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Development and Feasibility of a 3D Augmented Reality-Based Picture Storybook to Support the Reading Motivation of Third-Grade Students

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ABSTRAK

The low level of reading motivation among elementary school students remains a significant challenge in Indonesian language learning. The 2022 Programme for International Student Assessment (PISA) reported that Indonesia's reading literacy score was 359, which is substantially below the OECD average of 476, highlighting the need for more interactive and engaging instructional media. This study aimed to develop a 3D Augmented Reality (AR)-based Picture Storybook that is both feasible and effective in supporting students' reading motivation. The novelty of this study lies in the integration of a picture storybook with QR code-based 3D Augmented Reality (AR) technology. This research employed the Research and Development (R&D) method using the ADDIE model and was conducted at SDN Sukorejo 01, involving 19 third-grade students. Data were collected through observations, interviews, documentation, and questionnaires, and were analyzed using percentage analysis, validity testing, reliability testing, and the One-Sample t-test. The findings indicated that the developed media achieved a very feasible category, with validation scores of 88% from media experts, 92% from subject matter experts, 90% from teachers, and 87.4% from students. The results of the One-Sample t-test revealed that the mean reading motivation score was significantly higher than the predetermined benchmark (Sig. < 0.001), indicating that the developed media met the established effectiveness criteria. This study is limited by its relatively small sample size (n = 19), the use of a single research site, and the evaluation of effectiveness based solely on a One-Sample t-test without a comparison group. Therefore, the findings should be interpreted within the scope and limitations of the study.

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1. INTRODUCTION

Reading literacy is one of the essential competencies that serves as the foundation for students' success in acquiring knowledge, developing critical thinking skills, solving problems, and fostering lifelong learning abilities [1]. n Indonesian language learning at the elementary school level, reading is not merely defined as the ability to recognize written language symbols but also as the ability to comprehend, interpret, evaluate, and utilize information obtained from various reading materials[2]. Therefore,

developing reading skills from the early stages of formal education is a crucial component in preparing students to become literate, adaptive individuals who are capable of addressing the challenges of the twenty-first century. However, the achievement of reading competence is influenced not only by students' cognitive abilities but also by their reading motivation, which serves as a primary driving force for engagement in reading activities. The higher the level of students' reading motivation, the greater their opportunity to develop literacy skills optimally [3].

Various empirical studies have indicated that reading literacy among Indonesian students remains a major challenge in improving the quality of education. According to the Programme for International Student Assessment (PISA) 2022, published by the Organisation for Economic Co-operation and Development (OECD), Indonesia's reading literacy score was 359, which remains well below the OECD average of 476. Furthermore, only approximately 25% of Indonesian students achieved the minimum reading proficiency at Level 2, compared with the OECD average of 74%[4]. These findings indicate that the majority of students continue to experience difficulties in comprehending information, establishing connections among ideas within a text, and critically evaluating reading materials. This condition is consistent with the 2024 Indonesian Education Report Card (Rapor Pendidikan Indonesia 2024), which identifies literacy improvement as one of the priority indicators in the transformation of national education quality [5]. Meanwhile, Statistics Indonesia (BPS), through Statistics Indonesia 2024, reported that internet usage among school-aged children has continued to increase annually[6]. Nevertheless, the widespread access to digital technology has not been accompanied by a corresponding improvement in the quality of reading literacy activities. Therefore, the integration of digital technology into classroom instruction should be directed toward enhancing students' reading motivation and engagement in reading activities. These findings underscore the need for innovative instructional media that are not only visually engaging but also capable of optimizing the use of digital technology to support students' reading motivation.

Instructional media play a crucial role in creating effective learning experiences by facilitating students' understanding of learning materials in accordance with their developmental characteristics. According to Crowther (2019), picture storybooks are instructional media that combine textual content with visual illustrations to help children understand stories, expand their vocabulary, stimulate their imagination, and increase their engagement in reading activities[7]. Advances in technology have further encouraged the development of three-dimensional (3D) learning materials that provide more authentic and engaging visual representations of objects. In addition, Ghina Rohmatullah (2022) stated that 3D learning media can enhance students' attention, engagement, and comprehension by presenting learning objects in a more realistic manner [8]. One implementation of 3D instructional media is Augmented Reality (AR), which, according to Milgram and Kishino (1994), is a technology that integrates virtual objects with the real environment in real time, thereby enabling students to interact directly with digital objects[9]. Mayer's Cognitive Theory of Multimedia Learning (2002) explains that the integration of text, images, and interactive visual elements enhances the learning process through the simultaneous processing of verbal and visual information, thereby providing a strong conceptual foundation for integrating picture storybooks with 3D Augmented Reality technology[10]. Furthermore, according to Keller's ARCS Motivation Model (2010), learning motivation can be enhanced through instructional media that capture students' attention, are relevant to their needs, build their confidence, and provide satisfying learning experiences [11]. Therefore, 3D Augmented Reality-based picture storybooks have a strong theoretical foundation for use as instructional media to support students' reading motivation. [37]

This study is grounded in three complementary theoretical frameworks that align with its research objectives. The media development process was guided by the ADDIE model, popularized by Robert Maribe Branch (2009). This model provides a systematic framework for instructional media development through five phases: Analysis, Design, Development, Implementation, and Evaluation[12]. According to Suharsimi Arikunto (2019), instructional media are considered feasible when they meet the required standards for content, presentation, language, and graphical design, as determined through expert evaluation. Accordingly, the quality of the developed media was assessed based on the concept of feasibility evaluation [13]. Furthermore, the effectiveness theory proposed by Cherniss and Goleman (2001) was adopted to evaluate the effectiveness of the developed media in supporting students' reading motivation. This theory suggests that the success of an instructional intervention is reflected in increased student motivation, engagement, persistence, and intrinsic drive to achieve learning objectives[14]. Collectively, these three theoretical foundations provide a comprehensive conceptual framework for explaining the media development process, evaluating product quality, and assessing the effectiveness of the developed media in supporting students' reading motivation.

