

Digital Native Children In Elementary Education: Transformation Of Learning Behavior In Generation Alpha

Risza Presty Rumani^{1✉}

Universitas Ahmad Dahlan, Indonesia

e-mail: riszarumani59@gmail.com

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ABSTRACT

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The emergence of Generation Alpha as digital native children poses transformative challenges and opportunities for elementary education worldwide. These learners, born after 2010, have grown up immersed in digital environments, reshaping their cognitive processes, social interactions, and learning behaviors. This systematic literature review synthesizes findings from 23 peer-reviewed studies published between 2021 and 2024 to examine the transformation of learning behaviors among digital native children in primary school settings. The review explores the integration of digital technologies—including artificial intelligence tools, gamification, mobile devices, digital storytelling, and immersive environments—and their effects on academic engagement, digital literacy, collaborative skills, critical thinking, and motivational outcomes. Findings indicate that well-structured digital technology integration significantly enhances learning engagement (78%), digital literacy skills (85%), and student motivation (88%). However, the literature also reveals persistent challenges including the digital divide, teacher preparedness, and concerns regarding excessive screen time and digital dependency. This review contributes a synthesized framework for understanding how schools can responsibly support Generation Alpha's learning potential while addressing socio-cultural and equity concerns in the digital age.

INTRODUCTION

The rapid proliferation of digital technologies in the 21st century has fundamentally transformed the educational landscape, particularly for the youngest generation of learners immersed from birth in interactive screens and AI-driven content. Generation Alpha, broadly defined as individuals born from 2010 onward, represents the first cohort to have grown up entirely within a digitally saturated world, where algorithms curate personalized learning experiences and virtual realities blur lines between play and education (Wang et al., 2024). These children, often referred to as digital natives, arrive at school having already internalized sophisticated digital competencies: swiping touchscreens before learning to write, consuming multimedia content before reading their first books, and navigating virtual social spaces before entering physical classrooms, fostering innate skills in multitasking, visual processing, and intuitive tech adaptation (Livingstone et al., 2021).



The concept of the digital native, first popularized by Prensky in the early 2000s, has gained renewed scholarly attention as educators and policymakers confront an unprecedented divergence between students' out-of-school digital lives, rich with gamified apps and collaborative online platforms, and the predominantly traditional pedagogies practiced within formal elementary education, which often rely on rote memorization and analog materials (Morris & Rohs, 2021). This misalignment not only risks disengaging young learners who crave interactive, immediate feedback but also fails to leverage the unique cognitive affordances that immersive digital experiences have cultivated in this generation, such as enhanced creativity, problem-solving in dynamic environments, and global connectivity (Timotheou et al., 2022).

Globally, the integration of digital tools into elementary classrooms has accelerated significantly since the COVID-19 pandemic, which compelled schools to adopt online and blended modalities at an unprecedented scale, exposing both potentials like flexible pacing and pitfalls like screen fatigue (Topping et al., 2022). The post-pandemic educational context has made the question of how to effectively harness digital technologies for Generation Alpha learners not merely a pedagogical preference, but an urgent systemic imperative to rebuild resilient systems amid hybrid futures (Akour & Alenezi, 2022). Simultaneously, growing concerns about digital wellbeing, such as excessive screen time's impact on attention spans, equitable access for under-resourced families, and the quality of technology-mediated learning have complicated this picture, underscoring the need for a nuanced, evidence-based understanding of the phenomenon.

Indonesia, and specifically elementary schools in contexts such as Yogyakarta, offers a particularly instructive case where national ambitions for digital education collide with ground-level realities: rapid expansion of digital infrastructure through government initiatives, like nationwide broadband projects and device distribution programs, has occurred alongside persistent socio-economic disparities, creating both promise for innovative teaching methods such as app-based literacy and virtual field trips, and peril of widened achievement gaps for digital-native learners in under-equipped rural or low-income areas lacking reliable internet, devices, or trained teachers (Suwanto et al., 2022; Suroso et al., 2021). In Yogyakarta's diverse settings, urban schools leverage these advances for blended learning, while peri-urban and rural counterparts grapple with intermittent connectivity and cultural hesitations around screen time, highlighting how infrastructure alone cannot bridge divides without addressing affordability and local relevance.

