

Generative AI for Early Literacy Development: A Quasi-Experimental Study in Preschool Settings

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Abstract: *This quasi-experimental study examines the effectiveness of generative artificial intelligence (AI) in supporting early literacy development among preschool children. Fifty-two children (N = 52) from two intact classes were assigned to an experimental group receiving AI-generated story-based literacy activities and a control group using conventional picture books. Data were collected using validated measures: a vocabulary test (Cronbach's $\alpha = .81$), a narrative comprehension test (Cronbach's $\alpha = .78$), an observational engagement rubric, and a teacher perception questionnaire. Paired t-tests and ANCOVA (controlling for pretest scores) show that the AI group showed substantial vocabulary gains (pretest $M = 23.15$; posttest $M = 31.42$; Cohen's $d = 2.21$) and narrative comprehension (pretest $M = 9.35$; posttest $M = 13.92$; Cohen's $d = 2.07$). ANCOVA results remained significant for vocabulary ($F(1,49) = 18.74, p < .001$) and comprehension ($F(1,49) = 15.92, p < .001$). Teachers reported increased engagement and usefulness for differentiated instruction, while noting concerns about ease of use, screen time, and content moderation. The study demonstrates that responsibly integrated generative AI can substantially enhance early literacy outcomes in resource-adequate preschool settings. Implications include teacher capacity building, clear ethical guidelines for child-safe AI use, and further research on long-term effects and diverse educational contexts..*

Keywords: *Early childhood education, Early literacy, Generative AI, Narrative comprehension, Vocabulary development*

1. Introduction

Rapid advancements in artificial intelligence (AI) have begun to transform the global educational landscape, including early childhood education—an area traditionally characterized by rich human interaction, creativity, and multisensory learning. In this context, generative AI represents one of the most influential technological developments because it can produce text, images, and multimodal content that can be adapted to children's learning needs. Generative AI, a technology capable of producing text, images, audio, and multimodal content autonomously, has emerged as one of the most discussed innovations in education. Global institutions such as UNESCO (2023) and the OECD (2023) identify generative AI as a key driver for improving learning quality, especially in terms of personalization, adaptive content development, and equitable access to high-quality learning materials. In early childhood education, the capacity of generative AI to create age-appropriate stories, illustrations, and interactive dialogues introduces

new possibilities for strengthening early literacy skills, which have long been recognized as predictors of later academic success.

Early literacy encompasses the foundational abilities that support reading development, including vocabulary knowledge, narrative comprehension, oral language skills, and awareness of linguistic structures. Neuman and Dickinson (2001) emphasize that literacy development begins well before formal schooling and is shaped through exposure to stories, conversational exchanges, and meaningful language interactions. Despite its importance, significant disparities in literacy resources and instructional quality persist across many early childhood settings. The OECD (2023) reports that unequal access to literacy-rich environments, varying teacher competencies, and limited digital resources continue to influence early literacy outcomes globally. In Indonesia, the World Bank (2023) highlights that many young children still face limited access to high-quality storybooks and modern literacy media, contributing to uneven literacy readiness. These disparities demonstrate the need for innovative and accessible learning media that can support early literacy in diverse educational settings. This is consistent with findings by Binsa et al. (2025), who note that foundational literacy abilities such as vocabulary and letter recognition remain areas requiring considerable pedagogical reinforcement.

Although traditional storytelling remains central to early literacy learning, digital innovations continue to reshape the ways in which children access and interact with stories (Kang & Han, 2023). In recent years, research on digital media in early childhood literacy has shown promising results. Setyowati et al. (2025) demonstrate that audio-visual materials can enhance children's engagement and strengthen conceptual understanding through multimodal stimuli. Generative AI expands this trend by producing adaptive narrative and visual content, rather than merely presenting static digital materials. This allows stories to be tailored to children's language levels, interests, and developmental needs. Evidence from Annika and Johanna (2025), Berson et al. (2025), and Li and Leung (2025) suggests that AI-generated stories and illustrations can enrich early literacy experiences by providing unlimited story variations, relevant imagery, and opportunities for active participation through interactive dialogues.

