JPPIPA 12(5) (2026)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Development of AR-Based Interactive Reading Media to Support SDG 4 and Improve Student Learning Independence at SDN Lemahireng

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Received: February 13, 2026
Revised: April 26, 2026
Accepted: May 25, 2026
Published: May 31, 2026

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DOI: 10.29303/jppipa.v12i5.14975

Abstract: This study aimed to develop and examine the feasibility and effectiveness of an Augmented Reality (AR)-Based Reading Book learning media on science learning outcomes related to the human digestive system for fifth-grade students at SDN Lemahireng. The study employed a Research and Development (R&D) method using the ADDIE model, consisting of analysis, design, development, implementation, and evaluation stages. The participants were 30 fifth-grade students selected from one class during the product trial. Data were collected through pretest and posttest, observations, interviews, questionnaires, and documentation. Data analysis included normality, homogeneity, N-Gain, and paired sample t-test. The validation results showed that the media was highly feasible, with scores of 90% from material experts and 96% from media experts. The average student score increased from 62.63 in the pretest to 82.00 in the posttest, with an N-Gain score of 0.52 in the moderate category. The paired sample t-test indicated a significant improvement in learning outcomes ($t = 10.87$, Sig. < 0.05). In addition, students gave positive responses toward the media, reaching 89.69%. In conclusion, the AR-Based Reading Book learning media is feasible and effective in improving students' science learning outcomes.

Keywords: Augmented reality (AR); Learning media; Learning outcomes

Introduction

Education plays a crucial role in shaping individuals with character, knowledge, and the skills needed to participate responsibly in society (Akbar et al., 2024). This is in line with Law Number 20 of 2003 concerning the National Education System, which states that education is a conscious and planned effort to develop students' potential holistically. In its implementation, the curriculum serves as a fundamental guideline that directs the learning process systematically and in accordance with national education goals. Through the Independent Curriculum, learning is designed to strengthen student competencies by balancing knowledge, skills, and attitudes (Al Ghifari et al., 2026). One of the transformations in this curriculum is the integration of Natural Sciences (IPA) and Social Sciences (IPS) into Natural and Social Sciences (IPAS) (Alawyah et al., 2024). This integration is expected to improve students' competencies, enabling them to adapt to scientific developments and global challenges more effectively (Amalia et al., 2025). In addition, science learning is not only directed toward conceptual mastery but also toward the development of Graduate Profile Dimensions, including learning independence (Aman et al., 2025). According to the Ministry of Education and Culture Regulation No. 058/H/KR/2025 concerning the Learning Outcomes Flow, learning independence refers to students' ability to manage and direct their own learning process without excessive dependence on teachers or others.

How to Cite:
Ikhtiarini, S. A., & Kurnianto, B. K. (2026). Development of AR-Based Interactive Reading Media to Support SDG 4 and Improve Student Learning Independence at SDN Lemahireng: Pengembangan Media Interaktif Berbasis AR dalam Membaca Buku. *Jurnal Penelitian Pendidikan IPA*, *12*(5), 549–560. https://doi.org/10.29303/jppipa.v12i5.14975

Learning independence is essential because it encourages discipline, responsibility, initiative, and problem-solving abilities in students. However, students' independent learning behavior remains relatively low. Several factors contribute to this issue, including internal factors such as intellectual ability, emotional condition, and physical readiness, as well as external factors such as family environment, school facilities, and learning methods. The PISA 2022 Results Factsheets – Indonesia also indicate that Indonesian students' ability to apply knowledge independently and creatively is still below the OECD average. Initial observations and interviews conducted at SDN Lemahireng on Monday, January 26, 2026, revealed similar conditions. Fifth-grade teachers explained that although interactive learning media had been used in both physical and digital forms, limitations in learning resources, such as inadequate projector availability and limited media variation, still affected the learning process. Furthermore, although students showed initial interest during classroom activities, their sustained engagement and initiative in independent exploration remained low.

