



Journal of Educational Sciences

Journal homepage: <https://jes.ejournal.unri.ac.id/index.php/JES>



P-ISSN
2581-1657

E-ISSN
2581-2203

Optimizing Science Learning Outcomes Through the Use of Pop-Up Books Among Elementary School Students

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ARTICLE INFO

Article history:

Received: 24 June 2026

Accepted: 29 July 2026

Available Online: 05 Aug 2026

Keywords:

Pop-Up Book,
Learning Outcomes,
IPAS

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Article Doi:

<https://doi.org/10.31258/jes.10.8.p.442-454>

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ABSTRACT

This study was motivated by the low learning outcomes of fifth grade students in IPAS lessons at SD Negeri 1 Patalagan due to the suboptimal use of concrete and visual learning media. This study aims to determine the effect of using pop-up books on students' learning outcomes. The study employed a quantitative approach using a pre-experimental method through a one-group pretest-posttest design. The sample consisted of 20 students selected using total sampling. Data were collected through learning outcome tests and observation sheets. The test instrument consisted of five essay questions that met the criteria for validity (calculated $r >$ table r of 0.444), reliability (Cronbach's Alpha of 0.761), discriminative power (corrected item-total correlation $>$ 0.30), and difficulty level (4 questions in the moderate category and 1 in the easy category). Data analysis utilized the N-gain test and the paired t-test. The results showed that the average score increased from 66.00 to 81.25, with an N-gain value of 0.4461 (moderate category). Hypothesis testing revealed a significance value of $0.000 < 0.05$, indicating that the use of pop-up books has a significant effect on students' learning outcomes. Thus, pop-up books are effective in improving learning outcomes and creating interactive.

1. Introduction

Educational development in the 21st century is characterized by rapid advances in technology and information, which require students to possess a variety of skills. These skills include critical thinking, creativity, communication, and collaboration, which are key competencies in supporting successful learning (Widiанти et al., 2024). Therefore, the learning process needs to be designed innovatively by utilizing various supporting components, one of which is through the use of effective learning media. Learning media serve as a tool that facilitates teachers in delivering lesson material in a clearer, more engaging, and easier to understand manner for students (Kamal et al., 2024). Ahmad Rohani (Fadilah et al., 2023)

defines learning media as anything that can be perceived by the five senses and functions as an intermediary, a means, or a tool that clarifies the delivery of material, thereby enhancing students' understanding. Additionally, instructional media also play a role in enhancing the effectiveness of information delivery so that learning objectives can be achieved optimally (Iskandar et al., 2023). However, in practice, learning in elementary schools still tends to rely on conventional, one way methods, making it less effective at actively engaging students. This situation results in a lack of encouragement for students to develop their knowledge and skills independently. When students become disengaged, learning outcomes tend to be suboptimal because the learning process is not effective (Febriani et al., 2023).

Hamalik (Suprihatin & Manik, 2020) states that learning outcomes are reflected through observable and measurable changes in student behavior, encompassing aspects of knowledge, attitude, and skills. Additionally, Rusmono (Rahmawati & Sati, 2021) asserts that learning outcomes represent behavioral changes occurring in an individual following the learning process. These changes emerge as a result of students' interactions with various learning resources and the learning environment while completing the learning program. This aligns with the assertion by (Mulia et al., 2021) that learning outcomes are the comprehensive changes in behavior and abilities possessed by students after undergoing the learning process. Thus, learning outcomes are changes in students' behavior and abilities following the learning process, evident in terms of knowledge, attitudes, and skills. These changes indicate positive development resulting from the learning experiences students have undergone.

Based on observations conducted in the fifth grade class at SDN 1 Patalagan, it was found that students' learning outcomes in IPAS particularly regarding the human digestive system remain low. The average pretest and posttest scores for the 20 students were 22.75 and 34.00, respectively. Although there was an improvement in learning outcomes after the instruction, these average scores still fell below the established Learning Objective Achievement Criteria (KKTP) of 75. Therefore, there is a need for innovative teaching media that align with the characteristics of elementary school students. According to (Zakiya et al., 2025), effective learning requires the selection of appropriate media to support the optimal achievement of students' learning outcomes.

