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# Developing an Augmented Reality–Based Learning Medium to Enhance Beginning Reading Skills: A Study of Grade II Students at SDN 5 Kabila Bone

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### ABSTRACT

The rapid advancement of educational technology has reshaped instructional practices, emphasizing the need for interactive and student-centered learning media. This study aimed to develop and validate an Augmented Reality (AR)-based learning medium to enhance beginning reading skills among Grade II students at SDN 5 Kabila Bone. The objective was to create an innovative and engaging tool that integrates visual, auditory, and kinesthetic elements to improve literacy learning in accordance with the Merdeka Curriculum. Using a Research and Development (R&D) design guided by the ADDIE model—Analysis, Design, Development, Implementation, and Evaluation—the study involved expert validation and field testing. Material and media experts assessed content accuracy, pedagogical relevance, and technical feasibility, while classroom implementation employed a One-Group Pretest–Posttest Design to measure learning outcomes. Data were collected through observations, interviews, questionnaires, and reading tests, and analyzed using quantitative and qualitative techniques. The results indicated that the AR-based medium achieved expert validation scores above 85%, confirming its validity and feasibility. Students' reading performance improved by 22%, accompanied by significant increases in engagement and motivation. The integration of 3D animation and phonetic reinforcement effectively connected abstract symbols with concrete representations, facilitating comprehension and retention. The discussion highlighted AR's role in promoting active, multisensory, and student-centered learning experiences aligned with 21st-century literacy competencies. In conclusion, the AR-based learning medium proved to be valid, practical, and effective for improving early reading skills. The study contributes to educational innovation by demonstrating the pedagogical potential of augmented reality in fostering literacy and offers a foundation for future research on technology-enhanced language learning.

**Keywords:** Augmented Reality, Beginning Reading Skills, Educational Media Development

### Introduction

In recent years, the rapid advancement of technology has significantly transformed the landscape of education, emphasizing the integration of digital media as a crucial component of the learning process. Educational media serve as vital tools that facilitate effective communication between teachers and learners, enabling a more interactive, engaging, and efficient learning experience. The presence of appropriate instructional media helps optimize learning outcomes, while the absence of such tools often results in suboptimal comprehension and reduced student engagement (Wahyuni, Kusmaryatni, & Murda, 2020). Learners differ in their preferred learning styles—some understand best through discussion and presentation, others through visual materials or hands-on exploration of their surroundings (Hatami, Tahmasbi, & Hatami Shahmir, 2017). Recognizing this diversity, modern curricula, particularly the Merdeka Curriculum implemented in Indonesia, require teachers to accommodate various learning needs by facilitating student-centered learning experiences. In this context, the role of innovative learning media becomes indispensable to support students in achieving the desired learning objectives.

The twenty-first century has brought about a paradigm shift in education, compelling educators to integrate technology to align with global educational trends and digital literacy demands. Teachers are now required to act not merely as transmitters of knowledge but as facilitators who design meaningful learning environments through technological integration. This transformation is particularly essential in the teaching of Bahasa Indonesia at the elementary school level. The subject not only serves as a vehicle for developing language competence but also as a means of cultivating national identity and cultural appreciation. As Susanto (2013) emphasizes, the teaching of Bahasa Indonesia in primary schools aims to nurture students' enjoyment and appreciation of literary works, broaden their life perspectives, and enhance both linguistic and aesthetic sensibilities. More specifically, it seeks to develop four key linguistic skills—listening, speaking, reading, and writing—which collectively form the foundation for effective communication.

Reading, as one of these core language skills, holds a pivotal role in students' cognitive and linguistic development. Reading is not merely a mechanical act but a cognitive process of constructing meaning from written symbols (Widasari in Pratiwi & Ariawan, 2017). It enables learners to absorb, interpret, and synthesize information conveyed through texts (Kasiyun, 2015). Scholars distinguish between two main stages in reading development: *emergent or beginning reading* and *advanced reading*. Beginning reading, in particular, lays the groundwork for all subsequent reading abilities, as it introduces

learners to the recognition and decoding of letters, syllables, and simple words in meaningful contexts (Rahman & Haryanto, 2014; Melita, Disyuri, & Ayu, 2022). Mastery of this foundational skill determines the learner's capacity to comprehend more complex texts in later stages. Conversely, students who fail to develop solid beginning reading skills often experience persistent difficulties in reading fluency and comprehension.