One effort to foster learner autonomy is through the use of innovative and engaging learning media (Andrianu et al., 2025). Learning media function as tools that support the teaching and learning process by helping students understand learning materials more effectively and efficiently (Assuyuthi & Ekawati, 2024). Kemp and Dayton, in their book on learning media (2022), describe learning media as communication tools that transfer messages from the sender to the receiver, enabling learning content to become more attractive and easier to comprehend. Meanwhile, according to Marshall McLuhan, quoted (Billa & Restian, 2026) argues that media function as extensions of human capabilities that can influence others without direct interaction. Therefore, selecting appropriate learning media is an important aspect of achieving effective learning outcomes (Dafit et al., 2025). Appropriate media selection is particularly important in science learning because many scientific concepts are abstract and require concrete visualization for students to understand them effectively.

One technology that can support this need is Augmented Reality (AR), which combines virtual objects with the real world in real time to visualize abstract concepts more concretely and interactively (Darmawan et al., 2024). AR technology enables educators to integrate virtual and physical environments so that abstract concepts can be projected interactively. In addition, AR provides attractive two-dimensional and three-dimensional visualizations that can be manipulated directly through smartphone interaction (Dewi & Fransyaigu, 2024). In accordance with opinion of Guswita et al. (2025) previous studies have demonstrated that AR-based learning media positively influence students' motivation and conceptual understanding (Hasibuan et al., 2026). Found that AR media increased students' motivation in science learning by 93.23% (Hidayat et al., 2024) reported that AR improved students' understanding of science concepts through more realistic visualization (Isa et al., 2022)

Most previous studies have primarily focused on motivation and cognitive learning outcomes, while limited attention has been given to how AR-based learning media can support students' learning independence (Jannah et al., 2025). In addition, studies on AR-integrated printed learning books at the elementary school level are still limited in examining how such media encourage students to explore learning materials independently without continuous teacher guidance. Therefore, the novelty of this study lies not merely in the use of AR-enabled reading books, but in the integration of AR features into printed science books specifically designed to stimulate students' self-directed learning behaviors, such as initiative, exploration, and independent engagement during the learning process. This focus provides a different perspective from previous AR studies that mainly emphasized motivation and conceptual understanding.

This research is important because strengthening students' learning independence has become a major challenge in implementing the Independent Curriculum, particularly in elementary science education. Students are expected not only to understand concepts but also to actively construct knowledge independently through meaningful learning experiences. In schools with limited technological facilities, integrating AR technology into printed books can become an accessible and practical innovation that bridges conventional and digital learning approaches. Moreover, this study contributes to the development of interactive learning media that support twenty-first-century learning demands by promoting active participation, learner autonomy, and technology-assisted learning. Therefore, this research focuses on developing AR-based interactive reading books for science learning on the human digestive system in fifth-grade students at SDN Lemahireng. The study examines three main aspects: the feasibility, improvement, and effectiveness of the developed media (Hutahaean et al., 2022). Accordingly, the research aims to determine the feasibility of the AR-based interactive reading book, analyze its effectiveness in improving students' learning outcomes, and examine its potential in encouraging students' learning independence.

Method

This research was conducted at SDN Lemahireng. The study employed a Research and Development (R&D) approach using the ADDIE development model consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was adopted from Robert Maribe Branch in Instructional Design: The ADDIE Approach (2009). This research aimed to develop an Augmented Reality (AR)-based interactive media integrated into reading books on the human digestive system to improve the learning independence and learning outcomes of fifth-grade students (Sugiyono, 2022). This type of research uses the ADDIE model developed by Robert Maribe Branch in (Sugiyono, 2013). This research will develop a product in the form of AR-based interactive media in reading books on the human digestive system to improve the learning independence of fifth-grade students at SDN Lemahireng.

