined at state and district levels, leading to fragmented implementation despite baseline protections under the Children's Online Privacy Protection Act and Family Educational Rights and Privacy Act (Holmes *et al.*, 2019; Williamson and Eynon, 2020).

The UK and Australia occupy intermediary positions, combining national-level policy guidance with institutional autonomy. Initiatives led by the Department for Education and coordinated federal–state approaches in Australia emphasise responsible AI use, teacher oversight, and alignment with curriculum and safeguarding frameworks; however, empirical studies suggest that such hybrid models often result in uneven implementation and limited institutional capacity to critically evaluate AI tools in practice (D'Mello, 2021; Luckin and Holmes, 2016; Selwyn, 2019).

Critically, this cross-national divergence reflects competing priorities between innovation, risk mitigation, and pedagogical control, while exposing the absence of a coherent global framework for AI integration in primary education. This fragmentation not only complicates standardisation and accountability but also highlights deeper inconsistencies in how educational systems conceptualise risk and learning in relation to AI. Addressing these challenges requires theoretically grounded, developmentally informed models that extend beyond regulatory compliance to incorporate socio-technical and pedagogical dimensions of AI adoption (Holmes *et al.*, 2019; Miao *et al.*, 2021).

7. Guiding principles for responsible use of student-facing AI

To maximise the pedagogical potential of student-facing conversational AI while mitigating developmental, ethical, and pedagogical risks, a set of guiding principles is essential. The guiding principles proposed in this section emerge from the conceptual synthesis outlined in the methodology and the preceding analysis of developmental contexts (Section 3), pedagogical opportunities (Section 4), and associated risks (Section 5). Rather than presenting generalised recommendations, these principles are derived from recurring tensions identified across these domains, particularly where the affordances of conversational AI intersect with, or diverge from, established learning processes in primary education (see Figure 3).

In this sense, the principles are not intended as fixed prescriptions, but as analytical reference points that can inform context-sensitive decision-making. Each principle reflects an attempt to reconcile competing considerations, including cognitive development, instructional design, ethical responsibility, and institutional constraints (Holmes *et al.*, 2019; Jaakkola, 2020). By grounding these principles in the preceding discussion, the framework seeks to provide a more coherent basis for understanding how AI can be integrated in ways that support, rather than disrupt, foundational learning processes. These principles are intended to be adaptable across diverse international education systems, acknowledging variations in policy, infrastructure, and pedagogical practices.

7.1 Teacher-mediated interaction

The role of teacher mediation emerges as a central consideration in reconciling the tension between AI-generated responsiveness and pedagogical intentionality. As discussed in Section 3.3, effective scaffolding involves adaptive and context-sensitive support (Van de Pol *et al.*, 2010; Vygotsky, 1978), whereas conversational AI systems are primarily oriented toward generating immediate and complete responses (Kasneki *et al.*, 2023; Luckin and Holmes, 2016). This distinction suggests that unmediated access may shift learning from a process of guided exploration toward one of answer acquisition.

Positioning teachers as intermediaries allows AI outputs to be evaluated, contextualised, and aligned with instructional goals before being introduced into the



Figure 3. Guiding principles for responsible use of student-facing AI in primary school classrooms. Source: Authors’ conceptualisation based on literature synthesis

learning process (Holmes *et al.*, 2019; Luckin and Holmes, 2016). In this configuration, AI functions as a supplementary resource rather than an autonomous source of instruction, preserving the relational and dialogic aspects of teaching that are critical in primary education (Durlak *et al.*, 2011; Henriksen *et al.*, 2025). Teacher mediation therefore serves not only as a safeguard against inaccuracies, but also as a mechanism for maintaining coherence between AI use and pedagogical intent (Holmes *et al.*, 2019).

7.2 Developmentally calibrated use

The use of conversational AI should be calibrated in accordance with learners' developmental readiness. As outlined in Section 3.1, primary students exhibit significant variability in cognitive capacity shaped by prior knowledge and instructional context (Goswami, 2019; Siegler, 2014). At the same time, Section 5.1 highlights the risks of cognitive offloading and over-scaffolding when assistance is provided in ways that exceed the learner's current level of understanding (Bakar and Tapsoba, 2026; Bjork and Bjork, 2011).

