



Development of Augmented Reality Interactive Media to Support Reading Skills in Elementary Students

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ARTICLE INFO

Keywords:

Interactive Media;
Augmented Reality;
Reading Skills;
Elementary Students

Article history:

Received 2026-06-04

Revised 2026-08-28

Accepted 2026-09-10

ABSTRACT

Reading skills are essential for elementary students' academic development, yet conventional reading instruction often lacks interactivity and student engagement. This study aimed to develop an augmented reality-based interactive learning media to support reading skills in elementary education. A research and development approach was employed using the ADDIE model, comprising analysis, design, development, implementation, and evaluation stages. The study involved 23 fourth-grade students, one classroom teacher, and two expert validators (material and media experts). Data were collected through expert validation sheets and teacher and student response questionnaires, then analyzed descriptively using percentage scores. The results indicated that the learning content achieved a feasibility score of 82% (very feasible), while the media design obtained a score of 75% (feasible). User responses showed very positive results, with a 100% positive response from the teacher and a 90% positive response from students. These findings demonstrate that the developed augmented reality-based interactive learning media is pedagogically appropriate, technically feasible, and well accepted in elementary reading instruction. The study concludes that augmented reality has strong potential to support interactive and multisensory reading activities, thereby enhancing student engagement. Further research is recommended to examine the effectiveness of this media on students' reading achievement through experimental designs and broader implementation contexts.

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<http://journal.umg.ac.id/index.php/didaktika>

INTRODUCTION

Reading skills are a core component of literacy development and serve as a foundation for students' learning across all subjects in elementary education. In the early grades, reading competence includes letter recognition, word decoding, fluency, and basic comprehension. However, recent studies indicate that many elementary students still encounter difficulties in developing adequate reading skills, particularly when learning activities rely on conventional instructional media that offer limited interaction and engagement (OECD, 2019; Sari, Supardi, & Widodo, 2021).

One contributing factor to this problem is the dominance of teacher-centered instructional practices and the minimal integration of interactive learning media in reading instruction. Traditional approaches often position students as passive recipients of information, which can negatively affect motivation and learning outcomes. Contemporary literacy research emphasizes that effective reading instruction should be engaging, multisensory, and responsive to students' developmental characteristics (Afflerbach, Cho, & Kim, 2019). Therefore, innovative learning media are increasingly required to support reading instruction in elementary classrooms.

Advances in educational technology have opened new opportunities to address these challenges. Interactive digital media are widely recognized for their potential to enhance student engagement and learning effectiveness. Among these technologies, Augmented Reality (AR) has gained significant attention in recent educational research. AR is a technology that integrates virtual objects into the real-world environment in real time, enabling learners to interact with both physical and digital elements simultaneously (Radianti, Majchrzak, Fromm, & Wohlgenannt, 2020). In educational contexts, AR has been shown to improve students' motivation, engagement, and conceptual understanding by presenting learning content in a more concrete and visually rich format (Garzón, Pavón, & Baldiris, 2019).

Recent empirical studies suggest that AR-based learning media have the potential to support literacy and language learning, including early reading skills (Yunita, 2026). AR can facilitate letter-sound correspondence, vocabulary recognition, and word comprehension through visual and interactive representations, making reading activities more meaningful for young learners (Chen, Liu, & Huang, 2019; Kurniawan & Pratiwi, 2022). Despite these promising findings, most AR applications in elementary education are still concentrated in science and mathematics learning (Alfazri & Yulianengsih, 2026). Research focusing on the development of AR-based interactive media specifically designed to support reading skills remains relatively limited, particularly in the context of elementary education in developing countries (Ibáñez & Delgado-Kloos, 2018; Garzón et al., 2019).

Furthermore, several existing AR learning products prioritize technological features over pedagogical alignment. As a result, the media may appear attractive but are not fully integrated with instructional objectives or students' reading development stages (Radianti et al., 2020). This gap highlights the importance of developing AR-based learning media that are grounded in pedagogical principles and aligned with elementary students' literacy needs.

Based on needs analysis and preliminary observations conducted in this study, reading instruction in elementary classrooms still relies heavily on printed materials, with limited use of interactive digital media. Students show low engagement during reading activities, and teachers face challenges in providing varied and motivating instructional strategies. These conditions indicate the need for innovative learning media that combine technological innovation with sound instructional design to support reading skill development.