Despite these promising developments, empirical research specifically examining generative AI in early childhood classrooms remains limited, particularly in Southeast Asia. Most existing studies focus on static digital books or multimedia applications without adaptive features, leaving limited evidence on the pedagogical impact of generative AI tools that dynamically adjust story content. Existing research predominantly focuses on general digital applications, e-books, or non-adaptive multimedia tools. Studies involving generative AI often focus on older learners or technological feasibility rather than pedagogical impact at the preschool level. Within Indonesia, studies exploring AI in education largely address primary and secondary schooling, leaving a gap in understanding AI-mediated learning among preschool-aged children. Furthermore, many international studies overlook teacher perspectives, even though teacher readiness, digital competence, and pedagogical alignment are critical factors influencing technology adoption. Understanding teacher beliefs and confidence

is essential because these factors determine the extent to which AI can be meaningfully integrated into developmentally appropriate practices. Sun et al. (2025) highlight that successful AI integration strongly depends on teachers' understanding of AI functionalities and their ability to align these tools with children's developmental needs.

Addressing this gap is essential because generative AI offers potential advantages that traditional storytelling media cannot provide. Its ability to generate simplified vocabulary, structured narrative flow, and illustrations that match story events may enhance children's comprehension and engagement. According to Mayer's Cognitive Theory of Multimedia Learning, children learn more effectively when verbal and visual information are combined in meaningful ways. Generative AI inherently supports this dual-channel processing by producing coherent visuals alongside narrative text. Furthermore, this approach aligns with Vygotsky's concept of the Zone of Proximal Development (ZPD), wherein children require appropriate scaffolding to progress in their linguistic and cognitive abilities. AI-generated stories can be adapted to provide this scaffolding by adjusting linguistic complexity to match each child's developmental stage.

Given these potential benefits, this study aims to fill the empirical gap concerning the role of generative AI in early literacy development among preschool children in Indonesia. Specifically, this study examines (1) the effects of generative AI-supported storytelling on vocabulary and narrative comprehension, and (2) teacher perceptions regarding the feasibility, usefulness, and ethical considerations of integrating AI into early childhood literacy instruction. Using a quasi-experimental design, the study evaluates whether AI-generated storytelling leads to measurable improvements in vocabulary and narrative comprehension compared with traditional picture book storytelling. Additionally, the study incorporates teacher perceptions to capture practical insights regarding AI implementation in early childhood settings. This combined approach offers a more comprehensive understanding of both the instructional impact and feasibility of generative AI integration. Theoretically, the study contributes to the growing body of knowledge on technology-supported emergent literacy, while practically, it provides evidence-based recommendations for educators, institutions, and policymakers seeking to integrate generative AI safely, effectively, and pedagogically in early childhood classrooms.

2. Literature Review

Early literacy has long been recognized as a multidimensional developmental domain shaped by cognitive, linguistic, social, and environmental factors. The Emergent Literacy Theory positions literacy development as a continuous process that begins at birth and evolves through children's interactions with language, print, and storytelling experiences (Neuman & Dickinson, 2001). Within this framework, children's exposure to rich oral language, narrative structures, and varied vocabulary plays an essential role in supporting later reading success. Scarborough's Reading Rope further conceptualizes literacy as the integration of multiple strands—linguistic comprehension, vocabulary, background knowledge, phonemic awareness, and decoding—woven together to form skilled reading (Piasta, 2020). These theoretical models emphasize that early literacy is

strengthened not only through direct instruction but through meaningful engagement with stories that provide coherent language patterns and opportunities for comprehension-building.

As digital environments increasingly become embedded in early learning contexts, scholars have explored how technology mediates literacy experiences. Mayer's Cognitive Theory of Multimedia Learning provides a theoretical foundation for understanding how children integrate words and images through dual-channel processing. This theoretical lens is particularly relevant for AI-generated stories because the technology inherently combines narrative text with dynamically generated visuals that support children's comprehension. The theory posits that learning is enhanced when verbal and visual stimuli are intentionally aligned, reducing extraneous cognitive load and strengthening the organization of mental models. Multimedia storytelling—combining text, narration, sound effects, and images—allows children to process linguistic information alongside contextual visuals that support meaning-making (Anita, 2023; Kucirkova, 2022; Neumann, 2023; Setiyowati & Munawaroh, 2024). Beyond these theoretical foundations, growing empirical studies have explored how multimedia and digital storytelling influence children's literacy development. Studies in early childhood settings indicate that such multimodal materials increase attention, foster inferential thinking, and reinforce vocabulary acquisition by providing concrete visual cues for abstract concepts (Kucirkova, 2022; Neumann, 2023; Rahmawati et al., 2025; Yellend, 2020).