Previous studies have demonstrated that both picture storybooks and Augmented Reality (AR) contribute positively to improving reading instruction in elementary education. The use of picture

storybooks has been shown to enhance students' reading motivation and interest by presenting engaging illustrations that encourage greater enthusiasm and participation in reading activities. However, these studies were limited to conventional printed books without the support of digital technology[15]. Similarly, the development of picture storybooks has been reported to be feasible for Indonesian language instruction because it helps students comprehend reading materials while fostering character values. Nevertheless, these instructional media remain limited to printed formats and have not incorporated three-dimensional (3D) technology or Augmented Reality (AR)[16]. Studies on AR storybooks have further revealed that such media can improve students' reading motivation, promote positive attitudes toward reading, and increase engagement by providing more interactive and immersive reading experiences. However, these media have not been specifically developed to accommodate the characteristics of Indonesian language instruction at the elementary school level in Indonesia [17]. Other studies have also demonstrated that Augmented Reality-based storybooks positively influence students' reading comprehension, story-retelling ability, and reading motivation compared with conventional storybooks. Nevertheless, the developed products have not integrated physical picture storybooks with three-dimensional object visualization[18]. [38]

In addition, numerous studies have reported that the use of Augmented Reality (AR) enhances students' attention, engagement, learning experiences, and reading comprehension. However, its implementation has primarily focused on specific learning contexts or different educational levels and has not specifically developed 3D Augmented Reality (AR)-based picture storybooks as instructional media for Indonesian language learning to support the reading motivation of third-grade elementary school students[19]. Based on the review of previous studies, the novelty of this research lies in the development of a 3D Augmented Reality (AR)-based picture storybook that integrates a printed storybook with interactive three-dimensional object visualization as an instructional medium for Indonesian language learning in elementary schools. Unlike previous studies, which generally focused either on conventional picture storybooks or on the use of Augmented Reality (AR) as a standalone visual medium, this study combines both approaches into a single instructional product designed in accordance with the learning outcomes for third-grade Indonesian language instruction. Furthermore, this study extends beyond media development and feasibility evaluation by examining the effectiveness of the developed media in supporting students' reading motivation through a more interactive, contextual, and immersive reading experience. Therefore, this study is expected to contribute to the advancement of innovative instructional media that integrate digital technology with reading literacy to support Indonesian language learning at the elementary school level.

The significance of this study is underscored by the importance of improving reading literacy as a key priority in educational development at both the national and international levels. Globally, Sustainable Development Goal (SDG) 4 aims to ensure inclusive, equitable, and quality education while emphasizing the development of literacy competencies as a foundation for lifelong learning[20]. In Indonesia, the government has identified the promotion of literacy culture as a strategic effort to enhance the quality of human resources through the National Literacy Movement (Gerakan Literasi Nasional/GLN) established by the Ministry of Education, Culture, Research, and Technology [21]. Moreover, the implementation of the Merdeka Curriculum emphasizes student-centered learning through the integration of digital technology and the development of innovative instructional media to create active, contextual, and meaningful learning experiences [22]. Nevertheless, findings from both national and international assessments indicate that Indonesian students' reading literacy continues to require substantial improvement. Consequently, innovative instructional media are needed to strengthen students' reading motivation while optimizing the integration of digital technology into the learning process. Accordingly, the development of a 3D Augmented Reality-based picture storybook represents an important alternative instructional medium for advancing SDG 4, as it not only supports the implementation of the Merdeka Curriculum and the digital transformation of education but also contributes to strengthening the reading literacy culture among elementary school students.

The preliminary observations conducted at SDN Sukorejo 01 through classroom observations and interviews with the third-grade teacher revealed that Indonesian language instruction continues to face challenges in fostering students' reading motivation. These challenges were reflected in students' low enthusiasm during reading activities, the fact that several students still experienced difficulties in comprehending reading materials, and the continued reliance on conventional teaching methods and printed textbooks as the primary instructional media, which limited the creation of engaging and dynamic learning experiences. Although the school has access to digital technology, its integration into literacy instruction remains limited. These findings highlight the need for innovative instructional media that integrate digital technology with picture storybooks to better support students' reading motivation. Accordingly, this study aims to develop a 3D Augmented Reality-based picture storybook as an instructional medium for Indonesian language learning, evaluate its feasibility based on expert validation,

and examine its effectiveness in supporting the reading motivation of third-grade students at SDN Sukorejo 01. The findings of this study are expected to contribute to the development of innovative instructional media while providing an alternative approach to strengthening the reading literacy culture in elementary schools.

2. METHODS

This study employed a Research and Development (R&D) approach to develop a 3D Augmented Reality (AR)-based picture storybook as an instructional medium for Indonesian language learning and to evaluate its feasibility and effectiveness based on predetermined criteria [23]. The study was conducted at SDN Sukorejo 01 over a three-month period, from January to March 2026, using the ADDIE instructional design model (Analysis, Design, Development, Implementation, and Evaluation), which consists of five sequential phases: analysis, design, development, implementation, and evaluation[24]. The research participants comprised 19 third-grade students selected through purposive sampling, a sampling technique in which participants are chosen according to specific criteria aligned with the objectives of the study. The participant selection process began with classroom observations and interviews with the third-grade teacher to identify the characteristics of Indonesian language instruction across the lower elementary grades. Based on these findings, the third grade was selected because students had entered Phase B of the Merdeka Curriculum, which requires them to read fluently, comprehend reading materials, identify main ideas, and retell the content of texts. However, the preliminary observations revealed that several students still experienced reading difficulties, had limited comprehension of longer narratives, demonstrated relatively low reading motivation, and showed greater interest in visually rich and technology-enhanced instructional media.