Accordingly, this study aims to develop an augmented reality-based interactive learning media to support reading skills in elementary students. The development focuses on content validity, media feasibility, and user responses from teachers and students. This study is expected to contribute to

current educational technology research by providing empirical evidence on the feasibility of AR-based interactive media for elementary reading instruction and by offering practical insights for integrating augmented reality into literacy learning.

METHODS

Research Design

This study employed a research and development (R&D) approach to produce and validate an augmented reality-based interactive learning media designed to support elementary students' reading skills. The development process followed the ADDIE instructional design model, which consists of Analysis, Design, Development, Implementation, and Evaluation stages. ADDIE was selected because it provides a systematic framework for developing instructional media that aligns learning objectives, content structure, and learner characteristics (Branch, 2009; Molenda, 2018).

Research Subjects

The research subjects consisted of fourth-grade elementary students and a classroom teacher. A limited trial was conducted involving 23 fourth-grade students and one teacher. In addition, expert validators participated in the study, including one material expert and one media expert, to assess the feasibility and quality of the developed learning media. The involvement of experts and end users is consistent with recommended practices in educational product development research (Akker et al., 2013).

The development procedure for this augmented reality (AR)-based interactive learning media was systematically carried out through five stages: Analysis, Design, Development, Implementation, and Evaluation. Beginning with classroom observations and teacher interviews to identify fourth-grade students' reading needs, the process moved to designing learning objectives, materials, and marker-based AR flashcards. The prototype—comprising AR reading games and flashcards tailored to fourth-grade reading levels—underwent expert validation and subsequent revisions before being implemented in a limited classroom trial. Finally, the evaluation stage assessed the overall feasibility and usability of the media based on expert feedback and participant responses.

The primary product consisted of AR-based interactive media, marker flashcards, and elementary-adapted reading materials, evaluated using material/media validation sheets and teacher/student questionnaires on a Likert scale. Data analysis combined quantitative methods—converting validation and questionnaire scores into percentage categories of feasibility—with qualitative descriptive analysis of expert and user feedback to guide product refinements. All instruments and analytical methods aligned with established educational development research standards to ensure product quality and usability (Sugiyono, 2019; Nieveen, 2013; Akker et al., 2013; Plomp & Nieveen, 2013).

FINDINGS AND DISCUSSION

Findings

This section presents detailed findings from the development and evaluation of the augmented reality-based interactive learning media designed to support elementary students' reading skills. The findings are derived from expert validation results and user responses collected during the limited implementation stage.

In the analysis phase, researchers gathered information to ensure that Augmented Reality (AR)-based learning media in the form of interactive games met the needs of fourth-grade elementary school students. Interview results indicated that conventional reading instruction tended to be monotonous and less effective in increasing student interest and motivation, particularly due to differences in reading ability. Students require engaging, interactive media that utilizes technology and

adapts to varying reading abilities. Furthermore, a curriculum analysis was conducted to ensure the media's alignment with the Independent Curriculum, including learning outcomes, learning objectives, and the dimensions of the Pancasila Student Profile. In terms of student characteristics, fourth-grade students are in the concrete operational stage, with a tendency toward visual and kinesthetic learning styles and a high enthusiasm for technology. Therefore, AR media was deemed appropriate to support reading learning.

In the design phase, researchers systematically designed the learning media based on the results of the previous analysis. The design included establishing reading learning objectives that refer to the learning outcomes and objectives of the Independent Curriculum, compiling material in stages from letter recognition to understanding the main ideas of the reading, and determining learning strategies using the Problem-Based Learning (PBL) model packaged in an AR-based interactive game. In addition, researchers designed the media's appearance and interactivity through storyboards, visuals, animations, and sound, and developed evaluation instruments in the form of teacher and student response questionnaires to assess the media's feasibility and attractiveness. The technical specifications for the development were determined by utilizing Unity, Vuforia, Blender 3D software, and Android devices as a means of implementing the learning media.

The learning media was developed using Unity version 2022.3.49.f1 and the Vuforia Engine to support Augmented Reality (AR) technology. The development process began with the creation of AR letter cards (flashcards) as markers designed using Canva with an attractive appearance and suitable for elementary school students, where each card contains one letter and supporting images to strengthen visual understanding. Next, the flashcards were uploaded to Vuforia as target images and connected with digital objects such as 3D letters, pronunciation sounds, and supporting images, then all target images were integrated into Unity as part of the AR-based learning media.



