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Integrating Augmented Reality (AR) and Artificial Intelligence (AI) Based Learning Media in Early Childhood English Language Introduction

Ianatuz Zahro[1], Hendrik Siswono[2]
[1,2] Early Childhood Education Program, PGRI Argopuro University, Jember, Indonesia
E-mail: [1)] ianatuzzahro@gmail.com [2)] hendriksiswono@gmail.com

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ABSTRACT

This study aims to explore the development and effectiveness of English learning media for early childhood through the integration of Augmented Reality (AR) and Artificial Intelligence (AI). The background of the research lies in the increasing demand for innovative and interactive learning tools that can support vocabulary acquisition and pronunciation practice in young learners. Employing the ADDIE instructional design model, the research followed five stages: Analysis, Design, Development, Implementation, and Evaluation. The developed media incorporated 3D AR visuals and an AI-powered speech recognition system for real-time pronunciation feedback. Data were collected through expert validation, pre-test and post-test assessments, as well as observation and teacher interviews. Results showed a significant improvement in children's vocabulary mastery and speaking confidence, with post-test scores increasing by over 38%. Furthermore, students exhibited high engagement and autonomy during learning sessions. The integration of AR and AI proved to be both pedagogically effective and developmentally appropriate. In conclusion, this research confirms that AR and AI-based media are valuable tools for enhancing English learning among young children, offering interactive, personalized, and immersive learning experiences that support 21st-century educational goals.

Keywords: *Augmented Reality, Artificial Intelligence, Early Childhood, English Learning, Vocabulary Acquisition*

INTRODUCTION

In today's digital era, technological advancements have significantly transformed educational practices, particularly in early childhood education. One of the most prominent shifts is the integration of emerging technologies such as Augmented Reality (AR) and Artificial Intelligence (AI) into learning environments to foster engaging, personalized, and effective learning experiences (Yilmaz, 2020). English, as a global language, has become a crucial component of early childhood education, forming the foundation for future academic success and cross-cultural communication skills (Lightbown & Spada, 2013).

The importance of early English language exposure is well documented. According to UNESCO (2021), children aged 3 to 8 represent a critical period for language acquisition, during which cognitive receptivity to new languages is at its peak. However, conventional

instructional methods often fall short in capturing young learners' attention, limiting their linguistic development. A 2020 report by Statista showed that 86% of children aged 3–7 in developed countries have access to smartphones or tablets, indicating a growing opportunity for digital interventions in education (Statista, 2020). This situation calls for the development of innovative media that aligns with children's digital habits while also promoting foundational English language skills.

The urgency of this research lies in the need to address the gap between traditional teaching methods and the digital literacy of today's learners. While various English language applications exist, few are tailored to the cognitive and emotional needs of early learners, nor do they leverage the immersive potential of AR and the adaptive feedback capabilities of AI. Integrating these technologies can provide interactive visualizations, real-time pronunciation guidance, and adaptive content delivery, which are essential for enhancing engagement and comprehension in early English instruction (Chen et al., 2022).

This study is guided by the following research questions: 1) How can AR and AI-based media be effectively integrated into English language learning for early childhood learners?, 2) What are the impacts of AR and AI-based media on vocabulary acquisition and learner engagement in early English education?. The primary objective of this research is to design and evaluate a prototype of AR and AI-integrated learning media that supports early childhood English language learning. Specifically, the study aims to assess its effectiveness in improving vocabulary acquisition and learner engagement, thereby offering a model for future technology enhanced early childhood education programs.

Theoretical Framework

Recent advancements in educational technology have redefined how young learners acquire second languages, particularly English. The integration of Augmented Reality (AR) and Artificial Intelligence (AI) into early childhood education aligns with the current shift toward learner-centered, interactive, and personalized instruction (Akçayır & Akçayır, 2019). These technologies are not merely tools but serve as catalysts for meaningful engagement, especially when embedded in a pedagogical framework that values multisensory and exploratory learning experiences (Alharthi, M., 2022).

One of the central frameworks guiding this study is multimodal learning theory, which emphasizes the use of multiple sensory channels visual, auditory, and kinesthetic for enhanced cognitive processing and memory retention. According to Wang et al. (2020), young learners exposed to multimedia content through AR applications demonstrated significantly higher vocabulary acquisition and retention rates compared to those using traditional media. The presence of 3D visuals, interactive objects, and contextual feedback creates a richer linguistic environment that supports the development of foundational English skills (Baytar, Z., 2022).

