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Critical Thinking Development Through Digital Play: A Systematic Literature Review of Early Childhood Context

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Abstract. In today's modern era, the world of early childhood education is inseparable from both online and offline games. Games are no longer viewed merely as tools for entertainment, but also as potential learning media that can support children's development. The rapid advancement of technology has made digital play an integral part of children's daily lives. Although digital games present certain challenges, they also offer notable educational benefits, particularly in fostering children's critical thinking abilities. This study aims to systematically collect, evaluate, and analyze research related to the development of critical thinking skills in early childhood through digital games. The research employs a Systematic Literature Review (SLR) approach focusing on identifying pedagogical strategies, digital game designs, and aspects of critical thinking embedded within digital play. It also explores the teacher's role and the empirical findings within early childhood education contexts. A total of 12 eligible studies were analyzed. The findings indicate that digital games contribute positively to the enhancement of children's critical thinking skills. The most frequently stimulated components of critical thinking include problem-solving, logical reasoning, decision-making, independent evaluation of information, memory enhancement, and understanding of cause-and-effect relationships. Teachers play a crucial role as facilitators, companions, and guides in ensuring meaningful learning experiences through digital play. The reviewed digital games were generally designed to be both educational and interactive, highlighting the integration of learning and engagement. These findings underscore the significance of teachers' involvement in achieving learning objectives through digital games and provide valuable insights for future curriculum development and digital educational innovation in early childhood settings.

Keywords: Critical Thinking, Digital Games, Early Childhood

1 Introduction

Learning in the 21st century requires children to master not only knowledge but also essential skills. One of the key cognitive aspects in early childhood is the development of critical thinking skills. At this stage, critical thinking becomes crucial because

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learning involves not only understanding concepts but also the ability to discern between accurate and misleading information [1]. Critical thinking is recognized as one of the core components of 21st-century competencies, commonly referred to as the 6Cs (Character, Citizenship, Critical Thinking, Creativity, Collaboration, and Communication) [2]. Building a foundation of critical thinking from an early age helps children become problem solvers and adaptable individuals capable of functioning effectively in various academic and social contexts [3], [4]. Through the enhancement of critical thinking skills, students are better prepared to face challenges in daily life while developing their ability to identify and create solutions to diverse problems they may encounter in the future [5]. Critical thinking has also been designated as one of the expected learning outcomes in the national education framework [6]. However, the level of children's critical thinking skills in Indonesia remains relatively low. This condition is often attributed to instructional approaches that remain predominantly teacher-centered and emphasize rote memorization rather than the cultivation of analytical and reflective thinking. Consequently, students tend to be less confident in expressing their ideas and show limited ability to articulate independent reasoning [7].

Amid the rapid advancement of information and technology, children's reasoning and critical thinking abilities have become major concerns in education. Recent data from the Programme for International Student Assessment (PISA) indicate that Indonesian students continue to perform below the global average in literacy, numeracy, and science [8]. This consistent underperformance suggests that Indonesia's educational outcomes have not yet aligned with international standards. The low level of reading literacy which serves as the foundation of critical thinking reveals challenges in students' ability to comprehend and analyze information in depth. This situation reflects a broader weakness in critical thinking skills, which are essential for understanding, analyzing, and solving complex problems. Learning practices that remain oriented toward memorization rather than conceptual comprehension have caused students to prioritize content mastery over the development of analytical reasoning skills [9]. Consequently, the PISA findings underscore the need for an educational system that focuses not only on content acquisition but also on nurturing students' reasoning and critical thinking abilities.

According to UNESCO, the preschool and elementary years represent crucial periods for the formation of critical thinking skills. During this stage, children begin to explore solutions, recognize cause-and-effect relationships, and predict possible outcomes of their actions as part of the problem-solving process [10], learning activities designed to stimulate critical thinking are still rarely implemented in early childhood education, even though children have been shown to demonstrate this ability through social interactions with peers and adults [11]. Empirical evidence also indicates that the level of critical thinking among Indonesian children remains relatively low. This is exemplified by observations in six early childhood education institutions within Cluster 7 of Sukaraja District [12], where many children were unable to express their opinions, respond to questions independently, or effectively summarize what they had learned. These findings illustrate that stimulation of critical thinking has not yet been fully optimized within early education settings, resulting in children who tend to be

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passive and less accustomed to articulating their ideas or engaging in reflective reasoning.

