Integration of Augmented Reality (AR) Technology in Early Childhood Literacy Learning: A Joyful, Meaningful, and Mindful Learning Approach

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Abstract: The rapid advancement of digital technology has opened new opportunities in early childhood education, particularly in enhancing literacy skills. This study explores the integration of Augmented Reality (AR) technology into early childhood literacy learning through the lens of the Joyful, Meaningful, and Mindful Learning Approach. AR offers interactive, immersive, and engaging experiences that can stimulate children's curiosity, support their understanding of abstract concepts, and improve motivation to learn. The literature review highlights how AR applications can create joyful learning environments, promote meaningful connections between digital content and real-world experiences, and foster mindful engagement through focused attention and cognitive involvement. This paper also identifies pedagogical strategies and practical implications for educators in implementing AR-based literacy instruction. The findings suggest that AR, when used appropriately, can become a powerful educational tool to support holistic literacy development in young children while maintaining a balance between play and structured learning.

1 INTRODUCTION

Early literacy is a crucial aspect of early childhood development. It encompasses children's skills in listening, speaking, emergent reading, and emergent writing, which form the foundation for their future academic abilities. Early literacy begins to develop during the preschool years and is significantly influenced by the environment, media, and teaching approaches experienced by the child (Whitehurst & Lonigan, 2001; Lonigan et al., 2008). The introduction of digital literacy in early childhood can further support children's social-emotional and cognitive development through the use of technology. Moreover, digital literacy serves as a fundamental competence for navigating the Society 5.0 era and preparing for Indonesia Emas 2045 (Mauluddia & Yulindrasari, 2024; Widya & Munisa, 2025).

With the advancement of digital technology, children are becoming increasingly familiar with digital devices from an early age. This condition creates opportunities to integrate technology into the learning process. One technological innovation that has begun to be utilized in Early Childhood Education (ECE) is Augmented Reality (AR). AR technology enables children to interact with digital content projected into the real world, thereby creating more interactive and engaging learning experiences for young learners (Billinghurst & Duenser, 2012). In the context of literacy learning, AR can present interactive picture stories, animated letter characters, and more immersive reading activities. AR functions not only as a visual aid but also as a medium that supports children in constructing knowledge through meaningful, hands-on experiences. This aligns with Vygotsky's constructivist theory (1978), which emphasizes the importance of social interaction,

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environment, and media in the child's learning process.

To ensure the effectiveness of AR implementation in early childhood education, it is essential to apply appropriate pedagogical approaches. One such approach involves incorporating joyful, meaningful, and mindful learning into early literacy instruction. The joyful learning approach encourages children to engage in literacy activities with enthusiasm and happiness. Learning takes place in a fun and pressure-free environment, filled with enjoyable exploration activities that excite and motivate young learners. Meaningful learning emphasizes the connection between learning content and children's real-life experiences, making the learning process more relevant and engaging for them. Meanwhile, mindful learning supports children in becoming more focused and aware during the learning process, fostering deeper understanding and reflection (Ausubel, 2000; Kemendikbudristek, 2022; Napitupulu et al., 2022).

Although numerous previous studies have examined the use of digital technology in early childhood education, many have yet to specifically reveal how the integration of Augmented Reality (AR) can be optimized in literacy learning that considers emotional engagement (joyful), relevance (meaningful), and cognitive awareness (mindful). Most earlier studies have primarily focused on academic outcomes or the technical aspects of media development, without deeply connecting these with a holistic pedagogical approach aligned with the developmental characteristics of young children. Therefore, this study aims to address the issue of how AR applications can create joyful learning environments, foster meaningful connections between digital content and real-world experiences, and cultivate mindful engagement through focused attention and cognitive involvement. This research also identifies pedagogical strategies and practical implications for educators in implementing AR-based literacy learning. Ultimately, the study is expected to contribute not only to the development of instructional media but also to a strategic understanding of learning approaches that are developmentally appropriate for young children and responsive to the demands of the digital age.

2 METHOD

This study employs a descriptive qualitative approach using the literature review method. Data sources were obtained from national and international journal articles indexed in SINTA, DOAJ, and Scopus, as well as relevant books published between 2015 and 2025. The keywords used in the search included: *augmented reality*, *early childhood education*, *literacy learning*, *joyful learning*, *meaningful learning*, *mindful learning*, and *educational technology*.

