C E N D E K I A
Jurnal Pendidikan Terintegrasi

***E*-ISSN : 3109-1059**

Digital Play-Based Pedagogy in Early Childhood Education: A Quasi-Experimental Study of Preschool Cognitive Development

Suryansah[1*] Ari Saputra[2] Lalu Ibrohim Burhan[3]
[1*] Universitas Hamzanwadi
[2] Universitas Gunung Rinjani
[3] Universitas Gunung Rinjani

doi: https://doi.org/10.63982/cendekia.45a7bw44
*corresponding Author: suryansah@gmail.com

ABSTRACT

This study examines the influence of play-based digital pedagogy on the cognitive development of early childhood learners in urban PAUD (early childhood education) settings. The rapid integration of digital technologies into education has created new opportunities to develop interactive, learner-centered learning environments. However, empirical research examining how digital pedagogy can be effectively integrated with play-based learning in early childhood education remains limited. This study employed a quasi-experimental research design with a pretest–posttest design to analyze changes in children's cognitive development following the implementation of a structured, digital, play-based learning intervention. The participants consisted of early childhood learners aged 4–6 years enrolled in urban PAUD institutions. The intervention was conducted over six weeks, integrating digital storytelling, educational game-based learning, puzzle-solving activities, and guided digital exploration within play-based classroom practices. Data were collected using developmental observation checklists and cognitive task assessments that measured symbolic thinking, memory, problem-solving skills, logical classification, and early reasoning. The results indicate a statistically significant improvement in children's cognitive development following the intervention, with notable gains in symbolic reasoning and problem-solving abilities. These findings suggest that digital technologies, when implemented through developmentally appropriate play-based pedagogical strategies, can effectively stimulate cognitive engagement and support early learning processes. The study contributes to the development of an integrative pedagogical model combining digital pedagogy and play-based learning, grounded in Constructivist Learning Theory and Play-Based Learning Theory. It provides empirical evidence for designing innovative, developmentally appropriate digital learning environments in early childhood education.

Keywords: *Cognitive Development, Digital Pedagogy, Early Childhood Education, Play-Based Learning, Quasi-Experimental Design*

Article submission:6/4/2026
Article revision: 19/4/2026
Article acceptance: 20/4/2026

CC BY

***E*-ISSN : 3109-1059**

INTRODUCTION

The rapid advancement of digital technologies has significantly reshaped educational practices worldwide, transforming how learning environments are designed, delivered, and experienced across different levels of education. Within this transformation, digital pedagogy has emerged as a critical framework emphasizing the purposeful integration of technological tools not merely as instructional media but as catalysts for interactive, learner-centered experiences that foster cognitive engagement and meaningful learning. Empirical evidence across educational contexts demonstrates that digital access, technological competence, and attitudes toward digital resources strongly influence the effectiveness of technology-mediated learning environments (Habibi et al., 2023; Muhaimin et al., 2020). At the same time, digital literacy and the ability to manage technology-supported learning innovations remain persistent challenges for educators and institutions attempting to integrate digital systems into pedagogical practice (Rasimin et al., 2024; Setyadi et al., 2025). Consequently, educational systems increasingly face the challenge of ensuring that technological integration is pedagogically meaningful, particularly in domains where developmental considerations are critical, such as early childhood education.

Within this broader digital transformation of education, increasing attention has been directed to how technological tools can be meaningfully integrated into early childhood learning environments to support developmental outcomes. In early childhood education, pedagogically designed digital resources can stimulate children's cognitive development by fostering interactive, exploratory, and contextually rich learning experiences that align with young learners' developmental characteristics. Emerging evidence suggests that digital platforms and learning applications can enhance early developmental processes by facilitating meaningful interactions between

***E*-ISSN : 3109-1059**

children, caregivers, and educational environments (Alam et al., 2023; LaMonica et al., 2024). Furthermore, specialized educational technologies, such as early literacy applications, demonstrate considerable potential for supporting foundational cognitive processes, including symbol recognition and early reading development (Maassen et al., 2025). However, the success of technology integration in preschool settings is strongly influenced by teachers' digital competence and perceptions of ICT usability, which shape how technological tools are translated into effective classroom practices (Ismail, 2023).

