



# Development of Augmented Reality (AR) Based Pop-Up Book Interactive Learning Media to Improve Class V Science Learning Outcomes

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**Abstract:** Science learning in elementary schools still faces various obstacles and limitations, particularly in the use of learning media that lacks interactivity and the inability to concretely visualize abstract material. This research, conducted through R&D, aims to test the feasibility, practicality, and effectiveness of the interactive Pop-Up Book learning media based on Augmented Reality (AR). The media's feasibility was demonstrated by validation results from media experts with a percentage of 78.18% and material experts with a percentage of 84.61%. Based on the results of the pretest and posttest, it shows that the Pop-Up Book media based on augmented reality (AR) is effective in improving student learning outcomes with an increase in the average pretest and posttest scores indicated by the N-Gain test results obtaining a value of 0.77 with a high category. Practicality is shown from the results of the teacher response questionnaire which obtained a percentage of 92.50% with a very good category, while student responses in small-scale trials obtained a percentage of 83% with a very good category and large-scale trials of 80.40% with very good. The data shows that the interactive learning media Pop-Up Book based on augmented reality (AR) is practical, feasible, and effective to be used to improve the learning outcomes of science students of grade V SDN Sadeng 01 Semarang.

**Keywords:** Augmented reality (AR); Interactive learning media; Pop-up book; Research and development (R&D); Science learning outcomes

## Introduction

Education plays a crucial role in developing quality human resources. This aligns with Law Number 20 of 2003 concerning the National Education System, which aims to develop students' potential to become religious, creative, independent, and responsible individuals. Furthermore, (Minister of Education, Culture, Research, and Technology Regulation) Number 16 of 2022 emphasizes the importance of interactive learning to create an effective and meaningful learning process. Therefore, educators are required to provide innovative, engaging learning media that align with technological developments in the digital age. In this era of technological advancement, the use of innovative learning media is crucial for improving the quality of

learning. One such medium is the Pop-Up Book, a book featuring interactive and engaging three-dimensional images that helps students understand the material in a more concrete and enjoyable way (Wijono et al., 2024). Pop-Up Books are also considered effective in improving students' understanding of abstract material (Regina & Wulandari, 2025; Pitaloka et al., 2025). Furthermore, the integration of Augmented Reality (AR) technology into Pop-Up Books can provide more realistic interactive visualizations in science learning.

The use of AR media can increase student interest, understanding, and active participation because the material is presented visually via smartphone (Ghafar, 2024; Menrisal, 2022). AR-based learning media is also considered capable of creating more interactive and enjoyable learning, thereby increasing student

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engagement in the learning process (Wibowo et al., 2022; Nurhikmah et al., 2024). Research on Augmented Reality (AR)-based Pop-Up Books has shown positive results in elementary school learning. Nyoman Sutrana et al. (2025) and Aripuddin et al. (2025) stated that AR-based Pop-Up Books are feasible to use and can increase student interest in learning. Al Kamil et al. (2023) also showed that AR-based Pop-Up Books were categorized as very valid and able to increase student self-efficacy with an N-gain value of 0.81. Furthermore, Ferdianto et al. (2026) and Yanto et al. (2023) explained that Pop-Up Book media effectively increased the interest, motivation, and learning outcomes of elementary school students through interactive three-dimensional visualizations.

Research by Elmunsyah et al. (2019) Fatmawati et al. (2025) demonstrated that the integration of AR technology into Pop-Up Book media helped students understand abstract material in a more concrete and engaging way. Meanwhile Sukma Wijayanti et al. (2025) and Ratnasari et al. (2025) stated that AR-assisted Pop-Up Book media effectively improved learning outcomes based on N-gain results in small-scale and large-scale trials. Based on these studies, Augmented Reality (AR)-based Pop-Up Book media has the potential to increase student interest, engagement, and learning outcomes. Based on observations and interviews in fifth-grade students at SDN Sadeng 01 Semarang, it was discovered that science learning still uses conventional media such as textbooks, PowerPoint presentations, and simple learning videos. The use of these media is considered ineffective in helping students understand the material optimally, resulting in less active and enthusiastic students during the learning process. Furthermore, the use of technology-based learning media such as Augmented Reality (AR) has never been implemented in science lessons (Prananta, 2025; Yulia et al., 2022).

