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Enhancing Narrative Text Reading Comprehension Through Augmented Reality-Assisted Pop-Up Book Media Development

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ABSTRACT

The limited variety of learning media in Grade IV Indonesian language lessons, particularly in local content on narrative texts, has led to low student interest and poor reading comprehension. To address this issue, this study developed and evaluated a Pop-Up Book learning medium enhanced with Augmented Reality (AR). This research involved Grade IV teachers, students, and expert reviewers. Data were collected through observations, interviews, tests, and questionnaires. The primary instruments were questionnaire sheets, while data were analyzed using both qualitative and quantitative descriptive techniques. Effectiveness was measured through pretest–posttest comparisons and N-gain analysis on small- and large-scale trials. Feasibility assessments yielded high scores: material experts (96.66%), media experts (98.75%), teacher responses (97.5%), and student responses (97.08%). Pretest–posttest results showed improved knowledge competence, with N-gain scores of 0.79 (small scale) and 0.66 (large scale), indicating the media was "quite effective" in enhancing reading comprehension. The integration of Pop-Up Books with AR technology provided interactive, visually engaging content that stimulated student interest and facilitated comprehension. The consistently high ratings from experts, teachers, and students confirm its quality and relevance to classroom needs. The AR-assisted Pop-Up Book is highly feasible, effective, and suitable for improving narrative text reading comprehension in Grade IV Indonesian language lessons. Its implementation can serve as an innovative approach to enhance learning engagement and outcomes.

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1. INTRODUCTION

Education plays a vital role in shaping the life of a nation, as it directly influences the intellectual, moral, and social development of its citizens. Fundamentally, education is inseparable from human life, as humans function simultaneously as subjects and objects of educational processes—teaching and

being taught. Through education, individuals pass on their knowledge, values, and culture to younger generations, ensuring the continuity and advancement of society (Dewi et al., 2022; Puspitasari et al., 2019). The importance of education is also legally enshrined in the 1945 Constitution of the Republic of Indonesia, Article 31, Paragraph 1, which guarantees every citizen the right to receive an education. This constitutional provision emphasizes the state's responsibility to ensure equitable and quality education for all Indonesian citizens.

Within the educational framework, language learning—particularly Indonesian language instruction—plays a crucial role in enabling effective communication between teachers and students. The teaching of Indonesian emphasizes the use of proper oral and written language skills (Sulistyawati & Amelia, 2021). As a core subject in primary and secondary education, the Indonesian language is taught from Grade 1 through Grade 6 in elementary schools (Subakti & Prasetya, 2022). Its significance lies not only in its status as a national language but also in its function as a medium for developing students' literacy skills, which are foundational to learning across all subjects (Ali, 2020). Accordingly, literacy becomes a central focus in Indonesian language instruction, particularly in terms of reading comprehension, which is a key component of student assessment (Trimurtini et al., 2021).

Reading comprehension is a fundamental skill that enables students to access, process, and interpret information from written texts. It serves as a gateway to academic success, as it facilitates understanding across various subject areas. According to Habibah (2020), reading comprises several core processes, among which comprehension holds a central role. Comprehension involves the reader's ability to construct meaning from a text by applying specific strategies, such as identifying themes, analyzing structures, and evaluating content (Rohayati & Budiarti, 2022).

In the context of elementary education, reading skills are particularly crucial, as they influence the development of other language abilities, such as writing (Rinawati, 2020). However, recent research indicates that many elementary school students still struggle with reading comprehension. For instance, Frans et al. (2023) reported that low reading comprehension among students is often attributed to a lack of motivation. Similarly, Diki Ardiyanto et al. (2021) found that many students face difficulties in identifying key information, drawing inferences, and retaining content from reading passages. These challenges are often compounded by limited interest in reading and increased exposure to entertainment-focused digital media, which detracts from time spent on reading activities (Putri & Setiawan, 2021).

Furthermore, the use of conventional and monotonous teaching methods in the classroom has been identified as a contributing factor to low student engagement and poor reading outcomes. This is supported by findings from interviews conducted by the researchers with Grade IV teachers at SD Negeri 2 Baturagung, Grobogan Regency, where many students were observed to struggle with narrative text comprehension. Students reportedly had difficulty understanding the messages and storylines in narrative texts due to low concentration, minimal reading interest, and the use of unvaried instructional media—typically limited to textbooks, YouTube videos, and static images from the internet. These limitations have led to suboptimal learning outcomes, with 62.5% of students failing to meet the Minimum Mastery Criteria (KKM) of 70 for narrative text comprehension, as evidenced by daily assessment results.

