WORLD EDUCATION POLICY
AN INTERNATIONAL JOURNAL
OPEN ACCESS
Review Article
Check for updates

The Effects of Technology on Early Childhood Learning Literature

Moses Adondua Abah[1], **Kelvin Ehiwario**[2], **Micheal Abimbola Oladosu**[1] and **Nathan Rimamsanati Yohanna**[1]

[1]*ResearchHub Nexus Institute, Nigeria*
[2]*Department of Human Resources, Faculty of Management, Law & Social Sciences, University of Bradford, United Kingdom*

Corresponding author: **Moses Adondua Abah** | E-mail: **m.abah@fuwukari.edu.ng**

Citation: Moses Adondua Abah, Kelvin Ehiwario, Micheal Abimbola Oladosu and Nathan Rimamsanati Yohanna (2025). The Effects of Technology on Early Childhood Learning Literature. *World Education Policy: An International Journal.* **DOI: https://doi.org/10.51470/WEP.2025.3.2.01**

Received 13 August 2025 | Revised 11 September 2025 | Accepted 12 October 2025 | Available Online 04 November 2025

Abstract

Technology has transformed early childhood learning, offering new opportunities and challenges. Young children are increasingly exposed to digital devices, apps, and online content, shaping their cognitive, social, and emotional development. Research explores the impact of technology on early learning, focusing on effects on language development, literacy, and social skills. This review examines the literature on technology's role in early childhood education, highlighting benefits and drawbacks. Studies show technology can enhance early learning when used appropriately. Interactive apps and games promote language skills, problem-solving, and creativity. Digital storytelling and e-books foster literacy development. However, excessive screen time is linked to decreased physical activity, sleep disturbances, and delayed social skills. Technology can also exacerbate socio-economic disparities, as not all children have equal access to digital resources. Educators and parents play a crucial role in guiding technology use, ensuring balance and relevance to learning goals. Effective integration of technology supports personalized learning, engagement, and preparation for a digital world. Technology's impact on early childhood learning is complex, offering benefits and risks. Thoughtful integration, guided by educators and parents, can enhance learning outcomes. Balance, equity, and relevance are key to harnessing technology's potential, ensuring young learners thrive in a digital age.

Keywords: *Technology, Early childhood learning, Digital age, Learning, and Emotional development.*

Introduction

Digital technology integration in early childhood education has accelerated at a never-before-seen rate in recent years. These days, even infants engage with tablets, smartphones, laptops, televisions, and more and more AI-powered devices [1]. This change has altered the early learning environment and reflects larger societal trends in digitization. Early childhood education has historically placed a strong emphasis on play-based, experiential learning that is based on social interaction, physical contact, and sensory exploration. However, new learning approaches that combine instruction, entertainment, and interaction often on the same platform have been made possible by the growth of digital media [2]. Teachers, parents, and researchers are simultaneously excited and concerned about the shift from tactile play to screen-based engagement.

On the one hand, digital tools provide an opportunity for cognitive stimulation, access to a wealth of instructional content, and customized learning experiences. For instance, through gamified forms, interactive apps can help with problem-solving, language learning, and numeracy skills. Platforms driven by AI are starting to modify information to suit different learning preferences, which could improve retention and engagement [3]. Conversely, excessive or unsupervised technology use might impede social development, shorten attention spans, and encourage sedentary behavior. According to studies, screen time takes the role of exercise and in-person interactions, both of which are essential for young children's emotional and social development [4].

There is conflicting and frequently context-dependent evidence about early technology exposure. While some studies emphasize the cognitive advantages of controlled digital learning environments, others advise against relying too much on screens, particularly in situations that are unsupervised or focused on entertainment. According to a review of the literature by [5], the impacts of digital media differ according to the quality of the content, the amount of time spent using it, and the engagement of parents. Furthermore, differences in digital literacy and access might worsen educational inequities, ; therefore, socioeconomic considerations must be taken into account when assessing results [6].

