

## Development of Interactive Digital Flipbook Learning Media Assisted by Augmented Reality to Improve Concept Understanding in Science Subjects at Elementary School

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**Abstract:** *This study aims to develop and test the feasibility and effectiveness of digital flipbook learning media assisted by Augmented Reality (AR) on the five senses material in Natural Sciences (IPA) learning for fifth grade elementary school students. This study uses the Research and Development (R&D) method with the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. The research subjects were 37 fifth-grade students at SDN Kumbang I. The research instruments included validation sheets from media experts, language experts, and subject matter experts, student response questionnaires, and science concept comprehension tests. The validation and student response data were analyzed using percentage techniques, while the concept comprehension data were analyzed using N-Gain Score. The results showed that the AR-assisted digital flipbook media had a very high feasibility level based on the assessments of media and language experts at 95% and subject matter experts at 100%. Student responses to the use of the media also showed a very feasible category with a percentage of 86.95%, indicating that the media was interesting, easy to use, and helped with understanding the material. The effectiveness test showed an N-Gain value of 0.7525 in the high category, indicating a significant increase in students' science concept comprehension after using the media. Thus, AR-assisted digital flipbook media is declared feasible and effective for use as an alternative science learning medium for sensory material in elementary schools.*

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### INTRODUCTION

Education is an important indicator of a nation's progress because it plays a role in producing quality human resources. Optimal education will shape a future generation that is knowledgeable, has good character, and is competitive. Law No. 20 of 2003 emphasizes that education is a conscious and planned effort to realize the learning process so that students are able to develop their spiritual potential, self-control, intelligence, noble character, and the skills needed in social, national, and state life (Habe & Ahiruddin, 2017). This proves that the progress of a nation depends on the quality of education. Quality education is an effort that can improve the welfare and culture of a person (Arisandhi et al., 2023). This certainly gives meaning to the goal of education, which is to humanize humans, so that education needs to be taken into consideration (Yahya et al., 2025).

In the learning process, teachers have a strategic role as facilitators tasked with creating an

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innovative, creative, and meaningful learning environment. One of the efforts that can be made is through the use of learning media. Learning media serves as a means to help students acquire information, skills, and attitudes more effectively (Ahunaya et al., 2025).

The use of appropriate media can simplify information, focus students' attention, and encourage independent learning (Alfarizi & Mahmud, 2024). In addition, learning media also affects students' psychological aspects, such as increasing motivation, interest, and active involvement in the learning process.

The development of information and communication technology has brought significant changes to the world of education. However, in practice, learning in elementary schools is still often dominated by lecture methods and the use of textbooks due to teachers' limited skills in utilizing technology. This condition causes students to easily get bored and have difficulty understanding abstract material. In the digital age, teachers are no longer the only source of learning because students can access various sources of information through digital media anytime and anywhere. Therefore, a technology-based learning approach is needed that can provide a more interactive and meaningful learning experience.

One technological innovation that has the potential to improve the quality of learning is Augmented Reality (AR). Augmented Reality is a technology that can combine the real world with virtual elements in the form of text, animation, three-dimensional models, or videos displayed through digital devices such as smartphones or tablets (Nistrina, 2021). AR technology is considered effective in helping students understand abstract concepts, especially in science education, because it allows for more concrete visualization of objects. Three-dimensional visualization is very important in science education, which has complex and abstract material characteristics (Alfarizi et al., 2024).

The use of Augmented Reality (AR) in education has grown significantly and is now applied at almost all levels of education, from kindergarten to college (Ahmad et al., 2022). The purpose of this latest technology is to integrate virtual elements with the real world to create a more interactive and contextual learning experience (Wibowo, 2025). Augmented Reality (AR) combines virtual objects in the form of text, animations, three-dimensional models, or videos displayed through digital devices, thereby supporting a more realistic understanding of concepts.

Various studies show that the use of Augmented Reality (AR) has been applied at various levels of education and has had a positive impact on the learning process and outcomes. Research (Febriyanto et al., 2024) shows that AR-based learning media can increase students' interest and understanding of learning materials. However, the integration of AR technology with flipbook media in science learning at the elementary school level is still relatively limited. In fact, flipbooks have great potential in presenting material systematically and dynamically, especially when combined with AR technology to create a more interactive and engaging learning experience.

Previous studies have shown that Augmented Reality (AR)-assisted flipbook media are valid and feasible for use in learning and can improve students' self-efficacy (Atut, 2023; Muhdiyati & Utami, 2020). However, empirical evidence regarding the development and application of AR-assisted flipbook media to improve science concept understanding, especially at the elementary school level, still needs to be strengthened.