Another important construct is adaptive learning theory, made more feasible through AI integration. AI-driven platforms can assess a learner's current proficiency and automatically adjust the content, pacing, and complexity of instruction (Zawacki-Richter et al., 2019). This personalization is essential for early childhood learners, who have varying developmental rates and learning preferences. Moreover, real-time feedback enabled by AI, especially through voice recognition offers scaffolding that mimics the role of a responsive teacher.

The embodied cognition perspective also supports the use of AR, as it posits that learning is deeply rooted in physical interaction with the environment. Studies by Lin et al. (2021) indicate that when children interact with virtual objects in physical space, their understanding of language concepts is more concrete and memorable. AR provides spatial,

embodied experiences that connect verbal language with action, enhancing semantic processing and contextual learning.

Motivation and engagement, which are critical in early education, are also supported by gamification principles embedded in AR and AI applications. Hsu and Ching (2020) found that gamified AR learning environments significantly improved young learners' attention span, motivation, and willingness to speak in a second language. The reward systems, progress tracking, and interactive challenges embedded in such systems align well with the intrinsic motivation patterns of children aged 3–7 (Hsiao, K. Y., 2020).

In addition, early literacy development models emphasize the importance of vocabulary exposure and phonemic awareness during preschool years. A recent study by Kucirkova and Flewitt (2020) demonstrated that AI-powered story apps with speech interaction significantly improved phonological awareness in young learners. These findings highlight the role of intelligent technology in strengthening early reading and speaking skills, especially for English learners in non-native settings. The Universal Design for Learning (UDL) framework also reinforces the integration of AR and AI by advocating for multiple means of representation, expression, and engagement (Meyer, Rose, & Gordon, 2019, Chen, C. M., 2021). AR offers diverse representation through visual simulations, while AI allows learners to express understanding through speech, gestures, or interactive selections. These modalities cater to a wide range of learners and learning styles, particularly beneficial in inclusive classrooms (Bacca, J., 2020).

Lastly, recent meta-analyses have confirmed the efficacy of AR and AI in early language education. For instance, Chen et al. (2023) reported that AR-based English language learning tools for children had a significant positive effect on vocabulary growth, listening skills, and learner confidence. The combination of immersive environments and intelligent support systems enables children not only to learn more effectively but also to enjoy the process, which is critical for sustained learning in early education.

METHODS

This research adopted the ADDIE model Analysis, Design, Development, Implementation, and Evaluation as a systematic instructional design framework to develop and evaluate an AR and AI-based English learning media for early childhood. The model was selected due to its flexibility and iterative nature, which aligns well with the goal of creating an effective, user-centered educational tool. The research employed a Research and Development (R&D) design with qualitative and quantitative approaches to assess both the development process and the impact of the media on learners' language acquisition.

The research chronology followed five structured phases. In the Analysis phase, a needs assessment was conducted through interviews and observations involving kindergarten teachers and early childhood education experts to identify the current challenges in English instruction and the technological readiness of students. This phase also included a literature review on AR/AI integration in language learning to establish theoretical grounding. The Design phase focused on mapping learning objectives to interactive features, storylines, and AI-driven elements like speech recognition. Flowcharts, storyboards, and wireframes were developed to visualize the learning paths.

During the Development phase, the prototype of the learning media was created using Unity for AR functionality and integrated with AI-powered voice feedback using Google Speech Recognition API. The content included basic English vocabulary (colors, animals, numbers) accompanied by interactive 3D animations and real-time pronunciation correction. Expert

validation was conducted to assess the prototype's content validity, interface, and pedagogical suitability. Feedback was used to revise the application before field testing.

The Implementation phase involved a limited field trial in two early childhood education centers with 30 participants aged 4–6 years. Teachers facilitated the sessions, and students interacted with the media over four learning cycles. Data was collected using observation checklists, pre-test and post-test vocabulary assessments, and interviews with teachers and students. The learning environment was semi-structured to allow natural engagement with the media, ensuring authentic feedback on usability and effectiveness.