These characteristics were considered appropriate for the objectives of the study; therefore, all third-grade students who met the established criteria were included as research participants. During the Analysis phase, classroom observations, interviews, and document analysis were conducted to identify the curriculum in use, students' characteristics, existing instructional media, and the need for media development. The Design phase involved preparing the storyboard, selecting the fable content, designing the illustrations and book layout, and planning the 3D Augmented Reality (AR) features. In the Development phase, the instructional media were created using Canva, ChatGPT, Adobe Photoshop, Assemblr Edu, and Book Creator. The prototype was subsequently validated by a subject matter expert, a media expert, and the third-grade teacher as the classroom practitioner before being revised in accordance with their recommendations. During the Implementation phase, the developed media were used in Indonesian language instruction to collect data regarding their feasibility and students' reading motivation. Finally, the Evaluation phase involved analyzing the results of expert validation, teacher responses, student responses, and the reading motivation questionnaire to refine the final product.

Prior to conducting the study, the researcher submitted a formal research permission request to the principal of SDN Sukorejo 01 and coordinated with the third-grade teacher regarding the research schedule and implementation procedures. After obtaining approval from the school, preliminary observations and interviews were conducted to identify instructional needs and determine the research participants. The implementation phase consisted of four instructional sessions. During the first session, the researcher introduced the study to the students, explained the learning objectives, and provided instructions on how to use the instructional media. The second session focused on the use of the 3D Augmented Reality-based picture storybook in Indonesian language learning. In the third session, students read the story, accessed the three-dimensional objects by scanning QR codes, and discussed the story with the teacher. During the fourth session, students completed the validated media response questionnaire and the reading motivation questionnaire. Upon completion of the instructional activities, the researcher conducted classroom observations, interviewed the third-grade teacher regarding the implementation of the learning process, documented the activities, and completed the required administrative procedures with the school. The data obtained from these procedures were subsequently analyzed to evaluate the feasibility and effectiveness of the developed instructional media.

Data were collected through classroom observations, interviews, questionnaires, and documentation. Classroom observations and interviews were conducted during the needs analysis phase to obtain

information regarding the learning conditions and students' characteristics. The questionnaire instruments were used to collect data on the feasibility of the developed instructional media through evaluations conducted by the subject matter expert, media expert, classroom teacher, and students. Meanwhile, data on the effectiveness of the developed media were obtained using a students' reading motivation questionnaire. The subject matter expert was a university lecturer with expertise in Indonesian language education and the development of instructional materials for elementary schools, whereas the media expert was a university lecturer specializing in educational technology and digital instructional media development. In addition, the third-grade teacher served as the classroom practitioner to evaluate the implementation of the developed instructional media during the learning process.

The subject matter expert validation instrument consisted of 10 items covering three aspects: the alignment of the instructional media with the intended learning competencies, the quality of the instructional content, and the appropriateness of the language used. Similarly, the media expert validation instrument consisted of 10 items assessing three aspects: visual design, image clarity and text readability, and ease of use. Before data collection, all research instruments were validated by expert validators to ensure their content validity, construct validity, and linguistic appropriateness, thereby confirming their suitability for use in the study.

The reading motivation questionnaire was developed based on the reading motivation theory proposed by Cherniss and Goleman. It consisted of 10 items representing three indicators: interest, attention, and willingness to read. The interest indicator measured students' interest in reading activities, enjoyment of reading picture storybooks, interest in the story content, and enthusiasm during reading activities. The attention indicator assessed students' attention to the relationship between illustrations and text, curiosity about the story content, and concentration while reading. The willingness to read indicator measured students' willingness to read without being instructed, their intention to finish reading a book, and their willingness to read independently without assistance from others. All questionnaire items were measured using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Higher scores indicated higher levels of students' reading motivation. Data were analyzed using descriptive quantitative methods, including feasibility analysis and effectiveness analysis. The feasibility analysis was based on the results of expert validation and user responses, which were subsequently converted into percentages using the following formula.

$$P = \frac{X}{X1} \times 100\%$$

Notes:

P : Percentage searched for
X : Respondent’s score for one item
X1 : Maximum possible score for one item
100% : Constant

The formula for calculating the overall questionnaire data is as follows:

$$P = \frac{\sum X}{\sum X1} \times 100\%$$

Notes:

P : Percentage searched for
X : Total score of respondents’ answers
X1 : Total maximum possible score
100% : Constant

Before being used in the study, all research instruments underwent content validity assessment by expert validators to evaluate the appropriateness of the indicators, the clarity of the language, and the relevance of each questionnaire item to the research objectives[25]. Subsequently, the reading motivation questionnaire was subjected to empirical validity testing using the Pearson Product–Moment correlation with the assistance of IBM SPSS. Each questionnaire item was considered valid if it obtained a significance value (Sig.) of < 0.05. After the instrument had been confirmed as valid, its reliability was

evaluated using Cronbach's Alpha. The instrument was considered reliable if the Cronbach's Alpha coefficient exceeded 0.60.

Table 1 Validity Criteria

Validity Criteria	Validity Level
80% - 100%	Highly Acceptable
61% - 80%	Acceptable
41% - 60%	Moderate
21% - 40%	Unacceptable
0% - 20%	Highly Unacceptable

Through this analysis, the researcher obtained an overview of the feasibility level of the developed instructional media.

The effectiveness analysis began with evaluating the quality of the reading motivation questionnaire through validity and reliability testing. Empirical validity was assessed using the Pearson Product–Moment correlation with the assistance of IBM SPSS, in which each questionnaire item was considered valid if it obtained a significance value (Sig.) of < 0.05.

