

The Integration of Digital Play Tools in Project-Based Learning for Early Childhood Education: A Systematic Literature Review

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Abstract

This study aims to emphasize the significance of integrating digital plays in Project-Based Learning (PBL) in Early Childhood Education (ECE) for the overall development of children in modern classrooms. A research methodology of a systematic review was used, where ten high-impact research articles published in Scopus and Google Scholar databases from 2020 to 2025 were reviewed. These articles were related to early childhood settings and met certain predetermined selection criteria. The data was synthesized, and themes were identified to find patterns in the research. The study revealed that integrating digital plays in PBL is beneficial for motivating, developing, and enhancing cognitive skills, and for early literacy, while highlighting the role of teachers in integrating technology. A research gap was identified in relation to Indonesian society, and it was recommended that appropriate models of PBL be developed, teachers be trained, and more research be conducted in real-life settings in preschools.

Keywords: *Project-Based Learning In Early Years, Digital Play Integration In Education, Early Childhood Education, Use Of Educational Technology In Preschool Settings*

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1. INTRODUCTION

Digital technologies have rapidly permeated early childhood education worldwide. The OECD (2023) notes that this shift provides new learning materials, novel digital environments, and stronger connections among families and educators. In fact, recent research notes that the use of devices (tablets, smart toys, etc.) by children aged 0–8 is “a rapidly growing topic of interest” worldwide or example, educators can use tablets or interactive apps for digital storytelling, or robotics kits to build models, blending traditional play with digital tools. Such digital play tools offer new avenues for exploration and skill development in early childhood (Hibana, Rahman Nayla, & Nurhayati, 2024). At the same time, increasing screen use raises concerns about excessive screen time and children’s data privacy. Many governments are also concerned about related physical, social, and emotional risks and widening digital divides.

In this context, digital play tools (such as apps, interactive games, and learning toys) are being designed to support inquiry-based, hands-on learning. A “digital play” framework highlights how these tools can foster children’s exploration, collaboration, and imaginative expression. Introducing technologies, digital media and popular culture together with a playbased approach has proven to be a challenge for preschool teachers. According to Edwards, one problem in existing research efforts is that it often focuses on the teachers’ beliefs, attitudes and/or confidence about digital technology rather than the actual practice (Lund et al., 2025). Project-based learning (PJBL) is a play-based approach that engages children as active constructors of knowledge through hands-on projects. Integrating digital play tools into PJBL can create rich learning opportunities- for example, children might use coding games or storytelling apps as part of a class project. Recent research suggests that digital play experiences often support children’s learning and development in interactive and meaningful ways (Pratiwi et al., 2023). Considering that there is an increase in the incorporation of digital devices in the lives of children, the resultant effect is that risks, there is a pressing need for targeted education strategies. This systematic review aims to synthesize existing research on strategies developed for teaching digital citizenship skills to young children, with a focus on their effect upon children’s online behaviour and understanding (Li, Valdez, & Du, 2025). The roles of parents and educators in this process were also explored.

Despite these opportunities, several concerns persist. Many early childhood teachers lack formal training to use digital tools effectively. Some countries report stark inequalities in access to devices and high-quality digital resources in preschools (Anis, Faizatunisa, & Kuniati, 2024). There is also ongoing debate about the appropriate amount of screen time for young children and how to balance digital with traditional play (Colliot et al., 2024). In Indonesia context, previous curriculum approaches before the implementation of the Kurikulum Merdeka framework focused more on structured and teacher-directed learning, thus affecting the consistent implementation of project-based learning in early childhood education setting (Ministry of Education, Culture, Research, and Technology, 2022, Kurikulum Merdeka policy document). Though there was a presence of active learning, project-based learning was not extensively integrated in classroom settings. However, with the implementation of the Kurikulum Merdeka framework, more attention is given to student-centered and flexible learning, including initiatives such as the “Projek Penguatan Profil Pelajar Pancasila” that aims to integrate project-based and exploratory learning (Muin, Maisaroh, Ramadhan, & Sulaimon, 2024). However, research has revealed that teachers are having challenges in implementing this, including challenges in designing project-based learning, insufficient training, and resources (Fabela et al., 2024).