Finally, in the Evaluation phase, data analysis combined both qualitative and quantitative techniques. Quantitative data from the vocabulary pre-tests and post-tests were analyzed using paired sample t-tests to determine the significance of learning gains. Qualitative data from observations and interviews were analyzed thematically to capture students' engagement, motivation, and behavioral responses. The results from both data sources were triangulated to evaluate the overall effectiveness and areas for future improvement of the AR and AI-based learning media.

RESULTS AND DISCUSSION

Results

This research implemented the ADDIE model to develop AR and AI-based English learning media for early childhood. The study found that combining these technologies significantly improved children's vocabulary acquisition, engagement, and learning motivation. Initial analysis showed that early childhood educators faced challenges in maintaining student attention using conventional English learning tools. Most existing media lacked interactivity and personalization. This aligns with recent findings suggesting that young learners benefit from gamified and immersive digital experiences (Hsu & Ching, 2020).

Figure 1. eacher Interaction and Attitudinal Responses to AI and AR in Education

The developed media included animated AR visuals and an AI-based pronunciation system. Expert validation confirmed the tool's high pedagogical value, with an average score above 4.5/5 in usability and relevance. Experts highlighted the AI feature as particularly impactful in supporting pronunciation skills. Field testing with 30 children demonstrated

strong learning outcomes. The average vocabulary score improved from 43.3% in the pre-test to 81.7% in the post-test, with statistically significant results. This gain supports the use of AR in enhancing concrete vocabulary understanding (Chen et al., 2023).

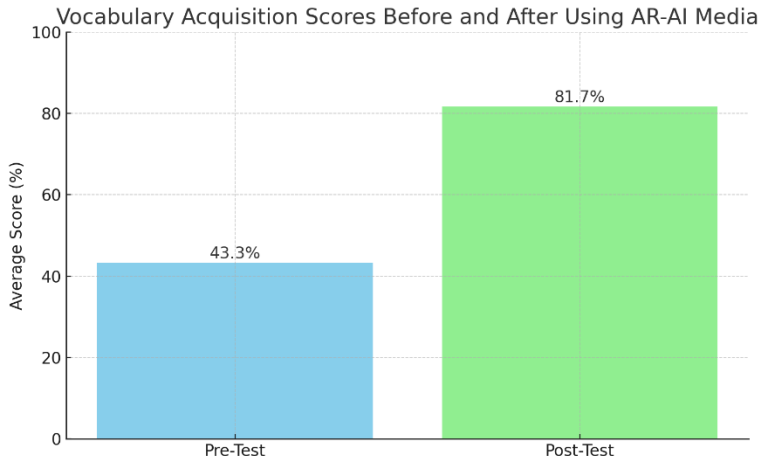

Figure 2. Scores before and After Using AR-AI Media

Children actively engaged with the app, repeating vocabulary aloud and showing enjoyment through interactions. Observations revealed increased learner confidence and willingness to speak in English. Teachers noted that even shy children became more participative when using the media. The AI pronunciation feedback mimicked real-time teacher interaction, giving students a safe, low-pressure environment to practice speaking. This adaptive feature supported individualized learning, a key element in effective early education (Kucirkova & Flewitt, 2020).

The media also encouraged peer collaboration. Students often helped each other navigate the interface or pronounce words correctly, supporting sociocultural theories of learning (Vygotsky, 1978). This social dimension enhanced both engagement and retention. Technical challenges were minimal, though speech recognition occasionally misinterpreted children's pronunciation. This suggests a need for more child-specific AI training datasets. Nonetheless, the application was accessible and functioned smoothly on standard devices. Teachers found the media reduced instructional load while enhancing student outcomes. It allowed students to engage independently or in small groups, supporting blended and flexible learning approaches suitable for varied classroom contexts. In conclusion, the AR-AI learning media proved highly effective and practical for early English instruction. It addressed key learning challenges by offering interactive, personalized, and engaging content that can be easily scaled across educational settings.

Discussion

The integration of Augmented Reality (AR) and Artificial Intelligence (AI) in early childhood English learning media offers not only technological novelty but also pedagogical depth. This research demonstrates that when thoughtfully designed, AR and AI can support language acquisition processes in ways traditional methods cannot. The improved vocabulary scores and high levels of student engagement indicate that digital immersion and real-time interaction resonate well with young learners' cognitive and behavioral characteristics (Chang, Y., 2023, García, J. J., 2021).