Examining their distinct functions in early learning is essential, given the variety of platforms and devices that are currently accessible. The most widely utilized devices are tablets and smartphones, which are

frequently introduced prior to the start of formal education. Young children find them appealing because to of their portability and touch interfaces, but there is a risk of overexposure and distraction. Even if they are more sedentary, computers and televisions still have an impact on education through instructive instructional games and programming [7]. As new technologies like voice assistants and AI-based tutors start to make their way into the early childhood sector, concerns about data privacy, developmental appropriateness, and long-term impacts on learning autonomy are being raised [8].

This review's objective is to evaluate critically how digital technology affects early childhood education, with a particular emphasis on children between the ages of 0 and 8. It examines the transition from traditional pedagogies to digital-integrated environments, weighs the advantages and disadvantages of different gadgets, and takes into account the wider effects on social, emotional, and cognitive development it also aims to educate educators, caregivers, and legislators about the best ways to incorporate technology into early learning environments by summarizing recent research and pointing out knowledge gaps. The ultimate objective of this study is to achieve a balance between innovation and developmental integrity so that digital technologies support rather than interfere with the formative years of infancy.

Overview of Early Childhood Learning and Development

Early childhood, which is defined as the time between birth and about age eight, is characterized by quick and fundamental growth in a number of areas. These include cognitive development, which encompasses memory, attention, and problem-solving; language development, involving speech perception, vocabulary acquisition, and grammar; motor skills, both fine (e.g., grasping, drawing) and gross (e.g., walking, jumping); and social–emotional development, which includes empathy, self-regulation, and relationship-building [9, 10]. These domains don't change on their own. Rather, they engage in dynamic interactions that are influenced by both ambient experiences and biological maturity. For instance, linguistic understanding is supported by cognitive development, and learning is fueled by exploratory play made possible by physical coordination. Table 1 provides a developmental snapshot from infancy through the early school years by summarizing key milestones in each of these domains.

Table 1. Core developmental milestones from birth to 8 Years

Age range	Cognitive development	Language development	Motor skills	Social–emotional development
0–12 months	Object permanence begins	Babbling, first words	Rolling, crawling	Attachment formation
1–2 years	Symbolic thinking emerges	Vocabulary explosion	Walking, climbing	Expresses basic emotions
3–4 years	Problem-solving improves	Sentence formation	Running, drawing shapes	Cooperative play begins
5–6 years	Logical reasoning develops	Storytelling, grammar use	Writing, skipping	Understands rules, empathy grows
7–8 years	Abstract thinking begins	Reading comprehension	Refined coordination	Peer relationships deepen

Sources: *[4, 10]*

Brain plasticity, or the brain's capacity to rearrange and create new connections in response to experience and learning, is the foundation for these milestones. During critical periodswindows of increased sensitivity when certain skills, like language or emotional regulation, are most easily learned, this plasticity is most noticeable. The brain experiences structural and functional changes in early childhood that set the stage for lifetime learning.

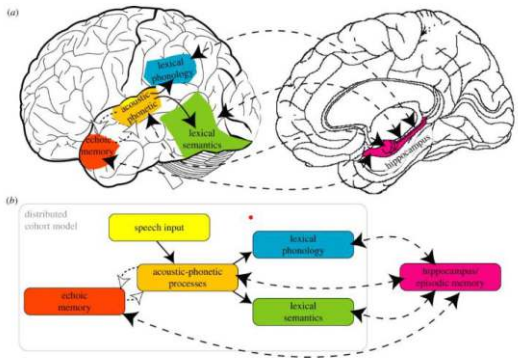

Figure 1. Brain regions developing rapidly in early childhood (prefrontal cortex, temporal lobe for language).
Source: *[2]*

The developmental paths of important brain areas are shown in Figure 2. During the preschool years, the prefrontal cortex, which is in charge of executive skills like impulse control and attention, grows significantly.

Language processing and semantic comprehension are supported by the temporal lobe, especially the superior and middle temporal gyri. Children are able tocan store and recall knowledge because the hippocampus, which is involved in memory consolidation, develops quickly. Through pathways that analyze voice input, connect acoustic-phonetic signals to lexical meaning, and encode events into episodic memory, these regions interact [9].