Inclusion criteria include: 1) Studies that examine the use of AR technology in early childhood learning; 2) Articles focusing on the development of children's literacy or language skills; 3) Literature that links the joyful, meaningful, and mindful learning approaches in early childhood education; and 4) Sources written in either Indonesian or English related to early childhood literacy learning. Exclusion criteria include: 1) Studies that focus solely on the use of AR at the primary, secondary, or higher education levels; 2) Articles discussing digital technology in general without explicitly addressing AR technology; 3) Research that centers on the technical aspects of AR programming without a direct connection to pedagogical or early childhood literacy aspects; and 4) Literature that is incomplete (abstract only), unverified, or not peer-reviewed.

Data analysis was conducted through the stages of data reduction, data presentation, and conclusion drawing. Each reviewed literature source was analyzed based on the thematic relevance, pedagogical approach, type of AR technology used, and its impact on children's literacy development.

3 RESULTS

3.1 Early Childhood Education in the Digital Technology Era

The impact of the digital technology era has influenced all aspects of life, including Early Childhood Education (ECE). ECE must undergo significant transformation in its curriculum, teaching methods, and the role of educators. This transformation is necessary to produce graduates with competencies that align with the demands of a rapidly evolving world. In the past, early childhood teachers introduced literacy to children through traditional methods, such as reading storybooks or folktales aloud. In today's digital era, teachers need to integrate digital technology into their instructional practices to capture children's interest and enhance learning. For example, using digital storytelling or interactive videos can be more engaging for young learners. This shift is especially important considering that today's early childhood learners are part of Generation Alpha,

who are digital natives and highly familiar with technology from an early age.

The use of educational technologies such as digital storytelling, interactive videos, and learning applications can enhance the cognitive, language, artistic, and learning motivation aspects of early childhood development. However, the integration of technology must be adapted to the age and developmental stage of the child to avoid diminishing important social skills, such as face-to-face interaction and peer play. The use of digital technology in early childhood learning also requires strong collaboration between teachers and parents. Such synergy ensures that when children are at home, parents are willing to accompany and supervise their use of digital technology so that it remains developmentally appropriate and safe. Ultimately, the use of digital tools introduced by teachers at school and supported by parents at home will be aligned, creating a consistent and supportive learning environment for the child (Hidayat et al., 2023; Atmojo & Wulandari, 2024; Sumarni, 2022; Mustakimah et al., 2023).

In the context of technology-based learning innovations, Augmented Reality (AR) has emerged as one of the technologies increasingly applied in early childhood education (ECE) across various regions in Indonesia. AR is a technology that integrates virtual objects with the real environment in an engaging, interactive, and real-time manner. AR can stimulate children's imagination and provide an immersive learning experience. Ultimately, the use of AR in ECE can enhance children's engagement in learning activities and enrich their overall learning experiences (Billinghurst & Duenser, 2012; Arisanti, Habiby, & Muttaqin, 2024).

In addition to the role of technology, the readiness of teachers and parents is also a critical factor in early childhood education. A study by Mauluddia & Yulindrasari (2024) emphasizes that teachers' digital literacy plays a significant role in maximizing the use of technology in ECE settings. However, teachers' technological competencies vary, which can affect the effectiveness of the learning process (Ningsih & Rahmawati, 2023). Meanwhile, research by Rahmawati (2024) highlights the importance of parental digital literacy in establishing healthy digital mediation practices at home. From a digital pedagogy perspective, the SAMR framework (Substitution, Augmentation, Modification, and Redefinition) is increasingly being adopted in early childhood education. Within this framework, AR holds significant potential to reach the Modification and Redefinition levels, meaning it can create learning experiences that would not be possible without the technology (Korhonen et al., 2024).

Thus, early childhood education in the digital era holds great potential to enrich children's learning experiences, provided that technologies like AR are used wisely, educators and parents possess adequate digital literacy, and pedagogical approaches are tailored to the developmental stages of young children.

3.2 AR Technology in Supporting Joyful, Meaningful, and Mindful Literacy Learning in Early Childhood Education

Augmented Reality (AR) is a form of technology that superimposes 3D virtual objects or content onto the real-world environment to create a mixed reality experience, enabling natural and physical interaction (Law & Heintz, 2021; Li et al., 2024). The use of AR technology in early childhood education aligns with Vygotsky's constructivist theory and Kolb's experiential learning theory**,** which state that knowledge construction in young children is influenced by direct experience**,** social interaction**,** and environmental context.