Given these circumstances, an innovative learning tool that can help students clearly understand the material and is interactive is the pop-up book. A pop-up book is a three dimensional medium that features illustrations that rise up or move automatically when the book's pages are opened. As stated by Riwahyudin (Winda et al., 2022), pop-up books are a type of book capable of stimulating students' creativity and imagination through three dimensional elements that move when the pages are opened, presenting beautiful and engaging visuals. Bluemel and Taylor (Ningsih et al., 2022) state that a pop-up book is a book that moves when its pages are opened, utilizing paper as the material for folds, shapes, rolls, wheels, or rotating mechanisms. Additionally, Dewantari (Yusriati et al., 2022) defines a pop-up book as a card or book where, when the paper or pages are opened, three dimensional shapes or images emerge from the surface, thereby providing a more engaging and

vivid visual experience for the reader. Thus, a pop-up book is a book that features moving elements as well as two dimensional or three dimensional forms through paper cuts, folds, or mechanisms. This medium is capable of presenting a more vivid and interactive visualization of the story, allowing readers to experience the reading process in a more engaging way. With its ability to appear and change shape when the pages are opened, the pop-up book is effective in preventing boredom and increasing reader interest.

Maturah (Athifah et al., 2022) highlights the advantages of pop-up books, namely: they can present images in a more engaging way; they can be used individually or in groups; they are practical and can boost students' enthusiasm for learning; they have a distinctive and unique appearance; and they feature raised images that emerge when the pages are opened. As for the disadvantages of pop-up books, as stated by Dzuanda (Jannah et al., 2020), these include: their production requires a considerable amount of time due to the need for high precision, creativity, and meticulous attention to detail in every part to ensure the moving mechanisms function properly, and the production costs are relatively higher because they require specialized materials and more complex production techniques than standard printed materials.

Previous studies have also shown that the use of visual and interactive learning media, such as pop-up books, can significantly improve students' learning outcomes. A study conducted by Haloho et al. (2025) using an experimental method with a pretest-posttest design showed an increase in students' average scores from 51.09 on the pretest to 86.74 on the posttest, with an N-gain of 0.74, which falls into the high category. Hypothesis testing results also indicated a significant difference between pre and post intervention conditions. Another study conducted by Carolin & Kristin (2024) also indicated that the use of pop-up books can improve learning outcomes, with an increase in the average score from 68.34 on the pretest to 80.88 on the posttest, as well as a media validation level in the "very good" category.

Based on previous research studies, it is evident that pop-up books are effective in improving students' learning outcomes. However, most studies have focused on media development or application to specific subjects, so the use of pop-up books for the human digestive system curriculum in elementary schools particularly in IPAS instruction remains limited. Therefore, the novelty of this study lies in the application of pop-up books in IPAS instruction on the human digestive system for fifth grade elementary school students. Thus, this study was conducted to determine the effect of using pop-up books on students' IPAS learning outcomes, specifically regarding the human digestive system, in the fifth grade at SD Negeri 1 Patalagan. It is hoped that this study will serve as a reference for teachers in using innovative learning media and as a guide for future researchers, taking into account different variables, learning contexts, and student characteristics.

2. Methodology

Type and Design

This study employs a quantitative approach using an experimental method. The experimental method is a way of providing children with learning experiences by conducting various experiments on a given medium and observing the resulting effects (Hasibuan & Suryana, 2022). The research design used is a pre-experimental design of the one group pretest-posttest type. This design involves a single group of subjects who are administered a pretest to assess their initial abilities, followed by the treatment. After the treatment is administered, a posttest is conducted to determine the students' learning outcomes following the learning process (Silitonga, 2023). The research design is outlined in Table 1 as follows:

Table 1. Research Design

Pretest O ₁	Treatment x	Posttest O ₂
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This study was conducted in the fifth grade class at SD Negeri 1 Patalagan in May of the 2025/2026 school year. The population of this study consisted of all fifth grade students at SD Negeri 1 Patalagan. The sample used in this study comprised 20 fifth grade students from SD Negeri 1 Patalagan. The sampling technique used in this study was total sampling. This technique was used because the population size was relatively small, so all members of the population were included as research subjects. Thus, all students are involved as research subjects.