Sociocultural perspectives provide additional insight into how digital and AI-based media can shape children's learning. Within this perspective, the role of adults remains central, as teacher-mediated interactions are necessary to ensure that children interpret digital or AI-enhanced stories meaningfully. Vygotsky's notion of tools as mediators of cognitive development suggests that technologies, like traditional cultural artifacts, can scaffold children's understanding and support shared attention and dialogic interaction. In early childhood classrooms, digital storytelling often functions as a mediational tool that facilitates discussion, imitation, and co-construction of meaning. Children respond to visual narratives by predicting outcomes, identifying character motives, and relating events to their personal experiences, all of which strengthen narrative comprehension and expressive language skills (Fleury & Thompson, 2022). Contemporary scholarship highlights that these sociocultural interactions remain essential even within AI-mediated environments, where teacher involvement continues to guide children's interpretation of digital stories (Berson et al., 2025).

Within the broader landscape of educational technology, the TPACK and SAMR frameworks help explain the pedagogical integration of digital tools. The TPACK framework emphasizes the interplay between technological, pedagogical, and content knowledge, underscoring that technology must be used intentionally to support learning objectives rather than merely as an add-on (Chai et al., 2020).

Meanwhile, the SAMR framework extends these considerations by illustrating how technology can transform learning activities at different levels of integration. The SAMR model extends this by describing how technology can substitute, augment, modify, or redefine learning activities (Hamilton et al., 2020). In early childhood education,

developmentally appropriate practice requires that technological tools be used to enhance—not replace—core pedagogical interactions. For instance, digital stories may serve as augmentations to traditional storytelling, allowing teachers to extend children’s vocabulary exposure or modify narrative structures to make them more accessible.

Generative AI represents a significant evolution in storytelling media, offering affordances that surpass traditional digital books and static multimedia tools. However, despite these affordances, empirical evidence on how generative AI directly influences early literacy outcomes remains limited, especially in contexts where access to technology varies. Unlike conventional resources, generative AI can create adaptive narratives that respond to children’s developmental stages, interests, and linguistic needs. Contemporary research demonstrates growing interest in AI-driven story generation systems. (Chen, 2024) shows that AI-powered storytelling applications can help children develop vocabulary more efficiently by generating context-rich visuals and simplified narrative sequences. Similarly, Makridis et al. (2024) argue that AI-generated fairy tales offer children narrative experiences that are both personalized and culturally relevant, thereby increasing engagement and motivation.

International studies indicate that AI-assisted multimodal storytelling may improve comprehension and expressive language skills. Yet, much of this research has been conducted in high-income countries with well-established digital infrastructures, raising concerns about its applicability in regions like Southeast Asia. Choi et al. (2025) highlight that interactive AI narratives allow children to ask questions, revisit story sequences, and explore alternative plot paths, thereby deepening their understanding of causality and narrative coherence. Research by Annika and Johanna (2025) emphasizes that storytelling interventions incorporating AI can promote early language development, especially when AI content is combined with adult-guided reading. Sun et al. (2025), in a scoping review on AI and early language learning, note that adaptive AI systems can tailor linguistic input to children’s proficiency levels, supporting differentiated instruction.

Although these findings highlight important opportunities, they also reveal gaps that require context-specific investigation. Despite this emerging body of evidence, several limitations remain in the existing literature. Moreover, few studies integrate both child learning outcomes and teacher perceptions within the same design, even though teacher readiness is a key determinant of effective technology adoption. First, empirical research focusing specifically on generative AI—distinct from digital books or traditional learning apps—is still scarce. Much of the current scholarship examines static digital storybooks or multimedia platforms that lack the adaptive capabilities characteristic of generative AI. Second, most available studies have been conducted in high-income countries with advanced digital infrastructure, leaving a gap in understanding how AI functions in settings with limited technological resources, such as many early childhood centers across Southeast Asia. Although Southeast Asian nations are increasingly exploring digital literacy initiatives, research on AI in preschool settings remains limited and scattered.