Figure 1. Augmented Reality Flashcard Design



Figure 2. Integrating Augmented Reality Flashcards into Unity

The app's interface is designed directly within Unity, including the main menu, letter scanning panel, material panel, three game levels (easy, medium, hard), and score display. Various interactive elements, such as effects, sounds, animations, and an automated feedback system, are also added to enhance student engagement. AR flashcards serve as the initial part of the interactive learning. When scanned by the app's camera, they display the corresponding letters and virtual objects. Students are then directed to games based on their reading ability level.

The media developed is an Augmented Reality (AR)-based learning application with the theme "Letter Adventure" that can be operated on Android devices. The application consists of several main displays, including a home menu, a letter scanning panel, a material panel, three game levels (easy, medium, hard), and a final score panel.



Figure 3. Initial Menu Display

The letter scanning panel is used to scan printed AR flashcards. When a flashcard is detected, the app displays the 3D letter and accompanying image, complete with pronunciation sounds.



Figure 4. Scan Panel



Figure 5. Scan Flashcard

Students are directed to a mini-material panel about vowels and consonants. This panel serves as an introduction before they enter the game stage.

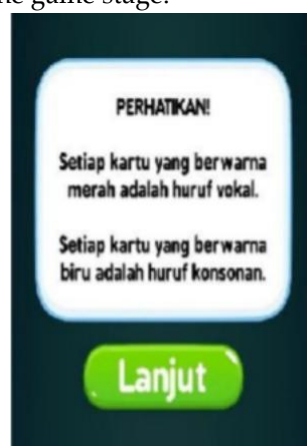


Figure 6. Mini Material

The game consists of three levels arranged in stages. At the easy level, students are asked to arrange letters into words based on pictures. At the medium level, students are asked to construct simple sentences. At the hard level, students are asked to determine the main idea.



Figure 7. Level View

After completing the game, the app will display the final score, including the number of stars earned and the number of attempts. This display also provides buttons to restart the game or exit the app.

Easy		
Percobaan	Nama Lencana	Deskripsi
2 Kali	Coba Lagi Hebat!	Mengumpulkan level dalam 2 kali percobaan
Medium		
Percobaan	Nama Lencana	Deskripsi
3 Kali	Semangat Terus!	Mengumpulkan level dalam 3 kali percobaan
Hard		
Percobaan	Nama Lencana	Deskripsi
3 Kali	Semangat Terus!	Mengumpulkan level dalam 3 kali percobaan
Gabungan		
Percobaan	Nama Lencana	Deskripsi
2 Kali	Coba Lagi Hebat!	Mengumpulkan level dalam 2 kali percobaan

Buttons: Main Lagi, Beranda

Figure 8. Final Score Display

This media is designed to provide a fun and meaningful learning experience, with the hope of gradually increasing students' engagement, motivation, and reading ability.

Feasibility of Learning Content

The material expert validation focused on the relevance, accuracy, clarity, and instructional alignment of the reading materials embedded in the AR-based media. The validation results showed a feasibility score of 82%, categorized as very feasible. This indicates that the reading materials were appropriate for fourth-grade students and aligned with curriculum objectives and students' reading development stages.

The expert confirmed that the learning content supported key components of reading skills, including letter recognition, word decoding, and basic comprehension, presented through interactive and contextualized activities. Minor revisions were suggested to improve sentence simplicity and consistency of difficulty levels across learning units.

Feasibility of Media Design

The media expert evaluation assessed technical quality, interface design, interactivity, and ease of use. The media received a feasibility score of 75%, categorized as feasible. The results indicate that the AR-based interactive media functioned properly and could be used in classroom learning, although improvements were needed in visual layout consistency and navigation clarity.

The expert emphasized that the marker-based AR system successfully integrated digital objects with physical flashcards, allowing students to interact with reading content in a concrete and engaging way. Revisions were implemented to enhance usability prior to classroom implementation.

The results obtained from the research have to be supported by sufficient data. The research results and the discovery must be the answers, or the research hypothesis stated previously in the introduction part. For ease of reading and comprehension, findings are presented first followed by discussion. The Findings sub-title and Discussion sub-title are presented separately. This section should occupy the most part, length 40-60% of the total length of the whole body of the article.

Table 1. Expert Validation Results

Validator	Focus of Evaluation	Feasibility (%)	Category
Material Expert	Content quality	82	Very feasible
Media Expert	Media design	75	Feasible

Teacher Response to Media Use

Teacher responses were collected to evaluate the practicality and instructional relevance of the developed media. The results showed a 100% positive response, indicating that the teacher strongly agreed that the AR-based interactive media supported reading instruction, increased student engagement, and was easy to integrate into classroom activities.