In the context of early literacy learning, AR plays a significant role in presenting letters, words, and stories through visual, auditory, and kinesthetic modalities, making them easier for children to understand. For example, when children are learning to recognize letters and vocabulary, AR can display animated letters and three-dimensional objects that can be rotated and zoomed in by the child. This makes the process of letter and vocabulary recognition more engaging and meaningful. A study by Wulandari et al. (2020) found that: *"AR flashcard media had a greater influence on children's early literacy than 2D animated video media... children could see its shape, imitate it, and listen to its name from the displayed object."* Therefore, the use of AR can enhance children's attention, retention, and understanding of basic literacy concepts in a joyful and meaningful way.

The use of AR technology in early childhood literacy learning has demonstrated a variety of significant benefits. Ramos et al. (2025) state that: *"AR-based pop-up book media can enhance children's engagement and meaningful understanding of early literacy."* Such media provide a multisensory experience that strengthens children's absorption of reading materials. Similarly, Putri et al. (2024) found that: *"AR-based reading applications contribute to the simultaneous development of*

cognitive and early literacy skills." This indicates that AR is not only visually appealing, but also supports the development of children's thinking abilities. Inayah et al. (2024) also note that: *"Symbolic AR learning media are effective in enhancing early childhood symbolic thinking skills, which are directly related to emergent reading abilities."* Arisanti et al. (2024) emphasize that: *"AR technology can improve motivation and comprehension of abstract concepts, such as letters and phonemes, which are difficult to teach through conventional methods."* Similar findings are presented by Artawan et al. (2022), who show that AR-based digital games such as *maze games* and *e-books* are effective in improving the literacy skills of children aged 5-6 years through visual stimulation and active interaction.

The integration of AR in joyful early literacy learning is supported by the findings of Pan et al. (2021), who discovered that the use of AR applications led to a 6.28% increase in rapid letter naming skills among children using AR media, compared to only 3.35% in the group using 2D video. Moreover, children's learning motivation also increased by +11.5%, slightly higher than the control group (+10.9%), indicating that the 3D visuals and in-app interactions created an enjoyable and exploratory learning environment for preschoolers. The integration of AR into meaningful literacy learning is supported by Citariani et al. (2024), who assert that AR strengthens the meaning of learning by presenting contextual and relevant content. For example, AR can visualize topics such as financial literacy or environmental literacy, which are closely related to children's everyday lives. As a result, children perceive learning as more meaningful because it is directly linked to familiar, real-life experiences. Furthermore, the use of AR to promote mindful literacy learning is supported by Rinakit Adhe et al. (2025), who implemented an AR-AI model (SMARP) featuring interactive storytelling, real-time feedback, and 3D simulations. The study showed a significant improvement in critical thinking skills (*N gain = 0.845*) compared to the control group. AR effectively facilitated focused attention and reflection, fostering mindfulness throughout the learning process.

The effectiveness of integrating AR technology in early literacy learning is further supported by research from Novianti & Pratiwi (2024), which demonstrated that children's emergent reading skills increased from 43% to 78% after the use of story- and sound-based AR media. This underscores how interactive AR media can significantly enhance children's memory retention and engagement in foundational literacy activities. Additionally, findings from Sari et al. (2024) revealed that 3D AR learning media not only improved literacy skills, but also significantly boosted children's motivation and emotional engagement in reading and storytelling activities.

The above findings indicate that the integration of AR technology can significantly expand the pedagogical scope of early childhood education, particularly in conveying symbolic and abstract literacy concepts. As such, early childhood educators can utilize AR as an innovative tool to create joyful, meaningful, and mindful learning experiences. AR can enhance joyful learning by incorporating visual, auditory, and interactive elements that naturally spark children's curiosity. It supports meaningful learning by delivering contextual and relevant content that bridges the gap between children's real-world experiences and digital learning environments. Furthermore, AR promotes mindful learning, as its interactive and visually stimulating features require children's focused attention, analysis, and reflection, making the learning process more conscious and profound. The combination of AR technology with appropriate pedagogical approaches, teacher training, and active parental involvement is essential to ensure that this technology is not merely a source of entertainment, but an effective and holistic medium for literacy learning in early childhood education.