Play, engagement, and exploration have a significant impact on this brain development. Play-based learning promotes social negotiation, creativity, and problem-solving skills. While exploration through movement and sensory engagement promotes cognitive and motor progress, interaction with peers and caregivers improves language and emotional abilities. Environments that facilitate active, hands-on learning are crucial for maximizing early development, according to NAEYC's developmentally appropriate practice guidelines [10].

Types of Technology Used in Early Childhood

Technology is now a central feature of early childhood learning environments, with a wide range of devices and platforms used to support cognitive, social, and emotional development. These tools offer interactive, personalized, and often gamified experiences that can enhance engagement and learning outcomes when used appropriately. According to the National Association for the Education of Young Children (NAEYC), integrating technology into early learning

must be developmentally appropriate, intentional, and guided by adult interaction to optimize developmental benefits [10].

With regard toConcerning their portability, touch-screen interfaces, and wealth of kid-friendly apps, tablets and smartphones are the gadgets that young children utilize the most. These gadgets are used for both amusement and education, and they are frequently introduced prior to the start of official schooling. Through interactive games, riddles, and storytelling, apps made for early learners can promote literacy, numeracy, and problem-solving skills. But worries about excessive screen time and passive consumption still exist, particularly when gadgets are used unsupervised by an adult [11].must be developmentally appropriate, intentional, and guided by adult interaction to optimize developmental benefits [10].

With regard toConcerning their portability, touch-screen interfaces, and wealth of kid-friendly apps, tablets and smartphones are the gadgets that young children utilize the most. These gadgets are used for both amusement and education, and they are frequently introduced prior to the start of official schooling. Through interactive games, riddles, and storytelling, apps made for early learners can promote literacy, numeracy, and problem-solving skills. But worries about excessive screen time and passive consumption still exist, particularly when gadgets are used unsupervised by an adult [11].

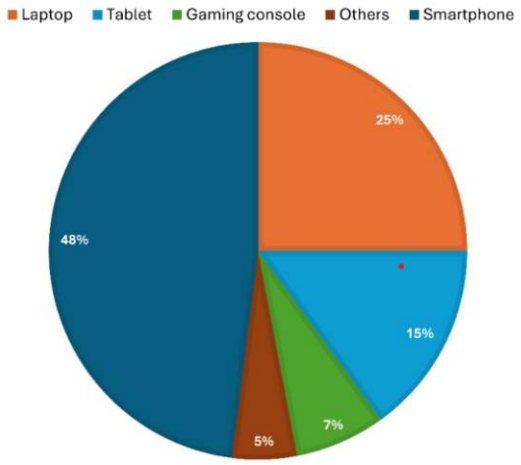

Figure 2. *Pie chart showing proportion of device use among children aged 0–8 (e.g., 40% tablets, 30% phones, etc.).*
Source: *[12]*

Based on recent observational data, Figure 3 shows the typical distribution of gadget use among children aged 0–8. 48% of all digital devices are smartphones, followed by laptops (25%), tablets (15%), gaming consoles (7%), and other devices (including wearables) (5%). This distribution emphasizes the prevalence of mobile technology in early infancy and emphasizes the necessity of directed use and content regulation. The widespread use of cellphones is a reflection of their accessibility and versatility, but it also raises concerns regarding developmental appropriateness and attention span [13].

Learning games and educational applications are essential components of early childhood digital pedagogy. Adaptive learning algorithms, which modify difficulty according to user performance and encourage customized learning routes, are frequently incorporated into these systems. According to research, when included into controlled learning environments, well-designed educational applications can enhance language, early math skills, and executive functioning [14].

Particularly in homes where screen time is a regular part of everyday life, televisions and streaming services continue to have a significant impact. Prosocial conduct and language development have been shown to benefit from educational television like Sesame Street and PBS Kids. However, passive viewing lacks the interactivity of other digital tools and, if not counterbalanced with physical play, may lead to sedentary habit [10]. Preschool and early primary classes are more likely to have computers and interactive whiteboards. These resources facilitate multimedia inquiry, digital storytelling, and cooperative learning. Specifically, interactive whiteboards enable teachers to deliver dynamic content and involve students in group activities that combine kinesthetic, auditory, and visual learning modalities [11].