Table 2 Validity Index Ranges

Index	Interpretation
0,81 – 1,00	Very High
0,61 – 0,80	High
0,41 – 0,60	Moderate
0,21 – 0,40	Low
0,00 – 0,20	Very Low

Subsequently, the reliability of the questionnaire was assessed using Cronbach's Alpha, with the instrument considered reliable if the Cronbach's Alpha coefficient exceeded 0.60. After the instrument had been confirmed as valid and reliable, the reading motivation data were tested for normality using the Shapiro–Wilk test, as the sample size comprised fewer than 30 participants[26]. The data were considered to be normally distributed if the significance value (Sig.) was > 0.05.

$$x^2 = \sum \frac{(f_0 - f_e)^2}{f_e}$$

Notes:

f_0 : Observation frequency
f_e : Expected frequency

The effectiveness of the developed instructional media was evaluated using the One-Sample t-test with the assistance of IBM SPSS at a significance level of 0.05. The instructional media were considered effective if the significance value (Sig.) was < 0.05 and the mean score of students' reading motivation was higher than the predetermined criterion value [27].

$$t_{hit} = \frac{\bar{x} - \mu_0}{\frac{s}{\sqrt{n}}}$$

Notes:

t : calculated t-value
$\bar{x}$: sample mean
μ_0 : parameter value
s : sample standard deviation

n : sample count

3. RESULT & DISCUSSION

a. Result

1) Development Process and Feasibility of the 3D Augmented Reality-Based Picture Storybook

(a) Analysis

The analysis phase of this study aimed to identify the existing learning conditions and collect preliminary data as the basis for developing the instructional media. Based on classroom observations and interviews with the third-grade teacher at SDN Sukorejo 01, the school had implemented the Merdeka Curriculum using a deep learning approach that emphasizes students' in-depth understanding of learning materials and their relevance to real-life contexts. However, the use of instructional media had not yet been fully optimized, resulting in learning activities that were relatively less varied. The teacher had previously implemented word cards within the Problem-Based Learning (PBL) model; however, their implementation was not optimal because of limited instructional time, and students tended to focus more on playing than on the intended learning activities. In contrast, the use of technology-based media, such as a Smart TV, generated greater student enthusiasm and participation during classroom instruction .

The content analysis focused on third-grade Indonesian language instruction, particularly on reading fiction and nonfiction texts and identifying character traits. In this study, fables were selected as the primary content because animal characters are easier to visualize through illustrations and can help students better understand the story while recognizing the characteristics of each character [28]. Furthermore, the use of animal characters supports the integration of 3D Augmented Reality (AR) features, enabling more engaging and varied visual representations. The analysis of students' reading abilities indicated that their reading skills still required improvement. Many students became easily bored when reading lengthy texts and experienced difficulties in understanding the storyline. These findings highlight the need for instructional media that are more engaging, user-friendly, and aligned with students' developmental characteristics. Therefore, the development of a 3D Augmented Reality-based picture storybook is expected to provide an effective instructional alternative for supporting students' reading motivation in Indonesian language learning.

(b) Design

The design phase was carried out after the completion of the analysis phase and focused on preparing the instructional media for development. A product storyboard was created using Canva to serve as the blueprint for developing the instructional media. The storyboard comprised the design of the front cover, the content pages, and the back cover of the picture storybook.

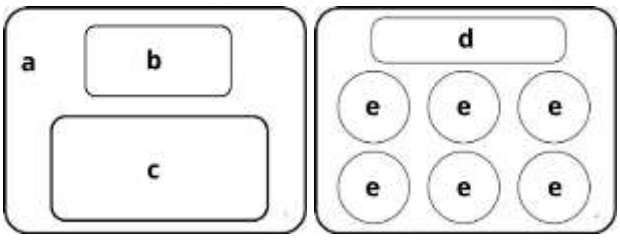

Figure 1 Front Cover

Figure 1 presents the design of the front cover of the picture storybook. The front cover consists of (a) the story setting background, (b) the story title, (c) the main characters, (d) instructions for scanning the QR code, and (e) the steps for accessing the QR code. During this phase, the researcher also determined the story title as well as the characters and their characteristics to be presented in the story.

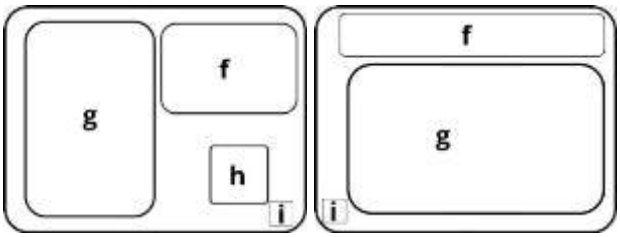

Figure 2 Table of Content

Figure 2 illustrates the layout of the content pages of the picture storybook. The content pages include (f) the story text, (g) illustrations corresponding to the story, (h) a QR code, and (i) the page number. The QR codes were placed only on selected pages, particularly those introducing the main characters. This design was intended to provide character information only at the characters' initial appearance, thereby avoiding unnecessary repetition on subsequent pages. Consequently, the placement of the QR codes was adapted to the narrative structure and the needs of the story.

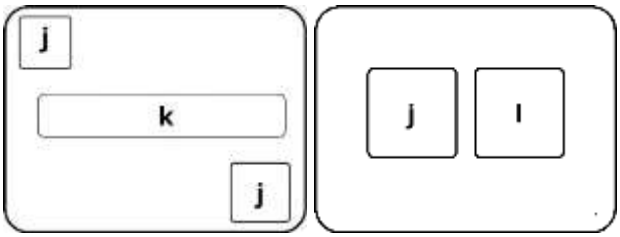

Figure 3 Back Cover

Figure 3 shows the design of the back cover of the picture storybook, which consists of (j) animal illustrations, (k) the moral message of the story, and (l) a QR code providing access to the PDF version of the picture storybook.