The analysis of science scores also showed that out of 22 students, 10 (45.50%) still had difficulty understanding the material. One learning medium that can be used to help students understand the material concretely is the Pop-Up Book. This medium display engaging three-dimensional visuals, increasing student attention and motivation. To make learning more interactive, the Pop-Up Book is combined with Augmented Reality (AR) technology, which can display three-dimensional virtual objects through a smartphone. The use of AR technology in learning can help students understand abstract material in a more realistic and engaging way. Therefore, this study developed an interactive AR-based Pop-Up Book learning medium to improve the science learning outcomes of fifth-grade students at SDN Sadeng 01 Semarang.

## Method

This study used a quantitative approach with a Research and Development (R&D) approach. The aim was to develop an interactive Pop-Up Book learning medium based on Augmented Reality (AR) and to test its feasibility, practicality, and effectiveness in science and science learning. The ADDIE development model, consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation, was used. However, this study was limited to the implementation stage. In developing this media, the researchers employed the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. However, in this study, the development process was limited to the implementation stage because the research focused on the development and testing of the learning media. The first stage, analysis, was conducted through observation, interviews, and documentation in a fifth-grade class at SDN Sadeng 01 Semarang to determine learning conditions, student needs, and problems encountered in science and science learning. The analysis revealed that the use of learning media was still limited to PowerPoint and simple learning videos, resulting in students experiencing difficulty understanding abstract material. The research outline can be seen in Figure 1.

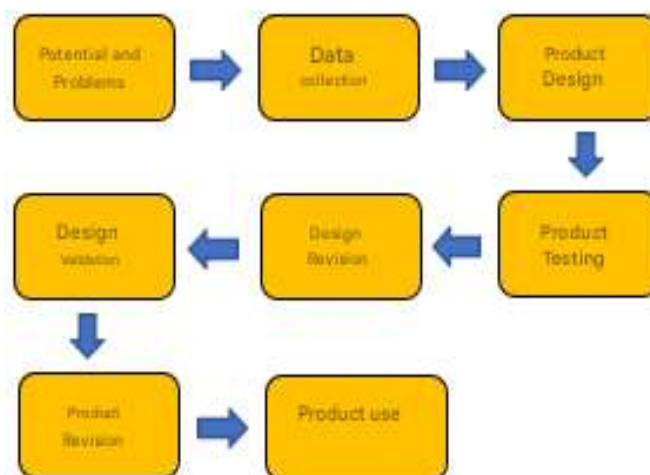


Figure 1. Modified from the Borg and Gall model

The second stage, design, involved designing the Augmented Reality (AR)-based Pop-Up Book media, starting with material development, media display design, illustration creation, and designing AR features accessible via smartphone. The third stage, development, involved creating the learning media product and validating it with media and material experts using a Likert-scale questionnaire to determine the feasibility of the developed media. After receiving

suggestions and input from the validators, the media was revised to meet learning needs. The fourth stage, implementation, involved product trials with fifth-grade students at SDN Sadeng 01 Semarang. The trials were conducted in two stages: a small-scale trial involving 10 students and a large-scale trial involving 12 students. In this stage, students used the Augmented Reality (AR)-based Pop-Up Book media in science lessons. After the learning activities were completed, students and teachers were asked to complete a response questionnaire to determine the practicality of the developed learning media.

The data used in this study consisted of qualitative and quantitative data. Qualitative data were obtained through observation, interviews, documentation, and suggestions and input from the validator. Meanwhile, quantitative data were obtained from expert validation results, teacher and student questionnaire responses, and student pretest and posttest results. Data collection techniques used both test and non-test techniques. Test techniques were used to determine improvements in student learning outcomes through pretest and posttest questions, while non-test techniques were conducted through observation, interviews, questionnaires, and documentation. Data analysis was conducted using quantitative descriptive and inferential statistics. Validation data were analyzed in percentage form to determine the appropriateness of the learning media. Student learning outcome data were analyzed using normality tests, t-tests, and N-Gain tests to determine the effectiveness of the Augmented Reality (AR)-based Pop-Up Book learning media in improving science learning outcomes for fifth-grade students at SDN Sadeng 01 Semarang.