Based on the results of needs analysis, interviews, and documentation studies at SDN Kumbung I, it was found that science learning was still dominated by conventional media in the form of two-dimensional images in textbooks without the support of concrete media such as anatomical models of the five senses. This limitation caused fifth-grade students to have difficulty understanding the abstract concept of the five senses, which was reflected in the low average scores for the five senses material compared to other science materials.

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Although various studies have proven the effectiveness of Augmented Reality in learning, the integration of AR technology into digital flipbook media, especially in science learning of the five senses at the elementary school level, is still limited. In addition, most previous studies have focused more on increasing learning interest, while studies on the effectiveness of AR-assisted flipbook media on elementary school students' understanding of science concepts are still rare. Therefore, this study is important to fill this gap.

## **RESEARCH METHODS**

This study uses the Research and Development (R&D) method with the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. The ADDIE model was chosen because it provides systematic development stages in producing effective learning products that are tailored to the needs of students (Hidayat & Muhamad, 2021). The purpose of using the R&D method in this study is to develop learning media that is tailored to the characteristics of the material and students so as to produce innovative and effective products (Sa et al., 2020).

The analysis stage was conducted at SDN Kumbung I to identify learning needs, student characteristics, and curriculum suitability through observation, interviews, and documentation studies. The design stage was carried out by designing a digital flipbook assisted by Augmented Reality (AR) using the Canva and Assemblr Edu applications, which were tailored to the material and the students' ability levels. Next, the media was developed and validated by media experts, subject matter experts, and language experts. The revised media was then implemented in fifth-grade students to obtain feedback and measure its effectiveness. The evaluation stage was carried out to assess the feasibility of the media, student responses, and the effectiveness of the learning media in the learning process.

The population of this study was all fifth-grade students at SDN Kumbung I, with a sample of 37 students selected purposively according to the characteristics of the material. The research instruments were developed by the researcher with reference to the indicators of learning media feasibility and adapted to the characteristics of elementary school students. The instruments used included expert validation questionnaires (media, language, and material), student response questionnaires, and science concept comprehension tests.

Expert validation data were analyzed using percentage techniques (Saputri et al., 2021) and categorized into media feasibility criteria (Sudijono, 1998). Student response questionnaire data were analyzed descriptively using the same technique. Meanwhile, the concept comprehension test data were analyzed using the N-Gain Score to determine the improvement in student learning outcomes (Fauzi et al., 2022). The data were then classified into high, medium, and low categories (Gustati et al., 2025).

## **RESULT AND DISCUSSION**

### **Development Of Interactive Flipbook Learning Media Assisted By Augmented Reality (AR) For “Five Senses” Material In Natural Sciences (IPA) Subject For Grade V At SDN Kumbung I Elementary School**

The development of interactive learning media in the form of flipbooks assisted by Augmented Reality (AR) on the subject of the Five Senses was carried out using the ADDIE development model, which consists of five stages, namely Analysis, Design, Development, Implementation, and Final Evaluation (Hidayat & Muhamad, 2021). The following is a complete description of the media creation process.

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During the analysis stage, science learning needs were analyzed through observation of the learning process, interviews with teachers and students, and a study of student learning outcomes at SDN Kumbung I. This analysis aimed to identify learning problems, student characteristics, and learning media needs in line with the curriculum.

The design stage was carried out by designing AR-assisted digital flipbook media, which included the formulation of learning objectives, material structure, visual design, and planning for the integration of AR objects. The media was designed using the Canva application for flipbooks and Assemblr Edu for the development of AR objects.



**Figure 1. Flipbook Design**

During the development stage, the media design was realized as an AR-assisted digital flipbook product. The developed product was then validated by media experts, subject matter experts, and language experts to assess the suitability of the content, appearance, and language. The validation results were used as a basis for media improvement.



**Figure 2. AR-assisted Digital Flipbook Barcode**

The implementation stage was carried out by testing the media on fifth-grade students at SDN Kumbung I. The implementation aimed to determine the feasibility of using the media and the students' responses during the learning process.

The evaluation stage was conducted formatively and summatively. Formative evaluation was based on expert validation and limited trials, while summative evaluation was conducted through student response questionnaires and pretest–posttest tests to assess the effectiveness of the learning media.

### **Feasibility of Digital Flipbook Media Assisted by Augmented Reality (AR)**

The design of the Augmented Reality-assisted Digital Flipbook for fifth-grade students at SDN Kumbung 1 was consulted with experts. Assessment was carried out using a validation sheet covering four criteria with four alternative answers.