Thus, this is a transition toward a more explicit implementation of project-based learning. For example, teachers struggled to select and adapt appropriate learning media aligned with the intended learning outcomes. Additionally, the provided teaching modules were sometimes unsuitable, requiring teachers to create their own (Aisyah & Novita, 2025). These challenges highlight the need to understand how digital play and project-based learning can best be combined in diverse early childhood settings worldwide. Effective integration of digital tools in early childhood requires a clear pedagogical foundation. This paper focuses on three fundamentals, interconnected pedagogical principles that should guide the use of technology: Play-Based Learning: Digital tools should encourage spontaneous, motivating, and exploratory play, transitioning from passive consumption to active, interactive engagement with digital elements. Active Learning: It is essential for children to actively engage with digital content, rather than merely observing it passively. Tools should serve as a medium for creativity, problem-solving, and independent discovery. Social Interaction: Digital tools should enrich and support collaboration, communication, and joint learning among peers and with adults, countering concerns that technology may isolate children (Durchevska Georgieva et al., 2025). This review examines recent (2020–2025) Scopus-indexed and Google scholar research to explore how digital play tools are integrated into project-based learning for early childhood. We focus on global trends and emerging practices. Specifically, we ask: How are digital play tools integrated in project-based learning for early childhood, and what are the educational impacts and best practices emerging globally?

2. METHODS

The research design used in this research is a systematic review approach in gathering and analyzing research literature on integrating digital play in project-based learning (PBL) in early childhood education (ECE). A systematic review is considered a good research design for this research since it allows a comprehensive and systematic analysis of existing research literature that can identify patterns and trends in a given research subject. It is particularly useful in exploring new research subjects like integrating digital play in project-based learning. The data that this research collected are research literature published in peer-reviewed journals and scholarly publications that concentrated on research subjects like digital play, gamification, robotics, and virtual learning environments in a project-based setting for preschool and kindergarten children. Only research literature published between 2020 and 2025 was considered to ensure that the research literature is still relevant and recent. The study used a systematic search strategy that included databases such as Scopus and Google Scholar, in addition to Indonesian and international journals related to early childhood education. Keywords such as “digital play,” “digital gamification,” “project-based learning,” and “early childhood education” were used in the search. The selection of studies was conducted by applying a set of predefined inclusion criteria. An article screening and quality assessment checklist was used primarily as a tool in the selection of studies. Some of the indicators used in the checklist include the clarity of the research design, the relevance of the sample, the intervention, and the validity of the results.

The analysis of the collected data was conducted by applying a technique of thematic synthesis, whereby the extracted information was coded and categorized into major themes such as types of digital play interventions, characteristics of participants, the domain of development, the role of the teacher, and the outcomes of learning. The research process adopted by this research is a systematic process that consists of a series of steps. Key steps involved are research question identification, database search, screening of articles based on inclusion and exclusion criteria, quality assessment, data extraction, and synthesis of findings. The overall research process is illustrated in Figure 1.

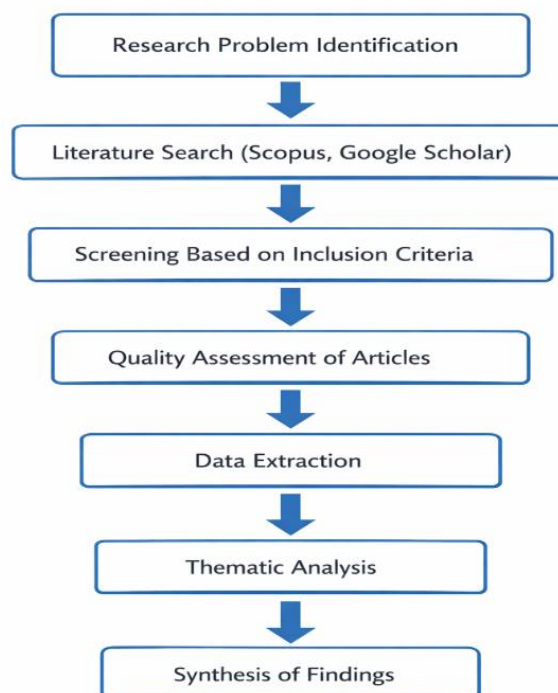


Figure 1. Research Flow of the Study

Selection Procedure

The multi-phase review procedure involved first examining the titles and abstracts of all the search results in order to exclude irrelevant publications. The review continued with full-text screening for relevance of content, clarity of methodology, age group, and connection to digital play within PJBL. These have resulted in ten studies meeting all the criteria for inclusion into the synthesis. These studies represent a mix of international and Indonesian contexts, incorporating systematic reviews, empirical classroom studies, and technology-integrated project implementation.