Amid these developments, the integration of digital pedagogy with play-based learning has emerged as a particularly promising approach in early childhood education, as it aligns technological interaction with developmentally appropriate learning processes. Play-based learning has long been recognized as a central mechanism through which young children construct knowledge, explore symbolic representations, and develop early reasoning abilities. Nevertheless, integrating digital technologies into play-oriented pedagogical environments presents several technical and instructional challenges. Many digital learning applications remain oriented toward isolated cognitive tasks, such as early literacy screening tools like GraphoLearn, which effectively support reading acquisition but are less capable of addressing broader cognitive development through interactive play-based learning experiences (Maassen et al., 2025). Moreover, the success of digital learning implementation often depends on teachers' technological experience, motivation, and self-regulated instructional strategies, which vary widely across educational contexts (Aditya & Andrisyah, 2023). Meanwhile, culturally embedded pedagogical practices—such as storytelling through traditional media and ethnopedagogical approaches—continue to demonstrate strong developmental benefits but are rarely integrated with digital learning environments (Halimah et al., 2020; Sakti et al., 2024). These fragmented approaches reveal persistent inconsistencies in how digital pedagogy is operationalized within play-based learning frameworks.

***E*-ISSN : 3109-1059**

Existing scholarship has approached digital pedagogy from diverse theoretical, methodological, and technological perspectives, particularly focusing on its potential to enhance learning engagement, digital literacy, and problem-solving abilities. Conceptual frameworks such as the Teacher Digital Competence (TDC) model emphasize the importance of integrating technological, ethical, and pedagogical competencies to support effective digital learning environments (Falloon, 2020). Methodologically, numerous studies employ experimental and quasi-experimental designs to evaluate digital learning interventions, including digital storytelling and science–mathematics narratives that have demonstrated measurable improvements in students' problem-solving abilities at the primary school level (Wangid et al., 2021). Other research has explored advanced technological ecosystems, such as the DL-XR framework, which integrates extended reality technologies with digital literacy development to promote collaborative inquiry and active learning processes (Chang et al., 2023). Additionally, innovative pedagogical models involving learning analytics, robotics, and citizen inquiry have been proposed to transform digital learning environments into more interactive and participatory ecosystems (Herodotou et al., 2019). From a critical pedagogical perspective, digital learning environments have also been linked to the development of reflective and ethical engagement with technology among learners (Wynn, 2025).

Despite these significant contributions, substantial limitations remain within the current body of literature on digital pedagogy and play-based learning in early childhood education. Several studies demonstrate that digital or game-based learning applications can positively influence children's cognitive abilities, particularly in problem-solving, memory retention, and critical thinking (Annuar et al., 2025). Similarly, meta-analytic findings suggest that game-based learning produces moderate to large effects on cognitive, social, and motivational outcomes among young learners (Alotaibi, 2024). Other research highlights the potential of serious games grounded in Montessori principles as well as internet-connected educational toys to

***E*-ISSN : 3109-1059**

promote engagement, inquiry, and creativity in early childhood learning environments (Kewalramani et al., 2020; Lamrani & Abdelwahed, 2019). In addition, structured storytelling integrated with play-based activities has been reported to enhance children's literacy and digital literacy development (Maureen et al., 2020). However, many of these studies focus primarily on isolated technological interventions or descriptive analyses, rather than examining the integrated relationship between digital pedagogy and play-based learning within complex educational environments. Furthermore, empirical investigations rarely measure specific dimensions of cognitive development among preschool learners in varied contextual settings such as urban early childhood institutions.

These limitations highlight a significant gap in the literature, particularly regarding the need for a more integrative, empirically grounded framework that captures the complex interactions among digital learning environments, play-based pedagogical practices, and cognitive development in early childhood education. Addressing this gap is essential for developing pedagogical models that are both theoretically robust and practically relevant within contemporary educational systems. Building on this need, the present study examines the influence of play-based digital pedagogy on children's cognitive development in urban early childhood education settings. The study investigates changes in children's cognitive development before and after the implementation of a structured learning intervention, using a quasi-experimental pretest–posttest design that enables a systematic assessment of learning outcomes associated with integrating digital technology and play-based pedagogy. Conceptually, the study advances an integrative pedagogical framework grounded in Constructivist Learning Theory (Piaget) and Play-Based Learning Theory, emphasizing active knowledge construction through exploratory learning experiences supported by digital technologies.