(a) Development

(1) Product Development Process

- The first stage involved determining the dimensions of the picture storybook, designing the layout of the content pages, and incorporating the fable storyline into the designated pages.

Figure 4 Design of the contents page

- The initial illustrations were designed using Canva to establish the visual foundation of the picture storybook.

Figure 5 Basic Illustration Design

- The illustrations were subsequently refined using ChatGPT and Adobe Photoshop to produce more engaging and realistic visual representations that aligned with the instructional objectives.

Table 3 Basic Illustration Design

Initial Illustration	After refinement using ChatGPT	After further refinement using Adobe Photoshop
		

- The 3D Augmented Reality (AR) content was then developed using Assemblr, featuring a forest habitat populated with animal and plant objects corresponding to the storyline.

Table 4 3D AR Animation Creation Process

Arranging 3D AR Elements	Adding Information Bubbles and Sound Effects	Creating a QR Code
		

- The completed illustrations were integrated into the content pages that had been prepared during the initial stage of the development process.

Figure 6 Combining elements using the Canva App

- The completed picture storybook was compiled into a digital format using Book Creator.

Figure 7 ***The process of creating a PDF version of the book***

- The final stage involved designing the book cover and preparing the instructions for accessing the QR code.

Table 5 Cover Layout

Front Cover	Instructions for Scanning the QR Code	Back Cover
		

(2) Product Validation

The product validation process was conducted by distributing questionnaire instruments to the expert validators. The questionnaires consisted of a series of statements evaluated using a five-point Likert scale.

The validation of the picture storybook instructional media involved one subject matter expert and one media expert.

- Subject Matter Expert Validation

The subject matter expert validation was conducted to evaluate the quality and appropriateness of the instructional content presented in the picture storybook. The validation instrument consisted of 10 questionnaire items measured using a five-point Likert scale. Both quantitative and qualitative data were collected to support the refinement of the developed product. The validation was conducted by Mrs. Karina Kurnia Sari, S.Si. The results of the subject matter expert validation are presented as follows:

Table 6 Results of Subject-Matter Expert Validation

No.	Assessment Aspect	Score
1.	Alignment of the resource with the intended learning outcomes	10
2.	Content and material	23
3.	Appropriateness of language	13
	Total	**46**
	Maximum Score	**50**
	Percentage	**92%**
	Note	**Highly Suitable**

- Media Expert Validation

The media expert validation was conducted to evaluate the feasibility of the developed picture storybook instructional media. The validation instrument consisted of 10 questionnaire items measured using a five-point Likert scale. The collected quantitative and qualitative data were used to improve the quality of the product. The validation was conducted by Mr. Muhammad Afton Ulin Nuha, M.Pd. The results of the media expert validation are presented as follows:

Table 7 Results of The Media Expert Validation

No.	Assessment Aspect	Score
1.	Presentation	13
2.	Clarity of images and legibility of text	13
3.	Ease of use of the media	18
	Total	**44**
	Maximum Score	**50**
	Percentage	**88%**
	Noted	**Higly Recomended**

Based on the comments and suggestions provided by the subject matter expert and the media expert, several revisions were made to the product. These revisions included enlarging the illustrations that were previously too small or insufficiently clear, adding the author's identity, and improving the smoothness of the 3D Augmented Reality (AR) animations. However, one recommendation could not be fully addressed, namely the relatively long QR code scanning time. This limitation was due to the characteristics of Augmented Reality (AR) technology, which requires a stable internet connection to function effectively. Consequently, when the network connection is weak or unstable, the QR code scanning process may take longer to complete.

(b) Implementation

During the implementation phase, the developed product was first implemented in Indonesian language instruction using the 3D Augmented Reality-based picture storybook as the instructional medium. Upon completion of the classroom implementation, data were collected using three questionnaire instruments: the teacher response questionnaire, the student response questionnaire regarding the instructional media, and the reading motivation questionnaire.

- Teacher Responses to the Picture Storybook Instructional Media

Table 8 Results of The Teacher

No.	Assessment Aspect	Score
1.	Appearance	13
2.	Content and Material	19
3.	Language	5
	Ease of Use	8
	Score	**45**
	Maximum Score	**50**
	Percentage	**90%**
	Note	**Highly Satisfactory**

The results of the teacher response questionnaire, which consisted of 10 items, yielded a percentage score of 90%, indicating that the developed instructional media fell into the highly feasible category for use in classroom instruction.

- Student Responses to the Picture Storybook Instructional Media

Tabel 9 Results of The Assessment of Pupils' Responses

No.	Name	Total marks	Percentage	Comments
1.	Yogi	43	86%	Highly Suitable
2.	Afrizal	43	86%	Highly Suitable
3.	Ahmad	43	86%	Highly Suitable
4.	Nindi	43	86%	Highly Suitable
5.	Ardan	42	84%	Highly Suitable
6.	Bianca	44	88%	Highly Suitable
7.	Dealova	45	90%	Highly Suitable
8.	Defita	43	86%	Highly Suitable
9.	Deren	42	84%	Highly Suitable
10.	Marcel	42	84%	Highly Suitable
11.	Enjel	46	92%	Highly Suitable
12.	Iandra	44	88%	Highly Suitable
13.	Putri	46	92%	Highly Suitable
14.	Ivan	44	88%	Highly Suitable
15.	Naufal	45	90%	Highly Suitable
16.	Rahma	42	84%	Highly Suitable
17.	Reva	48	96%	Highly Suitable
18.	Revika	45	90%	Highly Suitable
19.	Tegar	41	82%	Highly Suitable
	Mean	**43,7**	**87,4%**	**Highly Suitable**

Based on the results of the student response questionnaire, the maximum possible score was 50. The responses from the 19 students produced a mean score of 43.7, corresponding to a percentage of 87.4%. These findings indicate that the developed picture storybook instructional media were considered highly feasible for use as instructional media.