3.3 Pedagogical Strategies and Practical Implications for Early Childhood Educators in Implementing AR-Based Literacy Learning

In introducing Augmented Reality (AR) as a literacy medium in early childhood education, teachers need to apply appropriate pedagogical strategies to ensure that the technology is used effectively and meaningfully. At least five key aspects need to be considered, as follows:

3.3.1 Integrating Digital Pedagogy Based on Learning Theories

A systematic review has shown that the effectiveness of AR largely depends on the quality of the accompanying pedagogy. Many AR applications fail because their design does not consider proper pedagogical principles, such as teacher–child interaction frameworks, scaffolding, and content relevance. Therefore, early childhood educators need to implement adaptive scaffolding strategies. For example, a teacher may provide verbal support when

a child tries to spell letters using AR technology, and gradually reduce assistance as the child's skills improve, this aligns with the concept of Developmentally Appropriate Practice (Bruner in Vygotsky, 1978).

3.3.3 Teacher as Facilitator and Observer

Literature on early childhood pedagogy emphasizes that teachers are not merely content deliverers, but should serve as facilitators who recognize children's interests, guide exploration, and actively participate in AR-based literacy learning activities. Therefore, teachers must be actively involved in selecting and adapting AR materials to align with children's interests, not just presenting pre-made literacy content**.** This approach ensures that AR integration becomes child-centered**,** meaningful, and responsive to individual learning needs.

3.3.4 Designing Learning Activities that Are Playful, Meaningful, and Reflective

AR technology should ideally be designed to provide learning experiences that are playful (joyful learning)**,** meaningful (meaningful learning)**,** and stimulate reflection (mindful learning) in children. For example, teachers can use interactive 3D AR flashcards**,** engage children in question-and-answer sessions**,** allow them to manipulate virtual objects, and connect letters or words to real-life objects in the child's environment. This helps bridge digital experiences with tangible, everyday contexts that children understand and relate to.

3.3.5 Teacher Training and Collaboration with Developers

Several studies have shown that many educational AR applications are developed without collaboration with educators, resulting in high technical quality but low pedagogical value. Therefore, teacher training is essential so that educators can understand how to select, adapt, and utilize AR applications according to the learning needs of young children in early childhood classrooms. Collaboration between teachers and developers ensures that AR tools are both technologically effective and pedagogically meaningful.

3.3.6 Context and Impact-Based Evaluation

Teachers need to evaluate the use of AR not only based on academic outcomes (e.g., letter recognition or early reading skills) but also on children's motivation, emotional engagement, and attention during learning activities. Formative assessments such as classroom observations, interviews with children, and teacher reflections can help enhance the effectiveness of AR integration in early childhood literacy learning. This approach ensures that the technology supports not just cognitive development, but also social-emotional aspects of learning.

The practical implications for early childhood teachers in implementing AR-based literacy learning can be carried out through the following strategies:

1. Teachers design AR-based literacy learning by dividing children into small groups. They initiate the activity by asking stimulating questions to spark children's curiosity, guide them to explore AR elements, engage in dialogue, and encourage reflection. For example, after a child scans an AR letter, the teacher might ask, *"What do you see?"*
2. Teachers provide adaptive scaffolding according to the child's ZPD (Zone of Proximal Development). For instance, at the beginning, the teacher demonstrates how to use the AR tool, then gradually transfers control to the child as their competence increases.
3. Early childhood institutions should provide technical and pedagogical training for teachers so that they can effectively use AR with a constructivist approach.
4. Collaboration between teachers and parents is also essential in applying AR-based literacy learning. Teachers can guide parents on how to use AR applications at home, ensuring that educational content is used safely and appropriately.
5. Holistic evaluation is crucial to assess the effectiveness of AR-based literacy learning in early childhood. Implementation should be evaluated not only based on literacy outcomes but also on changes in children's motivation, engagement, and learning reflection.

4 CONCLUSIONS

The integration of Augmented Reality (AR) technology in early childhood literacy learning has been shown to have a positive impact in creating joyful, meaningful, and mindful learning experiences. R offers interactive and contextual learning opportunities that align with the developmental characteristics of young children. However, the success of AR implementation in education largely depends on the pedagogical strategies employed by

teachers. Therefore, a holistic approach to learning, grounded in child development principles, must serve as the foundation for the development and use of AR technology in early childhood education settings.

This study recommends that the development of Augmented Reality (AR) media for early childhood education should go beyond mere technological sophistication and deliberately integrate pedagogical principles that holistically support early literacy development. Furthermore, it is essential that early childhood educators receive comprehensive training on how to effectively facilitate AR-based learning experiences, ensuring alignment with the developmental goals and literacy objectives of early childhood education. The limitation of this study lies in the limited number of articles reviewed, which restricts the depth of the results and discussion. For future literature review research, it is recommended to include a greater number of articles to enable a more comprehensive analysis and discussion.

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