This suggests that AI use should not be treated as uniformly beneficial across age groups or contexts. Instead, interaction with AI systems should be structured to ensure that support remains proportionate to the learner's developmental stage. This may involve limiting the extent of direct answers or embedding AI use within guided instructional activities. Such an approach aligns with research emphasising the importance of maintaining productive cognitive effort in learning processes (Fisher, 1998; Raximboyevna, 2026), thereby reducing the risk that AI substitutes rather than supports skill development.

7.3 Transparency and critical engagement

The apparent fluency and coherence of AI-generated outputs introduce challenges related to epistemic trust and evaluation. As discussed in Section 5.3, conversational AI systems may produce inaccurate or biased information (Bender *et al.*, 2021; Hadi *et al.*, 2024), while primary learners may lack the metacognitive skills required to critically assess such outputs (Flavell, 1999). At the same time, inquiry-based learning depends on questioning, comparison, and reflection rather than passive reception (Abdelghani *et al.*, 2022; Council, 2000).

Transparency in AI use therefore extends beyond simply indicating that content is machine-generated. It involves fostering an awareness of the limitations and uncertainties associated with AI outputs. Encouraging students to question responses, compare them with alternative sources, and reflect on their validity can support the development of critical engagement (Daher, 2025). In this sense, AI can function not only as an information source, but also as a context for cultivating evaluative and reflective learning practices (Daher, 2025; Luckin and Holmes, 2016).

7.4 Curriculum alignment

While conversational AI has the capacity to generate varied and personalised content, its outputs are not inherently aligned with structured curriculum frameworks. Section 4.1 suggests that differentiation is pedagogically meaningful only when it is connected to learning objectives (Tomlinson, 2017), while Section 5.4 highlights the risks of misalignment with curriculum standards (Holmes *et al.*, 2019; Selwyn, 2019).

To address this, AI use should be embedded within clearly defined instructional goals and sequences. Teachers play a critical role in ensuring that AI-generated content reinforces, rather than disrupts, the progression of learning. This involves designing tasks and prompts that are consistent with curriculum expectations and using AI outputs selectively to support specific learning outcomes. Such alignment is essential to maintain coherence in knowledge progression and to avoid reinforcing misconceptions or inappropriate levels of complexity (NSW, 2026; Polikoff *et al.*, 2011).

7.5 Privacy and data protection

The use of conversational AI in primary education raises important considerations regarding data privacy and child protection, as outlined in [Section 5.3](#). AI systems often rely on user inputs for processing, creating potential asymmetries in how student data are collected and used ([Regan and Jesse, 2019](#); [Williamson and Eynon, 2020](#)). These concerns are particularly significant in primary contexts, where learners may have limited awareness of digital risks ([Steeves and Mačėnaitė, 2022](#)).

Addressing this issue requires more than regulatory compliance; it involves ensuring that data practices are consistent with the educational context in which they are embedded. Minimising identifiable inputs, restricting unnecessary data collection, and maintaining transparency around data handling are essential safeguards ([D’Mello, 2021](#); [Miao et al., 2021](#)). Such measures help ensure that the integration of AI aligns with broader ethical responsibilities associated with working with minors ([Kurian, 2025](#)).

7.6 Equity and access considerations

The integration of AI in education must also be considered in relation to issues of equity and access. As discussed in [Section 5.3](#), disparities in technological infrastructure and digital literacy may influence how different learners benefit from AI-supported tools ([Hussein et al., 2025](#); [Rasheed et al., 2025](#)). While conversational AI has the potential to support personalised learning ([Pane et al., 2016](#)), unequal access may lead to uneven educational outcomes.

This highlights the importance of situating AI implementation within broader considerations of resource distribution and institutional capacity ([Ahmed, 2024](#); [D’Mello, 2021](#)). Ensuring equitable access involves not only providing technological resources, but also supporting teachers in developing the skills required to integrate AI effectively ([Marrone et al., 2025](#)). Without such measures, the benefits of AI may remain unevenly distributed, reinforcing existing inequalities rather than addressing them ([Zoelfakar and Ibrahim, 2026](#)).

8. Conclusion and recommendations

Student-facing conversational AI offers substantial pedagogical opportunities in primary education. When used thoughtfully, these tools can enhance differentiated learning, support self-directed inquiry, reinforce writing and editing skills, and reduce teacher workload on repetitive tasks. They have the potential to provide personalised scaffolding that complements classroom instruction, extending opportunities for engagement and practice beyond what is feasible in traditional teaching environments ([Luckin and Holmes, 2016](#); [Pane et al., 2016](#)). These benefits underscore AI’s promise as an educational resource capable of supporting the diverse developmental needs of young learners.