Voice assistants and adaptable applications are two examples of AI-assisted learning tools that are becoming increasingly useful in early education. These tools can answer questions from kids, tailor information delivery, and even facilitate language acquisition through dialogue. AI tools are promising, but they also bring ethical questions about data privacy, developmental appropriateness, and the possibility of less human involvement [12].

The cutting edge of early childhood technology is represented by wearables and virtual reality (VR). These tools provide immersive experiences that help improve spatial awareness, empathy, and experiential learning, despite their low usage. VR field trips, for instance, enable kids to investigate historical locations or ecosystems in ways that are not possible with traditional media. Fitness trackers and other wearables can encourage exercise and health consciousness, but their use in young people needs to be closely watched [13].

Positive Effects of Technology on Early Childhood Learning

Early childhood education now relies heavily on digital learning technologies, which provide individualized and interactive experiences that reinforce fundamental skills. High-quality educational applications have demonstrated quantifiable gains in literacy and language development. For example, children who used ABCmouse showed significant improvements in phonemic awareness and early reading skills, while children who used Endless Alphabet showed a 40% increase in vocabulary acquisition [14].

Apps like Khan Academy Kids and Prodigy, which employ gamified challenges and adaptive learning routes to develop mathematical reasoning, help improve numeracy and problem-solving skills. These platforms have been linked to a 25–30% improvement in early math performance among preschool and early primary learners [15].

Crucially, children with developmental disabilities can receive specialized support through special needs apps. Children with autism, ADHD, and speech difficulties can benefit from speech therapy and cognitive activities provided by programs like Otsimo and Speech Blubs. These applications support inclusive learning environments by promoting communication, focus, and emotional control [16]. Children who use digital tools that provide instant feedback, prizes, and entertaining interfaces regularly exhibit higher levels of engagement and motivation. Playing interactive games fosters perseverance and curiosity, two qualities that are essential for cognitive growth. Children that who play instructional games have longer attention spans and better executive functioning, according to research [15].

Early learning is becoming more accessible, particularly in underprivileged areas, thanks to the growth of telelearning and remote education. Teachers can offer lessons, monitor progress, and interact with families through platforms like ClassDojo and Seesaw, which facilitate learning continuity amid disruptions like the COVID-19 epidemic [16].

Table 2 highlights the variety and efficacy of technology in early childhood education by summarizing evidence-based technologies and their demonstrated educational outcomes.

Table 2. Examples of technology-based learning tools and documented educational outcomes

Tool/App	Primary Focus	Documented Outcome	Age Range
ABCmouse	Literacy & Phonics	35% improvement in early reading skills	3–7 years
Khan Academy Kids	Numeracy & Logic	30% gain in math reasoning	4–8 years
Endless Alphabet	Vocabulary Development	40% increase in word recognition	2–6 years
Prodigy	Problem-Solving & Math	25% boost in cognitive flexibility	5–8 years
Otsimo	Special Needs Support	Improved speech and attention in ASD users	3–8 years
ClassDojo	Remote Learning & SEL	Enhanced engagement and family interaction	4–8 years

Sources: *[3, 5, 7]*

The learning benefits of app-based interventions are highlighted in Figure 3, which displays percentage increases in vocabulary and numeracy across four popular platforms.

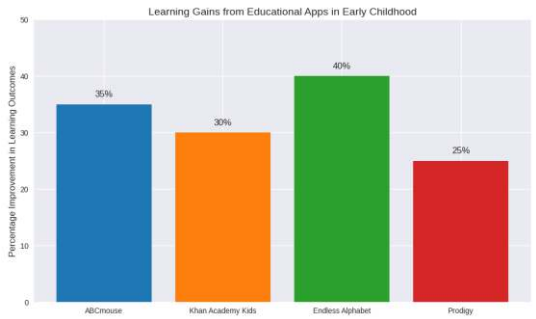

Figure 3: *Chart showing potential of digital tools to enrich Vocabulary*
Sources: *[5, 10, 13]*

These findings underscore the potential of digital tools to enrich early learning when used intentionally and supported by adult guidance. As technology continues to evolve, its role in shaping cognitive, linguistic, and emotional development will remain a critical area of research and practice.