The low performance in narrative text comprehension highlights the urgent need for innovative and engaging instructional media. Effective educational media not only facilitate the delivery of content but also enhance student motivation, encourage active participation, and improve learning outcomes (Nurul Audie, 2019). Interviews with teachers at SDN 2 Baturagung confirmed that existing media are insufficiently engaging for Grade IV students, reinforcing the need for alternative approaches tailored to students' developmental characteristics and learning needs. In response to this problem, the current study aims to develop and implement an educational medium that can enhance students' reading comprehension—specifically, an Augmented Reality (AR)-assisted pop-up book.

Pop-up books are interactive print media characterized by three-dimensional elements that physically emerge from the pages, creating a multisensory and immersive reading experience (Fitriani et al., 2020; Yanto et al., 2023). When enhanced with AR technology, these books gain the capability to project digital 3D models onto physical content, allowing abstract concepts to be visualized in dynamic and engaging ways (Majid et al., 2023; Sinuraya et al., 2023). AR technology overlays virtual content onto real-world environments, effectively blending physical and digital experiences.

The integration of AR in pop-up books offers numerous educational benefits. For students, it enhances narrative text comprehension by allowing them to visualize and interact with story elements, thereby deepening their understanding of the material. For educators, AR-assisted media provide innovative tools to facilitate instruction and increase classroom engagement. Motivated by these pedagogical advantages, this study seeks to design and evaluate the effectiveness of an AR-assisted pop-up book in improving Grade IV students' reading comprehension of narrative texts at SDN 2 Baturagung, Grobogan Regency.

Previous studies support the potential of AR-assisted pop-up books in improving students' learning outcomes across various contexts and subjects (Asnanda et al., 2022; Fairus et al., 2023; Sukasih, 2023). These findings provide a strong empirical foundation for the present study and underscore the importance of integrating technology into instructional media to foster deeper literacy development among elementary school students.

2. METHODS

This study employed a quantitative research approach, which, according to Sugiyono (2019), is grounded in the philosophy of positivism. The research utilized a Research and Development (R&D) design aimed at producing a specific product and testing its effectiveness. The development process followed Sugiyono's ten-step model: identifying potential and problems, collecting relevant data, designing the product, validating the design, revising the design, conducting product trials, making revisions, performing usage trials, making further revisions, and producing the final product on a mass scale. However, this study was conducted only up to the eighth step, ending at the stage of testing the media's feasibility and effectiveness. The process did not proceed to mass production due to time and budget limitations.

2.1 Research Participants

This research involved four main subjects: students, teachers, experts, and researchers. The primary participants were fourth-grade students of SDN 2 Baturagung, Grobogan Regency, during the 2024 academic year, totaling 32 students—12 males and 20 females. These students participated as research subjects in the processes of information gathering and product testing. The fourth-grade teacher of SDN 2 Baturagung also served as a research subject, contributing as a source of information and data related to classroom learning conditions. In addition, expert lecturers, comprising material experts and media experts, were involved as consultants who provided professional guidance in developing the Augmented Reality-assisted pop-up book media. Finally, the researchers themselves acted as research subjects, playing a crucial role in the design, development, and implementation of the AR-assisted pop-up book media throughout the study.

2.2 Instruments

Research instruments are tools used in measuring natural or researched phenomena (Sugiyono, 2020). The instruments used in this research are questionnaires, interviews, and tests. The questionnaire used is a questionnaire of teacher and student needs. The teacher and student needs questionnaire is used to find out the needs of teachers and students about the specifications of the learning media used

for this study. The material and media feasibility questionnaire is used to determine the feasibility of materials and media carried out by material experts and media experts so that the developed product, namely the Augmented Reality pop-up book, is feasible to use as a medium that improves reading comprehension of narrative texts of fourth-grade students of SD Negeri 2 Baturagung Grobogan Regency. Teacher and student response questionnaires were filled in by teachers and students as respondents to find out the extent to which the media was feasible to use and the extent of the increase in reading comprehension of student narrative texts after the use of development products.

Other instruments used in data collection besides questionnaires are interviews. In addition to interviews, the test method was also used as a data collection instrument with two tests, namely pretest and posttest. Pretest is used to know the extent of reading comprehension of student narrative text before the application of development products, while the posttest is used to determine the comparison of reading comprehension of student narrative text after learning using pop up book media products assisted by Augmentd Reality.