Data Collection

The data collection techniques used included tests (learning outcomes) and observation sheets (affective aspects, psychomotor aspects, teaching modules, and teacher performance). The test instrument consists of 5 essay type questions used to measure students' learning outcomes in IPAS. Before use, the instrument was first tested for suitability through validity, reliability, discriminant power, and difficulty level tests. The validity test results showed that all test items were deemed valid because they had a calculated r value $>$ table r value of 0.444 ($n=20$; $\alpha=0.05$). The reliability test results showed that the instrument was deemed reliable with a Cronbach's Alpha value of 0.761 $>$ 0.60. Furthermore, the discriminant validity test results showed that all test items had a corrected item-total correlation value $>$ 0.30, which is considered good. Meanwhile, the difficulty level test results indicated that, of the 5 test items analyzed, 4 were classified as moderate and 1 as easy.

Data Analysis

Data analysis was conducted through normality tests, N-gain calculations, and hypothesis testing using a paired sample t-test with the assistance of SPSS software at a significance level of 0.05. The results of the normality tests showed that the significance values were 0.062 for the pretest and 0.443 for the posttest; thus, both datasets were normally distributed because the significance values were greater

than 0.05. Furthermore, the N-gain calculation yielded a mean value of 0.4461 (44.61%), which falls into the moderate category. As for the results of the hypothesis test using a paired samples t-test, the Sig. (2-tailed) value was $0.000 < 0.05$; therefore, H_0 was rejected and H_a was accepted. Thus, there is a significant effect of using pop-up books on students' learning outcomes.

3. Results and Discussion

This study was conducted in the fifth grade class at SD Negeri 1 Patalagan, Pancalang Subdistrict, Kuningan Regency. The research subjects included all 20 fifth-grade students. The study was carried out over two sessions. The first session took place on Tuesday, May 5, 2026, and involved observing the learning conditions for the Human Digestive System (IPAS) before the use of the pop-up book. At this stage, the researcher conducted an initial observation to determine the students' learning activities and their level of understanding of the human digestive system. The second session was held on Wednesday, May 6, 2026, incorporating the pop-up book as a teaching aid in the IPAS lesson on the human digestive system.

The instruments used in this study included: (1) a learning outcome test consisting of five essay questions that had undergone validity, reliability, discriminant power, and difficulty level testing; (2) a teaching module observation sheet; (3) a teacher performance observation sheet; and (4) an observation sheet for student activities in the affective and psychomotor domains. Data collection was conducted before and after the implementation of pop-up books as a teaching medium in IPAS instruction.

The learning process in this study began with an introductory activity and the presentation of learning objectives; the teacher then presented a case study related to the digestive system as an initial stimulus to spark the students' thinking. Afterward, the teacher introduced the pop-up book to the students by showing them the physical form of the book and how to use it. The lesson then proceeded interactively, using the pop-up book as the primary medium, during which the teacher explained the material while opening each page that displayed the digestive organs in three dimensional form. Students were given the opportunity to observe, handle, and interact directly with the medium in small groups. The activity continued with group discussions to analyze the presented case, the completion of worksheets, and the presentation of discussion results. At the end of the lesson, the teacher and students summarized the material and reinforced key concepts. Below is an example of the pop-up book used in the learning process. Below is an example of the pop-up book used in the learning process, as well as students' interactions with it. The appearance of the pop-up book and students' activities while using it can be seen in Figure 1 and Figure 2.