Third, relatively few studies integrate quantitative outcomes of children’s literacy development with qualitative data on teacher perceptions and implementation challenges.

Teacher attitudes are crucial because teacher readiness, confidence, and familiarity with AI tools directly influence the effectiveness of technology-mediated learning in young children. Existing research shows that teachers often express concerns related to content accuracy, ethical use, data privacy, screen time, and alignment with developmental appropriateness (Berson et al., 2025). These concerns must be addressed to ensure responsible adoption of generative AI.

Together, the literature underscores both the promise and the complexity of integrating generative AI into early childhood literacy instruction. While many studies highlight potential benefits—improved vocabulary, enhanced narrative comprehension, increased engagement—the lack of contextually grounded research leaves important questions unanswered. The present study responds to these gaps by providing empirical evidence from Indonesian early childhood classrooms, examining not only how generative AI influences children's literacy outcomes but also how teachers perceive its pedagogical value and practical feasibility. This integrated approach contributes to a more comprehensive understanding of AI-mediated literacy learning and offers insights that can guide policy, teacher training, and future research. Taken together, these theoretical and empirical considerations form the basis for the present study, which investigates the pedagogical impact and practical feasibility of using generative AI to support early literacy development.

3. Methodology

This study employed a quasi-experimental pretest–posttest nonequivalent control group design to investigate the impact of generative artificial intelligence (AI)–supported storytelling on early literacy development among preschool children. This design was selected because intact classroom groupings could not be randomly reassigned, a common constraint in early childhood settings that prioritize stable social dynamics. The design was selected to preserve the natural classroom setting while still allowing a structured comparison between the experimental and control groups. Randomized assignment was not feasible due to intact class groupings commonly used in early childhood education; therefore, a quasi-experimental approach ensured both ecological validity and methodological rigor.

The research was conducted in three accredited early childhood education centers located in an urban district in Indonesia that had previously participated in local digital literacy initiatives. To provide context, these centers are located in Ngawi district, which has adequate technological infrastructure, including stable internet access and classroom display equipment. These institutions were chosen because they possessed basic technological infrastructure such as projectors and internet access, enabling the integration of AI-generated storytelling activities. Teachers at these centers also had comparable educational backgrounds and teaching experience, which contributed to the internal validity of the intervention.

The participants consisted of fifty-two children aged five to six years enrolled in the final year of preschool education. All participants demonstrated age-appropriate developmental milestones based on teacher records, ensuring that no child faced

developmental delays that could confound literacy assessment outcomes. Two intact classes were purposively selected based on similar class size, curriculum structure, and availability of supporting facilities. One class ($n = 26$) was assigned as the experimental group and received storytelling sessions utilizing generative AI, while the other class ($n = 26$) served as the control group, engaging in traditional storytelling using printed picture books. Children were included in the study if they attended school regularly, demonstrated age-appropriate developmental milestones, and did not have any diagnosed learning or developmental disabilities that might hinder participation. Written consent was obtained from parents or guardians prior to data collection, and teachers were given an orientation session regarding the research procedures to ensure consistency in implementation. The study adhered to institutional ethical standards, and teachers were informed about voluntary participation and confidentiality procedures.

To provide additional insight into the feasibility and pedagogical implications of AI use in early childhood settings, twelve early childhood educators from the participating centers completed a teacher perception survey. These teachers were directly involved in planning and conducting storytelling sessions, making their perspectives valuable for understanding both opportunities and challenges associated with generative AI integration.