2.3 Data Analysis

The researchers employed techniques of observation, interviews, and questionnaires. Observations were made in class IV during the Indonesian language learning process. Interviews were conducted with teachers and pupils to gather valuable information about the challenges and needs of pupils during the Indonesian language learning process. The questionnaire will be given to material experts and media experts with the aim of obtaining data on the feasibility of pop up book learning media assisted by Augmented Reality. There are five aspects in the media expert test: aspects of language, display aspects, aspects of use, aspects of expediency, and aspects of effectiveness. The five aspects can be described in the indicators as follows.

Table 1. Media Expert Validation Assessment Indicators

Aspect	Indicators
Linguistic aspects	– The language used is clear – Language suitability with students' level of thinking
Display aspects	– The appearance of the media Pop Up Book assisted by Augmented Reality emphasizes information according to the target – Selection of fonts and font sizes in the media Pop Up Book assisted Augmented Reality – Display of media, Pop Up Book, assisted Augmented Reality interesting
Aspects of use	– Ease of media use – Demonstration of media use – Appropriateness to the level of student development
Aspects of usefulness	– Pop-up book media assisted by Augmented Reality makes it easier for students to understand the material
Aspects of effectiveness	– Pop Up Book media assisted by Augmented Reality supports the learning process

The material expert validation test includes three aspects, namely presentation aspects, language aspects, and material aspects. The three aspects can be described in the following indicators.

Table 2. Material Expert Assessment Indicators

Aspect	Indicators
Presentation Aspect	– The suitability of the presentation technique of the Pop Up Book media assisted by Augmented Reality – The sequence of presentation of media components Pop Up Book assisted Augmented Reality

Language Aspect	–	The politeness of language use
	–	The suitability of language and student characteristics
Material Aspect	–	Suitability of material with learning outcomes and objectives
	–	The accuracy of the material
	–	The suitability of the material to the level of student development

Analysis of the feasibility of media and materials aims to test the use of pop up book media assisted by Augmented Reality using instruments that are analyzed by formula according to (Yusri, 2020) as follows:

Table 3. Media and Material Feasibility Assessment Criteria

Percentage	Criteria
82%<x≤100%	Very feasible
63%<x≤81%	Worthy
44%<x≤62%	Quite feasible
25%<x≤43%	Not feasible

2.4 Data Analysis

The data in this study were analyzed using both qualitative and quantitative analysis techniques. Qualitative analysis played an essential role in describing and understanding various aspects of the research topic. The qualitative data consisted of information gathered through interviews with fourth-grade teachers at SD Negeri 2 Baturagung, as well as responses from teacher and student needs questionnaires, media expert validation questionnaires, material expert validation questionnaires, and teacher and student response questionnaires. Meanwhile, the quantitative data were obtained from the daily reading comprehension scores of fourth-grade students at SD Negeri 2 Baturagung, Grobogan Regency.

In analyzing the qualitative data, thematic analysis was conducted to identify and interpret key themes related to students' learning needs in narrative text comprehension and to explore the characteristics of research participants. For the quantitative data, several statistical tests were employed to evaluate the product's validity, practicality, and effectiveness. Validation sheets from both material and media experts were analyzed to determine the feasibility of the developed Augmented Reality-assisted pop-up book media. The material validation was conducted by Dr. Panca Dewi Purwati, M.Pd., while the media validation was carried out by Mr. Abtadi Tris Handani, S.Pd., M.Pd. Additionally, two lecturers from the Elementary School Teacher Education program evaluated the practicality of the product, and data were also collected from 32 student participants.

Subsequently, the effectiveness of the AR-assisted pop-up book media was assessed using a paired sample T-test and an N-gain test to compare students' learning outcomes before and after the implementation (pre-test and post-test). The use of both qualitative and quantitative analysis techniques was considered appropriate for this research, as research and development (R&D) studies require a combination of approaches to ensure the validity and effectiveness of the developed product. Thus, the chosen analytical techniques effectively addressed the research questions and objectives, which aimed to determine the validity, practicality, and effectiveness of the Augmented Reality-assisted pop-up book media.