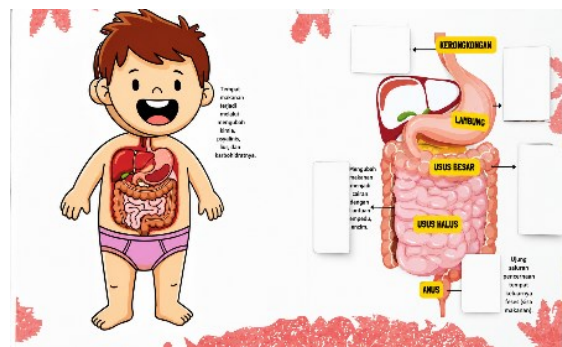


Figure 1. Illustration of a pop-up book depicting the human digestive system



Figure 2. Students' interaction with pop-up books

In IPAS instruction, particularly regarding the human digestive system, this teaching aid allows students to directly observe the structure and organs of the human digestive system, thereby making previously abstract concepts more concrete. Throughout the learning process, students appeared more enthusiastic, active, and demonstrated a high level of curiosity about the material presented. This indicates that student engagement in the learning process increased significantly. This is in line with the opinion of (Wajraprakara et al., 2025), who state that student engagement in the learning process is one of the key factors supporting learning success. Furthermore, this increase in student engagement can also be explained from a constructivist perspective. The constructivist theory proposed by Jean Piaget states that knowledge is more easily understood when students are directly involved in the learning process through real-life experiences (Arafah & Samsuddin, 2023). Thus, the use of pop-up books which are visual and interactive can create a more meaningful learning experience for students. This is also supported by research by Hikmah and Latifah (2025), which states that pop-up books can increase students' attention, engagement, and understanding of the learning material. Therefore, the use of pop-up books combined with effective instructional management can increase student engagement and help them understand the material more effectively. Furthermore, a comparison of students' learning outcomes before and after the use of pop-up books in IPAS instruction revealed a difference in their average scores. A detailed comparison of the pretest and posttest scores is presented in Table 1 below.

Table 1. Students' Learning Outcomes Before and After Using Pop-Up Book

Description	N	Before using the pop-up book (Pretest)	Before using the pop-up book (Posttest)	After using the pop-up book (Pretest)	After using the pop-up book (Posttest)
On average	20	22,75	34,00	66,00	81,25
Minimum Score	20	0	40	50	65
Maximum Score	20	10	50	90	95
KKTP 75	20	(0%)	(0%)	20%	90%

Based on Table 1 above, students' learning outcomes before the use of pop-up books in IPAS instruction (pretest) yielded an average score of 22.75, with a lowest score of 0 and a highest score of 10; no students achieved mastery (0%). Meanwhile, in the posttest phase before the use of pop-up books, students' average score increased to 34.00, with a lowest score of 40 and a highest score of 50; however, no students had yet achieved mastery (0%). Furthermore, after the use of the pop-up book, students' learning outcomes in the pretest phase showed an improvement, with an average score of 66.00, a lowest score of 50, and a highest score of 90, and 20% of students had achieved mastery. In the posttest phase following the use of the teaching aid, the average score increased again to 81.25, with a lowest score of 65 and a highest score of 95, and the percentage of students achieving mastery increased significantly to 90%.

Referring to Table 1 above, the learning outcome data show a significant improvement in students' learning outcomes following the use of pop-up books. This improvement is not only evident in the increase in average scores and the percentage of students meeting learning standards, but is also supported by the results of observations conducted during the learning process. The results of the observation show that the use of pop-up books in IPAS instruction, particularly for the topic of the human digestive system in Grade 5 at SD Negeri 1 Patalagan, has a positive impact on students. This improvement is evident in the affective and psychomotor aspects, as well as in the quality of learning as assessed through the implementation of the teaching module and teacher performance. To clarify these findings, Table 2 presents a comparison of achievement percentages before and after the use of pop-up books in IPAS instruction.

Table 2. Results of Observations Before and After Using the Pop-Up Book

Aspects Observed	Before Using the Pop-Up Book	Category	After Using the Pop-Up Book	Category
Affective	25%	Poor	80%	Good
Psychomotor	30%	Poor	90%	Very Good
Teaching Module	67%	Good	92%	Very Good
Teacher Performance	62%	Good	90%	Very Good

Based on Table 2 above, the observation results for the affective aspect showed a significant increase from 25% before the intervention to 80% after the use of the pop-up book. This increase indicates that the learning medium used was able to foster emotional engagement and positive attitudes among students during the learning process. Students appeared enthusiastic about participating in the activities, were active in discussions, demonstrated responsibility toward their tasks, and were able to collaborate effectively in groups. Through the use of pop-up books, students not only receive information from the teacher but also gain direct learning experiences by observing, discussing, and summarizing the material they have studied. Thus, the learning process becomes more meaningful and student-centered.