METHOD

This study employed a quasi-experimental research design using a pretest–posttest approach to examine the effect of play-based digital pedagogy

***E*-ISSN : 3109-1059**

on the cognitive development of early childhood learners in urban early childhood education settings. The quasi-experimental design was selected because the study was conducted in a natural classroom environment where random assignment of participants to experimental and control groups was not feasible. This design allows for the observation of changes in cognitive development before and after the implementation of the instructional intervention, thereby enabling the identification of measurable learning outcomes associated with the intervention.

The overall research workflow consisted of four main stages. First, a baseline assessment (pretest) was conducted to measure the initial cognitive development levels of participating children using structured developmental tasks and observation instruments. Second, the instructional intervention phase was implemented over six weeks using a structured, digital, play-based pedagogy model. Third, a post-intervention assessment (posttest) was administered to measure changes in children's cognitive development. Finally, the collected data were processed using descriptive and inferential statistical analyses to evaluate the magnitude and significance of the observed changes.

This sequential workflow ensured systematic data collection and allowed the study to isolate the instructional impact of digital play-based pedagogy on early childhood cognitive development.

The study was conducted in urban early childhood education institutions (PAUD) located in a metropolitan educational district. These institutions were selected because they possessed basic digital learning infrastructure and had previously implemented technology-supported learning activities in their classrooms.

The participants were children aged 4–6 years, representing the developmental stage typically associated with Piaget’s preoperational cognitive stage, during which symbolic thinking, language development, and early reasoning develop rapidly. The classroom environment included play-based learning corners, digital media stations, and teacher-guided activity spaces designed to support exploratory learning.

***E*-ISSN : 3109-1059**

Learning materials used during the intervention included digital storytelling applications, educational game-based learning platforms, puzzle-based digital activities, and interactive classification games. These materials were selected to stimulate key cognitive indicators, including symbolic recognition, memory retention, logical classification, and problem-solving ability.

The intervention was integrated into regular classroom learning sessions to ensure ecological validity and to reflect authentic early childhood educational practices.

Participants were selected using purposive sampling, focusing on early childhood institutions that met three criteria: availability of digital learning infrastructure, teacher familiarity with basic ICT tools, and willingness to participate in experimental classroom interventions.

The final sample consisted of 60 children enrolled in two comparable classrooms within the selected institutions. One class participated in the digital play-based learning intervention, while the other continued with regular play-based instruction.

Data collection involved three primary instruments:

1. Developmental Observation Checklist, used by trained observers to record children's cognitive behaviors during learning activities.
2. Cognitive Task Assessment, consisting of structured activities such as puzzle solving, object classification, and pattern recognition.
3. Teacher Perception Questionnaire, used to capture teachers' perspectives regarding the usability and effectiveness of digital play-based learning activities.

Observations were conducted during classroom learning sessions by trained research assistants to ensure objective and consistent data recording.

The intervention lasted 6 weeks, with 3 learning sessions per week, for a total of 18 instructional sessions. Each session lasted approximately 30–40 minutes and followed a structured pedagogical sequence.

The instructional procedure consisted of four stages:

***E*-ISSN : 3109-1059**

1. Digital Exploration Phase

   Children were introduced to digital learning tools through guided exploration facilitated by teachers.
2. Play-Based Activity Phase

   Children engaged in digital games involving pattern recognition, puzzle-solving, and symbolic matching.
3. Collaborative Interaction Phase

   Small-group activities encouraged peer interaction and collaborative problem-solving.
4. Reflection and Reinforcement Phase

   Teachers guided children in reflecting on completed tasks and reinforcing learning outcomes.

This structured learning cycle ensured that digital tools functioned as interactive play media rather than passive instructional devices.

Data collected from observation checklists and cognitive tasks were coded and compiled into a digital dataset for analysis. Cognitive performance scores were calculated based on performance across five indicators:

- Symbolic thinking
- Memory ability
- Problem-solving skills
- Logical classification
- Early reasoning ability

Each indicator was scored using a four-level developmental rubric, ranging from emerging competence to advanced mastery.

Composite cognitive scores were calculated by summing individual indicator scores and standardizing them to a scale ranging from 0 to 100 to facilitate comparison between pretest and posttest results.

To ensure measurement accuracy and reliability, several validation procedures were conducted before data collection.