The teacher reported that students were more attentive and actively involved during reading sessions when using the AR-based media compared to conventional methods. The media also helped the teacher provide variation in instructional strategies without increasing instructional complexity.

Student Response to Learning Media

Student responses demonstrated a high level of acceptance and enthusiasm toward the AR-based interactive media. The response analysis showed a 90% positive rating, categorized as very good. Students reported that learning to read using AR-based games and flashcards was enjoyable and helped them understand words and sentences more easily.

The findings indicate that the interactive and visual nature of AR media contributed to increased motivation and engagement during reading activities.

Table 2. User Response Results

Respondent	Response (%)	Category
Teacher	100	Very good
Students	90	Very good

Discussion

The findings of this study indicate that the augmented reality-based interactive learning media developed through the ADDIE model is feasible and well-received by both experts and users. The high feasibility score from the material expert suggests that the reading content embedded in the media aligns with fundamental principles of reading instruction in elementary education. Reading development theory emphasizes that early reading skills should be supported through structured, meaningful, and engaging learning experiences that connect symbols, sounds, and meanings (Afflerbach et al., 2019).

The feasibility of the media design, as indicated by the media expert validation score, highlights the importance of balancing technological innovation with usability. Although the AR-based media functioned effectively, expert feedback emphasized the need for iterative refinement. This finding aligns with educational design research, which asserts that learning media development is an iterative process requiring continuous revision based on expert and user feedback to improve instructional quality (Plomp & Nieveen, 2013).

The positive teacher response supports previous research indicating that teachers are more likely to adopt technology-based learning media when the media is perceived as practical, relevant, and supportive of instructional goals (Garzón et al., 2019). The teacher's perception that the AR-based

media enhanced student engagement suggests that the media successfully addressed limitations of conventional reading instruction, which often lacks interactive and multisensory elements.

Student responses further reinforce the potential of AR-based learning media to enhance motivation and engagement in reading activities. According to multimedia learning theory, students learn more effectively when information is presented through multiple channels, such as visual and interactive elements, rather than text alone (Mayer, 2020). The AR-based media in this study provided visual representations and interactive experiences that supported students' understanding of reading materials.

These findings are consistent with previous studies reporting that AR-based learning environments can increase student motivation and facilitate learning by making abstract concepts more concrete and engaging (Chen et al., 2019; Radianti et al., 2020). However, most prior studies have focused on science and mathematics learning, whereas this study contributes to the limited body of research on AR integration in elementary reading instruction.

Despite these positive findings, this study has limitations. The evaluation focused on feasibility and user responses and did not include experimental testing to measure the effectiveness of the media on students' reading achievement. Therefore, future research should employ experimental or quasi-experimental designs to examine the impact of AR-based interactive media on reading performance and comprehension outcomes. Further studies may also explore long-term implementation and scalability of AR-based reading media in diverse elementary school contexts

CONCLUSION

This study aimed to develop an augmented reality-based interactive learning media to support reading skills in elementary students. The findings demonstrate that the developed media is pedagogically appropriate and technically feasible for classroom use. Expert validation results indicate that the learning content and media design meet feasibility standards, while positive responses from teachers and students confirm the practicality and acceptability of the media in elementary reading instruction.

Beyond feasibility, this study highlights the potential of augmented reality as an instructional medium that supports interactive, multisensory, and engaging reading activities. The integration of AR technology with reading materials enables students to interact actively with text, symbols, and visual representations, thereby addressing limitations commonly found in conventional reading instruction. These findings suggest that AR-based interactive media can serve as a meaningful alternative learning resource to enhance student engagement in elementary literacy learning.

Nevertheless, this study is limited to product development and feasibility evaluation. The impact of the developed media on students' reading achievement was not examined through experimental testing. Therefore, future research is recommended to investigate the effectiveness of augmented reality-based interactive media on students' reading performance, fluency, and comprehension using experimental or quasi-experimental designs. Further studies may also explore large-scale implementation, long-term use, and integration of AR-based reading media within diverse elementary school contexts.

In conclusion, the developed augmented reality-based interactive learning media shows strong potential to support elementary students' reading skills and contributes to the growing body of research on educational technology in literacy learning. With further empirical validation, this media can be expanded and refined to strengthen its role in improving the quality of reading instruction in elementary education

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