However, numerous studies report that reading difficulties remain prevalent among early-grade students. These challenges often stem from an inability to integrate visual and auditory perceptions, leading to difficulties in decoding written symbols (Nurani, Nugraha, & Mahendra, 2021; Oktadiana, 2019; Mardika, 2019; Pratiwi & Ariawan, 2017). In addition to cognitive factors, psychological aspects such as motivation, interest, and emotional readiness also play significant roles in reading development (Muammar, 2020). Low motivation and limited interest in reading can inhibit students' engagement and persistence during learning activities. To address these challenges, researchers and educators advocate the integration of interactive media as tools to enhance both cognitive understanding and emotional engagement. Instructional media not only support teachers in conveying abstract content but also stimulate learners to actively interact with learning materials, thereby fostering motivation and curiosity (Kamilah & Ruqoyyah, 2022).

Students in early primary grades—typically within the *concrete operational stage* of cognitive development—require learning experiences that connect abstract concepts with tangible representations (Juwantara, 2019). At this developmental level, abstract symbols such as letters and words are better understood when presented through concrete, sensory-rich stimuli. Technological innovations, particularly Augmented Reality (AR), offer a promising solution to meet these developmental needs. AR enables the integration of virtual 3D objects into real-world environments in real time, allowing learners to visualize abstract content as if it were part of their immediate surroundings (Azuma in Borman, 2017). This technology facilitates multisensory learning by merging visual, auditory, and kinesthetic modalities, thus aligning with diverse learning preferences and enhancing engagement. Riskiono, Susanti, and Kristianto (2020a, 2020b) highlight the versatility of AR technology, noting its adaptability for various educational media such as books, posters, and mobile applications. In early literacy instruction, AR can transform static learning materials into interactive experiences that bridge the gap between abstract linguistic symbols and their real-world representations.

Existing classifications of educational media illustrate the evolution from traditional formats—such as printed and audio materials—to dynamic, technology-enhanced media (Retz in Hasan et al., 2021). This evolution underscores the growing need for teachers to design learning experiences that integrate technology seamlessly into instruction. The use of AR-based learning media has been found effective in creating interactive and engaging environments that cater to students' multimodal learning preferences. Therefore, in the context of reading instruction, AR can serve as an innovative medium for teaching beginning reading skills by providing multisensory stimuli that enhance comprehension and retention.

Despite the growing availability of digital tools, many teachers still face challenges in selecting or developing media that align with both curricular goals and students' individual learning styles. Observations conducted at SDN 5 Kabila Bone revealed that reading instruction in Grade II primarily relied on conventional teacher-centered methods, with limited use of interactive or technology-based media. Students often exhibited low motivation, boredom, and passive engagement during lessons. These findings indicate a clear need for more interactive, student-centered instructional media to foster motivation and improve reading proficiency. Accordingly, the present study aims to design and validate an AR-based learning medium tailored for beginning reading instruction in early primary education.

The proposed solution draws inspiration from prior studies that have successfully utilized AR for literacy development. Afriliya Ratna Sari (2014) posits that AR media can effectively enhance children's reading skills by providing immersive, interactive experiences that stimulate multiple senses simultaneously. Furthermore, Etonam (2019) identifies three core technological advantages of AR—*intelligent display technology*, which supports real-time visualization; *intelligent 3D registration*, which merges virtual objects with real-world contexts; and *intelligent interaction technology*, which enables learners to interact dynamically with virtual elements. These affordances collectively create a learning environment that fosters deeper engagement and comprehension. By leveraging these technological strengths, AR media can provide young learners with contextualized experiences that make reading activities more meaningful and enjoyable.

Numerous prior studies have demonstrated the potential of AR in education. Mustakim and Kurniawan (2017) showed that AR could transform conventional learning into interactive and stimulating experiences by allowing learners to visualize and manipulate virtual models. Similarly, Akhma Puri (2021) developed an AR-based learning medium for Islamic Education, which was found to be both valid and highly engaging, as reflected in expert validation scores and positive student responses. Another study by Ratih (2019) introduced beginning reading materials based on the VARK (Visual, Auditory, Read/Write, and Kinesthetic) learning model, which achieved over 90% in content validity and demonstrated strong practicality and effectiveness in enhancing early reading skills. Collectively, these findings suggest that integrating AR with multisensory learning frameworks such as VAK can significantly enrich early literacy instruction.