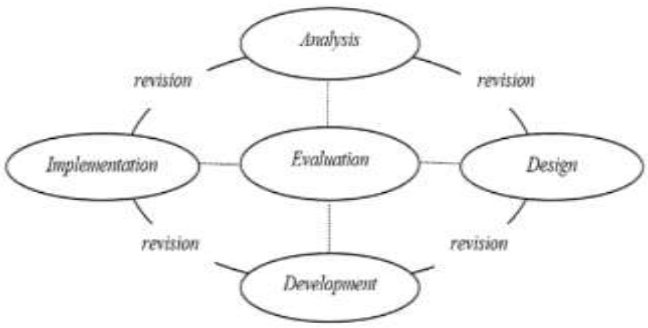

Figure 1. Types of ADDIE research models (Sugiyono, 2013)

This study used a Pre-Experimental Design with a One-Group Pretest–Posttest Design. The research design involved one experimental class that received treatment using AR-based interactive media. Students were given a pretest before the implementation and a posttest after the learning activities to determine improvements in learning outcomes and learning independence (Hakim et al., 2025). The procedures of the ADDIE model in this study are presented as follows:

Analysis Stage

This stage involved identifying learning problems, student characteristics, curriculum needs, and media requirements at SDN Lemahireng. Observations and interviews with teachers indicated that students experienced difficulties understanding the human digestive system material and showed low learning independence during science lessons

Design Stage

At this stage, the researchers designed the AR-based reading book, prepared learning objectives, created storyboards, developed the layout of the reading materials, and designed 3D AR objects related to the human digestive system. The researchers also designed research instruments, including cognitive tests and learning independence questionnaires.

Development Stage

The AR-based interactive media was developed using supporting software such as Unity and Assemblr Edu. The product was then validated by media experts and material experts to assess the feasibility of content, design, usability, and technical quality. Revisions were conducted based on expert suggestions before implementation.

Implementation Stage

The validated media was implemented in learning activities involving fifth-grade students of SDN Lemahireng during the 2025/2026 academic year. Students used the AR-based reading book during science learning on the human digestive system material.

Evaluation Stage

Evaluation was conducted to determine the effectiveness and feasibility of the developed media. The evaluation process included analyzing student learning outcomes, learning independence, teacher responses, and student feedback after using the media.

The population in this study consisted of all 30 fifth-grade students of SDN Lemahireng. The sampling technique used was saturated sampling (nonprobability sampling), in which all members of the population were selected as research samples. The subjects involved in this study included students, teachers, media experts, material experts, and researchers. The fifth-grade teacher provided information and assessments regarding the implementation of the media, while media and material experts validated the product feasibility (Agushybana, 2025). The data in this study consisted of qualitative and quantitative data. Qualitative data were obtained through observation, interviews, questionnaires, and documentation, while quantitative data were obtained from pretest and posttest scores as well as student learning independence questionnaires. The data sources included students, classroom teachers, media experts, and material experts (Agushybana, 2025). Data collection techniques in this study used both test and non-test methods. The test technique consisted of pretests and posttests used to measure student learning outcomes in science subjects related to the human digestive system. The cognitive test instrument

was in the form of 50 multiple-choice questions administered to 30 fifth-grade students. The validity test results showed that 26 items were valid and represented all indicators of competency achievement in the human digestive system material, while 24 items required revision and calibration before further use. Therefore, the valid items were considered sufficient to measure students' cognitive learning outcomes comprehensively. The reliability test produced a coefficient of 0.89, indicating that the cognitive test instrument was highly reliable for measuring student learning outcomes.

Meanwhile, learning independence as the main research variable was measured using a learning independence questionnaire and observation sheets. The questionnaire assessed aspects such as self-confidence, responsibility, initiative, discipline, and independent learning behavior during the use of AR-based interactive media (Slamet, 2022). To ensure data validity, triangulation techniques were employed through the comparison of observation results, interview findings, questionnaire responses, and documentation data. The collected data were analyzed using SPSS version 27. Initial data analysis included descriptive statistics, normality tests, and homogeneity tests to ensure the data met statistical assumptions. Furthermore, the effectiveness of the AR-based interactive media was analyzed using the N-Gain test to determine the improvement in student learning outcomes and learning independence, as well as a paired sample t-test to determine differences between pretest and posttest results before and after treatment. The results of the analysis were used to evaluate the effectiveness of the developed learning media.