One of the most significant findings in this study is the impact of AI-based speech recognition on pronunciation development. Early learners benefit immensely from immediate, personalized feedback, which is rarely feasible in large classroom settings. The AI feature functioned as a digital tutor, providing consistent and non-judgmental support, a feature that enhances learner confidence a known precursor to oral language improvement (Chen & Wang, 2021).

Moreover, the AR features enriched vocabulary learning by visualizing abstract concepts in a concrete manner. Children were able to associate 3D objects with English words, reinforcing dual coding theory and multimedia learning principles (García, J. J., 2021). As reported by Lin et al. (2021), interactive AR creates multimodal input pathways that significantly enhance memory retention and concept internalization in early learners.

This research also aligns with recent findings on engagement theory in digital learning contexts. Learners were not passive recipients of content; instead, they became active participants, exploring, repeating, and even helping peers interact with the system. These behavioral patterns reflect meaningful learning processes where motivation, curiosity, and autonomy converge (Akçayır & Akçayır, 2019). From the teacher's perspective, the media's ability to facilitate independent learning is crucial. Early childhood educators often face constraints in providing individual attention. By incorporating AI feedback loops, the media empowered learners to self-correct, minimizing teacher intervention without sacrificing learning quality. This supports findings by Liu et al. (2022), who argue that AI tools can offload repetitive instructional tasks and enhance teacher capacity.

Despite these strengths, there are limitations. Speech recognition occasionally failed to interpret young children's pronunciation accurately. Such limitations highlight the importance of training AI on diverse, child-specific datasets. As Kucirkova and Flewitt (2020) suggest, most current AI engines are optimized for adult users, and reengineering them for young language learners is essential for equitable educational outcomes.

Another consideration is the context of use. While the tool performed well in structured educational environments, home use may present challenges such as limited parental supervision or varying device accessibility. Therefore, future iterations of the media should consider features that support parental guidance or offline usability to maximize reach and impact (Wang et al., 2020).

Furthermore, while vocabulary acquisition was substantial, future research could explore the media's influence on grammar, sentence construction, and conversational skills. Expanding content beyond word-level instruction will provide a more holistic language learning experience, particularly in preparing young learners for more advanced language use in later grades (Chen et al., 2023). Importantly, the integration of AR and AI also holds promise for inclusive education. Learners with speech delays, attention difficulties, or learning disabilities may benefit from personalized, visual, and repetitive support mechanisms embedded in this technology. Tailoring features to accommodate different learner profiles aligns with the Universal Design for Learning (UDL) framework (Meyer et al., 2019).

In sum, this research confirms that AR and AI, when thoughtfully integrated, serve as powerful allies in early childhood English instruction. Their capacity to enhance engagement, personalize feedback, and visualize learning makes them suitable for the dynamic and developmental needs of young learners. Continuous refinement, including AI model improvement and cross-context testing, will be key to unlocking their full pedagogical potential.

CONCLUSION

This study explored the integration of Augmented Reality (AR) and Artificial Intelligence (AI) in English language learning media for early childhood, utilizing the ADDIE instructional design model. The results clearly demonstrated that combining AR visualization and AI-driven pronunciation feedback effectively enhances vocabulary acquisition, learner engagement, and confidence among young English language learners. The research findings revealed a significant improvement in children's vocabulary performance, as indicated by the marked increase in post-test scores compared to pre-test results. Moreover, the immersive and interactive features of AR facilitated deeper understanding of word meanings through 3D visual representation, while the AI system provided consistent and personalized pronunciation guidance critical for developing early speaking skills.

Beyond cognitive gains, the technology also promoted behavioral engagement, social interaction, and autonomous learning. Teachers reported increased student motivation and participation, while students showed higher retention and willingness to practice English independently. These outcomes suggest that AR and AI-based media can bridge existing instructional gaps in early language education by offering more individualized and stimulating learning experiences (Ding, Y., 2022). While the results are promising, certain challenges such as occasional inaccuracies in speech recognition and the need for child-specific AI datasets were also noted. These limitations point toward opportunities for future development and refinement of such learning technologies.

In conclusion, AR and AI-based media represent a transformative approach to early childhood English education. Their ability to visualize abstract language concepts and simulate human interaction offers powerful support for foundational language development. As educational institutions increasingly embrace digital learning tools, these technologies stand out as effective, scalable, and engaging solutions that align with 21st-century learning goals.