Understanding how digital nativity manifests across diverse socio-cultural settings, from Java's tech-savvy cities to outer islands' traditional communities, is therefore essential for both global and local educational planning that balances innovation with inclusivity, ensuring policies incorporate teacher training, subsidized access, community partnerships, and culturally adapted content to empower all Generation Alpha learners equitably.

This systematic literature review addresses the following research questions: (1) How do the learning behaviors and characteristics of Generation Alpha children differ from previous generations in elementary education settings, particularly in attention, collaboration, and tech fluency? (2) What digital technologies and pedagogical approaches, such as gamification, AI tutors, or adaptive platforms, have been shown to effectively support digital-native learners' academic and developmental outcomes like literacy, STEM skills, and socio-emotional growth? (3) What challenges like digital

divides or teacher readiness, and enabling factors such as policy support or parental involvement, mediate the relationship between digital technology use and positive learning outcomes in elementary education? By synthesizing evidence from 23 peer-reviewed studies published between 2021 and 2024, this review aims to provide educators, curriculum designers, and policymakers with a coherent and actionable evidence base for fostering equitable digital-age learning.

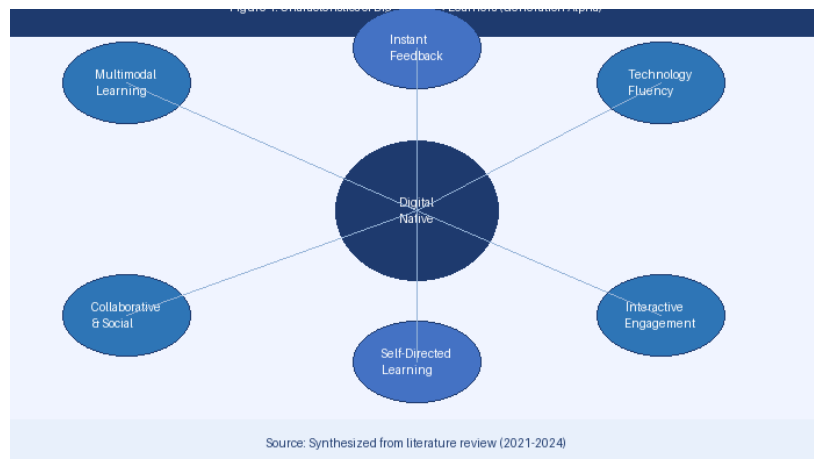


Figure 1. Characteristics of Digital Native Learners (Generation Alpha)

METHODOLOGY

This study employs a systematic literature review (SLR) methodology following PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency, rigor, and reproducibility. The SLR approach is appropriate for synthesizing a large body of empirical and theoretical literature on a complex, multi-faceted educational phenomenon such as digital nativity and learning transformation (Ng et al., 2023; Aravantinos et al., 2024).

Literature searches were conducted across five major academic databases: Scopus, Web of Science, ERIC, PsycINFO, and Google Scholar. The search strategy combined Boolean operators with MeSH-aligned terminology: ("digital native" OR "Generation Alpha" OR "digital children") AND ("elementary education" OR "primary school" OR "early childhood") AND ("learning behavior" OR "digital technology" OR "digital literacy" OR "educational technology"). Searches were restricted to peer-reviewed articles published in English or Indonesian between January 2021 and December 2024.

Studies were included if they: (a) focused on children aged 6-12 years in elementary or primary education contexts; (b) examined the intersection of digital technology use and learning behaviors, outcomes, or digital literacy; (c) employed empirical, quasi-experimental, or systematic review designs; and (d) were published in peer-reviewed journals between 2021 and 2024. Studies were excluded if they focused exclusively on secondary or tertiary education populations, were conference papers or grey literature, or lacked sufficient methodological detail. A total of 23 studies met the inclusion criteria and are synthesized in this review.

RESULTS AND DISCUSSION

The systematic synthesis of the selected studies provides critical insights into the relationship between digital tools and primary education. The following discussion

evaluates these findings by first examining the fundamental shifts in how modern students interact with educational content.