- Reading Motivation Questionnaire Results

The reading motivation questionnaire was administered to the students to assess their level of reading motivation following the use of the 3D Augmented Reality-based picture storybook during Indonesian language instruction.

Table 10 Results of The Motivation Questionnaire Assessment

No.	Name	Score	Percentage	Comments
1.	Yogi	43	86%	Highly Effective
2.	Afrizal	41	82%	Highly Effective
3.	Ahmad	43	86%	Highly Effective
4.	Nindi	45	90%	Highly Effective

5.	Ardan	48	96%	Highly Effective
6.	Bianca	44	88%	Highly Effective
7.	Dealova	46	92%	Highly Effective
8.	Defita	43	86%	Highly Effective
9.	Deren	41	82%	Highly Effective
10.	Marcel	45	90%	Highly Effective
11.	Enjel	45	90%	Highly Effective
12.	Iandra	44	88%	Highly Effective
13.	Putri	43	86%	Highly Effective
14.	Ivan	47	94%	Highly Effective
15.	Naufal	43	86%	Highly Effective
16.	Rahma	44	88%	Highly Effective
17.	Reva	45	90%	Highly Effective
18.	Revika	44	88%	Highly Effective
19.	Tegar	42	84%	Highly Effective
	Mean	**44**	**88%**	**Highly Effective**

Based on the results of the reading motivation questionnaire, as presented in the table above, the maximum possible score was 50. The responses from the 19 students yielded an overall mean score of 44, corresponding to a percentage of 88%. This percentage indicates that the students' reading motivation was classified as high.

(c) Evaluation

Following the implementation phase, the developed product entered the evaluation phase, which served as the final stage of refinement based on feedback from the classroom teacher and students. Based on the results of the instructional media questionnaire and the reading motivation questionnaire, no comments or suggestions requiring further revisions were identified. Instead, both the teacher and the students provided positive feedback regarding the developed product. These findings indicate that the developed picture storybook instructional media were considered highly feasible and effective for supporting students' reading motivation during the learning process. Therefore, the developed instructional media met the established feasibility criteria and required no further revisions. The product is expected to make a positive contribution to supporting students' reading motivation.

2) Effectiveness of the 3D Augmented Reality-Based Picture Storybook in Supporting Students' Reading Motivation

The data analysis in this study consisted of validity testing, reliability testing, normality testing, and the One-Sample t-test. Validity and reliability testing were conducted to ensure that the questionnaire instrument met the required standards of validity and reliability before being used for data analysis.

(a) Validity Test

The validity test was conducted to determine the validity of the reading motivation questionnaire. Prior to the empirical validity test, the instrument underwent content validity assessment by expert validators and was deemed appropriate for use in the study.

Table 11 Summary of The Validity Test Results for The Motivation Instrument

No.	Person Corelation	Sig. Value	Conclusion
1.	0,497	0,036	Valid
2.	0,547	0,019	Valid
3.	0,645	0,004	Valid
4.	0,481	0,043	Valid
5.	0,488	0,040	Valid
6.	0,528	0,024	Valid
7.	0,501	0,034	Valid
8.	0,556	0,016	Valid
9.	0,600	0,008	Valid

10.	0,529	0,024	Valid

Based on the results of the validity test presented in the table, all 10 items of the reading motivation questionnaire were found to be valid. This was indicated by significance values (Sig.) of < 0.05 for every questionnaire item. Based on the correlation coefficient values, most items were classified as having moderate validity, while one item was classified as having high validity.

(b) Reliability Test

Reliability testing was conducted to determine the internal consistency of the questionnaire instrument. In this study, reliability was assessed using Cronbach's Alpha with the assistance of IBM SPSS. The results of the reliability test are presented in the table below.

Table 12 Reliability Test Results

Cronbach's Alpha	N of Iems
0,727	10

As shown in the figure above, the Cronbach's Alpha coefficient was 0.727. This value indicates that the questionnaire instrument was reliable, as the Cronbach's Alpha coefficient exceeded the minimum acceptable threshold of 0.60. Therefore, the reading motivation questionnaire demonstrated good internal consistency and was considered suitable for use as a data collection instrument in this study.

(c) Normality Test

Normality testing was conducted to determine whether the data followed a normal distribution. In this study, normality was assessed using the Shapiro–Wilk test with the assistance of IBM SPSS. The normality test was performed based on the following criteria:

- Significance level (α) = 0.05
- If the significance value (Sig.) was > α, the data were considered to be normally distributed.
- If the significance value (Sig.) was < α, the data were considered not to be normally distributed.

The results of the normality test are presented in the following figure:

Table 13 Normality Test Results

	Kolmogrov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
MOTIVATION	0,134	19	0,200		19	0,487

Based on the results of the normality test presented in the table, the Shapiro–Wilk test produced a significance value of 0.487, which was greater than 0.05. This result indicates that the reading motivation data were normally distributed. Therefore, the assumption of normality was satisfied, allowing the analysis to proceed using the One Sample t-test.

(d) One Sample t-Test

The One-Sample t-test was conducted to evaluate the effectiveness of the 3D Augmented Reality-based picture storybook in supporting students' reading motivation. This statistical test was selected because the study involved only a single group of participants without a comparison group.

The test value used in this study was 30, which was derived from the midpoint of the five-point Likert scale. Given that the reading motivation questionnaire consisted of 10 items, the maximum possible score was 50. The test value served as the benchmark for determining whether students' reading motivation was above or below the predetermined criterion. The analysis was performed at a significance level of 0.05, with the following decision criteria:

- If the significance value (Sig. (2-tailed)) was < 0.05, the difference between the sample mean and the test value was considered statistically significant.
- If the significance value (Sig. (2-tailed)) was > 0.05, the difference between the sample mean and the test value was considered not statistically significant.