## 1. Media Expert Validation

**Table 1. Media Expert Validation Results**

No	Aspect	Indicator	Number of Items	Item Number	Result Score
1	Content	Accuracy and relevance of content to learning objectives	1	1	4
2	Learning Design	Logical and systematic presentation of material	1	2	4
3	Display Design	Appeal of appearance and suitability to learner characteristics	1	3	4
4	Display Design (AR)	Clarity and function of AR elements	1	4	4
5	Operation/Navigation	Ease of use of navigation features	1	5	4
6	Technical Operation	Stability and accessibility of media	1	6	3
7	Learning Communication	Clarity of delivery of learning messages	1	7	4
8	Interactivity (AR)	Appeal and motivation to learn through AR	1	8	4
9	Implementation Power	Ease of application in learning	1	9	3
10	User Response	Overall attractiveness and usefulness of media	1	10	4
<b>Total</b>					38
<b>Maximum Score</b>					40
<b>Percentage</b>					95%
<b>Criteria</b>					Highly Recommended

## 2. Language Expert Validation

**Table 2. Language Expert Validation Results**

No	Aspect	Indicator	Number of Items	Item Number	Result Score
1	Straightforward	Use of effective language (clear and easy to understand)	1	1	4
		Use of simple and direct sentences	1	2	4
2	Communicative	Points or information can be conveyed well	1	3	4
		Provide illustrations, analogies, or examples that are relevant and easy to understand.	1	4	4
3	Dialogic and Interactive	Able to motivate participants.	1	5	4
		Encourage students to do simple activities	1	6	4
4	Appropriate for Student Development	Use words/sentences that are appropriate for the cognitive development level of students.	1	7	4
		Providing examples that are relevant to the environment	1	8	4
5	Appropriate for Language Rules.	Writing material in accordance with Indonesian language rules	1	9	3

(EYD/PUEBI) with clear sentences, correct punctuation, and neat structure.			
Using correct and consistent scientific terms.	1	10	3
<b>Total</b>			38
<b>Maximum Score</b>			40
<b>Percentage</b>			95%
<b>Criteria</b>			Highly Recommended

### 3. Media Expert Validation

**Table 3. Results of Content Expert Validation**

No	Aspect	Indicator	Number of Items	Item Number	Result Score
1	Content suitability	Alignment of material with KI, KD, and indicators.	1	1	4
		Alignment of material with the scope of elementary school science.	1	2	4
2	Suitability for science literacy	Accuracy of material.	1	3	4
		Ease of understanding material.	2	4 5	4 4
3	Language readability and	Appropriate use of language.	1	6	4
		Material is easy to understand.	1	7	4
		Language used is appropriate for student characteristics.	1	8	4
4	Benefits	Student interest in using media.	1	9	4
		Attractiveness of media display.	1	10	4
<b>Total</b>					40
<b>Maximum Score</b>					40
<b>Percentage</b>					100%
<b>Criteria</b>					Highly Recommended

Based on this data, it can be concluded that media expert validation obtained 95%, language expert validation obtained 95%, and material expert validation obtained 100%. Judging from the assessment criteria, which are:

**Table 4. Assessment Criteria**

Rentang Persentase	Kategori
81,25% < skor ≤ 100%	Sangat Layak
62,50% < skor ≤ 81,25%	Layak
43,75% < skor ≤ 62,50%	Cukup Layak
25,00% < skor ≤ 43,75%	Tidak Layak

Thus, the validation results show that the validation results from experts, including media experts, language experts, and subject matter experts, can be considered “Highly Suitable” for use.

### Student Response to Digital Flipbook Media Assisted by Augmented Reality (AR)

Data from student response questionnaires were also analyzed and converted descriptively using the same formulas and methods as the expert questionnaires.

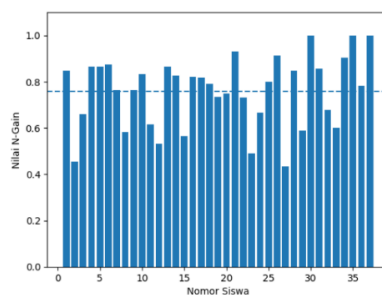
**Table 5. Student Response Questionnaire Results**

No	Aspect	Indicator	Number of Items	Item Number	Result Score	Maximum Score
1	Ketertarikan	Students are interested in using AR flipbooks because they look different from regular books.	1	1	132	148
		Students feel happy and motivated to learn science with the help of AR flipbooks.	1	2	114	148
2	Materi	The content of the flipbook is relevant to the topic being discussed.	1	3	130	148
		The material presented is easy to understand.	1	4	133	148
3	Bahasa	The material is presented using easy-to-understand language.	1	5	129	148
		Scientific terms in the flipbook are easy to understand.	1	6	137	148
4	Desain	The illustrations in the Augmented Reality (AR) flipbook are interesting.	1	7	135	148
		The images, text, and objects in the digital flipbook are easy to read and do not cause confusion.	1	8	107	148
5	Pengoprasian	Ease of operation.	1	9	139	148
		The media runs smoothly when used with a mobile phone/tablet without disrupting the learning process.	1	10	128	148
<b>Total</b>					1.287	1.480
<b>Percentage</b>					86,95%	
<b>Criteria</b>					Highly Recommended	

From this data, we can conclude that student response was 86.95%. Based on the assessment criteria, this can be considered “Very Good.”