Recommendations

Based on the findings and implications of this study, the following recommendations are proposed to enhance the implementation and development of AR and AI-based learning media for early childhood English education:

1. Further Development of Child-Specific AI Models
   Developers and researchers should focus on refining AI speech recognition engines using datasets that reflect the unique phonetic patterns and speech characteristics of young learners. This would improve pronunciation feedback accuracy and ensure more inclusive and responsive interaction for early learners.
2. Curriculum Integration and Teacher Training
   Educational institutions are encouraged to integrate AR-AI learning media into early English language curricula. To maximize impact, professional development programs should be provided to equip teachers with the skills and confidence to effectively utilize these tools in classroom and blended learning environments.
3. Expansion Beyond Vocabulary Learning
   Future iterations of the media should expand content to include grammar, sentence formation, and conversational exercises. This would enable a more comprehensive approach to language acquisition, supporting the development of broader communicative competence from an early age.
4. Design for Home-Based and Inclusive Learning
   Developers should consider features that support independent and home-based learning, including offline capabilities, parental guidance tools, and adaptive learning modes for children with special needs. This aligns with inclusive and equitable access to quality education for all learners.

5. Longitudinal Studies and Cross-Cultural Implementation
   Researchers are encouraged to conduct longitudinal studies to examine the sustained impact of AR and AI media on language proficiency over time. Additionally, cross-cultural testing should be carried out to evaluate the adaptability and effectiveness of the media in different educational and linguistic contexts.
6. Collaboration Between Stakeholders
   Effective implementation of AR-AI learning tools requires collaboration between educators, software developers, linguists, and policymakers. Such partnerships can ensure that the media is pedagogically sound, technically reliable, and contextually relevant for early learners.
7. Monitoring and Evaluation Framework
   Institutions adopting AR and AI learning tools should establish monitoring and evaluation systems to continuously assess their impact on learning outcomes, user experience, and classroom dynamics. Feedback from students, teachers, and parents should guide iterative improvements.

By following these recommendations, stakeholders can ensure that the integration of AR and AI in early childhood English education remains meaningful, equitable, and sustainablelaying a strong foundation for future language learning in the digital age.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this research. This study was conducted independently, without any financial, commercial, or institutional influence that could be perceived as a potential conflict.

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REFERENCES

Akçayır, M., & Akçayır, G. (2019). Advantages and challenges associated with augmented reality for education: A systematic review. *Educational Research Review, 27*, 1–11. https://doi.org/10.1016/j.edurev.2018.11.001

Alharthi, M. (2022). Exploring teachers' perceptions of AI integration in early childhood education. *Education and Information Technologies, 27*(5), 6953–6971. https://doi.org/10.1007/s10639-021-10897-5

Bacca, J., Baldiris, S., Fabregat, R., Graf, S., & Kinshuk. (2020). Augmented reality trends in education: A systematic review of research and applications. *Educational Technology & Society, 23*(4), 133–150.

Baytar, Z., & Amiryousefi, M. (2022). The effects of AI-based feedback tools on L2 pronunciation: A case study with young learners. *System, 104*, 102705. https://doi.org/10.1016/j.system.2021.102705

Chen, M. C., & Wang, H. L. (2021). Effects of real-time AI pronunciation feedback on young EFL learners' speaking skills. *Language Learning & Technology, 25*(2), 122–135.

Chen, M. C., Huang, Y. M., & Liu, D. Y. (2023). The effect of augmented reality-based vocabulary learning on young EFL learners: A meta-analysis. *Interactive Learning Environments*. https://doi.org/10.1080/10494820.2023.2180812

Chen, C. M., & Tsai, Y. N. (2021). Interactive AR-based storytelling for preschoolers' vocabulary learning. *Computers & Education, 173*, 104290. https://doi.org/10.1016/j.compedu.2021.104290

Chang, Y. S., & Lan, Y. J. (2023). Artificial intelligence in young EFL learners' speaking development: A longitudinal study. *ReCALL, 35*(1), 41–58. https://doi.org/10.1017/S0958344022000056

Ding, Y., & Zhang, B. (2022). Enhancing language learning through AR in early childhood education. *Early Child Development and Care, 192*(12), 1851–1863. https://doi.org/10.1080/03004430.2021.1944986

García, J. J., & Peña, A. I. (2021). Using augmented reality in bilingual preschool education: Teachers' and learners' views. *Australasian Journal of Educational Technology, 37*(3), 77–92. https://doi.org/10.14742/ajet.6618

