JOURNAL OF INNOVATION AND RESEARCH IN PRIMARY EDUCATION | ISSN 2829-775X
Vol. 4, No. 4, 2025, 2346-2355
https://doi.org/10.56916/jirpe.v4i4.2295

Enhancing Early Literacy Through Collaborative Digital Educational Games: A Classroom Action Research with Kindergarten Children Exhibiting ADHD Symptoms

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Keywords
early literacy
ADHD
digital educational games
collaborative learning
kindergarten

Article History
Received 2025-07-21
Accepted 2025-09-18

Abstract
Early literacy development presents significant challenges for kindergarten children exhibiting Attention Deficit Hyperactivity Disorder (ADHD) symptoms, who often struggle with concentration and traditional instructional methods. This study investigated the effectiveness of collaborative digital educational games in enhancing early literacy capabilities among children with ADHD symptoms. A classroom action research design following the Kemmis and McTaggart model was implemented over six months with a 5-6 year old male kindergarten student exhibiting ADHD symptoms. The intervention utilized the "Learn ABC" digital educational game within a collaborative learning framework across two cycles. Data collection included oral literacy assessments using a four-point scoring system and structured classroom observations. The intervention involved systematic group formation, collaborative gameplay, and peer presentations, with modifications between cycles based on reflective analysis. Substantial improvements were observed throughout the intervention period. The participant's performance increased from 26.67% at baseline to 88.87% upon completion, representing a 62.2 percentage point improvement that exceeded the established 76% success criterion. Cycle I showed progressive gains from 44.44% to 55.55%, while Cycle II demonstrated accelerated improvement from 66.67% to 88.87%. Qualitative observations revealed enhanced attention span, increased collaborative participation, improved confidence in letter identification, and sustained engagement during gaming activities. The findings demonstrate that collaborative digital educational games can effectively address attention and literacy challenges in children with ADHD symptoms. The intervention's success supports the integration of technology-enhanced collaborative learning approaches in inclusive early childhood education settings. The systematic implementation framework provides a replicable model for educators, though larger-scale studies are needed to establish broader generalizability.

INTRODUCTION

Early literacy development represents a critical foundation for academic success and lifelong learning, establishing the groundwork for later reading comprehension and scholastic achievement. Research demonstrates that early literacy skills originating in home environments significantly influence subsequent reading abilities and school performance outcomes. Enhancing and supporting early language and literacy skills during preschool has an important impact on children's learning skills at primary school, with specific abilities playing crucial roles in predicting later reading and writing outcomes at primary school (Koutsoftas et al., 2009; Murphy et al., 2016; Majorano et al., 2022). Furthermore, letter knowledge and phonological awareness are important early literacy skills, as children learning about letters acquire letter names, sounds, graphic forms, and the ability to connect these elements to identify relationships between letter names and their forms (National Early Literacy Panel, 2008; Robins, Treiman, & Rosales, 2014).

The significance of early literacy development becomes particularly pronounced when considering diverse populations, including children with attention and behavioral challenges. When children enter formal schooling, usually in kindergarten, they are expected to become effective speakers and readers rather quickly, yet some children may begin kindergarten at a disadvantage relative to their peers, particularly regarding early literacy skill development (Han & Huang, 2010; Hammer, Jia, & Uchikoshi, 2011). This academic vulnerability is especially evident among children exhibiting symptoms of Attention Deficit Hyperactivity Disorder (ADHD), a condition affecting approximately 7.2% of children and associated with persistent patterns of inattention, hyperactivity, and impulsivity that significantly impact learning processes (American Psychiatric Association, 2013; Thomas et al., 2015).

Children with ADHD symptoms face unique challenges in developing early literacy skills due to their difficulties in sustaining attention, controlling impulsive behaviors, and maintaining focus during traditional instructional activities. ADHD represents a complex neurodevelopmental disorder characterized by persistent patterns of inattention and/or hyperactivity/impulsivity, with hyperactivity representing one of the core features identified within diagnostic criteria (American Psychiatric Association, 2013; Burley et al., 2022). There is evidence suggesting that the presence and magnitude of hyperactive behavior in ADHD is influenced by environmental task conditions and is most evident under conditions that place high demand on executive functioning (Kofler et al., 2016). These executive function deficits directly impact children's ability to engage effectively with conventional literacy instruction methods, necessitating innovative pedagogical approaches.