3. FINDINGS AND DISCUSSION

3.1 Research Findings

The present study employed a Research and Development (R&D) approach to develop and evaluate Augmented Reality (AR)-assisted pop-up book media for fourth-grade students at SDN 2

Baturagung, Grobogan Regency. This chapter presents and discusses the results of the research process, which includes several key components: (1) the analysis of teacher and student needs regarding the AR-assisted pop-up book media; (2) the design and development of the product, including prototype creation based on the needs analysis; (3) the results of expert validation by material and media experts; (4) the outcomes of small- and large-scale product trials, as well as teacher and student response evaluations; and (5) the overall data analysis, encompassing initial, product, and final evaluations.

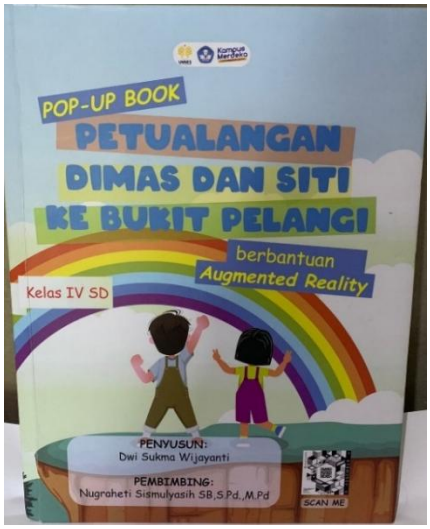
Based on the analysis of teachers' needs, several essential findings were obtained. Teachers expressed that the AR-assisted pop-up book media should contain a clear narrative title, well-defined learning outcomes, and specific learning objectives. They also emphasized that evaluation questions were unnecessary within the media itself, as the primary focus should be on fostering reading engagement and comprehension. Furthermore, teachers suggested that the media should feature engaging and visually appealing illustrations, particularly three-dimensional images, to attract students' attention and enhance learning motivation. They also preferred that the story text be concise and appropriate in length, using polite and conversational language to match the comprehension level of elementary school students.

At the elementary education level, such considerations are critical, as students are in a stage of rapid cognitive and linguistic development. Learning media that can stimulate attention and active engagement—such as AR-based pop-up books—have been shown to significantly improve comprehension and retention. According to Duke et al. (2021), instructional materials that integrate visual and interactive elements can enhance students' understanding of narrative texts by allowing them to connect textual and visual information more effectively. Therefore, the development of AR-based learning media tailored for elementary school students has substantial potential to strengthen their reading comprehension, particularly in narrative text learning aligned with their cognitive growth and developmental needs.

The results of the student needs analysis also informed the development process. Students expressed interest in AR-assisted pop-up book media that include scannable AR barcodes accessible via mobile devices, allowing them to view dynamic, augmented images alongside the printed content. They preferred the inclusion of bright, attractive colors and requested that the media exclude formal evaluation questions, focusing instead on interactive and enjoyable learning experiences. Moreover, students favored the use of polite yet conversational language, which supports better engagement and comprehension.

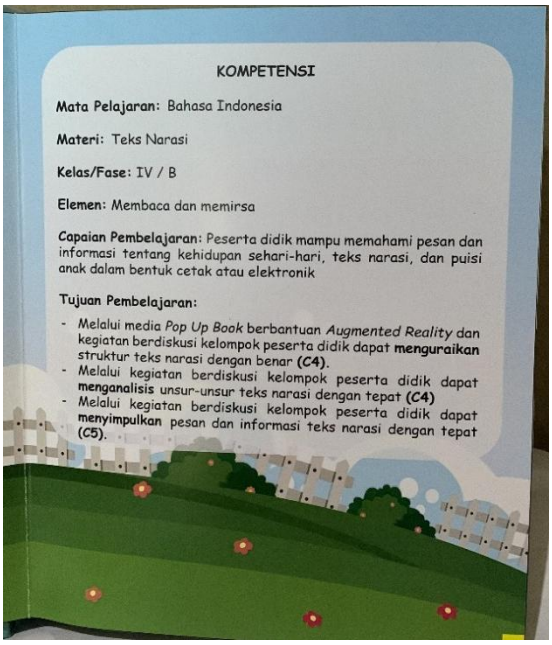
At the design and development stage, the researchers created a prototype of the AR-assisted pop-up book media based on the findings from the teacher and student needs analyses. The prototype design incorporated three-dimensional illustrations, AR barcode integration, and content aligned with the narrative text comprehension objectives for fourth-grade students. This prototype was then developed into a fully functional product, representing the realization of the design plan. The completed AR-assisted pop-up book media served as the foundation for subsequent validation, testing, and implementation phases.

