



Development of an Augmented Reality-Based Comic Integrating Balinese Local Wisdom for Enhancing Elementary Students' Learning Outcomes

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Abstract: This study aims to develop an Augmented Reality (AR)-assisted comic based on Balinese local wisdom to improve Indonesian language learning outcomes for third-grade elementary school students. The study employed a Research and Development method adapted from the ADDIE model, comprising the stages of Analysis, Design, Development, Implementation, and Evaluation. Data were collected through questionnaires and learning outcome tests and analyzed using both qualitative and quantitative methods. Product validity was evaluated by experts in content, media, and language, while practicality was assessed by 15 students and 11 elementary school teachers. Effectiveness testing employed a Non-Equivalent Control Group Pretest-Posttest Design involving 19 students per group. The developed comic integrates Balinese local stories, particularly the traditions of Pengrupukan and Nyepi Day, into a child-friendly visual medium enriched with AR features, including simple animations, videos, audio narration, and supporting visual objects. The comic was designed based on the Indonesian Language Learning Outcomes for Phase B. The results indicate that the product is highly valid, with a validity coefficient of 1.00, and highly practical, with a practicality score of 92.68%. It was also effective in improving students' learning outcomes, particularly in reading and listening comprehension, understanding story content, and information retention, as indicated by an N-Gain score of 0.79 and a Cohen's d effect size of 1.78. In conclusion, the AR-assisted comic is valid, practical, and effective as an interactive and contextual learning medium for elementary school students.

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Introduction

Basic education plays a strategic role in strengthening students' literacy, particularly reading and listening, as the foundation of language competence and further learning. In the Merdeka Curriculum, literacy is not limited to recognizing letters and sounds, but also includes the ability to comprehend, interpret, and reflect on information from oral and written texts (Kemendikbudristek, 2024). Accordingly, Indonesian language learning in elementary schools emphasizes the development of receptive language skills, especially reading and listening, because these skills form the basis for broader language acquisition (Tarigan, 2008; Kemendikbudristek, 2024).

Reading comprehension is a complex ability that enables students to construct meaning from written texts, while listening comprehension refers to understanding spoken language such as stories, instructions, and classroom explanations. Recent studies show that reading development is influenced not only by word recognition but also by oral language and listening comprehension, indicating that both skills are closely interconnected in early



learning (Duke & Cartwright, 2021; Sánchez-Vincitore et al., 2022; Hagen et al., 2022). Thus, before students can express ideas productively, they must first develop strong receptive abilities to process and understand information delivered orally and in writing (Elleman et al., 2022; Lam et al., 2024).

However, literacy problems in Indonesia should not be seen only through macro-level achievement data, but also through the cultural contexts in which literacy develops. PISA 2022 shows that Indonesian students' reading performance remains below the OECD average, and only around 25% of students reached at least Level 2 in reading. Yet literacy is not merely a cognitive skill; it is also a social and cultural process shaped by learners' language, experiences, and daily meaning-making practices. In this context, the integration of Balinese local wisdom becomes important because familiar cultural symbols, values, and stories can make literacy learning more meaningful, relevant, and accessible for elementary school students.

Low literacy levels are also evident at the elementary school level, particularly in Grade III. Students generally can understand texts at a literal level but still show weaknesses in inferential and critical comprehension (Muliawanti et al., 2022; Lena et al., 2023). In addition, weak reading ability is often associated with limited listening competence (Ubaidillah et al., 2025). One of the contributing factors is that Indonesian language instruction in elementary schools is often still conventional, teacher-centered, and focused on mechanical reading and listening activities, with limited opportunities for reflective and meaning-based learning (Tompkins, 2014).

This condition was also found in Cluster 3 of Tegallalang District, Gianyar Regency. Preliminary observations showed that Indonesian language learning was still dominated by lecturing and turn-taking reading activities without meaningful comprehension tasks. Teachers mainly relied on textbooks, while the use of audio, visual, or technology-based media was still very limited. This condition was reflected in students' low learning outcomes, as shown by Semester II assessment data in the 2024/2025 academic year, where Grade III students achieved only 51.82% in reading and 53.26% in listening. These findings indicate that students' basic literacy skills have not yet developed optimally.