Negative Effects and Risks of Technology Use

Concerns regarding unforeseen implications have been raised by the quick adoption of digital technology in early life. Although interactive media and educational apps provide learning possibilities, passive screen time, particularly with regard to television and non-interactive content, has been associated with delayed language development. Long periods of passive viewing frequently result in less verbal stimulation from caregivers, which is important for vocabulary development and conversational turn-taking. Early screen time without adult interaction is associated with lower expressive and receptive language skills, according to a comprehensive review published in MDPI's Children journal [12].

Overstimulation and a short attention span are also significant dangers.

Children may find it more difficult to concentrate on slower-paced, real-world work if their brains are conditioned to expect high levels of stimulation by from fast-paced animations, frequent scene changes, and continuous notifications. According to [13], children under the age of six are particularly vulnerable to the negative effects of digital overstimulation on executive processes, such as working memory and impulse control.

Sleep disruption brought on by exposure to blue light is another issue. Blue wavelengths from screens inhibit the generation of melatonin, delaying the onset of sleep and lowering its quality. Early children childhood sleep deprivation is linked to behavioral problems, mood swings, and poor learning. According to studies, kids who use screens right before bed typically sleep for up to 30 minutes less and have more nightly awakenings [14].

One consequence of excessive screen time is limited physical play, which can lead to poor motor development. The development of strength, coordination, and spatial awareness all depends on physical activity. Children may exhibit delays in gross motor milestones like running, jumping, and balancing when screen time takes the place of vigorous play. Sedentary screen habits are associated with decreased physical fitness and an increased risk of childhood obesity, according to the MDPI Proceedings publication by [15].

Social and emotional repercussions are as important. Parent-child connection, which is essential for emotional bonding and control, is frequently diminished by excessive screen time. When human interaction is replaced by digital media, children may experience difficulties with empathy, frustration tolerance, and peer relationships. Children with high screen time and little social engagement have been shown to exhibit emotional dysregulation, which can show up as tantrums, withdrawal, or anxiety [16].

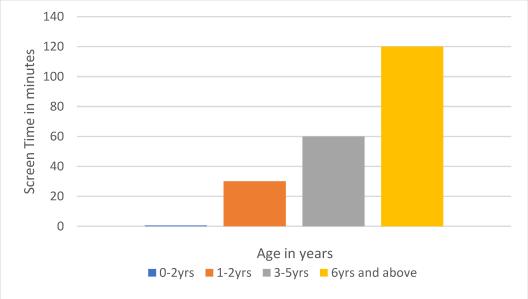

Figure 4. *Effects of high exposure in less parental child interaction*
Source: *[13]*

The dangers of excessive screen time in early development are shown in Figure 4. The figure illustrates how too much exposure results in less parent-child interaction, which in turn causes delayed language development and social-emotional difficulties. Other branches show inadequate physical play, improper content exposure, sleep difficulties, and attention deficits. This model highlights the significance of balanced, supervised technology use as well as the interconnectedness of digital dangers.

Moderating Factors Influencing Technology's Effects

Technology's effects on early childhood education are not consistent; they differ greatly based on a number of moderating factors. One of the most important factors is age. Children aged 0–2 are in a sensitive period for sensory and emotional bonding, and excessive screen exposure during this stage may interfere with attachment and language acquisition. In contrast, children aged 3–5 benefit more from interactive media that supports emerging literacy and numeracy, while those aged 6–8 can engage with more structured educational content and begin developing digital literacy skills [14].

Another significant factor is the kind of media, passive vs participatory. Active participation, problem-solving, and feedback-based learning are all promoted by interactive media, such as educational games and apps. Television and autoplay videos are examples of passive media that frequently lacks reactivity and can result in shorter attention spans and less cognitive stimulation. According to a meta-analysis that was published in Frontiers in Psychology, interactive digital tools considerably outperformed passive screen use in fostering academic results and executive functioning [15].