Result and Discussion

Result

An AR-based interactive reading book medium was developed as a result of this research to increase students' learning independence. The procedure for creating the AR-based interactive reading book media refers to the ADDIE Development Model, namely analysis, design, development, implementation, and evaluation.

Analysis

At this stage, researchers analyzed needs, identified problems, and collected information through interviews, observations, and questionnaires at SDN Lemahireng. The analysis reveals that although fifth-grade science and science education have made use of the Independent Curriculum, the learning process is still mostly teacher-centered, which underdevelops students' learning independence. While digital facilities at the school are quite adequate, they are not fully utilized interactively, and some abstract material remains difficult for students to understand. Furthermore, the use of monotonous media such as PowerPoint presentations reduces student enthusiasm, even though the use of instructional videos can increase student engagement (Swargiary, 2023).

Therefore, to improve student comprehension and independence while making learning more dynamic and engaging, creative learning materials that combine digital and physical media are required. The creation of reading books with augmented reality (AR) is one pertinent remedy.

Design

The design stage is carried out to prepare an interactive media product design in the form of an Augmented Reality (AR) Based Reading Book that will be developed, based on the results of the needs analysis which includes material selection, content preparation, book concept, and the application of the Problem Based Learning model. The material used is the human digestive system which is compiled based on student books, teacher books, and relevant references and adjusted to the Learning Outcomes (CP) and Learning Objectives (TP). In addition, researchers design the media display by determining visual elements, illustrations, type and size of letters, and the placement of the AR QR Code integrated in the book. The media layout contains the names of the digestive organs, brief material, organ visualization, AR QR Code, chapter title, and page number.

At this stage, research instruments were also prepared, including validation sheets from material experts and media experts, as well as teacher and student response questionnaires as data collection tools in development research.

Development

Product development is the third phase. Researchers are now working on the product, an interactive reading book with augmented reality. Furthermore, during this stage, researchers also conduct a feasibility test, which will be presented to media experts to obtain feedback in the form of suggestions and criticism regarding the suitability of the learning media to be used. The steps in this stage include:

Product Development

In this product development stage, several steps are taken in the process of creating AR-based reading media. This stage is crucial because once the product design is complete, the media will be submitted to learning media experts for a feasibility assessment.

This instructional resource's display goes beyond simply showing the text and pictures in the book.

However, this reading book learning media is equipped with AR features in each organ in the human digestive system material that supports the material and 3D displays in the learning media. The book contents include the cover page, Foreword, Instructions for Using the AR-Based Reading Book, CP and TP regarding the material, Concept Map of the material, Table of Contents, Material and Author Profile.

Figure 2. AR-based reading book product book

Product Validation

In addition to the product being developed being in accordance with research expectations, the researcher then provided AR-based reading book learning media, materials and learning modules that had been created and submitted to media and materials experts to receive improvements and provide an assessment of their feasibility.

Material Expert Validation

The material assessment covered the content of the AR-based reading books and teaching modules, which was assessed by Dewi Nilam Tyas, S.Pd., M.Pd., a lecturer in the Elementary School Teacher Education Study Program, Faculty of Education and Psychology, Semarang State University.

Table 1. Results of Material Expert Validation

Aspect	Number of Indicators	Total Score
Presentation of Material and Media	8	35
Material Suitability	5	24
Development of Student Skills	4	18
Language Suitability	3	13
Percentage Score		90/100%

Based on the calculation results in Table 1 above, it can be seen that the score obtained from the material experts was 90%, so that the developed learning media is included in the "Very Appropriate" category. This indicates that the materials and teaching modules that have been prepared are assessed to have met the standards of content suitability, so they can be used without revision in the learning process.