However, these advantages are counterbalanced by significant developmental, pedagogical, and ethical risks. Cognitive offloading and over-scaffolding may impede the acquisition of independent problem-solving and literacy skills, while AI’s limitations, including inaccuracies, biases, and unvetted content, pose challenges to critical thinking and factual understanding. Additional concerns around teacher authority, classroom management, privacy, equity, and curriculum misalignment further complicate the responsible integration of AI in primary classrooms ([Bender et al., 2021](#); [NSW, 2026](#)). Unsupervised access to AI by young students risks exacerbating these issues, undermining learning objectives, and compromising safety and fairness.

Rather than viewing these opportunities and risks as independent factors, this study has argued that they reflect underlying tensions between the operational logic of conversational AI and the developmental and pedagogical requirements of primary education. These tensions, such as those between immediacy and productive struggle, personalisation and curriculum coherence, and accessibility and equity, highlight the need for a more structured approach to integration.

In response, the guiding principles proposed in this paper are derived as analytical responses to these tensions, emphasising teacher-mediated interaction, developmental calibration of AI use, transparency, curriculum alignment, privacy protection, and equity considerations. Taken together, these principles position AI not as an autonomous instructional agent, but as a context-dependent educational resource whose effectiveness depends on how it is aligned with learning processes and instructional intent.

The analysis presented in this paper also has important practical and research implications. For educators and policymakers, the findings highlight the need to implement conversational AI in ways that prioritise teacher mediation, developmental appropriateness, curriculum alignment, privacy protection, and equitable access, recognising that AI is most effective when used as a complement to, rather than a replacement for, professional judgement and classroom interaction (Holmes *et al.*, 2019; Luckin and Holmes, 2016; Miao *et al.*, 2021). At the same time, the tensions identified throughout the paper underscore the need for further empirical research examining the developmental, pedagogical, and ethical impacts of student-facing conversational AI in primary education, particularly regarding learning outcomes, teacher-AI collaboration, and equitable implementation across diverse educational contexts (Daher, 2025; Henriksen *et al.*, 2025; Kasneci *et al.*, 2023).

To support responsible integration, three complementary actions are recommended. First, schools and education authorities should develop clear, operationally specific policies for AI use in primary settings (Holmes *et al.*, 2019; Marrone *et al.*, 2025; Miao *et al.*, 2021). These should address: minimum age and year-level thresholds for different types of AI interaction; acceptable-use protocols defining which tasks AI may support (e.g. editing feedback, reading support) and which it must not replace (e.g. initial drafting, foundational problem-solving); data governance requirements specifying which platforms comply with relevant privacy legislation; and accountability mechanisms for monitoring and reviewing AI use at the classroom and school level. Second, professional development should be structured around a defined set of AI mediation competencies for primary teachers (Daher, 2025; Henriksen *et al.*, 2025; Holmes *et al.*, 2019). These include: the ability to design AI-mediated tasks with appropriate parameters and constraints; skills in critically reviewing AI-generated content for accuracy, bias, and curriculum alignment; strategies for teaching students to engage with AI outputs critically; and familiarity with the developmental considerations outlined in Section 2 of this paper. Pre-service teacher education programs should also incorporate these competencies into their curricula. Third, empirical research is urgently needed to evaluate AI's developmental and pedagogical impacts in primary contexts (Holmes *et al.*, 2019; Jaakkola, 2020; Kasneci *et al.*, 2023). Priority research questions include: What are the effects of teacher-mediated AI use on writing fluency and independent composition skills in Years 3–4? How do primary students' metacognitive strategies differ when completing tasks with and without AI assistance? What implementation models are associated with equitable AI access across socioeconomic contexts? Longitudinal, mixed-methods designs that combine classroom observation with outcome measurement would be particularly valuable in this regard.

Although examples from specific jurisdictions such as Australia are referenced, the risks, opportunities, and guiding principles identified in this study are applicable across a wide range of international educational contexts. The global variation in AI policy and implementation further reinforces the need for coherent, theory-driven approaches to guide responsible adoption in primary education.

By situating conversational AI within the developmental and pedagogical realities of primary education, this paper highlights that the challenge is not simply whether AI should be adopted, but how its integration can be aligned with the processes through which young learners develop knowledge and skills. A tension-informed perspective provides a basis for understanding not only what AI can offer, but how its use can be structured to support meaningful and equitable learning outcomes.

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