Critical thinking emerges as the result of collaboration among various Higher Mental Functions, as described by Smolucha[13]. They emphasized that, from a Vygotskian perspective, critical thinking represents a psychological system involving the interaction of several higher mental processes, including memory, conceptual reasoning, analysis, synthesis, evaluation, and imagination. Within this framework, the development of a child's critical thinking ability can be observed through behaviors such as frequently asking questions, actively responding to teachers' prompts, demonstrating curiosity, and showing confidence in expressing opinions [14]. The question-and-answer activity constitutes an essential form of interactive discussion that serves as scaffolding within the Zone of Proximal Development (ZPD), thereby assisting children in refining their critical thinking abilities. Moreover, Vygotsky identified language as one of the most significant psychological tools that individuals use to regulate behavior, make plans, recall experiences, and solve problems [15]. According to Vygotsky [16], critical thinking, as part of higher mental functioning, develops through social interaction. He further introduced the concept of the Zone of Proximal Development (ZPD), describing it as the space in which children require guidance or direction to acquire new skills and advance their higher-order thinking abilities [17]. In essence, higher mental functions cannot develop optimally without constructive social interaction and supportive guidance [18]. Within this process, children rely on the role of a More Knowledgeable Other (MKO), a person with greater experience or understanding to help shape and nurture their cognitive and reasoning abilities.

At the early childhood education level, critical thinking skills remain relatively unfamiliar, as many educators still have limited understanding of effective strategies to stimulate children's reasoning abilities. This issue is further compounded by curricula and learning outcomes that do not explicitly highlight the development of critical thinking, leading to underutilization of this potential. In fact, critical thinking can be cultivated from an early age when appropriately aligned with the child's developmental stage [4], [11], [19]. Research indicates that more than three-quarters of children face difficulties in developing critical thinking, largely due to a lack of innovation in instructional media, teacher-centered pedagogical approaches, and monotonous, one-directional teaching methods [19]–[22]. This situation highlights the need to integrate technology-based innovations as alternative learning media that are more interactive, engaging, and aligned with the developmental needs of young children.

Technological advancement has also contributed to the increased use of digital tools and media in early childhood education [23]. The growing sophistication of technology has made digital games increasingly popular, as they provide more personalized and adaptive learning experiences based on children's individual ability levels [24]. Through the integration of technology, various learning applications can now be designed to be both interactive and personalized, enriching children's learning processes. For instance, digital games can automatically adjust their level of difficulty according to each child's abilities, thereby supporting the development of essential cognitive aspects such as concentration, reasoning, and problem-solving [25]. Within classroom contexts, digital games can be utilized to enhance children's active en-

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gagement while simultaneously serving as pedagogical tools that support instructional delivery. These games not only promote learning motivation but also help children practice problem-solving, narrative reasoning, and communication skills [26]. Given this potential, integrating digital games into the learning process represents an innovative strategy to optimize the development of children's thinking abilities from an early age. Nevertheless, despite their educational promise, the implementation of digital media for developing critical thinking skills in early childhood settings remains underutilized.

Various developmental theories provide a conceptual foundation for integrating technology into early learning practices. Piaget emphasized the significance of direct and concrete experiences as central to early childhood learning, while Vygotsky, through his sociocultural theory, highlighted that cognitive development occurs through meaningful social interaction. In this regard, technology can serve as a medium that fosters collaboration between children, teachers, and parents [27]. Educational technology, particularly in the form of digital games, can thus be leveraged to create interactive and meaningful learning experiences for young learners. Educational games hold a vital role in the preschool learning process. When designed with clear educational objectives, such games can act as mediators that facilitate effective learning [28]. The idea of a mediator corresponds to the principle of mediation in Vygotsky's cultural-historical theory, which positions mediation as a central mechanism in the learning process [29]. According to Vygotsky, mediation involves a reciprocal relationship between the social and individual dimensions of learning, each shaping and influencing the other [30].