The limited use of innovative and contextual learning media is therefore one of the main factors behind low student engagement and comprehension. Learning media are important in connecting instructional content with students' concrete experiences, and visual as well as technology-based media such as digital comics and Augmented Reality (AR) have been shown to improve attention, comprehension, and retention (Wu et al., 2020; Huang & Soman, 2013). Therefore, the development of AR-assisted comics based on Balinese local wisdom offers a strategic solution to improve students' reading and listening skills. By integrating visuals, text, audio, and local cultural content, this medium can create a more meaningful, contextual, and engaging learning experience while also supporting literacy development, character education, and students' cultural identity in line with the Merdeka Curriculum (Kemendikbudristek, 2024).

Research Method

This study used a Research and Development (R&D) approach to develop and evaluate AR-assisted comics integrating Balinese local wisdom for improving third-grade students' Indonesian language learning outcomes. This approach was chosen because R&D is intended to produce and test educational products through a systematic process of design, refinement, and evaluation in authentic learning contexts (Afriani et al., 2025). The



development followed the ADDIE model—analysis, design, development, implementation, and evaluation—because it provides a structured and iterative framework and remains widely used in educational media development due to its clarity, flexibility, and effectiveness (Spatioti et al., 2022; Abuhassna et al., 2023). The analysis stage identified students' needs, existing media, curriculum, and school facilities through document analysis, observation, and interviews, showing that students' reading and listening skills were still low, the available media were conventional, and schools had sufficient facilities to support AR-based learning. The design stage involved formulating learning objectives, preparing comic scripts based on Balinese local stories, designing storyboards and AR integration, and constructing research instruments. The development stage focused on producing the comic and validating both the media and the instruments through expert judgment and reliability testing, followed by revisions and field trials.

The implementation stage examined the effectiveness of the media through a quasi-experimental non-equivalent control group pretest-posttest design in Cluster 3 of Tegallalang District, Gianyar Regency. The population consisted of all third-grade students in the cluster, while the sample was taken from pre-existing classrooms, with Grade III students of SD Negeri 5 Sebatu as the experimental group and Grade III students of SD Negeri 4 Sebatu as the control group. Evaluation was conducted formatively through expert validation and product trials and summatively through comparison of learning outcomes between both groups. The research subjects included experts, teachers, students in the practicality test, and third-grade students in the effectiveness test. Data were collected through questionnaires, interviews, observations, and learning outcome tests. Qualitative data were analyzed descriptively, while quantitative data were analyzed using descriptive and inferential statistics, including N-Gain, normality and homogeneity tests, independent samples t-test, and effect size analysis.

Results and Discussion






The AR-assisted comic integrating Balinese local wisdom was developed based on a needs analysis in Indonesian language learning for third-grade elementary school students, which showed the need for visual, contextual, and interactive media because students still had difficulty understanding narrative texts through conventional textbooks (Mahartini et al., 2025; Utami et al., 2025). The comic incorporates Balinese cultural themes, particularly Pengrupukan and Nyepi Day, and presents the story through narrative structures, colorful panels, and communicative language suited to students' cognitive development. This design is consistent with culturally responsive pedagogy, which highlights the importance of connecting learning materials to students' cultural backgrounds to increase engagement and relevance (Dewi et al., 2025; Patras et al., 2024). The comic content was also aligned with the Indonesian Language Learning Outcomes for Phase B, especially in identifying main ideas, understanding important information, expanding vocabulary, and comprehending story sequences, so that it functions not only as reading material but also as a literacy medium supporting reading and listening development (Kemendikdasmen, 2024).

AR technology was integrated through markers on selected pages that displayed simple animations, audio narration, and supporting visuals when scanned using a mobile device. These features were intended to make the story more concrete and easier for students to understand. Previous studies have shown that AR-based literacy media can improve comprehension, cultural literacy, and learning engagement by combining text, images, sound, and interaction in one learning environment (Genç & Akyol, 2024; Maufur et al., 2025). As a




result, the final product is a printed comic with AR features that is practical, user-friendly, and flexible for both classroom and independent learning, with strong potential to serve as a meaningful Indonesian language learning medium for elementary school students (Mahartini et al., 2025; Dewi et al., 2025).