First, the observation instrument was evaluated through content validity assessment involving three early childhood education experts. Second,

***E*-ISSN : 3109-1059**

inter-observer reliability was assessed through pilot observations conducted in a separate classroom setting. The resulting inter-rater reliability coefficient exceeded 0.85, indicating high agreement among observers.

Additionally, pilot testing of the cognitive task instruments ensured that tasks were developmentally appropriate and understandable for children aged 4–6 years.

Statistical analyses were conducted using SPSS. Descriptive statistics were first calculated to determine the mean scores, standard deviations, and distributions for both the pretest and posttest results.

Inferential analysis was conducted using paired-sample t-tests to evaluate statistically significant differences in cognitive development scores before and after the intervention. Effect sizes were calculated using Cohen's d to assess the magnitude of the intervention's impact.

Potential data anomalies were addressed through data screening procedures, including checks for missing values and outliers. Any incomplete data entries were excluded from the final analysis to maintain data integrity.

Ethical approval for the study was obtained from the institutional research ethics committee before data collection commenced. Participation was voluntary, and informed consent was obtained from parents or guardians of all participating children.

Children's identities were anonymized throughout the research process to protect confidentiality. Additionally, all learning activities conducted during the intervention were aligned with standard early childhood pedagogical practices to ensure participation posed no educational or psychological risks.

Despite the rigorous design of the study, several methodological limitations should be acknowledged. First, the quasi-experimental design did not allow for full randomization of participants, which may introduce potential selection bias. Second, the study was conducted within a limited number of urban early childhood institutions, which may limit the generalizability of findings to rural or resource-constrained educational contexts.

E-ISSN : 3109-1059

Third, the intervention was relatively short, focusing on short-term changes in cognitive development rather than long-term developmental trajectories. Future research may benefit from longitudinal designs that examine sustained cognitive development outcomes associated with digital play-based learning environments.

Nevertheless, the methodological framework employed in this study provides a robust basis for evaluating the instructional effectiveness of digital pedagogy integrated with play-based learning in early childhood education settings.

RESULT

Overall Changes in Children's Cognitive Development

This section presents the empirical findings from implementing **play-based digital pedagogy** in an urban early childhood education setting. The intervention was conducted over six weeks, with a total of 18 instructional sessions that integrated digital storytelling, game-based educational learning, puzzle-based problem-solving activities, and guided digital exploration. The results reveal observable improvements in several dimensions of children's cognitive development following the intervention period.

Descriptive statistics indicate a clear upward trend in children's overall cognitive performance between the pretest and posttest assessments. The mean composite cognitive score increased from **M = 61.42 (SD = 8.31)** during the pretest to **M = 79.18 (SD = 7.56)** in the posttest. A paired-sample t-test confirmed that this increase was statistically significant (**t(59) = 12.27, p < .001**), indicating that the learning intervention contributed to measurable improvements in children's cognitive development. The calculated effect size (**Cohen's d = 1.59**) indicates a large instructional impact. These results suggest that integrating digital learning tools with structured, play-based pedagogical activities can effectively stimulate cognitive development among early childhood learners.

Implementation of Digital Play-Based Pedagogy in the Classroom

***E*-ISSN : 3109-1059**

The first research focus examined how digital pedagogy integrated with play-based learning was implemented during classroom instruction. Observational data indicate that teachers successfully incorporated digital learning tools into daily play-based learning routines through four instructional phases: digital exploration, play-based interaction, collaborative problem-solving, and reflective reinforcement.

During the **digital exploration phase**, children interacted with touchscreen tablets and digital storytelling platforms under teacher guidance. Observational records show that approximately **83% of children demonstrated active engagement** when interacting with interactive story elements and digital learning objects. In the **play-based activity phase**, children participated in educational games designed to stimulate pattern recognition, symbol matching, and object classification. Approximately **79% of children completed digital tasks independently after initial teacher guidance**.

The **collaborative interaction phase** encouraged children to work in small groups as they solved digital puzzles and classification tasks. Teachers reported that group interaction stimulated peer learning and increased children's willingness to attempt new problem-solving strategies. These findings indicate that the structured integration of digital media and play-based activities can be implemented effectively in early childhood classrooms with appropriate teacher facilitation.

Changes in Cognitive Development Before and After the Intervention

To examine changes in cognitive development before and after the implementation of digital play-based learning, children's performance was assessed using structured cognitive tasks and developmental observation instruments. Table 1 presents the comparison between pretest and posttest scores across five cognitive development indicators.