**Table 1.** Summary of Item Analysis Results

| Criteria    | Analysis Results                                                                                                                                                          |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Analysis    | All 20 questions were valid with a correlation coefficient value of $>0.51$ .                                                                                             |
| Validity    | Cronbach's Alpha coefficient 0.89                                                                                                                                         |
| Questions   | 10 questions: Easy Category<br>14 questions: Medium Category<br>1 question: Hard Category                                                                                 |
| Reliability | 5 questions: Very Good Category<br>10 questions: Good Category<br>5 questions: Fair Category                                                                              |
| Questions   | The pretest and posttest questions were found to meet the criteria for validity, reliability, difficulty level, and discriminatory power appropriate for use in research. |

Meanwhile, non-test techniques included observation, interviews, documentation, and questionnaires. Observations and interviews were conducted to determine the learning conditions of science and natural sciences (IPAS), student needs, and

the use of learning media in fifth-grade students at SDN Sadeng 01 Semarang. The questionnaire was used to obtain media validation data and teacher and student responses to the Augmented Reality (AR)-based Pop-Up Book learning media. Product feasibility was determined by analyzing the assessment results of validators from material experts and media experts. The validation process was conducted by lecturers from Semarang State University who are experts in their fields of expertise. Validation aimed to obtain suggestions, input, and assessments regarding the material, media presentation, and suitability of the developed learning media. The validator assessment results were analyzed using a Likert scale of 1–4 to determine the level of feasibility of the learning media. Product practicality was determined based on the results of a questionnaire surveying teacher and student responses to the use of the Augmented Reality (AR)-based Pop-Up Book learning media in the learning process. This assessment aimed to determine the ease of use of the media, student interest, and the media's usefulness in supporting the science and natural sciences learning process.

The results of teacher and student responses were analyzed using a Likert scale of 1–4 and presented as a percentage. Product effectiveness was determined through the analysis of student pretest and posttest results. The initial stage of analysis was carried out with a normality test using the SPSS application to determine whether the data was normally distributed. Next, a T-test was conducted to determine any significant differences between the pretest and posttest results after the use of learning media. The final stage was an N-Gain test to determine the level of improvement in student learning outcomes after using Pop-Up Book learning media based on Augmented Reality (AR). The results of the N-Gain test were used to determine the level of effectiveness of the developed learning media in improving the science learning outcomes of fifth-grade students at SDN Sadeng 01 Semarang.

## Result and Discussion

### *Potential and Problems*

Based on observations and interviews prior to the study in fifth-grade students at SDN Sadeng 01 Semarang, several problems were identified in science learning. These include the limited use of learning media, which often consists of textbooks, PowerPoint presentations, and simple instructional videos, resulting in students being less active and easily bored during the learning process. Furthermore, the use of technology-based learning media, such as Augmented Reality (AR), has never been implemented, despite the school having supporting facilities such as LCD projectors, Wi-Fi, and a computer lab. Teachers reported that students are

more interested in visual, interactive learning that involves technology, but the use of technology in learning is still suboptimal. Teachers also experience difficulties conveying abstract science material in a way that is understandable to all students with varying learning abilities. Based on the analysis of fifth-grade students' science scores at SDN Sadeng 01 Semarang, it was found that student learning outcomes are still suboptimal. Of the 22 students, 10 (45.50%) still have difficulty understanding the science material, while 12 (54.50%) have achieved a fairly good understanding. These results indicate a need for more innovative, engaging, interactive learning media tailored to the characteristics of elementary school students.

#### Initial Data Collection

Research data was obtained through observations, interviews, and questionnaires distributed to teachers and fifth-grade students at SDN Sadeng 01 Semarang. Based on the data collection, it was discovered that the use of science learning media is still suboptimal because teachers still use textbooks, PowerPoint presentations, and simple learning videos, which makes students easily bored and less active during the learning process. Teachers also experience difficulties in explaining abstract science material in a way that can be understood by all students with varying learning abilities. Furthermore, students prefer visual, interactive learning that involves the use of technology. Most students already own smartphones, but they still use them more for gaming and social media than for learning activities. Therefore, the development of technology-based learning media that can help students understand the material in a more concrete, engaging, and interactive way is necessary. Based on these conditions, researchers developed Pop-Up Book learning media based on Augmented Reality (AR) to increase student engagement and learning outcomes in science learning for class V at SDN Sadeng 01 Semarang.

#### Product Design

A Pop-Up Book learning media based on Augmented Reality (AR) was designed in accordance with the learning objectives of fifth-grade elementary school science (IPS) on the human respiratory system. This media combines a three-dimensional Pop-Up Book display with AR technology accessible via smartphone, helping students understand the material in a more concrete and interactive way. The development process began with preparing the materials, display design, image illustrations, and media layout using the Canva app. The Augmented Reality objects were created using the Assemblr Edu app. QR codes connected to the AR objects were then inserted into the materials so students could view the three-dimensional visualizations directly

via their smartphones. The media components include the cover page, learning materials, Pop-Up Book images, and QR codes for the AR objects. The media was designed using an attractive visual display with a combination of colors and images tailored to the characteristics of elementary school students, thereby increasing student interest and engagement in the IPS learning process.