Initial appearance design (before)



Initial appearance (after)

Learning objective design (before)



Learning objecyive (after)

Content display design (before)

Content display (after)

Final appearance design (before)

Final display (after)

Figure 1. Design Development Stages of the Augmented Reality-Assisted Pop-Up Book Media

At the product design stage, it is essential to evaluate the feasibility of the newly developed media—in this case, the Augmented Reality (AR)-assisted pop-up book—to ensure its effectiveness in improving students' reading comprehension of narrative texts. The feasibility assessment was carried out through expert validation and product trials. The validation process involved feedback and revisions from both media and material experts to refine the product's quality and instructional suitability. Following expert validation, the product was tested in two stages: a small-scale trial involving six fourth-grade students and a large-scale trial with 26 students. These trials aimed to evaluate the practicality, attractiveness, and overall effectiveness of the AR-assisted pop-up book as a learning medium. The results of the validity assessment of the AR-assisted pop-up book media are presented in Table 4, while the findings from the effectiveness tests are displayed in Tables 5 and 6, and the results of the N-Gain test are provided in Table 7.

Table 4. Product Validity Test Results

No	Test Subject	Validity Result	Description
1.	Media Expert Test	98.75%	Very Feasible
2.	Material Expert Test	96.66%	Very Feasible
3.	Small Group Test	66.67%	Feasible
4.	Large Group Test	76.93%	Feasible
5.	Classroom Teacher Response Test	97.5%	Very Decent
6.	Student Response Test	97.08%	Very Decent

Table 5. Results of Paired Sample T-test of Pretest and Posttest Scores on Small-Scale Trial

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest - Posttest	-30.00000	4.89898	2.00000	-35.14116	-24.85884	-15.000	5	.000

Table 6. Results of Paired Sample T-test

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest Posttest	--25.38462	9.92402	1.94626	-29.39301	-21.37622	-13.043	25	.000

The pretest and posttest mean difference test was conducted to evaluate the proposed hypothesis regarding the effectiveness of the Augmented Reality (AR)-assisted pop-up book media in improving students' reading comprehension of narrative texts. This test aimed to determine whether there was a significant difference between the learning outcomes of fourth-grade students at SDN 2 Baturagung, Grobogan Regency, before and after using the developed media. The decision-making criterion was based on the *significance value (sig. 2-tailed)*. If the sig. (2-tailed) < 0.05, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_a) is accepted, indicating a significant difference. Conversely, if the sig. (2-tailed) > 0.05, H_0 is accepted and H_a is rejected, indicating no significant difference.

Based on the results presented in the pretest and posttest mean difference table, the significance value (*sig. 2-tailed*) obtained for both the small-scale and large-scale trials was 0.000, which is less than 0.05. This result indicates that H_0 is rejected and H_a is accepted. Therefore, it can be concluded that there is a statistically significant difference in the reading comprehension outcomes of fourth-grade students before and after using the AR-assisted pop-up book media. These findings demonstrate that the use of AR-assisted pop-up book media is effective in enhancing students' comprehension of narrative texts at SDN 2 Baturagung, Grobogan Regency.

Table 7. N-gain of Small Scale Trial Results

Average pretest	Average posttest	Average difference	Maximum score	N-gain	Criteria
60.67	90.67	30	100	0.79	High

Table 8. N-gain of Large Scale Trial Results

Average pretest	Average posttest	Average difference	Maximum score	N-gain	Criteria
60.92	86.31	25.39	100	0.66	Medium

Based on Tables 7 and 8, which present the N-gain results from both the small- and large-scale trials, it can be observed that the use of Augmented Reality (AR)-assisted pop-up book media effectively improved the reading comprehension skills of fourth-grade students at SDN 2 Baturagung, Grobogan Regency. In the small-scale trial, the N-gain score increased by 0.79, which falls into the high category, with a mean difference of 30 points between the posttest and pretest scores. Meanwhile, in the large-scale trial, the N-gain score increased by 0.66, categorized as medium, with an average difference of 25.39 points between the posttest and pretest results. These findings indicate that the AR-assisted pop-up book media had a positive impact on students' comprehension of narrative texts, with consistent improvements observed across both trial scales.