Meanwhile, the results of observations on psychomotor aspects also showed an increase from 30% to 90%. These results indicate that the use of pop-up books can improve students' skills in carrying out learning activities. Students were able to observe directly, identify the parts of the human digestive system, complete worksheets, and present the results of their discussions more effectively. This demonstrates that interactive visual media such as pop-up books can help students transform abstract concepts into more concrete ones. This aligns with Hamalik view (Suprihatin and Manik, 2020), who states that learning outcomes are reflected through observable and measurable changes in student behavior whether in terms of knowledge, attitudes, or skills. Thus, the use of pop-up books not only contributes to improved cognitive learning outcomes but also fosters students' affective and psychomotor development throughout the learning process.

Furthermore, improvements were also observed in the quality of learning. The results of observations of the teaching modules showed an increase from 67% to 92%, indicating that the instructional materials were developed and implemented more effectively following the use of pop-up books. This suggests that lesson planning became more systematic, focused, and aligned with the intended learning objectives. Meanwhile, the results of observations on teacher performance also showed an increase from 62% to 90%. This improvement indicates that teachers were able to conduct lessons in accordance with the planned steps and create a learning environment that was more effective, interactive, and meaningful for students. Thus, the use of pop-up books not only impacted learning outcomes but also contributed to improving the overall quality of the learning process.

Next, a statistical analysis was conducted to test the significance of the improvement in students' learning outcomes following the use of pop-up books. The statistical analyses used in this study included a normality test to determine the data distribution, an N-gain calculation to assess the extent of improvement in learning outcomes, and a hypothesis test to determine whether or not there was a significant effect of using pop-up books on students' learning outcomes. The results of each of these statistical tests are presented in Tables 3, 4, and 5 below.

Table 3. Results of the Normality Test

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.187	20	.066	.909	20	.062
Posttest	.140	20	.200*	.955	20	.443

Based on Table 3 above, the normality test was conducted using the Shapiro-Wilk method because the sample size in this study was relatively small. This normality test aimed to determine whether the students' learning outcomes data were normally distributed or not, as one of the prerequisites for conducting further statistical tests. After conducting the test using SPSS software, the significance values (Sig.) obtained were 0.062 for the pretest data and 0.443 for the posttest data. These results indicate that the significance values for both the pretest and posttest were greater than the significance level of 0.05. Thus, it can be concluded that the students' learning outcome data, both before and after the intervention, are normally distributed.

Table 4. N-gain Test Results

	N	Minimum	Maximum	Mean	Std. Deviation
NGain_Score	20	.30	.75	.4461	.12777
NGain_Persen	20	30.00	75.00	44.6111	12.77678
Valid N (listwise)	20				

Based on Table 4 above, the N-gain test results show that the average value obtained was 0.4461, or equivalent to 44.61%, which falls into the moderate category. This value indicates that there was an improvement in students' learning outcomes following the use of pop-up books, although this improvement did not yet reach the high category. These results indicate that pop-up books are quite effective in helping students understand the learning material, particularly in the IPAS subject, as they are able to gradually improve learning outcomes. Furthermore, the moderate category also suggests that there is still room to optimize the use of learning media so that improvements in learning outcomes can reach a higher category. When compared to previous studies that showed a "high" category, this difference in results is influenced by several factors. One of them is the relatively limited duration of the learning intervention, meaning students had not yet fully optimized their use of the pop-up book. Furthermore, other contributing factors include student characteristics, such as prior knowledge, activity levels, and diverse learning backgrounds. Additionally, the relatively small sample size may have contributed to data variability and affected the average N-gain scores obtained.