Figure 2. Title page



Figure 3. Back cover page



Figure 4. Material page



**Figure 5.** QR- code augmented reality page

At this stage, researchers validated the Augmented Reality (AR)-based Pop-Up Book learning media product with media expert and material expert validators to determine the level of feasibility of the developed media. The validation process was conducted using an assessment questionnaire with a Likert scale of 1–4. After validation, the validators provided several suggestions and input regarding the media's appearance, material suitability, and its use in learning, allowing researchers to make improvements and refinements before conducting trials with students. Learning media was deemed highly feasible if it achieved a score of 76%–100%, feasible if it achieved a score of 56%–75%, less feasible if it achieved a score of 36%–55%, and unfeasible if it achieved a score of 20%–35%. A summary of the validation results for each component is shown in Table 2.

**Table 2.** Results of the Validator Expert Assessment of the Pop-Up Book Based on Augmented Reality

| Part          | Media expert | Subject matter expert |
|---------------|--------------|-----------------------|
| Total score   | 43           | 55                    |
| Maximum score | 53           | 65                    |
| Percentage    | 78.18        | 84.61                 |
| Criteria      | Very Worthy  | Very Worthy           |

Based on the validator assessment results presented in Table 2, the Augmented Reality (AR)-based Pop-Up Book learning media received a 78.18% rating from media experts, categorizing it as good, and a 84.61% rating from material experts, categorizing it as very good. These results indicate that the Augmented Reality (AR)-based Pop-Up Book learning media is suitable for use in fifth-grade elementary school science learning activities.

#### Design Revision

After validation by experts, the expert validators commented that the product was good and suitable, so no revisions were required.

#### Product Practicality

The next step was to conduct a small-scale product trial involving 10 fifth-grade students from SDN Sadeng 01 Semarang, selected heterogeneously based on their ability levels. After the learning activities using the Augmented Reality (AR)-based Pop-Up Book learning media were completed, teachers and students were given a response questionnaire containing several statements related to the media, materials, presentation, and use of the media in learning. Assessments were conducted using a Likert scale, with a score of 76%–100% being very positive, 51%–75% being positive, 26%–50% being negative, and 0%–25% being very negative.

**Table 3.** Results of the Assessment of Teacher and Student Responses in Large-Scale Tests of Pop-Up Books Based on Augmented Reality

| Part          | Teacher       | Learners      |
|---------------|---------------|---------------|
| Total score   | 94            | 524           |
| Maximum score | 96            | 560           |
| Percentage    | 97.90         | 93.60         |
| Criteria      | Very Positive | Very Positive |

#### The Effectiveness of AR-Based Pop-Up Books

A large-scale trial was conducted in a fifth-grade class at SDN Sadeng 01 Semarang with 12 students using Augmented Reality (AR)-based Pop-Up Book learning media in the science subject of the human respiratory system. This trial aimed to determine the effectiveness of the developed media based on student learning outcomes. The research design used was a pre-experimental design with a one-group pretest-posttest model. At this stage, students were given a pretest before using the learning media and a posttest after using the Augmented Reality (AR)-based Pop-Up Book learning media to determine improvements in student learning outcomes following the media's use in the learning process.

**Table 4.** Pretest and Posttest Results on Product Use

| Part     | Average | Average Difference |
|----------|---------|--------------------|
| Pretest  | 42.26   | 49                 |
| Posttest | 91.26   |                    |

Based on Table 4, it is known that the average student learning outcomes showed an increase of 49 points in the large-scale trial. This indicates a difference in student learning outcomes in the science subject before and after using the Augmented Reality (AR)-based Pop-Up Book learning media in fifth grade at SDN Sadeng 01 Semarang. To determine the level of improvement in student learning outcomes, an analysis was conducted using a normality test, a t-test, and an N-Gain test.

### Normality Test

One part of the data analysis requirements or assumption testing is the normality test. Before conducting data analysis, a normality test was first conducted to determine whether the research data was normally distributed. The normality test in this study used the Kolmogorov-Smirnov (KS) test using SPSS. The basis for making decisions in the normality test is that if the significance value (Sig.)  $> 0.05$ , the research data is normally distributed, whereas if the significance value (Sig.)  $< 0.05$ , the research data is not normally distributed.