Discussion

The development of Augmented Reality (AR)-assisted pop-up book media has been shown to support teachers in teaching reading comprehension of narrative texts. This learning medium captures students' attention, increases engagement, and fosters motivation, ultimately optimizing the learning process. As noted by Sukmawarti (2021), one of the advantages of pop-up book media is its ability to help students grasp material more easily by using vivid imagery, colors, and representations of abstract concepts that strengthen the delivery of content. In this study, the pop-up book was enhanced with AR technology, allowing students to scan QR codes and access three-dimensional simulations of story elements. This integration of print media with digital interactivity offers a novel learning experience, in line with the findings of Septiana et al. (2023), who highlight the value of combining traditional formats with technology to enrich classroom instruction.

The study's findings align with constructivist learning theory, as articulated by Piaget and Vygotsky, which emphasizes active engagement and interaction with one's environment (Fahrozi et al., 2024). The AR-assisted pop-up book provided an interactive, immersive platform where students could go beyond passive reading to visually experience story elements. Such contextual and exploratory learning, according to constructivism, is more effective in building comprehension and meaningful knowledge. The medium allowed students to construct their own understanding through dynamic interaction, reinforcing the potential of technology to deepen learning experiences.

From a pedagogical standpoint, this research also supports the Technological Pedagogical Content Knowledge (TPACK) framework developed by Mishra and Koehler, which integrates content, pedagogy, and technology knowledge (Mustaqimah et al., 2023). The AR pop-up book combined narrative text content with interactive strategies and digital tools, illustrating how effective technology integration requires both subject-matter expertise and instructional skill. Teachers using this medium must understand both the relevant learning content and how to leverage AR features to enhance comprehension and engagement. This underscores the importance of developing educators' TPACK competence to maximize the benefits of technology in instruction.

At the policy level, these results are relevant to global and national initiatives promoting technology-based learning. In Indonesia, the integration of Information and Communication Technology (ICT) in the 2013 curriculum reflects government efforts to modernize education (Sunismi et al., 2023). AR technology, as part of this digital transformation, has the potential to improve students' reading comprehension and engagement, supporting policy goals to enhance 21st-century skills such as critical thinking, creativity, and digital literacy. The findings also align with international trends emphasizing technology-rich learning environments as essential for future-ready education.

The effectiveness of AR-assisted pop-up book media is influenced by several contextual factors. Cultural relevance plays a critical role, as incorporating local folklore and mythology can strengthen students' connection to the material and increase motivation (Indah Kurniawati et al., 2023). In other countries, however, cultural elements should be adapted to ensure alignment with local values and experiences (Kudadiri, 2023). Technological accessibility is another key factor; disparities between urban and rural infrastructure in Indonesia may require modifications such as offline versions or lighter applications to ensure equitable access (Suyuti & Wahyuningrum, 2023). In contexts with advanced technological infrastructure, such as in parts of Europe or North America, implementation may be more straightforward, but adaptation to local needs remains important.

Overall, the results of this study demonstrate that AR-assisted pop-up book media are both feasible and effective in enhancing reading comprehension in Indonesian language learning, particularly for narrative texts. The medium motivates students to actively engage with content, meets the needs of teachers for innovative instructional tools, and supports school initiatives to develop relevant educational resources. As reading comprehension involves not only decoding words but also interpreting deeper meaning (Sahbana Damanik, 2021), the interactive and visual features of AR-assisted pop-up books provide valuable support for students' cognitive engagement. By combining visual appeal with interactive technology, this medium fosters an enjoyable and effective learning experience, and its structured design allows flexibility for application in various educational contexts (Nabila et al., 2021; Zakiyah et al., 2022).

4. CONCLUSION

This study concludes that the Augmented Reality (AR)-assisted pop-up book, designed with interactive three-dimensional features, is highly valid and effective for improving Grade IV students' reading comprehension of narrative texts at SDN 2 Baturagung. The media achieved very high validity scores across multiple aspects, including material content (95%), language (100%), media language

(87.5%), display, usability, and usefulness (100%). Effectiveness testing showed significant improvements in learning outcomes, with t-test results indicating p-values < 0.05 in both small- and large-scale trials, confirming a measurable positive impact. N-gain analysis revealed a high category increase (0.79) in small-scale trials and a medium category increase (0.66) in large-scale trials, demonstrating consistent learning gains. Despite these positive results, the study was limited by its scope, focusing on a single school, not progressing to mass production, and relying on specific technological infrastructure, which may affect generalizability. Future research should explore wider implementation across diverse schools and regions, adapt the media to various cultural contexts, and examine its long-term effects on different literacy skills. Additionally, developing lighter, offline-compatible versions of the AR-assisted pop-up book could address accessibility challenges in areas with limited technology resources.

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