Table 1. Pretest–Posttest Comparison of Cognitive Development Indicators

***E*-ISSN : 3109-1059**

Cognitive Indicator	Pretest Mean	Posttest Mean	Mean Gain
Symbolic Thinking	60.15	81.03	+20.88
Memory Ability	63.27	79.56	+16.29
Problem-Solving Skills	59.83	78.42	+18.59
Logical Classification	62.40	77.35	+14.95
Early Reasoning Ability	61.46	79.54	+18.08

The results indicate consistent improvement across all measured indicators. The largest gain was observed in **symbolic thinking**, which improved by more than twenty points following the intervention. Improvements were also evident in **problem-solving skills** and **early reasoning ability**, suggesting that digital play-based learning activities effectively stimulated higher-order cognitive processes.

Inferential statistical analysis confirmed that improvements across all cognitive indicators were statistically significant (**$p < .001$**), demonstrating that the instructional intervention was associated with meaningful cognitive development gains among participating children.

Cognitive Domains Most Influenced by Digital Play-Based Learning

Further analysis was conducted to determine which cognitive domains were most strongly influenced by the digital play-based learning intervention. Normalized gain scores indicate that **symbolic thinking** and **problem-solving skills** showed the greatest improvement among the measured indicators.

Digital storytelling activities appear to have contributed significantly to the development of symbolic thinking by encouraging children to interpret visual symbols, recognize narrative cues, and connect digital representations with real-world objects. During observational sessions, many children demonstrated the ability to identify symbols and associate them with contextual meanings presented in digital stories.

Similarly, puzzle-based digital games had a strong effect on children's reasoning and problem-solving abilities. Observational data show that **approximately 72% of children attempted multiple strategies when solving digital puzzles**, suggesting increased persistence and exploratory reasoning.

***E*-ISSN : 3109-1059**

These findings suggest that digital play-based learning environments can stimulate cognitive processes associated with symbolic interpretation, logical reasoning, and problem-solving among early childhood learners.

Student Engagement During Digital Play-Based Learning Activities

Student engagement during the intervention was assessed through behavioral observation across four dimensions: behavioral engagement, emotional engagement, cognitive engagement, and persistence.

The results indicate consistently high engagement levels across all learning sessions. Approximately **86% of children demonstrated active behavioral engagement**, characterized by participation in digital activities, responsiveness to teacher instructions, and willingness to interact with digital learning materials.

Emotional engagement was reflected in children's enthusiasm and positive affect during learning sessions. Many children expressed excitement when interacting with digital storytelling activities and game-based learning environments.

Cognitive engagement was observed through children's willingness to experiment with different strategies when completing classification and puzzle tasks. Additionally, persistence behaviors were frequently observed, with children attempting tasks multiple times after encountering initial difficulty. These engagement patterns suggest that integrating digital tools within play-based learning contexts promotes sustained attention and motivation among young learners.

Teacher Perceptions of the Digital Play-Based Learning Approach

Teachers' perceptions of the instructional approach were collected via structured questionnaires administered after the intervention. The results indicate a generally positive evaluation of the digital play-based pedagogy implemented during the study.

Approximately **88% of teachers agreed that digital play-based activities increased children's learning engagement**, while **84% reported improvements in children's ability to recognize patterns, symbols, and**

***E*-ISSN : 3109-1059**

object relationships. Teachers also indicated that digital storytelling and interactive games facilitated more dynamic classroom interactions compared with traditional instructional approaches.

However, several teachers emphasized the importance of balancing digital interaction with physical play-based activities to maintain developmentally appropriate learning environments for early childhood learners.

DISSCUSION

The findings of this study provide empirical evidence that integrating digital pedagogy with play-based learning significantly improves early childhood cognitive development in urban PAUD settings. The observed increase in post-intervention cognitive scores suggests that structured digital learning activities embedded within playful contexts can effectively stimulate multiple dimensions of young children's cognitive abilities. These findings support the broader argument presented in the introduction that digital technologies, when used pedagogically rather than merely as instructional media, can enhance interactive and learner-centered educational experiences. In particular, the results demonstrate that digital learning environments can facilitate active exploration, immediate feedback, and multimodal engagement, all of which are essential for supporting cognitive development during early childhood. These outcomes align with the growing recognition that digital pedagogy must be implemented through developmentally appropriate strategies that integrate technological interaction with meaningful learning activities rather than relying on passive screen-based exposure.