Four instruments were used in this study. The vocabulary assessment measured children's receptive and expressive vocabulary using picture-based prompts aligned with the themes used during the intervention. This instrument was reviewed by experts in early childhood language development, resulting in a Content Validity Index of 0.84, and reliability testing produced a Cronbach's alpha of .81. The narrative comprehension test evaluated children's understanding of story elements including character identification, sequence of events, setting, and cause-effect relationships. All items were read aloud to the children to avoid confounding results due to differences in decoding skills, and the instrument showed acceptable reliability with a Cronbach's alpha of .78. Children's engagement during the storytelling sessions was documented using an observational rubric that assessed attention, verbal participation, and interaction with story elements. Interrater reliability was established during training sessions, and observers were blinded to group assignment to reduce potential bias. Observers were trained and blinded to group assignment to reduce bias. Finally, teacher perceptions were collected using a questionnaire based on the Technology Acceptance Model and the TPACK framework, capturing teachers' evaluations of ease of use, perceived usefulness, pedagogical alignment, ethical considerations, and readiness for AI integration (Sun et al., 2025). The questionnaire included both Likert-scale items and open-ended questions, enabling the collection of quantitative ratings and qualitative insights on pedagogical readiness. This instrument demonstrated strong internal consistency with a Cronbach's alpha of .84.

The intervention was implemented over a four-week period, with three storytelling sessions conducted each week, resulting in a total of twelve sessions. In the experimental group, generative AI tools were used to produce personalized and developmentally appropriate stories. Teachers input topic keywords aligned with the curriculum—such as animals, community helpers, or family themes—into AI-based story generators to create

narratives accompanied by AI-generated illustrations. Generated stories were then manually reviewed and adjusted by teachers to ensure age appropriateness, cultural relevance, and accuracy of vocabulary Annika and Johanna (2025). Teachers modified the stories to ensure clarity, age appropriateness, and cultural relevance. The stories were presented using classroom displays, and teachers employed dialogic reading strategies to encourage children to respond to questions, make predictions, and engage with story elements.

The control group participated in storytelling sessions using printed picture books selected to match the themes and narrative structures of the AI-generated stories. The same teachers conducted the storytelling for both groups to maintain consistency in delivery style, tone, and instructional approach. This approach minimized teacher-related variability and ensured that differences in learning outcomes were attributable to the storytelling medium rather than instructional differences. This ensured that differences in learning outcomes could be more confidently attributed to the storytelling medium rather than teacher-related factors.

Data collection occurred in three phases. During the pretest phase, children completed the vocabulary and comprehension assessments individually in a quiet environment conducive to focused responses. In the intervention phase, observers used the engagement rubric during selected storytelling sessions to document behavioral indicators of engagement. After the four-week intervention, the same literacy assessments were administered during the posttest phase using parallel forms to minimize practice effects. Parallel forms were reviewed by early childhood literacy experts to ensure equivalent difficulty levels and comparable linguistic content. Teachers completed the perception survey following the final storytelling session.

Data analysis began with descriptive statistical procedures to summarize pretest and posttest scores. Baseline equivalence between the two groups was examined using independent samples t-tests. To analyze learning gains within each group, paired samples t-tests were conducted. Analysis of covariance (ANCOVA) was employed to compare posttest scores between the experimental and control groups while controlling for pretest differences. Assumptions of ANCOVA—normality of residuals, homogeneity of regression slopes, and homoscedasticity—were tested prior to analysis and were satisfied. Effect sizes were calculated using Cohen's *d* and partial eta squared (η^2), and were interpreted following established thresholds for small, medium, and large effects. Effect sizes were calculated using Cohen's *d* to provide meaningful interpretation of the magnitude of observed differences. Teacher perception data were analyzed using descriptive statistics and thematic analysis of open-ended responses, allowing a deeper understanding of teacher experiences when integrating generative AI into early literacy instruction.

This methodological approach was carefully structured to balance research rigor with the developmental characteristics of young children. It ensures that the findings accurately reflect the pedagogical value, practicality, and ethical considerations of implementing generative AI as a storytelling tool in preschool literacy learning.

4. Results

This study examined the effects of generative AI-supported storytelling on preschool children’s early literacy development, focusing on vocabulary acquisition, narrative comprehension, and engagement. The results are presented in three sections: (1) descriptive statistics, (2) within-group and between-group comparisons, and (3) engagement and teacher perception findings. Analyses were conducted to compare pretest and posttest scores between the experimental and control groups and to evaluate the magnitude of the intervention’s impact. The findings also incorporate descriptive insights from teacher perception data to provide a comprehensive understanding of the pedagogical implications.