Media Expert Validation

The media feasibility assessment was carried out by a media validator, namely Dr. Moh. Fathurrahman, M.Sn., a lecturer in the Elementary School Teacher Education Study Program, Faculty of Education and Psychology, Semarang State University.

Table 2. Media Expert Validation Results

Aspect	Number of Indicators	Total Score
Presentation of Material and Media	5	24
Material Suitability	5	24
Development of Student Skills	5	24
Language Suitability	5	24
Percentage Score		96/100%

Based on the results in the table above, it can be seen that the score obtained reached a percentage of 96%, so the developed learning media can be categorized as "Very Feasible." This media is declared suitable for use in the learning process during the research.

Implementation

The fourth stage is implementation. In this stage, researchers apply media and learning materials to the learning process. For Grade 6, the test was used to test the validity of the questions, and for Grade 5, the test was used for small and large groups.

Small-Scale Test

Small-Scale N-Gain Test

Based on Table 3 N-Gain test results above, the N-Gain Score and N-Gain Score (%) were 0.234 and 24.76%, respectively. Therefore, the data met the coefficient interval with medium criteria and the Low category. This category was obtained because it was in accordance with the coefficient interval and the percentage of effectiveness interpretation, namely N-gain ≤ 0.30 with a low category. This indicates that the media or method used has had a positive impact, but is not optimal and still needs further improvement or development so that learning outcomes can be more significant.

Table 3. Small-Scale N-Gain Test Results

Respondents	Pretest	Posttest	Posttest – Pretest	Ideal Score	N-Gain Score	N-Gain Percent
10	66.4	74.4	8	33.6	0.234	24.76%

Small-Scale Respondent Results

Based on Table 4, the student response questionnaire in the small group was administered to 10 students selected using purposive sampling. This questionnaire consisted of 15 statements with a 4-point Likert scale, where a score of 4 means Strongly Agree and a score of 1 means Strongly Disagree.

Table 4. Small-Scale Respondent Results

Respondents	Total Score	Maximum Score	Percentage
10	537	600	89.50%

Based on the questionnaire results, a total score of 537 was obtained out of a maximum score of 600. Overall, the responses of students in the small group showed very positive results with a percentage of 89.50%, which is classified as Very Good. These results indicate that the developed product was well received by students and is suitable for use in learning.

Large-Scale Test

Large-Scale N-Gain Test

Based on the N-Gain test results in Table 5 above, the N-Gain Score and N-Gain Score (%) were 0.52 and 52.25, respectively. Therefore, the data met the coefficient interval criteria for moderate and fell into the moderate category. This category was achieved because it met the coefficient interval and the effectiveness estimate percentage, namely 0.30 < N-gain < 0.70, which is considered moderate.

Table 5. Large-Scale N-Gain Test Results

Respondents	Pretest	Posttest	Posttest – Pretest	Ideal Score	N-Gain Score	N-Gain Percent
32	62.63	82	19.38	37.38	0.52	52.25%

Although not yet in the high category, these results indicate that the media or method used was effective and had a positive and optimal impact on improving student abilities.

Paired Sample T – test

Based on Table 6, the results of the Paired Sample Test t test which are used as information in determining the differences in the effectiveness of learning media. However, the thing that needs to be noted is in the Paired Samples Test table in the Sig (2-Tailed) section. In the data processing, it is known that the Sig (2-Tailed) value is 0.000 which means the sig value is less than 0.05. Thus, it can be firmly concluded that the treatment given in this study is proven to be effective and has a significant effect on improving the abilities of large group participants with a Sig value. (2-tailed) = 0.000 <0.05 and t count = 8.747> t table = 2.040, so the research hypothesis is accepted.

Table 6. Paired Sample t – Test Results

		Paired Sample Test							
		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Pretest – Posttest	-19.375	12.531	2.215	-23.893	-14,857	-8,747	31	,000

Large-Scale Respondents

Based on Table 7, the student response questionnaire for the large group was administered to 32 students selected using purposive sampling. The questionnaire consisted of 15 items with a 4-point Likert scale, where a score of 4 indicates Strongly Agree and a score of 1 indicates Strongly Disagree.