### The Effectiveness Of Augmented Reality (AR)-Assisted Digital Flipbook Media In Improving Students' Conceptual Understanding Of The “Five Senses” Material In Grade 5 Elementary School Science

Concept comprehension test data was analyzed using N-Gain Score to determine the effectiveness of improving student learning outcomes. The following are the N-Gain results visualized in a bar chart as shown in Figure 3 below:



**Figure 3. N-Gain Summary Diagram**

Effectiveness in improving students' conceptual understanding by using digital flipbook media in Natural Sciences (IPA) lessons on the subject of "The Five Senses"; this media received a score of 0.7525, so when viewed from the assessment criteria table,

**Table 6. N-Gain Assessment Criteria**

N-Gain	Category
>0,7	High
0,3 – 0,7	Medium
< 0,3	Low

Therefore, the effectiveness of digital flipbooks falls under the "high" category. This shows that there was a significant increase in students' understanding of the concepts after using this medium.

### Discission

1. The development of interactive learning media in the form of digital flipbooks assisted by Augmented Reality (AR) on the subject of the five senses was carried out using the ADDIE model, which provides a systematic and structured development process. The results of the analysis stage show that science learning in grade V at SDN Kumbang I is still dominated by lecture methods and textbooks, so that students have difficulty understanding the abstract concept of the five senses. The limitations of concrete media meant that the visualization of the structure and function of the five senses was not optimal. Therefore, the integration of Augmented Reality (AR) technology in digital flipbooks was an effective solution because it was able to present realistic and interactive three-dimensional object visualizations. This is in line with the opinion of (Pradita et al., 2024), which states that AR-assisted media can visualize abstract concepts more concretely, thereby facilitating students' understanding. At the design and development stage, the digital flipbook was designed by integrating text, illustrations, and AR objects embedded directly in the media pages. Unlike QR code-based AR media, the AR in this flipbook can be accessed directly without additional scanning, making it more practical and easier to use for elementary school students. The integration of a 3D model of the five senses that can be rotated and enlarged allows students to observe the structure of the organs from various angles. This visualization provides a more immersive learning experience and supports in-depth conceptual understanding, as stated by (Jumaena et al., 2023) that AR can enhance the learning experience through interactive three-dimensional objects.
2. The validation results show that AR-assisted digital flipbook media has a very high level of feasibility. Media and language experts each gave a rating of 95%, while subject matter experts gave a rating of 100%. These findings indicate that the media has fulfilled the aspects of appearance, language, navigation, and material suitability with the science curriculum on the five senses. These results are in line with research (Asri et al., 2025; Eriadyahningrum et al., 2022) stating that digital flipbook media is declared to be highly valid and suitable for use in elementary school learning.
3. Student responses to the use of digital flipbooks supported by AR also showed very positive results, with a percentage of 86.95%. Students expressed interest and motivation to learn due to the interactive media display, the use of attractive colors and images, and the presence of 3D visual objects that facilitated their understanding of the material. This is in line with (Juniati et al., 2025), who stated that digital flipbooks are capable of creating an

enjoyable learning experience that is in line with the learning characteristics of elementary school students.

4. The effectiveness of the media was tested by comparing the pretest and posttest results, which were analyzed using the N-Gain Score. An N-Gain score of 0.7525 is in the high category, indicating a significant increase in students' understanding of the concept after using the media. These findings prove that AR-assisted three-dimensional visualization can help students understand the structure and function of the five senses more concretely, rather than simply memorizing concepts. These results are in line with research (Dinda et al., 2024; Zulfa et al., 2025) which states that AR-based digital learning media can improve students' conceptual understanding and engagement in learning.

Thus, AR-assisted digital flipbooks have proven to be feasible, practical, and effective in improving understanding of science concepts related to the five senses in fifth grade elementary school.

## CONCLUSION

This study shows that the development of Augmented Reality (AR)-assisted digital flipbook media on sensory material has successfully fulfilled the research objectives, namely to produce learning media that is suitable and effective for use in science learning in elementary schools. The media developed is able to facilitate the visualization of sensory concepts in a more concrete and interactive manner in accordance with the characteristics of fifth grade students.

The research findings indicate that the use of Augmented Reality technology in digital flipbooks contributes positively to improving students' understanding of science concepts. Thus, AR-assisted digital flipbooks can be used as an alternative innovative learning medium that supports science learning, especially for abstract material.

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