Frequency and duration of use are other crucial factors. While extended, uncontrolled exposure is linked to detrimental effects like sleep disturbance, behavioral problems, and decreased physical activity, brief, planned sessions of excellent digital learning can improve development. For children ages 2 to 5, the American Academy of Pediatrics advises limiting screen usage to one hour each day, stressing the value of routine and balance. Parental participation can reduce dangers and increase benefits, particularly when it comes to co-viewing and directed interaction. When caregivers interact with kids while they're using screens, they ask questions, give context, and reinforce what they've learned.

Digital experiences become relational learning possibilities because to of this social scaffolding. Research indicates that children who watch instructional content with their parents exhibit improved emotional regulation and language skills [16].

Another important consideration is the quality of the content. Cognitive and linguistic development can be supported by educational materials created using developmental concepts, such as age-appropriate pacing, interactivity, and specific learning objectives. On the other hand, stimulation is sometimes given precedence over substance in entertainment-focused programming, which may result in hyperactivity or diminished attention control. According to a neuroscience study from UNESCO's Science of Learning Portal, overstimulating media may avoid deeper cognitive processing, whereas significant information engages brain regions linked to memory and understanding [4].

Lastly, access and results are influenced by digital inequality and socioeconomic status. Children from lower-income families could rely more on passive media and have less access to high-quality gadgets, dependable internet, or instructional apps. Existing educational inequalities may be made worse by this digital divide. Additionally, the usage of technology at home whether as a distraction or a teaching tool is influenced by parental digital competence. Policy interventions that enable fair access to devices, content, and caregiver support are necessary to address these disparities.

Future Research Directions

Future research must adapt to new opportunities and problems as digital technologies become more and more integrated into early childhood education. Long-term longitudinal studies that monitor developmental outcomes across time are crucial. The majority of current research is based on short-term observations, which do not account for cumulative effects or long-term repercussions of early digital exposure. The effects of screen time, app use, and digital interaction on cognitive, emotional, and social trajectories from infancy to adolescence would be better understood with longitudinal data [2, 3].

The influence of AI and tailored learning tools is another important topic. AI-powered platforms are starting to adapt instructional materials to each learner's preferences, pace, and learning style. Despite their potential, these technologies need to be thoroughly assessed to make sure they promote developmental objectives rather than just maximize participation. The effects of adaptive algorithms on learning outcomes, autonomy, and attention in children between the ages of 0 and 8 should be investigated [4, 5].

Research should also be done on the impacts of early exposure to VR and AR technologies. Immersion settings may improve experience learning, empathy, and spatial reasoning, but they may also diminish physical play or warp reality perception. Research should look at how virtual experiences affect social cognition and sensory development, particularly in young children [6].

Comprehending the disparities in digital equality is crucial for inclusive education. Access to devices, internet connectivity, and high-quality content are all impacted by socioeconomic gaps. Children from underprivileged backgrounds might not have parental support for directed use or rely more on passive media. According to [8], research must identify obstacles to fair digital learning and suggest scalable alternatives, including subsidized devices, community training, and culturally relevant content.

Conclusion

The use of technology in early childhood education has many facets and presents both opportunities and risks. Digital tools can improve literacy, numeracy, and engagement when utilized purposefully. Uncontrolled exposure, however, might interfere with concentration, sleep, and emotional development, particularly when it comes to passive or unsuitable content. Quality, age-appropriateness, and parental participation all affect the results. While excessive or unguided usage carries hazards, balanced, directed use promotes advantages. Policies, educator training, and evidence-based design are crucial going ahead forward to guarantee that technology enhances rather than detracts from the foundational years of development.

Acknowledgement

We thank all the researchers who contributed to the success of this research work.

Conflict of Interest

The authors declared that there are no conflicts of interest.

Funding

No funding was received for this research work.