Recent technological advances have created unprecedented opportunities for addressing these educational challenges through digital interventions. Studies using games as intervention strategies for ADHD children have found that game-based learning has positive effects on attention span and attention enhancement, with decreased occurrence of off-task behavior (Fabio & Antonietti, 2014; Shaw, 2005). Digital educational games leverage the natural appeal of interactive technology to create engaging learning environments that can sustain attention and motivation among children who struggle with traditional instructional methods. Games are defined as problem-solving activities approached voluntarily by players, consisting of goals, rules, feedback systems, and voluntary participation, elements that create motivation and enjoyment for sustained engagement (McGonigal, 2011; Schell, 2008).

Contemporary research has demonstrated promising results regarding digital educational games' effectiveness in promoting early literacy development. Studies have shown improvements in letter recognition and phonological awareness through educational game applications specifically designed for young learners (Arya, 2022; A'yunina & Masruroh, 2022). Research has indicated that educational game development can effectively enhance early literacy capabilities in young children aged 5-6 years (Irfan & Isyanti, 2021). Additionally, investigations have revealed that smart board media and educational games can significantly improve early literacy abilities in children (Ismawati & Widayati, 2023; Rosdiana et al., 2023).

The integration of collaborative learning principles with digital educational games presents an innovative approach to addressing the complex needs of children with ADHD symptoms. Collaborative learning environments promote peer interaction, shared problem-solving, and collective knowledge construction, potentially offsetting some attention and social challenges associated with ADHD. Recent intervention studies have investigated various approaches to developing early literacy skills, including both home-based and school-based programs that emphasize collaborative activities and structured interactions (Edwards, 2014; Krijnen et al., 2020; Bergman et al., 2021). When combined with the engaging features of digital games, collaborative learning may provide an optimal framework for supporting early literacy development among children with attention difficulties.

Despite growing interest in digital educational interventions, significant gaps remain in understanding how to effectively implement collaborative game-based approaches specifically for children exhibiting ADHD symptoms in kindergarten settings. Recent developments have focused on

creating word-wall based educational games and various digital platforms for improving early literacy recognition among children aged 5-6 years (Ramadhani et al., 2025; Supangat et al., 2025). However, research examining the effectiveness of educational games in enhancing language literacy among young children through specific media implementations remains limited (Widuroyekti & Luluk, 2023). Furthermore, studies investigating improved early literacy abilities through various innovative media approaches continue to emerge but require more comprehensive investigation (Widiana, Kania, & Utami, 2023).

This research addresses these gaps by investigating the implementation of collaborative digital educational game methods to enhance early literacy capabilities among kindergarten children exhibiting ADHD symptoms. The study aims to examine both the process and outcomes of implementing digital educational games within collaborative learning frameworks, specifically targeting letter recognition and early reading skills development. Understanding how these innovative pedagogical approaches can be effectively implemented may provide valuable insights for educators working with diverse learners and contribute to more inclusive early childhood educational practices.

The significance of this research extends beyond immediate educational outcomes to encompass broader implications for supporting children with attention and behavioral challenges in mainstream educational settings. By developing evidence-based strategies that leverage technology and collaborative learning principles, this study may inform policy and practice decisions regarding inclusive education and early intervention approaches. Furthermore, successful implementation of these methods could provide a foundation for scaling effective interventions to support larger populations of children facing similar challenges in early literacy development.

METHODS

This study employed a classroom action research design using mixed-methods approach, combining quantitative and qualitative methodologies to investigate the effectiveness of collaborative digital educational games in enhancing early literacy skills among kindergarten children exhibiting ADHD symptoms. The research followed the Kemmis and McTaggart cyclical model, consisting of four interconnected phases: planning, acting, observing, and reflecting. This iterative design allowed for continuous improvement and adaptation of interventions based on findings from each cycle, ensuring optimal outcomes for the target population.

The research was conducted over six months from December 2024 to May 2025 at TKNP (State Kindergarten), located in Sangatta Utara District, East Kutai Regency, East Kalimantan Province, Indonesia. The school was selected due to its adequate educational facilities, including comfortable classrooms, educational teaching aids, and audio-visual learning media necessary for implementing digital educational interventions.