Through mediation, individual understanding is developed and expressed within educational interactions that utilize tools such as language, writing, books, and technology [31]. Dengan Consequently, mediated learning emerges from social interactions that are strengthened using various cultural tools and learning aids. These tools serve as channels of communication and connection, preparing children to face future academic and professional challenges. In the context of the 21st century, rapid technological progressparticularly in digital and social technologies has transformed how teachers interact, communicate, and enhance their professional competencies. According to Vygotsky [17], [32], cultural tools encompass both technical tools—such as books, media, computers, and social software—and psychological tools, including language, symbols, and writing. Technology, as one of these cultural tools, enables children to engage in critical thinking, communicate their ideas, and articulate the understanding they have constructed [33]. The following section presents the Conceptual Framework, which illustrates the relationship between 21st-century skills and digital games in fostering children's critical thinking development.

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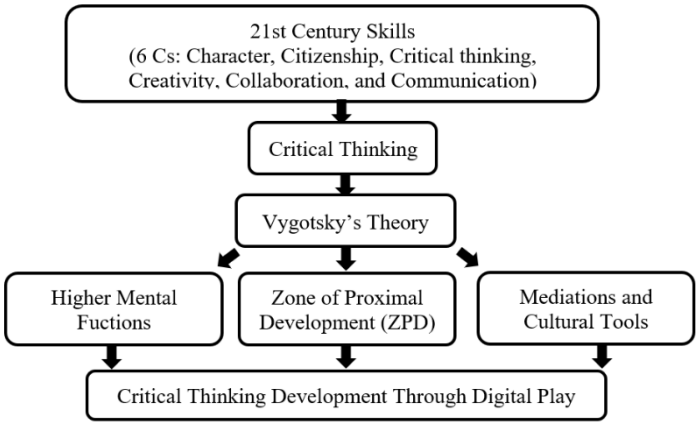

Fig. 1. Conceptual Framework

Based on a review of previous studies, it is evident that research on the use of digital games in early childhood education remains fragmented and has yet to demonstrate a strong integration between digital game design or media, the critical thinking components embedded within these games, and the role of teachers in facilitating learning. Most existing studies have primarily focused on enhancing learning motivation, promoting children's engagement, or generally improving cognitive aspects [34]–[36], without providing an in-depth analysis of how specific digital game elements can stimulate critical thinking processes in young children. The following section presents a summary table that outlines the identified research gaps.

Table 1. Research Gaps

Previous Research	Research Focus	Identified Research Gap
O'Reilly et al. [1]	Critical thinking in preschool classrooms	Did not examine the role of digital media in supporting critical thinking development
Muarifah et al. [26]	Digital games for early childhood education	Focused mainly on learning motivation rather than on children's critical thinking skills.
Behnamia et al. [37]	Use of Digital Game-Based Learning (DGBL)	Emphasized creativity enhancement instead of critical thinking development
Nirwana [38]	Effectiveness of Android-based digital *Calistung* games	Concentrated on general cognitive improvement, with no focus on critical thinking components
Dina & Purnamasari [39]	Use of PowerPoint-based educational games	Focused on stimulating general cognitive abilities rather than analytical or reasoning skills

These limitations reveal a research gap characterized by the absence of a comprehensive synthesis that connects key components such as digital game design and media, the critical thinking elements embedded within digital games, and the teacher's

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pedagogical role. Therefore, this Systematic Literature Review (SLR) was conducted to collect, review, and synthesize previous studies in order to provide a more holistic understanding of how these interconnected aspects contribute to the development of critical thinking skills among young children in the digital era.