The results of the One-Sample t-test are presented in the following figure:

Table 14 Results of The One-Sample T-Test

	Test Value = 30					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
MOTIVATION	33,425	18	<0,001	14.000	13,12	14.88

Based on the results of the One-Sample t-test on the students' reading motivation data, the significance value (Sig. (2-tailed)) was < 0.001, with a calculated t-value of 33.425. This result indicates a statistically significant difference between the mean reading motivation score and the predetermined test value. The mean reading motivation score was 44, which exceeded the test value of 30 by 14 points. These findings demonstrate that the developed instructional media met the effectiveness criteria established in this study.

b. Discussion

1) Development Process of the 3D Augmented Reality-Based Picture Storybook

The use of instructional media in third-grade Indonesian language classes at SDN Sukorejo 01 was still predominantly limited to textbooks and simple presentation media, providing relatively few opportunities for interactive learning. Consequently, students tended to become easily bored, showed limited attention during classroom activities, and experienced difficulties in understanding reading passages and following storylines[29]. Classroom observations further revealed that some students had not yet achieved fluent reading skills and showed greater interest when instruction incorporated visual and technology-based media, such as a Smart TV. These findings suggest that elementary school students require instructional media capable of integrating visual elements, text, and digital technology to create more engaging learning experiences. This finding is consistent with the study by Elmayanti, which reported that picture storybooks help students comprehend reading materials while stimulating their curiosity, as well as the study by Salsabila Dwi Karna, which demonstrated that engaging instructional media can enhance students' participation during the learning process [30], [31]. The instructional media were developed using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. During the analysis stage, students' needs and the characteristics of the learning process were identified as the basis for developing the instructional media. The design stage resulted in a storyboard containing the storyline, illustrations, and the visual layout of the picture storybook[32]. Subsequently, during the development stage, the media were produced using Canva, Adobe Photoshop, Assemblr, Book Creator, and ChatGPT, resulting in a picture storybook integrated with 3D Augmented Reality (AR) features[33]. The integration of these applications enabled the development of instructional media that were visually engaging, systematically organized, and appropriate for the developmental characteristics of elementary school students [34]. According to Crowther, picture storybooks facilitate students' comprehension by integrating written text with visual illustrations, thereby providing concrete visual representations of the story content[7]. Similarly, Ghina Rohmatullah argued that three-dimensional instructional media enhance learning experiences by allowing students to observe objects more realistically than conventional two-dimensional media[8]. This perspective is further supported by Milgram and Kishino, who defined Augmented Reality (AR) as a technology that integrates virtual objects into the real-world environment in real time, thereby creating more meaningful learning interactions [9]. Therefore, integrating picture storybooks with 3D Augmented Reality (AR) technology provides a reading experience that is not only visually engaging but also promotes greater student engagement throughout the learning process. [39]

2) Feasibility of the 3D Augmented Reality-Based Picture Storybook in Supporting Students' Reading Motivation

The feasibility of the developed instructional media was evaluated based on its validity and practical use, including assessments conducted by the media expert, the subject matter expert, as well as responses from the classroom teacher and the students. First, validation by the media expert and the subject matter expert was conducted to evaluate the feasibility of the developed product. The results of the expert validation are presented in the following table.

Table 15 Validation Sheet Assessment Results

Validator	Maximum Score	Total Assessment Score	Percentage Comments	Comments
Media Expert	50	44	88%	Highly Acceptable
Content Expert	50	46	92%	Highly Acceptable

Based on the validation conducted by the media expert and the subject matter expert, the 3D Augmented Reality (AR)-based picture storybook was classified as highly feasible. Although the instructional media achieved this classification, the validators provided several recommendations for improvement, including enhancing the smoothness of the 3D Augmented Reality (AR) animations, enlarging several illustrations, and adding the author's identity. These suggestions were incorporated into the revision process to further improve the quality of the instructional media.

Subsequently, responses from the classroom teacher and the students were collected to evaluate the practical feasibility of the developed instructional media during classroom implementation. The results are presented in the following table.

Table 16 Respondents' Assessment Results

Respondent	Maximum Score	Total Assessment Score	Percentage	Comments
Respon Guru	50	45	90%	Highly Satisfactory
Respon Siswa	50	43,7	87,4%	Highly Satisfactory

The validation results showed that the instructional media obtained a feasibility score of 88% from the media expert and 92% from the subject matter expert, placing the product in the highly feasible category. In addition, the teacher's evaluation yielded a score of 90%, while the students' responses reached 87.4%, both of which also fell within the highly feasible category. These findings indicate that the developed instructional media satisfied the criteria for content suitability, presentation, language use, visual design, readability, and ease of use in classroom instruction. Nevertheless, the validators recommended several refinements, including improving the smoothness of the 3D Augmented Reality (AR) animations, enlarging the illustrations, and adding the author's identity. These recommendations were implemented to refine the product before its classroom application. The high feasibility of the developed instructional media can be attributed to its ability to integrate textual content, visual illustrations, and digital technology into a unified learning experience. According to Crowther, illustrations in picture storybooks facilitate students' comprehension by strengthening the relationship between text and images, thereby supporting their understanding of the story content[7]. In the present study, these illustrations were further enhanced through three-dimensional visualizations, allowing students not only to read the story but also to observe concrete visual representations of the characters and story elements. [40]

From a technological perspective, Milgram and Kishino explained that Augmented Reality (AR) enables virtual objects to be integrated with the real-world environment in real time, thereby enhancing learners' interaction with instructional content Likewise, Ghina Rohmatullah argued that three-dimensional instructional media improve the quality of concept visualization and provide more authentic learning experiences [8]. Therefore, integrating picture storybooks with 3D Augmented Reality (AR) technology enabled the developed instructional media to satisfy both content-related and media-related feasibility criteria.