Table 7. Large-Scale Respondents Results

Respondents	Total Score	Maximum Score	Percentage
32	1722	1920	89.69%

Based on the questionnaire results, the total score was 1722 out of a maximum score of 1920. Overall, the student response in the large group was very positive, with 89.69% categorized as Very Good. These results indicate that the developed product was well-received by students and is suitable for use in learning.

Evaluation

The five stage is the evaluation. At this stage, researchers conducted an evaluation based on the results obtained from the implementation or application of the learning media (Risdianto et al., 2024). Next, final revisions and refinements were made to the Augmented Reality (AR)-Based Reading Book learning media to ensure that the developed media met eligibility standards and could be used optimally in the learning process. Researchers discovered that the Augmented Reality (AR)-Based Reading Book learning media has been deemed appropriate for use in the learning process based on the outcomes of small group and large group trials (Kumar et al., 2025).

Furthermore, the trial results also showed that the use of AR-based reading books increased student engagement and participation, particularly when the learning was designed around group activities that placed students at the center of learning, or student-centered learning.

However, technical challenges were still encountered, such as interruptions when scanning QR codes due to differences in internet connection quality. However, students demonstrated independence in overcoming these issues. Therefore, follow-up measures are needed, including providing a stable internet connection, checking devices before learning, and refining user instructions to ensure more effective use of the tool in the future.

Discussion

Development of AR-Based Interactive Reading Book Learning Media

This research is a research and development (R&D) study using the ADDIE development model. The ADDIE model consists of five interconnected stages, namely analysis, design, development, implementation, and evaluation (Kartika et al., 2024). Each stage in this model functions as a prerequisite for the next stage, so that the information produced from each stage will become the basis for the next stage. This is in line with the opinion of which states that the phases in the ADDIE instructional design model are systematic and interconnected with each other. Furthermore, Koparan (2025) added that the ADDIE model provides a systematic approach in creating learning that is learner-centered, interesting, and oriented towards measurable results.

The research and development of this learning media began with observation and interview activities at SDN Lemahireng with the principal and fifth-grade teachers. Based on these activities, the researchers found that the science learning process in fifth-grade students at SDN Lemahireng faced several problems, including a lack of student learning independence and difficulties in conveying abstract material. These problems are increasingly apparent when learning only relies on concrete media or digital media that has not been selected appropriately. In line with these findings, (Kusumaningrum & Hayat, 2025) explained that learning media plays a role as a supporting tool that can optimize various aspects of student development, including practical skills, cognitive knowledge, emotional intelligence, concentration skills, and overall competencies. Therefore, selecting appropriate learning media that suits students' needs is very important in the learning process. This is reinforced by Lubis et al. (2025) who stated that learning media is one of the main supporting factors that influences the level of student understanding of the material presented by teachers in class (Syatriana, 2025).

In this study, researchers created educational materials based on the findings of a requirements analysis derived from a variety of issues and challenges encountered during the learning process in grade V at SDN Lemahireng. The learning media developed in this study is an Augmented Reality (AR)-Based Reading Book, which utilizes three-dimensional (3D) displays as a means of delivering material visually and interactively. This aligns with the statement (Marta et al., 2026) that AR is capable of presenting comprehensive illustrations of the complexity of 3D structures, while simultaneously encouraging collaboration through learning experiences that can be shared between users. This is because AR is able to present visualizations, thus helping students with visual learning styles understand concepts that cannot be directly observed (Mu'afiqoh & Wachidah, 2024).