2 Method

This study employed a Systematic Literature Review (SLR) approach, which involved systematically identifying and analyzing relevant academic works to obtain new insights and summarize existing evidence related to the development of critical thinking skills through digital games. SLR is a research methodology designed to systematically collect and critically evaluate studies pertinent to a particular topic or field [40]. It provides a structured, transparent, and replicable framework for identifying, assessing, and synthesizing findings across multiple studies [41]. Unlike meta-analysis, which primarily integrates quantitative results from comparable studies to determine a statistically significant effect size [42], an SLR emphasizes thematic and conceptual synthesis that incorporates evidence from diverse research methodologies and contexts. This method also differs from qualitative or narrative reviews, which tend to be descriptive and may not strictly follow standardized procedures for data search and selection. The SLR approach enables researchers to identify patterns, recurring themes, and existing gaps in the literature by adhering to reporting standards such as PRISMA 2020 [43] thereby ensuring methodological rigor and transparency. Hence, this method is considered the most appropriate approach for achieving a comprehensive understanding of the relationship between digital games and the development of critical thinking skills in early childhood.

The initial stage of this SLR involved defining inclusion and exclusion criteria for article selection. The inclusion criteria comprised studies published between 2015 and 2025, indexed in Scopus, ERIC, DOAJ, Dimensions, Garuda, or SINTA, and directly addressing the relationship between digital games and the development of critical thinking skills in early childhood. The review specifically focused on studies that discussed digital game design or media, critical thinking elements within games, and the role of teachers. Meanwhile, the exclusion criteria involved studies that were irrelevant to the research focus, such as those that (1) did not discuss early childhood contexts, (2) did not address critical thinking development, (3) did not involve the use of digital media or games, or (4) did not explain the teacher's involvement in the learning process.

The article selection process in this study followed the stages outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, which comprises four phases: identification, screening, eligibility assessment, and final inclusion. In the identification phase, the researcher conducted searches across several databases, including Scopus, ERIC, DOAJ, Dimensions, Garuda, and SINTA, using a combination of relevant keywords such as "children's critical thinking," "digital games," "children's digital play," "critical thinking through games," and "early childhood thinking skills." This initial search yielded 26 articles

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considered potentially relevant to the research topic. During the screening phase, all identified articles were examined based on their titles and abstracts to ensure alignment with the study's focus—namely, the relationship between digital games and the development of critical thinking skills in early childhood. Duplicate records and articles that did not address early childhood education contexts were excluded at this stage.

The eligibility phase involved a full-text review of each remaining article to assess the extent to which it met three primary criteria: (1) the discussion of digital game design or media and (2) the identification of critical thinking indicators stimulated through gameplay (3) the teacher's role. Articles that failed to meet these criteria were excluded from further analysis. Finally, in the inclusion phase, a total of 12 articles met all established criteria and were deemed suitable for in-depth analysis in this systematic literature review. The selected studies include both national and international publications released between 2015 and 2025, all of which consistently explored the connection between digital play and the development of critical thinking skills in early childhood education.

3 Results and Discussion

Based on the conducted literature review, a total of twelve articles were identified as meeting the established inclusion criteria. The analysis of these studies is presented in the following section.

Table 2. Research Gaps

Source	Media/Type of Digital Game	Critical Thinking Aspects	Teacher's Role	Research Findings
Pengembangan Maze Game "Ayo Temukan Jalannya" untuk Menstimulasi Kemampuan Berpikir Kritis Anak Usia 5-6 Tahun [44]	Maze Game	Problem-solving, curiosity, evaluating information	Companion	The Maze Game was found to be highly effective for stimulating critical thinking in early childhood. Each game level presents unique challenges visualized through boxes, letters, and images, encouraging children to analyze and solve problems progressively
Penerapan Pembelajaran Berbasis Game Wordwall Guna Meningkatkan Kogni-	Wordwall (matching game dan memory	Problem-solving, active questioning	Facilitator	The use of Wordwall games significantly enhanced children's memory,