References

1. Blums, A., Holloway, S., & Barresi, J. D. (2024). Understanding child development. In *Introduction to Early Childhood Education*. https://pressbooks.pub/introductiontoearlychildhoodeducation/chapter/chapter-2-child-development/
2. Budzyna, D., & Buckley, D. (2023). *The Whole Child: Development in the Early Years*. ROTEL (Remixing Open Textbooks with an Equity Lens) Project. https://rotel.pressbooks.pub/whole-child/
3. Clemente-Suárez, V. J., Beltrán-Velasco, A. I., Herrero-Roldán, S., Rodriguez-Besteiro, S., Martínez-Guardado, I., Martín-Rodríguez, A., & Tornero-Aguilera, J. F. (2023). Digital device usage and childhood cognitive development: Exploring effects on cognitive abilities. *Children, 11*(11), 1299. https://doi.org/10.3390/children11111299
4. Healthy Kid Play. (2024). Child development: Cognitive, physical, social-emotional, language, and motor skills. https://healthykidplay.com/child-development-cognitive-physical-social-emotional-language-and-motor-skills/
5. Kabir, K. (2024). 10 innovative tech tools transforming early childhood education. *Education and Academy*. https://www.educationandacademy.com/10-innovative-tech-tools-transforming-early-childhood-education/
6. Maeneja, R., Rato, J., & Ferreira, I. S. (2024). How is the digital age shaping young minds? A rapid systematic review of executive functions in children and adolescents with exposure to ICT. *Children, 12*(5), 555. https://doi.org/10.3390/children12050555
7. Maitra, S. (2024). The influence of interactive digital tools on early childhood learning and cognitive development. *International Journal of Fundamental and Multidisciplinary Research, 6*(34147). https://www.ijfmr.com/papers/2024/6/34147.pdf
8. Mando School. (2024). The impact of educational apps on early childhood learning. https://www.mandoschool.com/blog/The%20Impact%20of%20Educational%20Apps%20on%20Early%20Childhood%20Learning
9. Mihăilă-Popa, V. (2023). Early childhood development: The influence of digital technology on psychological processes and mechanisms. *Journal of Digital Pedagogy*. https://digital-pedagogy.eu/early-childhood-digital-technology-psychological-processes
10. NAEYC. (2024). Principles of child development and learning and implications that inform practice. *National Association for the Education of Young Children*. https://www.naeyc.org/resources/position-statements/dap/principles
11. Rizzo, R., Fusto, G., Marino, S., Castagnola, I., Parano, C., Pappalardo, X. G., & Parano, E. (2024). Molecular and neurobiological imbalance from the use of technological devices during early child development stages. *Children, 12*(7), 909. https://doi.org/10.3390/children12070909
12. Slimmen, S., Timmermans, O., Mikolajczak-Degrauwe, K., & Oenema, A. (2022). How stress-related factors affect mental wellbeing of university students: A cross-sectional study. *PLOS ONE, 17*(11), e0275925. https://doi.org/10.1371/journal.pone.0275925
13. Van Herwegen, J. (2024). The impact of digital technology on cognitive processes and learning outcomes in early childhood: Evidence from neuroscience. *IBE–UNESCO Science of Learning Portal*. https://solportal.ibe-unesco.org/articles/the-impact-of-digital-technology-on-cognitive-processes-and-learning-outcomes-in-early-childhood-evidence-from-neuroscience/
14. Yi, H., Liu, T., & Lan, G. (2024). The key artificial intelligence technologies in early childhood education: A review. *Artificial Intelligence Review, 57*(12). https://doi.org/10.1007/s10462-023-10637-7
15. Zain, Z. M., Jasmani, F. N. N., Haris, N. H., & Nurudin, S. M. (2022). Gadgets and their impact on child development. *Proceedings, 82*(1), 6. https://doi.org/10.3390/proceedings2022082006
16. Zuo, R., Wenling, L., & Xuemei, Z. (2025). The impact of information and communication technology on learning outcomes in early childhood and primary education: A meta-analysis of moderating factors. *Frontiers in Psychology, 16*, Article 1540169. https://doi.org/10.3389/fpsyg.2025.1540169