Table 5. Hypothesis Test Results

	Mean	Std. Deviation	Paired Differences		95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
			Std. Error Mean		Lower	Upper			
Pair1 Pretest-Posttest	-15.250	6.584	1.472		-18.332	-12.168	-10.358	19	.000

Based on Table 5 above, the results of the hypothesis test using a paired-samples t-test show that the significance value (Sig. 2-tailed) is $0.000 < 0.05$. Based on the criteria for hypothesis testing, if the significance value is less than 0.05, then H_0 is rejected and H_1 is accepted. Thus, it can be concluded that there is a significant difference between students' learning outcomes before and after the use of the pop-up book medium. These results indicate that the use of pop-up books has a significant effect on improving students' IPAS learning outcomes. This improvement did not occur by chance but is the result of implementing a learning medium that captures students' attention, increases their engagement, and facilitates their understanding of the concepts being studied. Thus, pop-up books are effective as an alternative learning medium for improving students' learning outcomes in the IPAS subject.

The results of the study show that the use of pop-up books as a teaching medium has a significant effect on improving students' learning outcomes regarding the human digestive system. This improvement is evident from the difference in average scores between the pretest and posttest, which indicates a change in students' cognitive abilities after the intervention was administered. These findings suggest that the instructional medium used is capable of facilitating the learning process more effectively. These results are consistent with research stating that interactive learning media have a significant effect on learning outcomes because they can increase students' active engagement in the learning process (Agustina et al., 2025).

Theoretically, this effectiveness can be explained by the visual and interactive nature of pop-up books. Media capable of presenting concepts concretely have been shown to help elementary school students understand material that was previously abstract. This aligns with findings that concrete, visual media can reduce the level of abstraction in the material, making it easier to understand in line with students' cognitive development stages (Fitroh et al., 2024). Thus, transforming abstract concepts into visual representations is a key factor in improving students' understanding. In addition, the use of pop-up books also contributes to increased student motivation and attention during the learning process. Visually engaging and interactive media can create a more enjoyable learning environment, thereby helping students stay focused and actively engaged. This is supported by research showing that interactive media can enhance students' motivation to learn and their attention during the learning process (Fitrianingrum et al., 2025). This active engagement has a significant correlation with improved learning outcomes, as students not only passively receive information but also participate directly in the learning process (Muti'ah et al., 2023).

Furthermore, the findings of this study reinforce the view that the use of innovative instructional media is an effective pedagogical strategy for improving the quality of learning. The appropriate integration of media not only aids in the delivery of content but also creates meaningful learning experiences for students. This is consistent with research confirming that innovative instructional media can significantly improve the quality of learning and student learning outcomes (Hidayatullah et. al., 2025). Thus, the results of this study not only reinforce

previous empirical findings but also underscore the importance of selecting instructional media that align with students' characteristics. Interactive, visual, and innovative instructional media have been shown to enhance conceptual understanding, learning motivation, and students' overall learning outcomes.

4. Conclusion

Based on the results of the study, it can be concluded that the use of pop-up books as a learning medium has a significant impact on the science learning outcomes of fifth grade students at SD Negeri 1 Patalagan, particularly regarding the human digestive system. This improvement is evidenced by the increase in students' average scores following the intervention, as well as statistical analysis results indicating a significant difference between pretest and posttest scores. Conceptually, the effectiveness of pop-up books lies in their ability to transform abstract material into concrete, visual, and engaging representations, making them suitable for the cognitive development characteristics of elementary school students. Furthermore, the interactive nature of this medium not only facilitates conceptual understanding but also enhances students' attention, motivation, and active engagement during the learning process. Therefore, the integration of appropriate learning media is crucial in the context of elementary education. The use of innovative and interactive media, such as pop-up books, can serve as an effective pedagogical strategy to improve the quality of learning and students' academic outcomes.

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How to cite this article:

Permatasari, D., Karim, A., & Sati. (2026). Optimizing Science Learning Outcomes Through the Use of Pop-Up Books Among Elementary School Students. *Journal of Educational Sciences*, 10(8), 442-454.