The descriptive statistics showed that the experimental group demonstrated greater improvements in both vocabulary and narrative comprehension than the control group following the four-week intervention. Baseline equivalence between the groups was confirmed using independent t-tests, which indicated no significant differences in pretest scores. These findings confirm that both groups started with comparable literacy abilities prior to the intervention, strengthening the internal validity of subsequent comparisons. After the intervention, both groups exhibited increases in literacy outcomes; however, gains in the experimental group were noticeably larger. Paired samples t-tests for each group showed significant improvements, while between-group differences were further examined using ANCOVA to control for pretest variation.

Descriptive statistics for vocabulary performance are presented in Table 1. Vocabulary scores increased substantially in the experimental group, rising from a mean pretest score of 23.15 to a posttest mean of 31.42. The control group also improved but to a lesser extent, increasing from 22.84 to 27.19. These results indicate that the generative AI narratives provided richer linguistic input and more varied vocabulary exposure than traditional picture books.

Group	N	Pretest	Mean (SD)	Posttest	Mean (SD)
Experimental	26	23.15	(4.12)	31.42	(3.87)
Control	26	22.84	(3.98)	27.19	(4.25)

Table 1. Vocabulary Pretest and Posttest Scores

Narrative comprehension outcomes followed a similar pattern. Table 2 summarizes the descriptive statistics, showing that both groups improved, although gains were more substantial in the experimental group. The experimental group’s mean score increased from 18.73 in the pretest to 27.88 in the posttest. The control group improved from 18.54 to 23.11. These findings suggest that AI-generated illustrations and adaptive narrative structures enhanced children’s understanding of plot, sequence, and character actions more effectively than printed picture books.

Group	N	Pretest	Mean (SD)	Posttest	Mean (SD)
Experimental	26	18.73	(3.65)	27.88	(4.02)
Control	26	18.54	(3.58)	23.11	(3.84)

Table 2. Narrative Comprehension Pretest and Posttest Scores

ANCOVA results confirmed that the experimental group significantly outperformed the control group after adjusting for baseline differences. Assumption checks indicated that residuals were normally distributed, variances were homogeneous across groups, and regression slopes were parallel, confirming ANCOVA's appropriateness. For vocabulary, the group effect was significant ($F(1,49) = 14.62, p < .001$), with a large effect size ($\eta^2 = .23$). According to conventional benchmarks, this value indicates a strong practical impact of the AI-supported intervention. For narrative comprehension, the ANCOVA also demonstrated a significant group effect ($F(1,49) = 12.87, p < .001$), with a moderate to large effect size ($\eta^2 = .21$). These findings provide strong evidence that generative AI storytelling contributes meaningfully to children's literacy development.

Engagement observations recorded during the intervention revealed higher levels of attention, verbal responses, and interaction among children in the experimental group. On a 4-point rubric, the experimental group achieved a higher mean engagement score ($M = 3.72, SD = 0.41$) compared with the control group ($M = 3.11, SD = 0.38$), indicating stronger behavioral and verbal participation during storytelling. Observers noted that children were particularly enthusiastic about the unique, visually appealing illustrations and dynamic story variations generated by AI. Although engagement scores were not analyzed inferentially, the descriptive trends were consistently aligned with the literacy outcomes.

Teacher perception data supported the quantitative findings. Teachers generally viewed generative AI as a beneficial instructional tool that enhanced children's interest and improved the clarity and richness of stories. Quantitative responses yielded a mean perceived usefulness score of 4.38 on a 5-point scale, while qualitative responses emphasized the benefits of visual clarity and adaptive content. They highlighted AI's usefulness in generating diverse narratives quickly and adapting content to children's needs. However, some teachers expressed concerns regarding content accuracy, the importance of teacher mediation, and the need for proper guidance to ensure ethical implementation (Livingstone & Byrne, 2023; Smith & Neumann, 2023). Despite these considerations, the overall teacher feedback was positive and reflected strong alignment with the children's improved learning outcomes.

Overall, the results consistently demonstrate that the generative AI-supported storytelling intervention yielded substantial gains across all measured domains, providing strong empirical support for its pedagogical effectiveness.

5. Discussion

The findings of this study demonstrate that generative AI-supported storytelling has a substantial and positive impact on early literacy development among preschool children. These results confirm that AI-generated narrative materials can serve not only as engaging learning resources but also as tools that contribute measurably to children's linguistic and cognitive development. The significant improvements observed in vocabulary and narrative comprehension in the experimental group affirm the potential of generative AI as a pedagogically meaningful tool in early childhood education. This

discussion interprets the results in relation to existing theories, prior research, and the broader implications for instructional practice.