The study participant was a 5-6 year old male student exhibiting ADHD symptoms, learning alongside 19 classmates in group B12. The subject was purposively selected based on classroom observations indicating below-average early literacy abilities. Participant characteristics included: formal identification of ADHD symptoms through direct teacher observation and completion of ADHD instruments on the Early Detection and Intervention for Growth and Development (SDIDTK) assessment sheet; demonstrated difficulties with concentration and vocabulary articulation, with unclear sentence pronunciation; and inability to participate effectively in group learning activities.

Data collection utilized two primary instruments. First, an oral test assessed early literacy capabilities, specifically letter recognition from a-z, using a four-point scoring system: 0 (Underdeveloped - requires full guidance or demonstration), 1 (Beginning Development - needs teacher assistance or reminders), 2 (Developing as Expected - performs independently and consistently), and 3 (Highly Developed - performs independently and assists peers). The assessment framework aligned with Indonesian Ministry of Education Regulation No. 146/2014 regarding Early Childhood Education Curriculum 2013, focusing on letter sound recognition and understanding sound-symbol relationships. Test indicators included: recognizing or naming alphabetical letters presented

sequentially, identifying randomly presented letters, and naming letters from specified words with picture assistance.

Second, structured observations monitored classroom learning processes during digital educational game implementation. Observations occurred four times per action cycle, focusing on collaborative digital educational game methods for improving early literacy skills. The observation framework encompassed opening activities (classroom conditioning, greetings, student orientation), core activities (group formation, task presentation, learning activity execution with teacher facilitation, group presentations), and closing activities (reflection and evaluation, sharing post-learning feelings, closing prayers).

The intervention followed a systematic collaborative learning framework: orienting students to learning objectives and game rules, forming small groups (4 children per group, including the ADHD participant), designing learning tasks within the digital game environment, facilitating student collaboration during gameplay, and providing evaluation and assessment of collaborative learning outcomes. Each group rotated playing the educational game on laptops while others completed alternative activities. Groups collaboratively selected from four game menu options, took turns playing, recorded encountered letters on paper, and presented their learning experiences to the class.

Data analysis employed both quantitative and qualitative descriptive approaches. Quantitative analysis processed oral test results and rating scale data using percentage calculations: Percentage (%) = (Σn/N) × 100%, where Σn represents total respondent scores and N represents total ideal scores. Qualitative analysis described and examined observational data regarding classroom activities, student responses during gameplay, collaborative activities within groups, teacher reflections, and classroom notes. Success criteria required achievement of "Highly Developed" (BSB) category in early literacy recognition capabilities, indicating scores between 91-100% (Excellent), 76-90% (Good), 61-75% (Sufficient), 51-60% (Poor), or ≤50% (Very Poor). The combination of quantitative and qualitative analyses provided comprehensive understanding of intervention effectiveness and implementation processes.

RESULTS AND DISCUSSION

Results

Pre-action Assessment

Prior to implementing the intervention, a comprehensive assessment was conducted to establish the participant's baseline early literacy capabilities. The pre-action assessment involved five oral questions focusing on letter recognition presented sequentially, randomly, and through picture-supported word identification tasks. The participant demonstrated significant challenges in early literacy recognition, achieving a score of 4 out of 15 possible points, representing 26.67% of the maximum score (Table 1).

Table 1. Pre-action Test Results

Subject	Maximum Score	Pre-action Score	Percentage
AF	15	4	26.67%

The participant's performance revealed specific difficulties across different literacy components. While demonstrating some capability in sequential letter recitation, the participant required substantial teacher assistance for random letter identification, particularly struggling with visually similar letters (b-d, p-q, m-w, u-n). Picture-supported word identification tasks showed inconsistent performance, with the participant successfully completing only one task independently while requiring teacher guidance for the remaining two tasks.

Cycle I Implementation and Results

The first intervention cycle comprised two sessions conducted on April 17 and April 24, 2025, implementing collaborative digital educational games using the "Learn ABC" application. Each session

followed a systematic structure incorporating opening activities, core collaborative gaming activities, and closing reflection periods.

Performance improvements were evident throughout Cycle I, with progressive score increases from the pre-action baseline. Table 2 presents the quantitative results across all assessment points during the first intervention cycle.