The improvements observed across several cognitive indicators—including symbolic thinking, memory, and problem-solving—also provide empirical support for the **constructivist perspective on learning**, which emphasizes that children actively construct knowledge through interaction with their environment. From a theoretical standpoint, these results are consistent with **Constructivist Learning Theory (Piaget)**, which highlights the

***E*-ISSN : 3109-1059**

importance of exploratory experiences in facilitating cognitive development during the preoperational stage. The integration of digital storytelling, interactive puzzles, and classification games allowed children to manipulate symbolic representations, test problem-solving strategies, and connect visual information with contextual meanings. Such experiences appear to strengthen the cognitive processes underlying early reasoning and symbolic understanding. These findings also reinforce the principles of **Play-Based Learning Theory**, which holds that play is a natural and effective medium for knowledge construction in early childhood education.

Furthermore, this study's findings resonate with prior research demonstrating that **technology-supported learning environments can enhance engagement and cognitive development** among young learners. Previous studies have reported that digital and game-based learning applications can improve children's cognitive abilities, particularly in memory retention, critical thinking, and problem-solving (Annuar et al., 2025). Similarly, meta-analytic evidence indicates that game-based learning approaches produce moderate to large improvements in cognitive and motivational outcomes among early childhood learners (Alotaibi, 2024). The results of the present study extend these findings by demonstrating that digital learning tools can be particularly effective when embedded within **structured play-based pedagogical frameworks**, rather than functioning as isolated technological interventions. This integrative approach appears to create a learning environment where children can explore digital content while engaging in playful, socially interactive learning activities.

Another important contribution of this study lies in demonstrating that **digital tools can complement rather than replace traditional play-based learning practices** in early childhood classrooms. Previous research has highlighted the potential of serious games grounded in Montessori principles and internet-connected educational toys to support children's creativity, inquiry skills, and engagement in learning activities (Lamrani & Abdelwahed, 2019; Kewalramani et al., 2020). Similarly, studies on storytelling-based

***E*-ISSN : 3109-1059**

learning have shown that narrative-driven activities combined with play can enhance early literacy and digital literacy development among preschool children (Maureen et al., 2020). The present findings suggest that digital storytelling and interactive learning games can extend these benefits by providing visually rich and interactive environments that stimulate children's curiosity and encourage active participation. Importantly, the structured integration of digital tools with physical play activities appears to support balanced learning experiences that remain consistent with developmentally appropriate early childhood pedagogical practices.

In addition to supporting cognitive development, the results also highlight the role of **student engagement as a key mechanism underlying the effectiveness of digital play-based learning environments**. Observational data from the intervention indicate that children demonstrated high levels of behavioral, emotional, and cognitive engagement during digital storytelling and game-based learning activities. These engagement patterns are consistent with previous research suggesting that interactive digital environments can increase learners' motivation and participation when they provide opportunities for exploration, experimentation, and feedback. The playful nature of the digital learning activities appears to have encouraged children to experiment with multiple strategies while solving puzzles and classification tasks, thereby promoting persistence and deeper cognitive processing. Such findings reinforce the idea that engagement plays a central role in mediating the relationship between instructional strategies and learning outcomes in early childhood education.

Despite these promising findings, the results also point to several considerations for the effective implementation of digital pedagogy in early childhood education settings. The success of the intervention appeared to depend heavily on **teacher facilitation and pedagogical guidance**, highlighting the importance of teacher digital competence in translating technological tools into meaningful learning experiences. Previous studies have emphasized that teachers' technological knowledge, instructional

***E*-ISSN : 3109-1059**

strategies, and attitudes toward digital tools significantly influence the quality of technology integration in classroom settings (Ismail, 2023). Therefore, professional development programs aimed at strengthening teachers' digital pedagogical competencies may be essential for ensuring the effective implementation of digital play-based learning models. Additionally, maintaining a balance between digital interaction and physical play remains critical to ensure that technological integration supports rather than replaces essential developmental experiences associated with traditional play.