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tif Anak TK B Usia 5-6 Tahun [45]	games)			engagement, and problem-solving skills, fostering more active participation during learning activities
Didactic Games For Developing Critical Thinking in Children and Their Importance [46]	Board games, role-playing games, puzzle, and educational digital games	Logical reasoning, decision-making, problem-solving	Facilitator	Didactic games were identified as effective tools for fostering critical thinking, providing hands-on learning experiences that support children's cognitive, social, and emotional growth
Studi Literatur Review: Peran Media *Game Based Learning* Terhadap Pembelajaran [47]	Game-Based Learning (Kahoot, Wordwall, Baamboozle, Fun with English)	Analyzing, evaluating, and problem-solving	Designer & Facilitator	The study highlights that Game-Based Learning (GBL) is effective in enhancing critical thinking skills at various educational levels, including early childhood education
Impact of Electronic Educational Games on Developing Children's Productive Thinking in Early Childhood [48]	BabyBus (interactive educational digital games)	Memory, attention, problem-solving, evaluation, decision-making	Mentor	Findings reveal that digital educational games such as BabyBus have a sustained positive impact on stimulating children's critical and productive thinking abilities
Pengaruh Penggunaan Media Games Interaktif Dalam Pembelajaran Sains untuk meningkatkan Kemampuan Berpikir Kritis Anak [49]	Easy Learning H5P (image choice, drag-and-drop, memory game, and interactive video)	Membandingkan Comparing, classifying, predicting, constructing arguments, problem-solving, summarizing information	Facilitator	The study reported significant improvements across all critical thinking indicators, with classification and prediction skills increasing by more than 66% in the third learning cycle
Effect of Science Education Provided with Digital and in-Class Games on the Scientific Process Skills of Preschool	Scratch (digital and in-class games)	Analyzing, cause-and-effect reasoning, problem-solving, classifying, pre-	Facilitator	The findings indicate that both digital and in-class game formats were equally effective in enhancing children's

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Children [50]		dicting, drawing conclusions		scientific process and critical thinking skills
Penggunaan Media Game Digital pada Anak Usia Dini [26]	Side-scrolling, role-playing (RPG), and simulation games	Problem-solving, information retention	Facilitator	The study demonstrates that digital games possess significant potential as learning media for improving children's problem-solving abilities and memory retention
Video Games and Metacognition in the Classroom for the Development of 21st Century Skilss: A Systematic Review [51]	Video game	Analyzing, decision-making, problem-solving, strategic thinking	Facilitator	The results suggest that video games can foster metacognitive development and strengthen 21st-century competencies, particularly critical thinking and decision-making abilities
E-Way Game Platform as a Digital Media to Train Critical Thinking in Early Childhood [52]	E-Way Game	Analyzing, evaluating, providing solutions, decision-making	Companion	The research findings show that the E-Way game platform is an effective digital tool for developing critical thinking in children aged 4–6 years, especially in the context of increasingly technology-integrated learning environments
Pengembangan Imaginary Permainan Imajinasi Berbasis Aplikasi Melalui Scratch Jr untuk Meningkatkan Kemampuan Berpikir Kritis Anak Usia 5-6 Tahun [20]	Scratch Jr	Problem-solving, questioning, expressing opinions, recognizing differences, understanding cause-and-effect relationships	Companion	The findings confirm that imaginative play using Scratch Jr effectively promotes the development of critical thinking skills in early childhood through interactive and creative exploration
Pemanfaatan Zoomaze Untuk Meningkatkan Kemampuan Critical Thinking Pada Anak Usia 5-6 Tahun [53]	Zoomaze	Problem-solving, memory	Companion	The study found that Zoomaze effectively stimulates children's critical thinking and memory skills while

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	maintaining their motivation and enjoyment during learning activities

The results of a review of the twelve analyzed studies indicate that digital games hold significant potential for fostering critical thinking skills in early childhood through exploratory, reflective, and problem-solving activities. Several studies, such as those employing the Maze Game and Zoomaze, confirmed that challenge-based digital games can enhance children's ability to recognize patterns, anticipate sequences, and generate alternative solutions. These activities not only cultivate logical reasoning but also encourage persistence and independent decision-making. This approach is effective because it allows children to actively construct knowledge through direct experience, aligning with Piaget's constructivist principle, which emphasizes the importance of active engagement in concrete learning experiences.