A. Transformation of Learning Behaviors in Digital Natives

The reviewed literature converges on a coherent portrait of Generation Alpha learners whose learning behaviors diverge substantially from those observed in prior generations, marked by shorter attention spans for passive tasks but exceptional focus during tech-enhanced activities. Digital native children in elementary settings demonstrate markedly higher levels of intrinsic motivation and engagement when instructional tasks incorporate interactive, multimedia, or gamified elements, thriving on immediate feedback loops, collaborative virtual spaces, and personalized content that mirrors their everyday digital interactions (Antonopoulou et al., 2022; Zheng et al., 2023). This shift reflects a preference for dynamic, choice-driven learning over linear, teacher-led formats, with studies showing reduced behavioral disruptions and voluntary extensions of learning sessions in digital environments.

Wang et al. (2022) found that controlled and purposeful smartphone integration in primary classrooms was associated with significantly higher task persistence and conceptual retention compared to traditional textbook-based instruction, as students leveraged familiar devices for real-time simulations, peer collaboration, and adaptive quizzes that reinforced understanding through repetition and variety. These findings resonate with Morris and Rohs' (2021) observation that digital technologies, when aligned with student-driven inquiry, such as project-based apps or augmented reality explorations, can substantially enhance self-directed learning capacities, empowering children to explore concepts at their own pace while developing critical skills like information evaluation and creative problem-solving.

A particularly salient finding across multiple studies concerns the multimodal nature of digital-native learning preferences. Rahiem (2021) demonstrates that digital storytelling platforms allow young learners to integrate visual, textual, and auditory modalities in constructing and communicating knowledge, yielding significantly richer narrative outputs compared to traditional oral or written storytelling. Similarly, Suh and Ahn (2022) report that metaverse-based learning environments elicit higher levels of collaborative problem-solving and creative expression among elementary students, consistent with constructivist predictions about the educational potential of immersive, embodied learning spaces.

The role of artificial intelligence in personalized elementary education represents one of the most rapidly evolving dimensions of this literature. Yang et al. (2023) demonstrate that AI-enhanced embodied learning tools significantly improve young children's conceptual understanding and engagement with abstract STEM concepts. Jauhiainen and Guerra (2023) provide empirical evidence that generative AI tools such as ChatGPT can be effectively scaffolded for elementary school use, with appropriate teacher mediation enabling students to develop higher-order questioning and critical evaluation skills. Ng et al. (2023) offer a broader review confirming that AI literacy education, when introduced in a developmentally appropriate and socially embedded manner, contributes positively to students' computational thinking and creative problem-solving dispositions.

B. Digital Literacy Development and Challenges

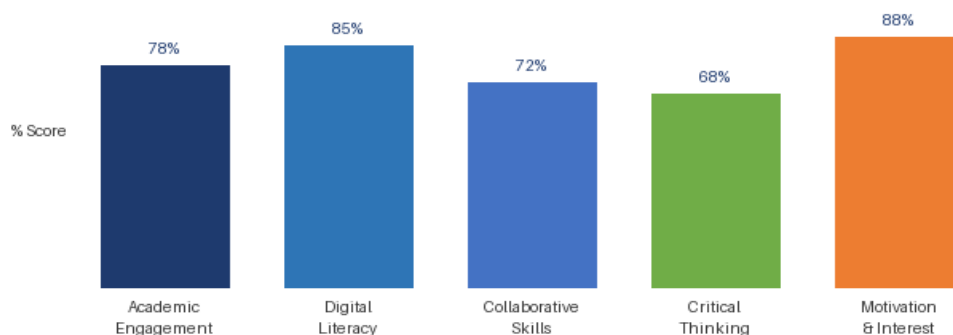
While the benefits of digital technology integration are well-documented, the

reviewed literature also surfaces a complex array of challenges. Audrin and Audrin (2022) identify three systemic barriers to effective digital literacy development in elementary settings: inadequate teacher digital competence, insufficient infrastructure in under-resourced schools, and the absence of coherent, curriculum-embedded digital literacy progressions. Suwanto et al. (2022), examining Indonesian elementary schools, find that while urban schools have made significant strides in digital infrastructure, rural and peri-urban settings continue to face significant connectivity and device access disparities that reproduce existing educational inequities.