**Table 5.** Normality Test Results

| Data     | Statistics | df | Sig. | Information |
|----------|------------|----|------|-------------|
| Pretest  | 0.96       | 25 | 0.20 | Normal      |
| Posttest | 0.95       | 25 | 0.08 | Normal      |

Based on Table 5, the significance value for the pretest data is 0.200 and for the posttest data, 0.08. Both significance values are greater than 0.05, thus concluding that the pretest and posttest data are normally distributed. Therefore, the requirements for normality testing have been met, allowing data analysis to proceed to the next stage.

### T-test

Next, a t-test is conducted, which is part of a comparative hypothesis test or comparison test. The t-test is conducted to determine whether there is a difference in the average learning outcomes of students before and after using the Pop-Up Book learning media based on Augmented Reality (AR). The data used are quantitative data from the students' pretest and posttest results. The test was conducted using the SPSS application. The basis for making decisions in the t-test is that if the significance value (Sig.) is  $< 0.05$ , there is a significant difference between the pretest and posttest results. If the significance value (Sig.) is  $> 0.05$ , there is no significant difference between the pretest and posttest results:  $H_0$  is rejected, and  $H_a$  is accepted. If the Sig. (2-tailed)  $< 0.05$ ;  $H_0$  is accepted and  $H_a$  is rejected if the Sig. (2-tailed) value is  $> 0.05$ .

### Research Hypothesis Formulation

$H_0$  = There is no difference in the average learning outcomes between the pretest and posttest. Therefore, the use of augmented reality-based Pop-Up Books has no effect on improving understanding and learning outcomes in the science subject of the human respiratory system in fifth grade students of Sadeng 01 Public Elementary School in 2026;  $H_a$  = There is a difference in the average learning outcomes in the pretest and posttest. This means that the use of augmented reality-based Pop-Up Books has an effect on improving

understanding and learning outcomes in the science subject of the human respiratory system in fifth grade students of Sadeng 01 Public Elementary School in 2026.

**Table 6.** T-Test Results

| Data                 | Mean   | Std. Dev | Std. Error | t      | df | Sig. (2 tailed) |
|----------------------|--------|----------|------------|--------|----|-----------------|
| Pretest-<br>Posttest | -35.00 | 11.70    | 3.38       | -10.35 | 11 | 0.00            |

Based on Table 6, the Sig. (2-tailed) value is  $0.000 < 0.05$ , therefore,  $H_0$  is rejected and  $H_a$  is accepted. This indicates that there is a difference in the average student learning outcomes between the pretest and posttest scores. Therefore, the use of Augmented Reality (AR)-based Pop-Up Book learning media has an effect on improving the science learning outcomes of fifth-grade students at SDN Sadeng 01 Semarang.

### N-Gain Test

To determine the effectiveness of the learning media used in this study using a pretest-posttest design, an N-Gain score test was conducted by calculating the difference between students' pretest and posttest scores. The N-Gain test was used to determine the improvement in student learning outcomes after using the Augmented Reality (AR)-based Pop-Up Book learning media. The N-Gain calculation reveals the effectiveness of the developed learning media in improving student learning outcomes. The N-Gain score categorization was determined based on the N-Gain value in percentage (%). The higher the N-Gain value obtained, the higher the increase in student learning outcomes after using learning media.

**Table 7.** Gain Score Distribution

| N-Gain Value            | Category |
|-------------------------|----------|
| $g > 0.70$              | High     |
| $0.30 \leq g \leq 0.70$ | Medium   |
| $g < 0.30$              | Low      |

**Table 8.** N-gain test results

| Data         | N  | Min   | Max   | Mean  | Std. Dev |
|--------------|----|-------|-------|-------|----------|
| N-Gain Score | 12 | 0.63  | 0.93  | 0.77  | 0.10     |
| N-Gain (%)   | 12 | 62.50 | 93.33 | 77.30 | 10.75    |

Based on Table 8, the N-Gain test results obtained an average value of 0.77 with a percentage of 77.30%, which is considered high. These results indicate an increase in student learning outcomes after using Augmented Reality (AR)-based Pop-Up Book learning media in fifth-grade science lessons at SDN Sadeng 01 Semarang. This improvement in learning outcomes indicates that the use of Augmented Reality (AR)-based Pop-Up Book learning media can help students better understand the learning material, as demonstrated by

changes in learning outcomes between the pretest and posttest. Therefore, Augmented Reality (AR)-based Pop-Up Book learning media is effective for use in science lessons because it can improve student learning outcomes. The results of this study indicate that Augmented Reality (AR)-based Pop-Up Book learning media is suitable for use in fifth-grade science lessons because it is feasible, practical, and effective in improving student learning outcomes. This is supported by several factors. First, Pop-Up Book media can create engaging, interactive learning and help students understand the material more concretely.