Furthermore, research utilizing the Wordwall and BabyBus platforms demonstrates how interactive digital games can help children grasp abstract concepts and strengthen their reflective thinking abilities. Such games require children to recall, categorize, and re-evaluate the decisions made during gameplay. The teacher's role in these studies was generally limited to providing technical facilitation and initial instructions, whereas deeper guidance on children's reasoning processes was still rarely observed. In fact, social interaction between teachers and children plays a crucial role in reinforcing the analytical and evaluative dimensions of critical thinking, as highlighted in Vygotsky's sociocultural theory.

Another study employing Scratch Jr emphasized children's ability to engage in causal reasoning and construct logical sequences through simple visual programming activities. In these tasks, children learn to organize actions sequentially and assess the outcomes, thereby strengthening both systematic and creative thinking skills. However, several studies have yet to provide detailed descriptions of teacher strategies in delivering scaffolding during the digital learning process. This finding indicates a persisting gap between the technological potential of digital games and the pedagogical role of teachers in supporting children's progression toward higher levels of reasoning, often referred to as Higher Mental Functions.

Additionally, several studies employing game-based learning and didactic game approaches have demonstrated that integrating digital games with traditional classroom activities can create a more meaningful and engaging learning environment. In such contexts, children participate in tasks that require observation, analysis, and reflection on their own experiences. Within this learning setting, the teacher functions as a facilitator, guiding children to reason through the outcomes of their explorations. However, most studies still rely predominantly on qualitative observations as their primary method of measurement. The absence of standardized instruments for evaluating critical thinking poses a unique challenge in objectively and accurately assessing the effectiveness of digital-based learning interventions.

Furthermore, advanced studies, such as those utilizing the E-Way Game platform, demonstrate a more adaptive integration of technology with pedagogical principles suited to early childhood characteristics. This platform was designed to promote criti-

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cal thinking through interactive scenarios that mirror real-life situations, encouraging children to analyze, compare, and draw logical conclusions from their gaming experiences. Despite its effectiveness, the findings also reveal several practical limitations, including teachers' low levels of digital literacy, limited technological infrastructure, and the potential for distraction caused by uncontrolled digital device use. These factors represent critical challenges that must be considered in developing and implementing digital media within early childhood education environments.

From the overall synthesis of the twelve studies, it can be concluded that digital games make a significant contribution to developing critical thinking skills in early childhood through active, collaborative, and meaningful learning experiences. Across all reviewed studies, the digital media used—ranging from Maze Game, Wordwall, BabyBus, Scratch Jr, Zoomaze, to the E-Way Game platform—stimulated multiple dimensions of critical thinking, including problem-solving, analytical reasoning, information evaluation, and decision-making. Nevertheless, the synthesis also highlights certain limitations, particularly concerning the integration of the teacher's role within digital game-based learning. The majority of studies positioned teachers merely as facilitators rather than as active mediators in the learning process. In fact, according to Vygotsky's sociocultural theory, the role of the More Knowledgeable Other (MKO) is crucial in shaping children's Higher Mental Functions, including their capacity for critical thinking.

4 Conclusion

Based on the results of a systematic review of twelve relevant studies, it can be concluded that digital games make a positive and meaningful contribution to the development of critical thinking skills in early childhood. The aspects of critical thinking most frequently stimulated include problem-solving, logical reasoning, decision-making, independent information evaluation, memory, and understanding of cause-and-effect relationships. Teachers play an essential role as facilitators, companions, and guides in this process. The digital games utilized across the reviewed studies were generally designed to be educational, interactive, and engaging, enabling children to think actively, explore creatively, and reflect on their learning experiences. The teacher's involvement remains a key factor in ensuring that play-based activities align with learning objectives through guided facilitation, concept reinforcement, and constructive feedback. Therefore, the integration of digital games into early childhood education is recommended as a pedagogical innovation that responds to the demands of the modern era. However, its implementation should be accompanied by adequate teacher training and curriculum development to ensure structured and intentional stimulation of children's critical thinking skills.

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