The media developed in this research is a printed or physical medium adaptively designed to suit the learning styles and needs of students. This media

contains science material on the human digestive system. The main novelty of this media lies in the Augmented Reality (AR) feature integrated to help students understand abstract concepts surrounding the human digestive system (Umar et al., 2025). Through AR technology, students can obtain realistic visual representations of the organ's shape. In addition to the AR feature, additionally, this media has a number of interactive features that directly engage students, such as learning films, educational games, reflection exercises, material evaluations, and an e-book edition that is packaged like a reading book and has a QR scanning capability. The learning process implemented in using this media refers to the Problem-Based Learning (PBL) model, an approach that places problems as a central topic in learning activities (Muti et al., 2024).

Feasibility of AR-Based Interactive Learning Media for Reading Books

The development of this Augmented Reality (AR)-based reading book has undergone a series of feasibility tests conducted by experts or validators, covering both media and material aspects. These feasibility tests aim to assess the suitability of the content contained in the developed learning media with the established standards and learning objectives. As stated by Natasya et al. (2025), validation of learning media is carried out to ensure that the resulting media meets feasibility criteria and can be implemented effectively in the learning process. The assessment was conducted by validators, both material experts and media experts, namely lecturers from the Elementary School Teacher Education Study Program (PGSD), Faculty of Education and Psychology, Semarang State University, who have competencies according to their scientific fields. Based on the results of the material expert validation test, a feasibility percentage of 90% was obtained, so that the developed learning media is classified as Very Feasible according to the percentage criteria proposed by (Nurrita & Suryani, 2025). During this material validation stage, researchers also received constructive comments and suggestions from the validators regarding the media content, particularly in the form of recommendations for additional material in the chapter discussing healthy food in the book.

Based on the assessment results provided by the media validator, a feasibility percentage of 96% was obtained, thus the developed learning media can be categorized as Very Feasible (Ratmaningsih et al., 2024). The suggestions and directions provided by the media expert as material for improvement covered several points. All of this input was immediately followed up by the researcher by revising the media and submitting a report of the revised results to the media validator. After the revision process was completed, the media was declared Very Feasible based on the final assessment results by the validator.

Improving Students' Learning Independence in Science Learning

This research and development aims to determine the improvement of student learning independence through interactive learning media, namely Augmented Reality (AR)-based reading books (Jantanukul, 2024). In this learning, the researcher used the Problem-Based Learning (PBL) model to support learning activities using AR-based reading books. The researcher applied the learning media at two learning process scales: small group trials and large group trials. Students benefit from learning with AR-Based Reading Book learning materials because they can freely comprehend the content and material by looking at three-dimensional visualizations, giving them unrestricted access to the book's contents. This is consistent with the assertion Parani et al. (2025) and Muliyadi et al. (2026) that learning independence is a condition in which students strive to increase responsibility in making various decisions, involving various resources and activities such as independent reading, group study, practice and correspondence activities. The increase in student learning independence will be determined based on the results of the PreTest and PostTest data normality tests that have been carried out by students in the learning process. This normality test is carried out to determine whether or not there is an influence of learning media on increasing student learning independence.

The first implementation of the AR-Based Reading Book learning media was carried out in a small group trial. Researchers applied the media to a fifth-grade class of SDN Lemahireng with 10 students with varying abilities. The results showed that students in the small group achieved a percentage of 89.50%, which is classified as Very Good, indicating that students responded very positively to the AR-Based Reading Book media and felt it helped in the independent learning process. The implementation of the two AR-Based Reading Book learning media was carried out in a large group trial. Researchers applied the learning media to grade V of SDN Lemahireng with a total of 32 students (Sriyanti et al., 2025). The ultimate outcome of the researchers' investigation and development was the media's application to this group. The results showed that students in the large group obtained a percentage of 89.69% which was classified as Very Good, higher than the percentage in the small group of 89.50%. This indicates that the developed product received a consistent response and even tended to increase when used in larger groups. This is in line with the results of a systematic study conducted by Prahani et al. (2025) in the Prima Edukasia Journal which concluded that

augmented reality has been practically proven to be able to improve students' abilities, understanding, and skills in learning, because its use has been proven to overcome problems, difficulties, and obstacles to learning by increasing student participation and collaboration in the process (Vari & Yamtinah, 2023).