Data Extraction And Analysis

Data extracted from each of the studies included publication year, country, research design, digital play tool used, project-based learning approach, participant characteristics, and reported outcomes. The data extracted then underwent analysis by thematic synthesis, which enabled the grouping of findings into recurring themes such as motivation, creativity, cognitive development, literacy improvement, teacher facilitation, and curriculum alignment. This was done to ensure that convergent and divergent insights across the studies were captured to enable a deeper interpretation of how digital play supports PJBL in ECE.

3. RESULT AND DISCUSSION

The themes that were identified in the present study were derived through a thematic synthesis of the chosen articles. In total, there were 10 research papers that were thoroughly analyzed, and the major findings of the respective papers were identified based on the recurring concepts related to digital play and project-based learning (PBL) in the context of early childhood education. For example, the articles that discussed the use of gamified applications, the use of robotics, and the use of virtual learning environments were grouped together. In the same context, the articles that discussed the use of gamified applications in enhancing the motivation levels of the children were grouped together. The same approach was followed for all the chosen articles, and the major themes were identified. The major themes that were identified include motivation, creativity, cognitive, and the use of teacher facilitation. The themes were derived based on the major findings of the respective papers, and the themes were not derived based on the opinions of a single author.

Table 1. Progression of Learning Outcomes in Digital Play-Enhanced PBL

Activities	Stage 1	Stage 2	Stage 3
Digital Story telling projects	Children explore digital tools with teacher guidance	Children Create stories	Children Independently produce meaningful stories
Robotics-Based project	Basic tool Familiarization	Guided problem-solving activities	Autonomous problem solving
Gamified literacy projects	Initial Participation and curiosity	Active engagement in literacy activities	Improved literacy skills and sustained motivation

The progression of learning outcomes for children at different stages of the implementation of digital play-enhanced project-based learning (PBL) is depicted in Table 1. In the first stage, the level of engagement is low, while in the second stage, the facilitation leads to active participation. In the final stage, the level of engagement, the level of independent problem-solving, and the level of literacy outcomes are high, thus showing the effectiveness of the integration of digital play in the context of PBL.

Gamified Apps in PBL

Various studies have reported positive effects of gamified apps on children's engagement and motivation within project activities. In particular, research on gamification in early childhood contexts suggests that gamified learning environments can "enhance learners' engagement and self-regulated learning behaviors" when linked to meaningful task.

"Overall, digital games have great potential as an effective educational strategy that helps young children develop skills in an interactive and engaging manner."(Anis et al., 2024)

The consistent pattern from study to study is that gamified applications enhance motivation when the rewards have been directly related to project goals. Such apps fostered repeated tries, exploration and peer collaboration-those are the very characteristics of PJBL in ECE.

Virtual Learning Environments and Robotics

Other works focused on integrating virtual learning environments and educational robotics within project activities. VLEs allowed children to simulate real-life scenarios and solve problems together, aligning with the emphases of PJBL on inquiry and authentic tasks. For instance, global synthesis research affirms that VLEs support multimodal learning experiences, wherein children engage in visual problem solving, narrative creation, and interactive simulations that are imbedded within project design. Digital tools like VLEs and robotics worked as cognitive scaffolding, allowing children to visualize complex ideas, test out hypotheses, or document progress within projects(Utami & Crescenzi-Lanna, 2025) .When robotics kits were part of the package, then they tended to be used within mini-project cycles where children needed to design a task, test it, and refine it.

Impacts on Learning Domains

First, motivation and engagement. In all, the engagement levels were higher in reporting for digital play tools than in traditional activities. One such study has mentioned that children participating in digital game-based tasks within projects "showed sustained engagement and higher task persistence" rather than non-digital project groups (Chu, Paatsch, Kervin, & Edwards, 2024). Motivation is a core predictor of persistence, curiosity, and positive project outcomes. When children experience immediate feedback—a feature of many gamified apps—their intrinsic motivation improves—supporting the PBL ethos of active inquiry.

Second, creativity and cognitive development. In recent years, the rapid integration of digital devices into daily life has significantly reshaped the environments in which children develop, prompting concerns over their impact on cognitive. However, the existing research literature indicates a conflicting result. Although digital devices provide opportunities for cognitive engagement through interactive education platforms, there is a rising concern about the potential for these platforms to adversely impact cognitive functions, such as attention, memory, and socio-emotional development, especially when used in excess (Clemente-Suárez et al., 2024). For instance, robotics projects and VLE tasks involved problem-solving of design challenges and narrative construction as part of the documentation process in carrying out the projects. Digital play tools also supported cognitive flexibility—a key dimension of early learning—by allowing children to try multiple solutions and revise outcomes based on feedback loops afforded by the technology.