Table 2. Cycle I Test Results

Meeting	Maximum Score	Obtained Score	Percentage
Pre-action	15	4	26.67%
I	9	4	44.44%
II	9	5	55.55%

The data in Table 2 demonstrates consistent improvement from pre-action through Cycle I completion. Meeting I showed an increase to 44.44%, while Meeting II achieved 55.55%, representing a 28.88 percentage point improvement from baseline. However, these results remained below the established success criterion of 76%.

Observational data revealed both positive developments and persistent challenges. The participant demonstrated increased enthusiasm for learning activities and showed improved willingness to attempt letter identification tasks. However, concentration difficulties persisted, requiring repeated teacher instructions and frequent redirection to maintain focus during collaborative gaming sessions. The participant's group participation remained limited, with one group member tending to dominate laptop operation despite teacher reminders to share responsibilities.

Cycle II Implementation and Results

Based on Cycle I reflections, several modifications were implemented for Cycle II, conducted on May 6 and May 14, 2025. Key adjustments included reducing group size from four to three members, enhanced classroom conditioning to minimize distractions, increased positive reinforcement through rewards, and more frequent teacher reminders for sustained attention.

The modified approach yielded substantial improvements, as demonstrated in Table 3's comparative results.

Table 3. Cycle II Test Results

Meeting	Maximum Score	Obtained Score	Percentage
I	9	6	66.67%
II	9	8	88.87%

Table 3 shows remarkable progress during Cycle II, with Meeting I achieving 66.67% and Meeting II reaching 88.87%, surpassing the 76% success criterion. This represents a 33.2 percentage point improvement from Cycle II Meeting I to Meeting II, and a 62.2 percentage point increase from the original pre-action baseline.

Overall Performance Progression

The complete intervention timeline demonstrates consistent upward trajectory in early literacy performance. Qualitative observations during Cycle II revealed significant behavioral improvements. The participant demonstrated enhanced focus during learning activities, reduced susceptibility to environmental distractions, increased confidence in letter identification attempts, and improved collaborative participation with group members. The participant successfully operated the educational game independently, made informed menu selections, and exhibited sustained engagement throughout gaming sessions.

Discussion

This study's findings demonstrate the effectiveness of collaborative digital educational games in enhancing early literacy development among kindergarten children exhibiting ADHD symptoms. The

intervention achieved substantial improvements, with the participant's performance increasing from 26.67% at baseline to 88.87% upon completion, representing a 62.2 percentage point improvement that exceeded the established success criterion.

The significant performance improvements align with existing literature supporting game-based interventions for children with attention difficulties. Studies using games as intervention strategies for ADHD children have found that game-based learning has positive effects on attention span and attention enhancement, with decreased occurrence of off-task behavior (Shaw, 2005; Mautone et al., 2005). The current findings corroborate these results, as evidenced by the participant's progressively improved focus and reduced distractibility throughout the intervention cycles.

The appeal of digital educational games appears particularly relevant for children with ADHD symptoms, as these platforms provide immediate feedback, visual stimulation, and interactive elements that sustain attention more effectively than traditional instructional methods. Games are defined as problem-solving activities approached voluntarily by players, consisting of goals, rules, feedback systems, and voluntary participation, elements that create motivation and enjoyment for sustained engagement (McGonigal, 2011; Schell, 2008). The "Learn ABC" application utilized in this study incorporated these essential gaming elements, contributing to increased participant motivation and sustained attention during learning activities.

The integration of collaborative learning principles with digital gaming proved particularly beneficial for addressing social and attention challenges associated with ADHD symptoms. The participant's improved group participation and collaborative behaviors in Cycle II suggest that structured peer interaction can enhance learning outcomes for children with attention difficulties. Recent intervention studies have investigated various approaches to developing early literacy skills, including both home-based and school-based programs that emphasize collaborative activities and structured interactions (Edwards, 2014; Krijnen et al., 2020).

The collaborative framework implemented in this study required participants to negotiate game selections, share operational responsibilities, and present collective learning outcomes. These activities promoted social skill development while maintaining focus on literacy objectives, addressing multiple developmental domains simultaneously.

The intervention's impact on specific early literacy components demonstrates alignment with established developmental frameworks. Early literacy skills associated with later reading ability and school success originate and develop through meaningful engagement with print-rich environments and systematic instruction (Bowman et al., 2001; Brooks-Gunn & Duncan, 1997; Xu et al., 2017). The systematic progression observed in this study, particularly in letter recognition and sound-symbol correspondence, suggests that digital gaming platforms can effectively deliver foundational literacy instruction.