Table 1. Sample Pages of the Developed Comic

No.	Comic Page/Visual	Description
1		Front Cover The front cover presents an illustration of <i>ogoh-ogoh</i> and a Balinese atmosphere using bright colors and a child-friendly style. It is completed with a clear title to attract students' attention and introduce the cultural theme as well as the support of Augmented Reality features.
2		Learning Objectives This page presents the learning objectives related to listening and reading skills, as well as the reinforcement of character values and Balinese local wisdom embedded in the comic.
3		User Guidelines This page provides brief instructions on how to use the comic and its AR features, including how to download the application, scan markers, follow the panel sequence, and access the quiz independently.
4		Character Introduction This page presents the introduction of the main characters along with Balinese cultural visuals to help students understand the roles of the characters and the storyline from the beginning.
5		Story Content and AR Barcode The story pages present sequential comic panels combining illustrations, narration, and dialogue to deliver the storyline in a coherent and engaging way. Balinese cultural visuals help students understand the story and its values, while AR barcodes on selected panels provide animations, audio, and interactive visuals. The integration of text, images, and AR features makes the comic more vivid, interactive, and supportive of deeper understanding.



No.	Comic Page/Visual	Description
6		Comprehension Quiz The quiz page contains a barcode linked to an interactive quiz, accompanied by brief instructions on how to scan and access the questions. This feature helps students evaluate and reinforce their understanding in a practical manner.

Results of Product Practicality Test

After the product was revised based on suggestions from experts during the product validation stage, the next step was conducting a practicality test to evaluate ease of use, clarity of instructions, attractiveness of the display, and the smooth operation of the AR features in learning. The results of the product practicality test obtained through a field test are presented in Table 2.

Table 2. Results of Product Practicality Test

Respondent Group	Display (%)	Material (%)	Motivation (%)	Operation (%)	Overall Average (%)	Category
Teachers	92.36	93.33	95.45	91.82	93.03	Very Practical
Students	92.53	91.56	95.33	90.00	92.33	Very Practical
Overall	92.45	92.45	95.39	90.91	92.68	Very Practical

Based on Table 2, the highest percentage of practicality test results from teachers was found in the motivation aspect at 95.45%, followed by the material aspect at 93.33%, the display aspect at 92.36%, and the lowest percentage in the operational aspect at 91.28%. Overall, the average practicality percentage of the AR-assisted Balinese local wisdom comic media according to teachers was 93.03%, which falls into the *very practical* category and indicates that no revision is required.

For the student respondents, the overall practicality percentage of the developed comic media was 92.33%, which is also categorized as *very practical* and does not require revision. The highest percentage was observed in the motivation aspect at 95.33%, followed by the display aspect at 92.53%, the material aspect at 91.56%, and the lowest percentage in the operational aspect at 90.00%. The total practicality percentage of the product based on both teacher and student assessments was 92.68%, which is classified as *very practical* and requires no revision. These results indicate that the developed comic media is very easy to use for both students and teachers. This finding strengthens the conclusion that the AR-assisted Balinese local wisdom comic media has a high level of practicality and can be effectively utilized by teachers and students in the learning process.

Results of Product Effectiveness Test

Based on the results of the product effectiveness test, the findings are described as follows.

Table 3. Results of Descriptive Statistical Analysis

Group	N	Min Score	Max Score	Mean	Standard Deviation
Control Pretest	19	20	88	58.74	21.71
Control Posttest	19	72	100	81.16	7.52
Experimental Pretest	19	20	84	56.42	19.64
Experimental Posttest	19	80	100	90.74	5.59

Based on the descriptive analysis results in Table 3, it is known that the average pretest scores of the experimental and control classes were relatively similar, namely 58.74



and 56.42, respectively. This indicates that the initial abilities of students in both classes were relatively equivalent. After the treatment was implemented, there was a significant increase in the average posttest score of the experimental class, reaching 90.74, which was higher than that of the control class with an average score of 81.16.