This supports the broader research that indicates digital affordances provide scaffolds for divergent thinking, which is of course a particular emphasis within project work where children are asked to navigate open-ended challenges. The workshop activities were designed to enhance creativity through tasks on digital storytelling, animation, and design (Alotaibi, 2024). Children were able to express ideas using images, sounds, and movements, supporting diverse learning styles. These findings support the hypothesis that digital play enhances creative thinking if the learning tasks are open-ended and inquiry-driven.

Third, early literacy and language development. Digital literacy, as stipulated by UNESCO in 2018, refers to the ability to use digital tools effectively, critically, and safely. In the context Digital literacy means the "capacity to proficiently and critically access, assess, and generate knowledge through a variety of digital tools and technology. Some Indonesian studies also indicated better literacy outcomes when digital storytelling applications or narrative-based gamified tools were integrated into language projects. Early exposure to narrative apps "enhanced phonemic awareness and vocabulary development" as part of literacy projects (Digital Play Literacy Case). Some studies conducted by Indonesian and other international researchers emphasize the importance of incorporating digital play tools, such as digital storytelling applications, with Project-Based Learning to offer intensive support to early literacy and language learning among young children when these applications are integrated with projects. According to Krstić Radojković (2025) with reference to issues of Early Childhood Education: Digital literacy entails some of the key elementary skills that can be associated with the use of digital tools for communication skills, problem-solving skills, and creativity.

This paper aims to present different angles on the subject of digital play as a means of developing children's literacy and power. Some of the learning projects conducted using digital language learning applications and gamified story platforms to allow the children to create and relate stories using various learning tools were found to help Indonesian class children improve phonemes and language skills when exposed to digital storytelling applications from the early years to relate to projects (Purnama, Ulfah, Ramadani, Rahmatullah, & Ahmad, 2022). Notably, it is important to highlight that according to the reviewed literature, achieving literacy skills results when digital technology is embedded within authentic meaning-making tasks and not necessarily used for drill activities. The instructional advantages of digital literacy extended to social development. Digital technologies enable children to get involved in collaborative learning, which is a crucial component of ECE. Though not all the studies focused on literacy, where a focus on literacy did occur, it was here that digital tools were found to be useful when they were fully integrated into project tasks relying on meaning-making rather than on the practice of rote skills.

Fourth, social interaction and collaboration. Integration of digital play into PjBL also favored collaborative learning. Group-based digital projects promoted the communication of their peers, turn-taking, and shared decision-making. Robotics activities were actually more effective in enhancing teamwork, since children had to negotiate roles within the team and solve problems together (Jumiatmoko et al., 2025). Pedagogical activities that incorporate the usage of iPads/tablets together. Various apps can be given as an example of learning using smart mobile technology. There is research that demonstrates the use of smart mobile technology along with game-based instructional strategies promotes students' motivation and learning (Sjöberg & Brooks, 2022). These findings support the argument that digital play does not isolate learners when appropriately integrated but instead enhances social interaction within meaningful project contexts. The systematic reviews from him reveal that the incorporation of digital play tools into problem-based learning environments increases interactions among young children and fosters collaborative learning. In group-based projects on digital activities, there was an observed peers' communication, such as taking turns, negotiation, and making joint

decisions. Robotics-based PBL activities proved to be effective in fostering teamwork since the children had to undertake role distribution, discussion about strategies, and solving problems together in project implementation processes (Jawaid et al., 2020). Contrary to fears that digital technologies could isolate learners, the evidence suggests that when digital play is purposefully embedded within collaborative projects, it enhances rather than diminishes social engagement. Children actively interacted with peers to co-construct knowledge and to work towards shared project goals. These findings support socio-cultural learning perspectives, which emphasize that learning occurs through social participation and guided interaction within meaningful contexts (Vygotsky, 1978). Thus, digital play tools act as mediational tools that foster collaboration rather than replacing interpersonal interaction.

Teacher Facilitation and Integration of Curriculum

A recurring theme across the literature was teacher readiness and intentional curriculum integration. The studies identified a number of insights that showed that technology alone does not guarantee learning gains; rather, it must be mediated by teacher scaffolding and embedded in a coherent project framework.