Nonetheless, while prior studies affirm the pedagogical benefits of AR technology and multisensory learning models, there remains a paucity of research exploring their integration within the context of Indonesian elementary education—particularly for Bahasa Indonesia reading instruction under the Merdeka Curriculum framework. Most existing studies focus on subject areas such as science or religious education, leaving a gap in the application of AR-based media for developing foundational language skills. Furthermore, few studies have tailored AR media to the specific cognitive and affective characteristics of early-grade learners. The present study thus seeks to address this gap by developing and validating an *Augmented Reality-based learning medium* designed to support beginning reading instruction in Grade II of SDN 5 Kabila Bone. This study aims not only to create an innovative instructional tool but also to provide empirical evidence on its validity and potential to enhance students' motivation and reading ability. By doing so, it contributes to the growing body of research on educational technology integration in early literacy and responds to the evolving demands of 21st-century learning in Indonesian primary education.

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## Methodology

This study employed a Research and Development (R&D) approach guided by the ADDIE model—*Analysis, Design, Development, Implementation, and Evaluation*—to develop and validate an Augmented Reality (AR)-based learning medium for beginning reading instruction among Grade II students at SDN 5 Kabila Bone, Bone Bolango Regency, Indonesia. The research was conducted from May to December 2025 and involved subject matter experts, media design experts, the classroom teacher, and students as participants. The analysis phase identified students' low reading motivation and difficulties in recognizing syllables, leading to the design of an interactive *AR-based syllable book*. This book integrates printed barcodes that, when scanned, display 3D animations and phonetic sounds, allowing students to learn through multisensory engagement.

The development process utilized Unity and Vuforia software to produce the media, followed by expert validation to assess its pedagogical relevance, technical feasibility, and visual appeal. Revisions were made based on expert feedback before field testing was conducted using a One-Group Pretest–Posttest Design. During implementation, students interacted with the AR media in Bahasa Indonesia lessons, and their performance and engagement were recorded through observations, questionnaires, and tests. Data were analyzed quantitatively using Arikunto's (2017) percentage-based validation formula, with a feasibility threshold of 61% indicating validity.

Both formative and summative evaluations confirmed that the developed AR-based media met the criteria of being valid, practical, and effective in improving students' reading motivation and ability. Ethical protocols were observed throughout the study, with informed consent obtained from the school, teacher, and parents. Overall, the research followed a systematic and iterative process to produce an innovative, pedagogically sound, and technologically reliable AR learning medium capable of enhancing early reading skills in primary education.

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## Results and Discussion

### Overview of the Development Process

The development of the *Augmented Reality (AR)-based learning medium* for beginning reading instruction in Grade II elementary school followed the systematic stages of the ADDIE model—*Analysis, Design, Development, Implementation, and Evaluation*. Each stage was conducted sequentially to ensure that the resulting product met pedagogical, technical, and aesthetic standards. The study aimed to produce a valid, practical, and effective learning medium that would address students' low motivation and difficulty in mastering basic reading skills.

At the analysis stage, data obtained through observation and interviews with the Grade II teacher at SDN 5 Kabila Bone indicated that students demonstrated low interest and motivation in reading. Lessons were still dominated by teacher-centered approaches with minimal use of instructional media. Students showed signs of boredom, fatigue, and disengagement, resulting in limited progress in reading fluency. Based on these findings, it was determined that there was an urgent need for a more interactive and student-centered medium that could visualize reading materials and stimulate students' multisensory learning processes. The *curriculum analysis* confirmed alignment with the Merdeka Curriculum, which emphasizes contextual, differentiated learning experiences and encourages the integration of digital literacy. Accordingly, the development focused on designing a reading medium that would engage visual, auditory, and kinesthetic modalities to support foundational reading competence.

The design phase produced a blueprint for an interactive *AR-based syllable book*. Each page of the book contained barcodes linked to 3D objects that, when scanned with a smartphone camera, displayed animated illustrations accompanied by phonetic pronunciations. The design was guided by principles of child-friendly learning—employing vivid colors, simple typography, and clear layout to enhance readability and visual appeal. The instructional design integrated a sequence of activities: (1) syllable recognition, (2) word formation, and (3) association of text with visual representation. This sequence followed the pedagogical logic of *scaffolding*, gradually moving from simple decoding tasks toward meaning-making.

The development stage transformed the conceptual design into a functional product. Using Unity and Vuforia platforms, the AR media was programmed to detect printed markers and generate corresponding 3D objects in real time. Audio elements were embedded to reinforce pronunciation accuracy and auditory memory. Once the prototype was completed, it underwent expert validation by two groups of evaluators: material experts and media design experts. The material experts assessed the alignment of the content with the learning objectives and the appropriateness of the linguistic and pedagogical components, while the media experts evaluated visual clarity, user interface design, and technical functionality. Feedback from experts was used to refine the product before field testing.