Results of N-Gain Score Analysis

Table 4. Results of N-Gain Score Analysis

Group	N	Min Score	Max Score	Mean	Standard Deviation
Control N-Gain	19	0.20	1.00	0.51	0.18
Experimental N-Gain	19	0.50	1.00	0.79	0.13

Based on Table 4, the average N-Gain Score of the experimental class was 0.79, which falls into the *high improvement* category. This indicates that the AR-assisted Balinese local wisdom comic media provides a significant improvement in students' Indonesian language learning outcomes. In contrast, the control class obtained an average N-Gain Score of 0.51, which is categorized as *moderate improvement*. The comparison between the two groups shows that the improvement in learning outcomes in the experimental class was more optimal. Thus, it can be concluded that the AR-assisted Balinese local wisdom comic media is more effective in improving Indonesian language learning outcomes of third-grade elementary school students.

Hypothesis Testing Results

After the data met the assumptions of normality and homogeneity, the next step was hypothesis testing to determine the effectiveness of using AR-assisted Balinese local wisdom comic media on the Indonesian language learning outcomes of third-grade elementary school students. The analysis was based on the improvement in pretest and posttest data from both groups as obtained from the N-Gain Score analysis.

Table 5. Results of Independent Sample t-Test

N-Gain Score	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	1,24	0,27	-5,60	36	0,000	-0,28	0,05	-0,38	-0,18
Equal variances not assumed			-5,60	32,475	0,000	-0,28	0,05	-0,38	-0,18

Based on Table 5, the Sig. (2-tailed) value is 0.000, which is less than 0.05. Therefore, H₁ is accepted and H₀ is rejected. This indicates that there is a significant difference in the average learning outcome scores between the experimental group and the control group. This significant difference is reinforced by the N-Gain Score results, where the experimental class achieved an average N-Gain Score of 0.79, which is higher than the control class average of 0.51. This indicates that the improvement in student learning outcomes in the experimental class was higher. Thus, it can be concluded that the AR-assisted Balinese local wisdom comic media has a significant effect on improving the Indonesian language learning outcomes of



third-grade elementary school students. To strengthen these findings and determine the practical magnitude of the treatment effect, an effect size analysis was conducted. The results of the effect size calculation are presented in Table 6.

Table 6. Results of Effect Size Analysis Using Cohen's d

Class	Mean N-Gain Score	Std. Deviation	N	SD _{Pooled}	Cohen's d	Category
Control	0,51	0,18	19	0,16	1,78	Very Big Influence
Experiment	0,79	0,13	19			

Based on Table 6, the effect size calculated using Cohen's d was 1.78, indicating a very large practical effect. This substantial impact may be interpreted from several complementary perspectives. First, the AR-assisted comic likely introduced a learning experience that was significantly different from students' usual classroom instruction, which had previously relied more on conventional textbooks and limited interactive media. As a result, the novelty and multimodal nature of the medium may have increased students' attention, motivation, and active involvement in learning. Second, the integration of Balinese local wisdom, particularly the narratives of Pengrupukan and Nyepi, may have reduced students' learning barriers because the content was culturally familiar and emotionally meaningful. When students encounter stories, symbols, and situations that closely reflect their everyday lives, comprehension becomes easier because they are not only processing language, but also connecting it with prior cultural knowledge and lived experience. Thus, the large effect is likely not caused by technology alone, but by the combination of interactive AR features and culturally resonant content, which together created a more engaging, accessible, and meaningful learning environment for third-grade students.

Discussion

This study focuses on why the AR-assisted comic integrating Balinese local wisdom was able to improve Indonesian language learning outcomes and its implications for elementary education. The effectiveness of this media can first be understood from the developmental characteristics of third-grade students. At this stage, learners tend to grasp concepts more easily when information is presented concretely, visually, and in a structured manner. The comic format addresses this need by transforming narrative texts into sequential illustrations, short dialogues, and familiar storylines, making abstract language content more accessible (Mayer, 2002; Mayer, 2019). Therefore, the improvement in learning outcomes did not occur simply because students used a new medium, but because the medium aligned with how young learners process and organize meaning.

Another crucial factor is the integration of Balinese local wisdom into the story content. Themes such as Pengrupukan and Nyepi likely reduced the distance between school literacy and students' everyday cultural experiences. When learning materials reflect the students' social environment, language is processed not as isolated information, but as something connected to memory, identity, and everyday understanding (Caingcoy, 2023; Oktavianti, Hendratno, & Subrata, 2026). This cultural familiarity may have helped students engage more deeply with texts, interpret events more easily, and respond with greater emotional involvement. Therefore, the comic's impact is best understood not merely as an attractive design, but as culturally relevant content functioning as a bridge that removes learning barriers, especially for students who struggle when instructional texts feel distant from their own world (Vélez-Ibáñez & Greenberg, 1992).