Finally, the findings of this study contribute to addressing the research gap identified in the literature regarding the **lack of integrative models that combine digital pedagogy with play-based learning in early childhood education contexts**. While previous research has explored digital learning technologies or play-based approaches separately, relatively few studies have examined how these two pedagogical dimensions interact to influence children's cognitive development. By demonstrating measurable improvements in cognitive development following the implementation of a structured, digital, play-based learning model, this study provides empirical evidence of the potential of integrated pedagogical approaches in early childhood education. These findings suggest that future research should continue to explore how digital learning environments can be designed to align with developmental theories and pedagogical principles that prioritize active, playful, and contextually meaningful learning experiences for young children.

CONCLUSION

This study investigated the influence of play-based digital pedagogy on the cognitive development of early childhood learners in urban PAUD settings through a quasi-experimental pretest–posttest design. The findings demonstrate that integrating digital learning tools within structured play-based pedagogical environments can significantly enhance multiple dimensions of children's cognitive development. Observable improvements were observed in key cognitive indicators, including symbolic thinking,

***E*-ISSN : 3109-1059**

memory, problem-solving, logical classification, and early reasoning. These improvements indicate that digital learning environments, when designed to support interactive and exploratory activities, can effectively stimulate cognitive processes that are essential during the early stages of child development.

From a pedagogical perspective, the results highlight that digital technologies function most effectively when positioned as interactive learning facilitators rather than passive instructional media. The integration of digital storytelling, educational games, and puzzle-based activities within playful classroom environments encouraged children to actively explore concepts, manipulate symbolic representations, and engage in problem-solving processes. Such learning experiences align closely with the principles of Constructivist Learning Theory (Piaget) and Play-Based Learning Theory, both of which emphasize active knowledge construction through exploration and experiential learning.

The study also contributes to the growing body of literature on digital pedagogy by demonstrating that technology-supported learning can be developmentally appropriate for early childhood education when embedded within play-based instructional frameworks. Unlike many previous studies that focus on isolated digital learning tools, the present research highlights the importance of integrating digital resources with structured pedagogical strategies that support children's engagement, collaboration, and cognitive exploration. In doing so, the study offers empirical support for the development of an integrative pedagogical model that combines digital pedagogy and play-based learning within early childhood education contexts.

Despite these contributions, several limitations should be acknowledged. The study was conducted within a limited number of urban early childhood institutions, which may restrict the generalizability of the findings to other educational contexts, particularly rural or resource-constrained settings. Additionally, the relatively short intervention focused

***E*-ISSN : 3109-1059**

primarily on short-term cognitive outcomes rather than on long-term developmental trajectories.

Future research should therefore explore longitudinal implementations of digital play-based pedagogy, examine its impact across diverse educational environments, and investigate how teacher training and digital competence influence the sustainability of such pedagogical innovations. Overall, this study underscores the potential of integrated digital and play-based learning approaches to support meaningful cognitive development in early childhood education.

REFERENCE

Aditya, B., & Andrisyah. (2023). Digital Transformation in Early Childhood Education: Teachers' Self-regulated Model for Digital Learning. International Journal of Information and Education Technology. https://doi.org/10.18178/ijiet.2023.13.2.1811

Alam, M., Hickie, I., Poulsen, A., Ekambareshwar, M., Loblay, V., Crouse, J., Hindmarsh, G., Song, Y., Yoon, A.-R., Cha, G., Wilson, C., Sweeney-Nash, M., Troy, J., & LaMonica, H. (2023). Parenting app to support socio-emotional and cognitive development in early childhood: iterative codesign learnings from nine low-income and middle-income countries. BMJ Open, 13. https://doi.org/10.1136/bmjopen-2022-071232

Alotaibi, M. (2024). Game-based learning in early childhood education: a systematic review and meta-analysis. Frontiers in Psychology, 15. https://doi.org/10.3389/fpsyg.2024.1307881

Annuar, H., Solihatin, E., & Khaerudin. (2025). Enhancing Early Childhood Cognitive Development via Mobile Game-Based Learning Applications: Insights and Practical Experiences. Int. J. Interact. Mob. Technol., 19, 208–229. https://doi.org/10.3991/ijim.v19i04.51897

Chang, C.-Y., Kuo, H., & Du, Z. (2023). The role of digital literacy in augmented, virtual, and mixed reality in popular science education: a review study and an educational framework development. Virtual Reality, 27, 2461–2479. https://doi.org/10.1007/s10055-023-00817-9

Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. Educational Technology Research and Development, 68, 2449–2472. https://doi.org/10.1007/s11423-020-09767-4