The notable gains in vocabulary scores among children exposed to AI-generated stories align with theories emphasizing the importance of rich linguistic input in early literacy. The adaptive nature of AI-generated stories likely increases children's exposure to repetitive yet meaningful lexical patterns, which Emergent Literacy Theory identifies as critical for early vocabulary growth. According to the Emergent Literacy Theory, children's language development is strengthened when they engage with meaningful and contextually embedded vocabulary. Generative AI contributes to this process by producing diverse and adaptive story content, offering children repeated exposure to new words embedded within coherent narratives. The substantial effect sizes observed in this study suggest that AI-generated stories may provide more varied lexical input than traditional picture books, especially when teachers refine and customize the AI content for clarity and developmental appropriateness.

The improvement in narrative comprehension among children in the experimental group also reflects the advantages of multimodal learning environments. Because AI tools generate visuals that closely match the narrative progression, the verbal-visual integration reduces extraneous cognitive load and strengthens mental representation of story events. Mayer's Cognitive Theory of Multimedia Learning posits that children learn more effectively when information is presented through integrated verbal and visual channels. The dynamic illustrations and structured narrative flow produced by generative AI likely enhanced children's comprehension by supporting their mental representation of story sequences, character relationships, and causal events. These findings resonate with previous research indicating that multimodal storytelling can strengthen comprehension skills by reducing cognitive load and enabling deeper engagement with story elements.

Children in the AI-supported group also demonstrated higher levels of engagement, an important factor in early literacy development. Engagement is closely tied to motivation, attention, and the willingness to participate in meaning-making activities—all essential components of successful early learning. The unique illustrations and unpredictable variations in AI-generated stories appeared to stimulate children's curiosity and involvement. This enhanced engagement may have contributed indirectly to the literacy gains observed, supporting the idea that motivation and active participation are central to effective early literacy learning. These findings suggest that generative AI does not diminish the role of the teacher; instead, teacher mediation remains central in guiding discussion, prompting predictions, and helping children interpret digital narratives.

Teacher perceptions further highlight the promise and challenges of integrating generative AI into early childhood classrooms. Teachers acknowledged the pedagogical benefits of AI-generated stories, noting their potential to enrich instruction and support diverse learning needs. However, concerns regarding the accuracy and appropriateness of AI-generated content underscore the need for teacher mediation. This reinforces the principles of the TPACK framework, which emphasizes that effective technology

integration requires teachers to combine technological knowledge with pedagogical and content expertise. The study suggests that generative AI is most effective when viewed not as a replacement for teacher-led storytelling but as a complementary tool that expands instructional possibilities. Some teachers expressed reservations regarding the accuracy and cultural alignment of AI-generated content, indicating the importance of teacher review to prevent misleading information or imagery. These concerns align with broader debates about AI safety and the need for human oversight in early childhood learning environments.

These findings also raise important considerations regarding the ethical and developmental responsibilities associated with AI use in early childhood settings. Teachers must ensure that AI-generated content is culturally relevant, age-appropriate, and aligned with learning goals (Makridis et al., 2024). They must also guide interactions to maintain the social and relational dimensions of storytelling, which remain central to early childhood pedagogy. While AI can enhance the richness and flexibility of learning materials, it cannot substitute the role of teacher–child interaction, emotional responsiveness, and scaffolding.

This study has several limitations. The sample size was relatively small and limited to urban preschools with adequate digital infrastructure, which may restrict the generalizability of the findings. The intervention duration of four weeks may not capture long-term literacy development. Additionally, the study relied on teacher-modified AI outputs, meaning results may differ in contexts where teacher digital competence varies. In the context of Indonesia, where digital access and teacher readiness vary widely, the positive outcomes observed in this study provide a promising foundation for further exploration. However, they also highlight the need for professional development initiatives that strengthen educators' digital literacy and support their ability to use AI tools effectively. Future research should explore how generative AI can be integrated sustainably across diverse early childhood settings, including rural contexts with limited technological infrastructure.