The home-school digital learning nexus is highlighted as a critical mediating factor by Soyoo et al. (2023), who find that parental mediation styles, both restrictive and active, significantly shape the quality and breadth of children's digital literacy development, influencing everything from basic navigation to ethical content evaluation. Children whose parents engage in collaborative, co-participatory digital activities, such as joint exploration of educational apps, guided online research, or family media discussions, demonstrate substantially stronger critical digital skills, including source verification and creative content production, compared to those in homes characterized by either permissive environments that foster unchecked exposure or prohibitive ones that limit experiential learning altogether.

Buchan et al. (2024) further underscore the importance of community-level digital literacy ecosystems, arguing that schools alone cannot adequately prepare digital-native children for the complex information environments they inhabit daily, where algorithms curate feeds and social media blurs fact from fiction. They advocate for integrated networks involving libraries, after-school programs, and local tech hubs to extend support beyond classrooms, ensuring holistic skill-building that aligns home practices with school expectations.

Lee and Hancock (2023) introduce the concept of digital resilience as a distinct developmental competency for Generation Alpha learners, demonstrating that targeted educational interventions, such as scenario-based workshops and peer mentoring, can significantly improve elementary students' capacity to navigate digital challenges, including online misinformation, cyberbullying, and information overload, with adaptive coping strategies like critical pausing, fact-checking, and positive online advocacy rather than avoidance or vulnerability.



Source: Aggregated findings from reviewed studies (2021-2024)

Figure 2. Estimated impact of Digital Technology Integration on Elementary Student Learning Outcomes

C. Pedagogical Frameworks for Digital-Native Learners

A unifying thread across the reviewed literature is the inadequacy of transmissive, teacher-centered pedagogical approaches for Generation Alpha learners, who disengage quickly from passive lectures and rote drills in favor of participatory, tech-infused methods. Timotheou et al. (2022) synthesize evidence from multiple European contexts to conclude that schools' digital transformation cannot be reduced to technology acquisition like laptops or software; rather, it requires comprehensive pedagogical redesign centered on active, inquiry-based, and collaborative learning experiences that empower students to co-create knowledge through projects, simulations, and real-world problem-solving.

Topping et al. (2022) find that online and blended learning models are most effective when they combine structured direct instruction, such as targeted video lessons, with significant student agency in choosing paths, peer collaboration via shared digital platforms, and formative feedback through instant analytics and adaptive tools, a design philosophy that aligns closely with the learning preferences documented across the digital-native literature, including preferences for gamification, personalization, and immediate relevance to everyday digital lives.

The integration of AI-based educational tools merits particular attention as a pedagogical frontier uniquely suited to Generation Alpha's digital-native expectations for personalization and interactivity. Aravantinos et al. (2024), in a comprehensive Scopus-based systematic review, identify five primary instructional approaches through which AI is being deployed in primary school settings: intelligent tutoring systems that adapt lessons in real-time to individual paces, AI-enhanced collaborative learning environments fostering global peer projects, automated assessment and feedback tools providing instant progress insights, AI-mediated creative learning platforms sparking innovative content generation, and robot-assisted learning that blends physical-digital engagement for kinesthetic learners. Each of these modalities demonstrates evidence of positive learning outcomes, such as improved retention, motivation, and skill transfer, when implemented with clear pedagogical intentionality, like curriculum alignment, and adequate teacher support to facilitate rather than replace human guidance.

Wang et al. (2024) similarly document, through bibliometric analysis of a global literature corpus spanning diverse languages and regions, that AI-driven educational reform is accelerating across diverse national contexts from Europe to Asia, with Generation Alpha positioned as both the primary beneficiary of tailored, data-informed instruction and the generative force driving this transformation through their intuitive tech fluency and demand for immersive experiences.