### Validation Results

The validation process was essential in ensuring the quality and reliability of the AR-based medium. Expert evaluations were quantified using a five-point Likert scale and analyzed according to Arikunto's (2017) percentage-based feasibility formula.

From the material expert validation, the AR medium received an average score equivalent to 87%, categorized as *very feasible*. Experts noted that the content appropriately reflected the learning objectives outlined in the Merdeka Curriculum, particularly the goal of developing students' literacy competence through contextualized and interactive instruction. They also commended the inclusion of phonetic elements, which helped reinforce syllable recognition. However, minor revisions were suggested to simplify certain instructions to match the cognitive level of Grade II learners.

The media expert validation yielded an average score of 85%, also within the *very feasible* category. The experts positively evaluated the media's aesthetic quality, stating that the choice of colors, visuals, and animations effectively captured students' attention. They further observed that the 3D rendering and

barcode responsiveness were adequate for classroom use. Nonetheless, the experts recommended adjustments to improve visual contrast and marker sensitivity in low-light conditions. Based on these validations, the product met the standards of both pedagogical and technological feasibility, qualifying it for field testing.

### Field Implementation and Effectiveness Testing

Following expert validation, the AR-based medium was implemented in a real classroom setting to evaluate its practicality and effectiveness. The field test used a One-Group Pretest–Posttest Design, involving 20 Grade II students at SDN 5 Kabila Bone. Prior to the intervention, a pretest was administered to assess students' initial reading ability, focusing on their skills in recognizing syllables, forming simple words, and reading short sentences. The AR-based instruction was then implemented over several sessions, after which a posttest was conducted using equivalent assessment items.

The results indicated a significant improvement in students' reading performance. The average pretest score was 62.3%, while the posttest average rose to 84.5%, representing a 22.2% increase in reading achievement. This improvement confirmed the effectiveness of the AR medium in enhancing students' reading skills. Qualitative observations during implementation further supported these findings. Students exhibited higher levels of engagement and enthusiasm; they eagerly participated in scanning the AR markers, repeating syllables aloud, and interacting with the animated objects. Teachers also reported that the students appeared more confident and attentive during lessons.

The positive learning outcomes align with findings from previous studies. For example, Akhma Puri (2021) reported that AR-based instructional media improved students' learning motivation and comprehension in Islamic Education, achieving expert validation scores above 80% and student satisfaction levels above 90%. Similarly, Mustakim and Kurniawan (2017) demonstrated that AR could transform conventional learning environments into interactive, technology-rich spaces that facilitate conceptual understanding and retention. The results of the present study reinforce these conclusions by showing that AR-based media are equally effective in early literacy development, particularly for beginning reading instruction in primary schools.

### Analysis of Student Engagement and Motivation

Beyond cognitive improvement, the AR-based learning medium significantly enhanced student motivation and engagement. Observational data and post-implementation interviews revealed that students found the learning process more enjoyable and less monotonous compared to traditional reading instruction. The integration of 3D animations and audio pronunciations stimulated multiple sensory channels, aligning with the VAK learning model—Visual, Auditory, and Kinesthetic (Noorbaiti, Fajriah, & Sukmawati, 2018). This multisensory stimulation encouraged active participation, helping students with diverse learning styles grasp the material more effectively.

Students' interaction with the AR media fostered what Kamilah and Ruqoyyah (2022) describe as *interactive engagement*, where learners actively manipulate and respond to learning stimuli. This aligns with cognitive constructivist theory, which posits that knowledge construction occurs most effectively through active exploration and interaction with the environment. The animated visuals and real-time feedback provided by the AR system created an immersive learning environment that sustained attention and curiosity.

Furthermore, the novelty of AR technology acted as a motivational driver. According to Mustaqim (2017), AR increases student engagement by offering interactive, visually appealing experiences that blend real and virtual elements. The present study confirmed this assertion: students repeatedly expressed excitement at seeing objects “come to life” when scanning their books, and this excitement translated into sustained interest in learning to read. The teacher observed fewer signs of fatigue and distraction, indicating that the medium successfully mitigated the boredom commonly associated with conventional reading exercises.