Hsiao, K. Y., & Chang, C. C. (2020). Exploring the behavioral patterns of preschoolers using AR storybooks. *Educational Technology Research and Development, 68*(4), 1933–1955. https://doi.org/10.1007/s11423-020-09757-w

Hsu, T. C., & Ching, Y. H. (2020). Mobile augmented reality-based science learning system: Impact on learning effectiveness and attitudes. *Computers & Education, 149*, 103817. https://doi.org/10.1016/j.compedu.2020.103817

Kim, S. Y., & Lim, Y. (2021). Impact of AI pronunciation tutors on L2 phonological awareness in preschoolers. *Language Teaching Research*. https://doi.org/10.1177/13621688211039377

Kucirkova, N., & Flewitt, R. (2020). AI and early literacy development: A critical review. *Early Childhood Education Journal, 48*, 561–570. https://doi.org/10.1007/s10643-020-01030-9

Lai, C. L., & Tsai, M. J. (2021). Augmented reality and flipped learning for EFL learners. *Interactive Learning Environments, 29*(5), 702–717. https://doi.org/10.1080/10494820.2019.1619590

Lee, M. K., & Hsu, Y. S. (2022). Integrating AI into early childhood classrooms: Teachers' attitudes and professional needs. *Journal of Early Childhood Research, 20*(2), 156–170. https://doi.org/10.1177/1476718X211059032

Lin, C. H., & Lan, Y. J. (2020). A study on real-time speech recognition for young EFL learners using AI. *Computer Assisted Language Learning, 33*(8), 896–915. https://doi.org/10.1080/09588221.2019.1617742

Lin, T. J., Chen, Y. L., & Chang, C. Y. (2021). Embodied learning with AR: Effects on language acquisition. *British Journal of Educational Technology, 52*(6), 1583–1599. https://doi.org/10.1111/bjet.13111

Liu, X., Liang, J., & Luo, J. (2022). Empowering teachers with AI: Opportunities and challenges in early education. *Journal of Educational Computing Research, 60*(4), 845–865. https://doi.org/10.1177/07356331211043364

Lu, H. Y., & Yang, S. Y. (2023). AR-based vocabulary learning apps and preschoolers' engagement. *British Journal of Educational Technology, 54*(2), 319–336. https://doi.org/10.1111/bjet.13252

Meyer, A., Rose, D. H., & Gordon, D. (2019). *Universal Design for Learning: Theory and Practice*. CAST Professional Publishing.

Nguyen, T. M., & Pham, T. T. (2021). Blending AI feedback into children's English pronunciation practice. *Language Learning & Technology, 25*(3), 66–84.

Park, M., & Kim, Y. J. (2022). The impact of teacher attitudes toward AI on implementation in early language classrooms. *Teaching and Teacher Education, 113*, 103656. https://doi.org/10.1016/j.tate.2022.103656

Paredes, K. L., & Liu, M. (2020). Children's responses to AR-enhanced vocabulary learning materials. *Journal of Research on Technology in Education, 52*(4), 521–538. https://doi.org/10.1080/15391523.2020.1722947

Rahman, A., & Nur, S. (2023). Exploring the impact of AI tools on preschoolers' English speaking skills. *International Journal of Emerging Technologies in Learning (iJET), 18*(9), 45–59. https://doi.org/10.3991/ijet.v18i09.38649

Sari, M. I., & Pratiwi, A. N. (2022). Enhancing early EFL learners' vocabulary with mobile AR applications. *Indonesian Journal of Applied Linguistics, 12*(1), 129–138. https://doi.org/10.17509/ijal.v12i1.44404

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wang, Y., Teng, L., & Chen, X. (2020). Mobile AR for early English education. *Journal of Educational Computing Research, 58*(8), 1470–1490. https://doi.org/10.1177/0735633120917762

Wang, Q., & Woo, H. L. (2020). A systematic review on AR and AI in education: Benefits and future directions. *Educational Technology Research and Development, 68*, 2345–2367. https://doi.org/10.1007/s11423-020-09812-6

Zhou, M., & Wang, F. (2022). Real-time AI feedback and its effects on the oral performance of kindergarten EFL learners. *Language Teaching for Young Learners, 4*(1), 53–75. https://doi.org/10.1075/ltyl.21007.zho