Table 2. Digital Tools and Their Documented Learning Outcomes in Elementary Education

Digital Tool Category	Examples	Learning Outcomes	Key References
Gamification Platforms	Kahoot, Classcraft	Motivation, engagement, social cognition	Antonopoulou et al. (2022); Zheng et al. (2023)
AI-Based Learning Tools	ChatGPT, AI tutors	Personalized learning, critical thinking	Jauhiainen & Guerra (2023); Ng et al. (2023)

Digital Tool Category	Examples	Learning Outcomes	Key References
Mobile Devices	Tablets, Smartphones	Instant feedback, self-paced learning	Wang et al. (2022); Morris & Rohs (2021)
Digital Storytelling	Book Creator, Storybird	Creativity, literacy, narrative skills	Rahiem (2021)
Immersive Environments	Metaverse, VR apps	Constructivist learning, collaboration	Suh & Ahn (2022)
Collaborative Platforms	Google Classroom, LMS	Communication, cooperative learning	Timotheou et al. (2022); Topping et al. (2022)

Note. Outcomes synthesized from peer-reviewed studies (2021-2024); effect sizes vary across individual studies and contexts.

D. Socio-Cultural Dimensions and the Indonesian Context

The socio-cultural embedding of digital nativity is a dimension that global literature has begun to address more systematically, recognizing that technology adoption cannot be isolated from the cultural fabrics shaping young learners' worlds. Suroso et al. (2021) argue, from an Indonesian socio-cultural perspective, that the digital transformation of younger generations must be understood in dialogue with local cultural values like collectivism and respect for authority, religious identities that guide moral online behavior, and community expectations around child-rearing, not as a purely technological or pedagogical phenomenon, but as an interplay that influences everything from app preferences to screen-time boundaries.

This resonates with Suwanto et al.'s (2022) findings in Yogyakarta, where digital literacy practices in elementary schools are shaped not only by infrastructure and teacher capacity, but also by community norms regarding appropriate technology use for children, such as parental concerns over social media exposure, and the role of schools as cultural institutions that balance modern tools with traditional values like communal learning and ethical storytelling.

Moreno-Morilla et al. (2021) similarly demonstrate, in the Spanish context, that children's digital literacy competencies are powerfully shaped by out-of-school environments, with socio-economic status determining device access and parental educational level moderating how families co-create digital experiences, significantly influencing the relationship between school-based digital instruction and students' broader digital capability, from creative production to safe navigation.

These findings collectively underscore that effective digital education for Generation Alpha must be contextually sensitive, culturally responsive, incorporating local languages, values, and family structures, and ecosystem-oriented, engaging homes, communities, and policies rather than narrowly technocentric, to truly empower diverse digital natives.

CONCLUSION

This systematic review synthesizes convergent evidence that Generation Alpha children bring fundamentally transformed learning orientations to elementary classrooms, characterized by heightened expectations for interactivity, multimodality, personalization, and collaborative engagement. The literature documents substantial positive effects of well-designed digital technology integration, including gamification, AI tools, digital storytelling, mobile devices, and immersive environments, on academic

engagement, digital literacy development, motivational outcomes, and collaborative learning skills.

However, the evidence base also reveals that technological availability alone is insufficient to realize these benefits. Pedagogical redesign, teacher professional development, family and community engagement, and equitable infrastructure access are all identified as essential enabling conditions. The digital divide, both within and between nations, represents a persistent structural challenge that risks exacerbating educational inequality if not proactively addressed in digital transformation agendas.

For elementary educators and policymakers, this review suggests several practical imperatives: invest in sustained teacher digital competence development that goes beyond basic tool training to encompass pedagogically grounded digital integration skills; develop coherent, curriculum-embedded digital literacy progressions that address all five dimensions of digital competence; create structured opportunities for parent engagement in children's digital learning; and ensure that digital transformation agendas are accompanied by robust equity and access frameworks.

Future research should prioritize longitudinal designs that trace the developmental trajectories of Generation Alpha learners' digital competencies across the elementary school years, as well as cross-cultural comparative studies that illuminate the socio-cultural mediators of effective digital-native pedagogy. The emerging domains of AI literacy, digital resilience, and ethical digital citizenship represent particularly urgent priorities for both research and curriculum development as Generation Alpha advances through its formative educational years.

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