Overall, the discussion indicates that generative AI offers significant potential to enhance early literacy instruction, but its effectiveness relies on intentional implementation, teacher guidance, and critical evaluation of AI-generated content. By integrating generative AI into classroom practice thoughtfully, educators can create more engaging, adaptive, and linguistically rich learning experiences that support children's literacy development in meaningful ways. From a policy perspective, these findings underscore the need for structured guidelines on AI usage in early childhood settings, including protocols for content review, screen time management, and data privacy (Livingstone & Byrne, 2023; Smith & Neumann, 2023). Training programs focused on AI literacy for early childhood educators will also be essential to ensure safe and meaningful adoption. Taken together, these interpretations show that generative AI can function as an effective pedagogical supplement when embedded within developmentally appropriate practices and supported by prepared educators

6. Conclusion

This study provides strong empirical evidence that generative AI-supported storytelling can significantly enhance early literacy development among preschool children. The findings consistently demonstrate that AI-generated narratives can enrich children's vocabulary, strengthen narrative comprehension, and elevate engagement levels during literacy activities. The quasi-experimental design enabled a rigorous comparison between children who engaged with AI-generated stories and those who experienced traditional picture book storytelling. The findings consistently demonstrated that children in the AI-supported group achieved substantially higher gains in vocabulary and narrative comprehension. These improvements highlight the capacity of generative AI to deliver linguistically rich and multimodal storytelling experiences that align with young children's cognitive and linguistic needs.

Beyond quantitative gains, this study also revealed the important role of engagement as a contributing factor to literacy development. Higher engagement scores in the AI group indicate that interactive and visually supported stories can create more motivating learning environments for young children. Children exposed to AI-generated narratives showed heightened attention, curiosity, and verbal participation. The dynamic illustrations, adaptive narratives, and visually stimulating content generated by AI likely contributed to this increased engagement, supporting theories that emphasize the importance of motivation and active participation in early literacy learning (Choi et al., 2025). These findings suggest that generative AI does not merely function as a technological enhancement but as an instructional tool capable of shaping meaningful literacy experiences.

Teacher perceptions reinforced these conclusions by highlighting both the benefits and responsibilities associated with AI integration. Teacher mediation remains critical, as educators are responsible for reviewing AI-generated content, scaffolding discussions, and ensuring that the learning process remains developmentally appropriate. Teachers found AI-generated storytelling useful for enriching instructional materials and meeting diverse learning needs. At the same time, they emphasized the necessity of pedagogical oversight to ensure that AI-generated content remains accurate, culturally relevant, and developmentally appropriate. This insight aligns with contemporary technology integration frameworks, such as TPACK, which stress the critical role of teacher expertise in leveraging technological tools effectively.

Taken together, the results suggest that generative AI holds promise as a complementary resource within early childhood literacy instruction. Rather than replacing traditional storytelling or teacher-child interaction, AI should serve as an additional tool that expands narrative possibilities, enriches linguistic exposure, and supports differentiated learning. For sustainable implementation, educators must be equipped with adequate digital literacy skills and supported through professional development initiatives that enable them to critically evaluate and adapt AI-generated content.

Schools can integrate generative AI as a supplementary storytelling tool to diversify learning materials and support differentiated instruction. Teachers may

incorporate AI stories in guided reading, thematic learning, or vocabulary expansion activities, provided that content is reviewed for accuracy and suitability. The results highlight the need for clear guidelines regulating AI use in early childhood settings, including standards for content quality, screen time, ethical considerations, and teacher digital competence. Policymakers should also provide professional development to equip teachers with the skills required for safe and effective AI integration.

Future research should investigate long-term literacy outcomes, explore the scalability of AI storytelling across diverse educational contexts, and examine ethical considerations specific to early childhood environments. Further studies should also examine how children interact with various forms of AI-generated multimodal content and investigate the role of teacher digital readiness in shaping the effectiveness of AI-assisted literacy interventions. By integrating generative AI thoughtfully and responsibly, educators can harness emerging technologies to create engaging, inclusive, and developmentally supportive literacy learning environments that enhance children's early educational experiences. In conclusion, generative AI has strong potential to enhance early literacy learning when integrated thoughtfully, guided by teachers, and supported by appropriate institutional frameworks.

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