Effectiveness of AR-Based Interactive Learning Media for Reading Books

The effectiveness of interactive learning media, Augmented Reality (AR)-Based Reading Books in this study was measured through student learning outcomes, namely PreTest and PostTest scores on the Human Digestive System material in the fifth grade of Lemahireng State Elementary School. PreTest scores were obtained before students used AR-Based Reading Book media in the learning process, while PostTest scores were taken after learning took place using the media. This is in line with the statement Prasetyo et al. (2025) that educational media is a tool that can aid in the process of teaching and learning in order to accomplish learning goals effectively and efficiently. Also in line with research (Putri et al., 2024) which states that learning media plays an important role in helping deliver material so that it is easier to understand and attracts students' attention.

Based on all the data analysis results, it can be concluded that the interactive learning media of Augmented Reality (AR)-Based Reading Books is effective for use in learning science on the Human Digestive System material in grade V of SDN Lemahireng. The results of this study are supported by research Rachim et al. (2024) which developed Augmented Reality-based learning media on the Animal Classification material for grade V of elementary school, where the PostTest results obtained a classical completion percentage of 87.5% which met the criteria for classical learning completion. Likewise, research Rahman et al. (2025) claimed that students' comprehension of science ideas was greatly enhanced by the usage of AR learning materials, and that students' comments were overwhelmingly favorable. This further emphasizes that Augmented Reality technology has great potential to improve the quality of learning, especially on materials that require visualization and understanding of abstract concepts such as the Human Digestive System in science (Rais & Saman, 2024).

The study's findings advance science, especially in the areas of educational technology and the creation of media for technology-based learning. This research empirically proves the feasibility of using the ADDIE model for interactive learning media, such as Augmented Reality (AR)-based reading books. This supports the theory that AR technology can present visualizations that cannot be achieved through direct observation, thus facilitating optimal learning (Yuendita & Dina, 2024).

Conclusion

Based on the results of the research and development, the interactive learning media of Augmented Reality (AR)-Based Reading Books on the Human Digestive System material for fifth-grade students at SD Negeri Lemahireng was declared very feasible and effective in improving student learning outcomes. The feasibility of the media was demonstrated through the assessments of media experts (96%) and material experts (90%), both categorized as very feasible, as well as positive student responses reaching 89.69%, which were classified as very good. The effectiveness of the media was indicated by the increase in the average student score from 62.63 on the pretest to 82.00 on the posttest. Furthermore, the N-Gain score of 0.52 showed a moderate improvement category, and the t-test results revealed a significant difference between pretest and posttest scores ($p < 0.001$). Therefore, it can be concluded that the use of AR-Based Reading Books has a positive and significant effect on improving student learning outcomes. It is recommended that future research examine the effect of AR-Based Reading Books on other variables, such as students' learning independence, motivation, or critical thinking skills, using more specific measurement instruments such as questionnaires or behavioral observations. Further studies are also suggested to involve larger samples and different educational settings to strengthen the generalizability of the findings.

Acknowledgments

Thank you to all parties who have provided support in the implementation of this research. The researcher would like to thank myself for my efforts, perseverance, and commitment in completing this research. Thank you to my family for their constant prayers, moral support, and motivation (Wijaya et al., 2025). The researcher would also like to express his appreciation to his supervisor for his guidance, direction, and invaluable input throughout the research process. Furthermore, thank you to the principal, teachers, and students of Lemahireng State Elementary School for their permission, assistance, and participation in the implementation of this research. Finally, the researcher would like to thank all parties whose names cannot be mentioned individually who have assisted in the completion of this research.

Author Contributions

The first author, S.A.I., designed the research; developed the product; collected and analyzed data; and wrote and drafted the article. The second author, B.K., provided direction,

provided academic guidance, and revised and refined the research manuscript.

Funding
This research was independently funded and did not receive funding from external parties.

Conflicts of Interest
There is no conflict of interest.

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