Habibi, A., Sofyan, S., & Mukminin, A. (2023). Factors affecting digital technology access in vocational education. Scientific Reports, 13. https://doi.org/10.1038/s41598-023-32755-6

Halimah, L., Arifin, R., Yuliariatiningsih, M., Abdillah, F., & Sutini, A. (2020). Storytelling through "Wayang Golek" puppet show: Practical ways in

***E*-ISSN : 3109-1059**

incorporating character education in early childhood. Cogent Education, 7. https://doi.org/10.1080/2331186x.2020.1794495

Herodotou, C., Sharples, M., Gaved, M., Kukulska-Hulme, A., Rienties, B., Scanlon, E., & Whitelock, D. (2019). Innovative Pedagogies of the Future: An Evidence-Based Selection. Frontiers in Education. https://doi.org/10.3389/feduc.2019.00113

Ismail, R. (2023). The preschool teachers' perspective of digital technology use in classrooms: A case study of North Maluku province, Indonesia. Journal of Education and E-Learning Research. https://doi.org/10.20448/jeelr.v10i2.4564

Kewalramani, S., Palaiologou, I., & Dardanou, M. (2020). Children's Engineering Design Thinking Processes: The Magic of the ROBOTS and the Power of BLOCKS (Electronics). EURASIA Journal of Mathematics, Science and Technology Education. https://doi.org/10.29333/ejmste/113247

LaMonica, H., Song, Y., Loblay, V., Ekambareshwar, M., Naderbagi, A., Zahed, I., Troy, J., & Hickie, I. (2024). Promoting social, emotional, and cognitive development in early childhood: A protocol for early valuation of a culturally adapted digital tool for supporting optimal childrearing practices. Digital Health, 10. https://doi.org/10.1177/20552076241242559

Lamrani, R., & Abdelwahed, E. H. (2019). Game-based learning and gamification to improve skills in early years education. Comput. Sci. Inf. Syst., 17, 339–356. https://doi.org/10.2298/csis190511043l

Maassen, B., Glatz, T., Borleffs, E., Martínez, C., & De Groot, B. (2025). Digital game-based learning for dynamic assessment and early intervention targeting reading difficulties: Cross-linguistic studies of GraphoLearn. Clinical Linguistics & Phonetics, 39, 576–601. https://doi.org/10.1080/02699206.2025.2452979

Maureen, I., Van Der Meij, H., & De Jong, T. (2020). Enhancing Storytelling Activities to Support Early (Digital) Literacy Development in Early Childhood Education. International Journal of Early Childhood, 52, 55–76. https://doi.org/10.1007/s13158-020-00263-7

Muhaimin, Asrial, Habibi, A., Mukminin, A., & Hadisaputra, P. (2020). Science teachers' integration of digital resources in education: A survey in rural areas of one Indonesian province. Heliyon, 6. https://doi.org/10.1016/j.heliyon.2020.e04631

Rasimin, Semma, A., Zakiyuddin, Ali, M., & Helmy, M. I. (2024). Multi-dimensional challenges in the Indonesian social science information technology-based learning: A systematic literature review. Heliyon, 10. https://doi.org/10.1016/j.heliyon.2024.e28706

Sakti, S. A., Endraswara, S., & Rohman, A. (2024). Revitalizing local wisdom within character education through ethnopedagogy apporach: A case study on a preschool in Yogyakarta. Heliyon, 10. https://doi.org/10.1016/j.heliyon.2024.e31370

Setyadi, A., Pawirosumarto, S., Damaris, A., & Dharma, R. (2025). Risk management, digital technology literacy, and modern learning

***E*-ISSN : 3109-1059**

environments in enhancing learning innovation performance: A framework for higher education. Education and Information Technologies, 30, 15095–15123. https://doi.org/10.1007/s10639-025-13380-4

Wangid, M., Putra, C. A., & Rudyanto, H. (2021). The Science-Math Stories Based on Digital Learning: Digital Literacy Innovation in Increasing Ability to Solve Problems. Int. J. Emerg. Technol. Learn., 16. https://doi.org/10.3991/ijet.v16i09.22039

Wynn, M. (2025). Beyond Competency: Developing Critical Digital Capabilities in Nursing Students Through Freirean Pedagogy. Nursing Inquiry, 32. https://doi.org/10.1111/nin.70011