Pop-Up Books have proven effective as visual media, attracting students' attention and facilitating conceptual understanding through interactive and engaging displays (Ariyani & Setiawan, 2025; Suryadin et al., 2021). Furthermore, they can enhance student comprehension by presenting material in a contextual and engaging manner, making them suitable for use in abstract learning (Ginting et al., 2025; Detyana et al., 2025). Pop-Up Books are also considered effective in increasing elementary school students' interest, motivation, and learning outcomes, making learning more engaging and less monotonous (Dori et al., 2018; Alamri, 2025). Second, the use of Augmented Reality (AR) technology in learning media can provide a more realistic and interactive learning experience for students. The integration of AR technology into Pop-Up Books can help students understand abstract concepts through engaging three-dimensional visualizations, thereby increasing their interest, understanding, and active participation in learning (Ngoc Tuong Nguyen & Thi Kim Oanh, 2025). The use of AR-based media is also considered capable of increasing learning motivation and making students more active in learning because the material is presented visually, as if it were directly in front of them (González-Zamar et al., 2020; Tharayil et al., 2018). Furthermore, AR technology can create a more enjoyable and innovative learning experience, thereby reducing barriers to student understanding (Kazlaris et al., 2025; Tian & Ironsi, 2025).

Third, Pop-Up Book learning media based on Augmented Reality (AR) can help students learn independently both at school and at home through the use of smartphones as learning support (Nursyaidah et al., 2025; Cabero-Almenara et al., 2019). The attractive visual display, the use of colors appropriate to the characteristics of elementary school students, and the integration of digital technology make students more interested and motivated in learning (Luthfi et al., 2024). This is also supported by the results of teacher and student responses, which received a very good category, thus deeming the developed learning media practical and suitable for use in fifth-grade elementary school science lessons. Fourth, Augmented Reality (AR)-based

Pop-Up Book learning media can help strengthen students' memory of the material being studied because they gain learning experiences through engaging and interactive visual media (Munajah et al., 2025; Boer et al., 2025). The use of visual media can help students understand the material more easily and strengthen their memory of learning concepts (Rahmawati et al., 2025; Staneviciene & Žekienė, 2025). Three-dimensional object visualization and Augmented Reality (AR) displays make learning materials more concrete, making it easier for students to retain the information learned for a longer period of time (Sagita et al., 2025; Alkhabra et al., 2023).

The implication of this research is that the developed Augmented Reality (AR)-based Pop-Up Book learning media can be used by teachers and students as a supporting medium for science learning in elementary schools (Darmawan et al., 2024; Mukti, 2022). This media can help teachers create more engaging, interactive, and innovative learning, thereby making students more active in participating in the learning process. Based on the research results and discussions, the Augmented Reality (AR)-based Pop-Up Book learning media is deemed feasible, practical, and effective for use in science learning because it can improve the learning outcomes of fifth-grade students at SDN Sadeng 01 Semarang.

## Conclusion

The results of the data analysis showed that the Pop-Up Book learning media based on Augmented Reality (AR) obtained a very feasible category based on the validation results of media experts of 78.18% and material experts of 84.61%. The results of the questionnaire responses of teachers and students to the Pop-Up Book learning media based on Augmented Reality (AR) also obtained a very positive category. The teacher's response obtained a percentage of 97.90%, while the student's response obtained a percentage of 93.6% so that the media was declared practical to use in learning. The average learning outcomes of students increased from a pretest score of 42.26 to a posttest score of 91.26 with an increase of 49 points. In addition, the results of the T-test showed a significance value of 0.000 < 0.05 which indicated a significant difference between the pretest and posttest results. The results of the N-Gain test obtained a value of 0.77 with a high category. Thus, the Augmented Reality (AR)-based Pop-Up Book learning media has proven feasible, practical, and effective for improving the science learning outcomes of fifth-grade students at SDN Sadeng 01 Semarang.

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## Author Contributions

S. M contributed to research, product development, data analysis, and article writing. S. S. A. served as a supervisor in research activities and article writing.

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## Conflicts of Interest

The researchers funded this research independently.

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