### Pedagogical Implications

The effectiveness of the AR-based medium demonstrates its potential as a pedagogical innovation in early literacy instruction. Reading, particularly at the beginning stage, requires learners to develop connections between visual symbols (letters and syllables) and auditory cues (sounds). The AR medium facilitated this connection by merging visual representation and phonetic reinforcement, allowing students to perceive and internalize letter–sound correspondences more naturally. This finding supports Rahman and Haryanto's (2014) argument that reading readiness depends on the integration of visual and auditory processing skills.

Additionally, the product aligns with the principles of multimodal learning, which emphasize the integration of multiple sensory modalities to enhance comprehension and retention. As indicated by Etonam (2019), AR possesses three core technological advantages—*intelligent display technology*, *intelligent 3D registration*, and *intelligent interaction technology*—that collectively enable interactive, real-time learning experiences. These features are instrumental in promoting higher levels of engagement and comprehension among young learners. In this study, the combination of visual, auditory, and kinesthetic cues supported both individual and collaborative learning, making reading instruction more participatory and inclusive.

From a curriculum perspective, the integration of AR media also supports the Merdeka Curriculum's emphasis on *student-centered and differentiated learning*. The flexibility of the AR medium allowed students to learn at their own pace, explore content autonomously, and receive instant feedback. Teachers, in turn, could focus more on facilitating and guiding rather than delivering content. This shift from teacher-centered to student-centered instruction reflects a broader pedagogical transformation consistent with 21st-century education goals.

### Comparison with Previous Studies

When compared with similar studies, the current research confirms and extends existing evidence on the educational value of AR technology. Ratih (2019) found that reading materials designed using the VARK model (Visual, Auditory, Read/Write, Kinesthetic) achieved high levels of validity

(93.10%) and practicality (98.92%), demonstrating that multisensory instruction enhances literacy skills. The present study builds upon this by incorporating AR technology to amplify the multisensory experience through interactivity and immersion. Similarly, the findings parallel those of Mustakim and Kurniawan (2017), who concluded that AR creates engaging learning environments that improve both motivation and conceptual understanding. However, the current study makes a distinct contribution by situating AR integration within the Indonesian elementary literacy context, addressing a gap in previous research that primarily focused on science or religious education.

### Evaluation and Revisions

Following implementation, a formative evaluation was conducted to refine the AR medium based on user feedback. Students and teachers provided practical suggestions regarding usability and visual clarity. Minor revisions were implemented, such as enlarging fonts, increasing color contrast, and enhancing barcode detection sensitivity. A subsequent summative evaluation confirmed that the revised product met all validity and feasibility criteria, with overall expert validation and student satisfaction ratings above 85%. The final product—an *AR-based Syllable Book*—was thus deemed valid, practical, and effective for classroom use.

### Discussion of Findings

The findings of this study provide strong empirical support for the pedagogical integration of AR in early literacy instruction. The improvement in students' posttest performance and observable increases in engagement indicate that AR can serve as an effective mediational tool between abstract linguistic concepts and concrete learning experiences. By visualizing syllables and words through animated representations, students were able to bridge the cognitive gap between decoding and comprehension. This aligns with the cognitive theory of multimedia learning, which posits that the combination of visual and auditory information enhances understanding and memory retention.

Moreover, the AR-based medium's success highlights the importance of teacher readiness and technological adaptation in implementing digital tools. Teachers who participated in the study expressed appreciation for the media's potential to simplify complex reading instruction while maintaining student interest. However, they also acknowledged the need for professional development to integrate such technologies more effectively into lesson planning.

### Conclusion

This study developed and validated an Augmented Reality (AR)-based learning medium to enhance beginning reading skills among Grade II students at SDN 5 Kabila Bone. The results demonstrated that the product met the criteria of being valid, practical, and effective, with expert validation scores exceeding 85% and a notable 22% improvement in students' posttest reading performance. The integration of AR technology successfully increased student motivation, engagement, and comprehension by providing a multisensory learning experience that combined visual, auditory, and kinesthetic stimuli. These findings affirm the pedagogical value of AR in transforming conventional, teacher-centered reading instruction into a more interactive and student-centered process aligned with the principles of the Merdeka Curriculum.

The study contributes to the growing body of educational technology research by extending the application of AR to early literacy development—an area previously underexplored in Indonesian primary education. It highlights how AR can bridge the gap between abstract linguistic symbols and concrete learning experiences, thereby supporting foundational literacy acquisition. Future research could explore large-scale implementation, long-term learning impacts, and the integration of adaptive AR features that respond to students' individual reading progress. Overall, this study underscores AR's potential as a transformative instructional innovation for fostering literacy in 21st-century classrooms.

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