These findings are consistent with those reported by Anggun Manjakani, who found that picture storybooks received positive responses because they increased students' interest in reading activities [15]. Similarly, Suhartina et al. concluded that picture storybook media were suitable for Indonesian language instruction, as they fulfilled the criteria of content quality, presentation, and language appropriateness [16]. However, the present study extends previous research by not only developing a conventional picture storybook but also integrating 3D Augmented Reality (AR) technology, which presents three-dimensional objects through QR code scanning. This integration creates a more interactive reading experience and reflects recent advances in educational technology.

3) Effectiveness of the 3D Augmented Reality-Based Picture Storybook in Supporting Students' Reading Motivation

The effectiveness of the developed instructional media was evaluated using the One-Sample t-test, which compared the mean reading motivation score with a predetermined test value of 3, representing the midpoint of the five-point Likert scale. The analysis revealed that the students' mean reading motivation score was 4.4, exceeding the predetermined reference value. Furthermore, the One-Sample t-test yielded a significance value of Sig. (2-tailed) < 0.001 with a t-value of 33.425, indicating that the mean reading motivation score was significantly higher than the reference value. Therefore, the developed instructional media met the effectiveness criteria established in this study. These findings indicate that the students demonstrated a high level of reading motivation after using the instructional media. However, the results should not be interpreted as evidence that the instructional media increased students' reading motivation, as the research design did not compare students' motivation before and after the intervention. Instead, the findings indicate that the observed level of reading motivation exceeded the predetermined reference criterion. From a theoretical perspective, the high reading motivation scores can be explained by the reading motivation theory proposed by Cherniss and Goleman, which emphasizes that motivation is influenced by students' interest, attention, and willingness to engage in reading activities[14]. The 3D Augmented Reality (AR)-based picture storybook attracted students' attention through engaging illustrations, three-dimensional visualizations, and interactive QR code features. As students experienced a more engaging and interactive reading process, their curiosity about the story increased, leading to greater attention to the reading material. This heightened attention subsequently encouraged students to complete the reading activities independently. These findings suggest that integrating picture storybooks with Augmented Reality (AR) technology has the potential to support students' reading motivation by fostering greater interest, attention, and willingness to read.

The findings of this study are consistent with those reported by Anggun Manjakani, who found that picture storybooks increased students' interest in reading activities. Similarly, Martia Sitorus reported that picture storybook media helped students comprehend reading materials while creating a more enjoyable learning environment [35]. Likewise, Okta Nur concluded that picture storybook media were effective in fostering elementary school students' interest in reading[36]. However, the present study extends previous research by integrating picture storybooks with 3D Augmented Reality (AR) technology, enabling students not only to read stories through visual illustrations but also to experience interactive learning through three-dimensional object visualization. This integration broadens the application of picture storybooks as digital instructional media capable of addressing the learning characteristics of twenty-first-century students. From a practical perspective, the developed instructional media provide teachers with an innovative alternative for creating Indonesian language learning experiences that are more engaging, interactive, and aligned with current technological developments.

From a theoretical perspective, the findings of this study reinforce Crowther's concept regarding the role of picture storybooks in supporting reading comprehension, Milgram and Kishino's theory on the effectiveness of Augmented Reality (AR) as an interactive instructional medium, Ghina Rohmatullah's perspective on the advantages of three-dimensional instructional media, and the reading motivation theory proposed by Cherniss and Goleman, which identifies interest, attention, and willingness as the primary components of reading motivation[8], [9]. This study has several limitations. First, the study involved only 19 students from a single elementary school, limiting the generalizability of the findings. Second, the instructional media were implemented over a relatively short period; therefore, the study does not capture their long-term effects. Third, the effectiveness of the instructional media was evaluated using a One-Sample t-test, which compared the mean reading motivation score with a predetermined reference value. Consequently, the findings indicate only that the students' reading motivation scores exceeded the reference criterion and should not be interpreted as evidence that the instructional media caused an improvement in reading motivation. Therefore, future research is recommended to employ experimental designs incorporating a control group or pretest-posttest designs, recruit larger and more diverse samples, and investigate the effects of the developed instructional media on students' reading achievement in addition to their reading motivation.

4. CONCLUSION

This study successfully developed a 3D Augmented Reality (AR)-based picture storybook as an instructional medium using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The novelty of this study lies in the integration of a picture storybook with 3D Augmented Reality (AR) technology accessed through QR codes, providing a more interactive reading experience that is aligned with the developmental characteristics of elementary school students. Based on the validation results, the instructional media achieved feasibility scores of 88% from the media expert, 92% from the subject matter expert, 90% from the classroom teacher, and 87.4% from the students, indicating that the product was highly feasible for use in Indonesian language instruction. The results of the One-Sample t-test showed that the students' mean reading motivation score was significantly higher than the predetermined reference value (Sig. < 0.001), indicating that the instructional media met the effectiveness criteria established in this study. However, these findings indicate only that the students' reading motivation scores after using the instructional media exceeded the predetermined reference value and should not be interpreted as evidence that the instructional media improved reading motivation, as the study did not include baseline measurements or a comparison group. This study has several limitations, including the relatively small sample drawn from a single elementary school, the short implementation period, and the evaluation of effectiveness using only a One-Sample t-test without a pretest or comparison group. Therefore, future studies are recommended to involve larger and more diverse samples, employ more rigorous experimental designs, such as a pretest-posttest control group design, and investigate not only students' reading motivation but also their reading ability, reading comprehension, and learning outcomes. For educational practitioners, the developed instructional media may serve as an alternative resource for Indonesian language instruction by integrating picture storybooks with digital technology to create learning experiences that are more engaging, interactive, and aligned with the development of twenty-first-century education.

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