The role of Augmented Reality (AR) should also be interpreted carefully. Its contribution was likely significant not only because it introduced technology, but because it



enriched the learning experience through multimodal representation. Audio narration, animation, and visual reinforcement supported students in processing information through multiple channels, which may have strengthened comprehension and retention (Mayer, 2019; Handayani & Nurlina, 2024). In classrooms that traditionally relied on textbooks and teacher explanations, AR created a sense of novelty and active participation, allowing students not only to read, but also to see, hear, and interact with the content in a way that directly supported meaning-making.

The findings also suggest broader implications regarding educational equity. The media appears to support not only higher achievement, but also more even understanding among students. Well-designed instructional media can function as a scaffold for learners with different initial ability levels. Visual sequencing, contextualized stories, and interactive support may help weaker students keep up, while still maintaining engagement for stronger students (Hambali, Nawir, & Nasir, 2023). From this perspective, the comic is not merely an alternative teaching aid, but a pedagogical tool that can help reduce comprehension gaps in elementary classrooms.

From a wider educational standpoint, this study supports the idea that literacy learning in elementary school should not be treated as a purely technical exercise focused solely on decoding and answering questions. Literacy is shaped by context, meaning, and cultural connection. Therefore, combining local wisdom with interactive technology provides a strategic direction for instructional innovation: digital media in elementary education becomes more powerful when rooted in students' cultural realities, rather than adopted for technology's sake. For teachers, culturally grounded and multimodal media can make Indonesian language learning more meaningful and engaging. For schools and curriculum developers, this highlights the importance of creating instructional resources that integrate literacy goals, character education, and local cultural values in a coherent manner (Caingcoy, 2023; Oktavianti et al., 2026).

Overall, the significance of this study lies in demonstrating that the success of instructional media depends on the interaction between pedagogy, culture, and technology. The AR-assisted Balinese local wisdom comic was effective not only because it was visually appealing or technologically innovative, but because it connected learning content with students' developmental needs and cultural identity. This finding reinforces the broader view that meaningful innovation in elementary education should not separate digital advancement from local relevance; rather, both should work together to create learning experiences that are accessible, engaging, and educationally transformative.

Conclusion

The expert validation results showed a validity coefficient of 1.00, indicating that the Balinese local wisdom-based AR-assisted comics had very high validity in terms of material, media, and language, and were feasible for use in elementary school Indonesian language learning. The practicality test also demonstrated a very high category, with an average score of 92.68%, showing that the media were easy to use, engaging, and supportive of classroom learning for both teachers and students. In terms of effectiveness, the AR-assisted comics were proven to improve the learning outcomes of third-grade students. The experimental group achieved a higher N-Gain score than the control group, and the effect size analysis showed a very large impact. These findings indicate that the comics not only enhanced students' comprehension and engagement but also supported the integration of Balinese



cultural values, making them a relevant and innovative medium for interactive and contextual Indonesian language learning.

Recommendation

Based on the scope and limitations of this study, several recommendations are proposed for classroom practice and future research. Elementary school teachers are encouraged to use AR-assisted comics based on Balinese local wisdom as an alternative to conventional textbook-based instruction, particularly in Indonesian language learning. By integrating visual narratives, audio, and AR features, this medium can enhance students' engagement, reading and listening comprehension, and overall learning experience. Teachers are also advised to incorporate local cultural contexts into literacy instruction and to design guided activities, such as reading, listening, and discussion tasks, so that AR functions as a pedagogical support rather than merely as entertainment.

For future research, broader samples across different grade levels, schools, and regions are needed to strengthen the generalizability of the findings. Future studies may also examine other variables, such as motivation, digital literacy, reading interest, teacher readiness, and school technological infrastructure. In addition, longer intervention periods, more controlled experimental designs, and the use of more advanced AR features are recommended to further explore the long-term effectiveness of Balinese local wisdom-based AR comics in improving elementary students' reading and listening outcomes.

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