The participant's particular improvement in identifying visually similar letters (b-d, p-q, m-w, u-n) indicates that the interactive visual presentation in digital games may address specific perceptual challenges common among children with ADHD symptoms. Letter knowledge and phonological awareness are important early literacy skills, as children learning about letters acquire letter names, sounds, graphic forms, and the ability to connect these elements (National Early Literacy Panel, 2008; Robins et al., 2014).

The current findings align with previous research demonstrating positive outcomes for educational game interventions with ADHD populations. Studies have shown improvements in math performance and concentration ability in reading when using digital platforms for children with ADHD (Ota & DuPaul, 2002; McClanahan et al., 2012; Park et al., 2019). However, this study extends previous research by specifically focusing on collaborative implementation and early literacy development in preschool settings.

The cyclical action research approach enabled systematic refinement of intervention procedures, yielding insights about optimal implementation conditions. The group size reduction from four to three members in Cycle II proved particularly effective, suggesting that smaller collaborative units may

optimize participation opportunities for children with attention difficulties while maintaining peer interaction benefits.

The study's success has significant implications for early childhood educational practice. The intervention required minimal technological resources (laptop computer and readily available educational software) while producing substantial learning gains. This accessibility suggests potential for broader implementation in diverse educational settings serving children with attention and learning challenges.

The systematic implementation framework developed through this research provides a replicable model for educators seeking to integrate digital educational games with collaborative learning principles. The importance of environmental conditioning, positive reinforcement, and appropriate group sizing emerged as critical implementation factors worthy of consideration in future applications.

Several limitations warrant acknowledgment. The single-participant design limits generalizability, requiring replication with larger, more diverse samples to establish broader effectiveness. The study's duration was constrained by external factors including participant illness, school flooding, and competing school activities, potentially affecting optimal intervention dosage.

Future research should investigate the intervention's effectiveness across different ADHD symptom presentations, explore optimal intervention duration and frequency, examine long-term retention of literacy gains, and assess implementation feasibility across varied educational contexts. Additionally, comparative studies examining different collaborative grouping strategies and digital game characteristics would inform optimal intervention design.

The promising results obtained through this preliminary investigation suggest that collaborative digital educational games represent a viable approach for supporting early literacy development among children with ADHD symptoms, warranting continued research and development efforts in this domain.

CONCLUSION

This classroom action research demonstrates the effectiveness of collaborative digital educational games in enhancing early literacy development among kindergarten children exhibiting ADHD symptoms. The intervention achieved remarkable improvement, with the participant's performance increasing from 26.67% at baseline to 88.87% upon completion, significantly exceeding the established success criterion of 76%. The systematic implementation of the "Learn ABC" application within a collaborative learning framework successfully addressed attention challenges while promoting letter recognition and sound-symbol correspondence skills.

The study contributes to the growing body of evidence supporting technology-enhanced interventions for children with attention difficulties in early childhood education. By integrating digital gaming with collaborative learning principles, this research extends previous findings and provides a practical framework for addressing early literacy challenges in inclusive classroom settings. The cyclical action research design enabled systematic refinement of intervention procedures, yielding valuable insights about optimal implementation conditions including appropriate group sizing, environmental conditioning, and positive reinforcement strategies.

The findings have significant implications for early childhood educators and special education practitioners. The intervention's accessibility, requiring only basic technological resources, suggests potential for widespread implementation across diverse educational contexts. The collaborative framework addresses multiple developmental domains simultaneously, promoting both academic and social skill development. Educational institutions serving children with ADHD symptoms may benefit from incorporating similar technology-enhanced collaborative approaches into their literacy instruction programs.

Several limitations constrain the generalizability of findings. The single-participant design requires replication with larger, more diverse samples to establish broader effectiveness. External factors including participant illness and school disruptions affected optimal intervention duration, potentially

influencing outcomes. The study's brief timeframe precluded examination of long-term retention effects.

Future research should investigate the intervention's effectiveness across different ADHD symptom presentations and severity levels, examine optimal intervention dosage and frequency, assess long-term literacy skill retention, and explore implementation feasibility in varied educational settings. Comparative studies examining different digital game characteristics and collaborative grouping strategies would further inform evidence-based practice. Additionally, cost-effectiveness analyses would support policy decisions regarding technology integration in early childhood special education programs.

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