“Successful technology integration in early childhood project activities depends on teacher planning, technical competence, and ability to facilitate child interaction with digital tools”(Jumiatmoko et al., 2025)

Through the systematic review, several significant research gaps and methodological challenges related to integrating digital play tools into PJBL were noted. Despite the fact that the studies reviewed indicate an emerging interest in digital play, the current body of knowledge is fragmented, incomplete, and empirically limited. Despite the importance of the research articles under evaluation, which indicate the developing power of the application of digital play tools in Project-Based Learning (PjBL) within Early Childhood Education (ECE), certain critical research gaps are still to be resolved. Most studies available do not look into either of these approaches but as disjointed entities of digital play tools and PJBL, rather than an integrated pedagogical framework. Only a limited number directly deal with how digital play tools are integrated into project cycles, including: planning, investigation, creation, Reflection, and presentation. This creates a big gap since ECE-specific PBL needs developmentally appropriate adaptation, but few studies have described practical classroom models that will demonstrate a step-by-step integration of digital play. This gap highlights several important issues, including how young learners engage with digital tools in long-term project work, how teachers scaffold digital exploration, and whether digital tools support socio-emotional development in early childhood. Hence, early childhood-specific empirical evidence remains weak and mostly concentrated in small-scale studies.

Conceptual Gap in Digital-Play-Based PBL Models

The existing research gap is that there are no obvious conceptual models that specifically embed the use of digital play tools within PJBL frameworks targeting the learning experiences of EC learners (Pratiwi et al., 2023). The literature mainly captures research on either digital play or PJBL, with minimal interpretation on how these technologies are linked to the different phases of project development (planning, exploration, development, reflection, and presentation).

Limited Empirical Evidence in Early Childhood Settings

The preponderance of science research has been on primary or secondary education, making preschools and kindergartens underrepresented. Studies on the ages 3 to 6 are still scarce, penetrating deeper in a small population, with a short intervention period. Hence, there is no conclusive Findings on the effect of PjBL supported with Digital Play on the development of individuals within that age group concerning cognitive, social, and emotionally updated skills.

Lack of Longitudinal and Large-Scale Studies

There is a lack of longitudinal research. This means that a huge number of the articles surveyed consider short-term effects in terms of engagement, motivations, but never analyze long-term learning effects, skill transfer, developments, etc. In addition, massive, multi-site research is a rarity, hindering the external validity of available research findings. A common issue within research includes the amount of screen use and how to maintain the well-being of children. Few research papers are concerned with how to maintain a balance between screen use and physical activity within PjBL Issues such as overexposure, lack of exercise, and how it affects interactive skills are domains that are still waiting to be researched.

Teacher Professional Development Gap

Teacher readiness is still a difficult issue. In fact, most teachers are insufficiently trained to use PJBL with educational technologies effectively, hence shallow integration of educational technologies. The literature has never investigated the structured professional development models that might affect the implementation of educational technologies with PJBL in enhancing teaching in ECE classrooms(Hibana et al., 2024) .The need to assess such areas as creativity, collaboration, problem-solving, or digital literacy skills is imperative in the early childhood setting. In teaching-learning for young learners, the teacher should give real things in the class for the children are more comfortable recognizing the vocabulary presented. Thus, young learners need real stuff as the media in the learning process(Eka Prasetyaningtyas, Jolanda Pentury, & Dewi Anggraeni, 2021).

4. CONCLUSION

This paper concludes that the integration of digital gameplay tools in PJBL significantly enhances the principles of Early Childhood Education. It also shows from the review that when digital gameplay is purposively connected with project-based activity engagement, children are more engaged, collaborate more, are more creative, and have enhanced problem-solving skills(Fadhli, Kuswandi, Utami, Sartika, & Hardyman Bin Barawi, 2023). The review also presents that digital tools provide a multimodal learning experience and opportunities for independent exploration, which constitute important cornerstones of PJBL. However, it was also noted that how far this integration is effective depends mostly on teacher preparedness, systematic design of projects, and management of screen time in a balanced way. This study suggest that when used appropriately, digital tools serve not merely as passive entertainment but as interactive learning aids, promoting cognitive development and active participation.

Although the amount of evidence has been increasing, the existing literature still reflects inconsistencies in methodological approaches, scant longitudinal studies, and a lack of research settings from diverse cultural backgrounds, including low-resource ECE environments. These shortfalls indicate further needs for more sophisticated empirical designs, comparative studies between countries, and exploration of teacher professional enhancement models that allow teachers to employ PJBL-digital integration with confidence. The future research directions should now be directed to determining the long-term cognitive and socio-emotional effects of digital-enhanced PJBL, devising scalable teacher-training frameworks, and assessing equitable access to digital tools within early childhood settings. The research also has to consider parents' levels of digital literacy and home-school collaboration since this influence the experiences and results of the children's learning(Pynnönen, Kumpulainen, & Lipponen, 2025)

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