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Development of 3D Book Media Based on Pop Up Books to Increase Student Learning Motivation in Mathematics Learning in Grade IV Elementary Schools

Rini Irmata Putri*, Siti Aisyah, Alfroki Martha
Master of Elementary Education, Adzkia University, Padang, 25175, Indonesia

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** Corresponding author:*

E-mail: riniirmataputri840@gmail.com

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A B S T R A C T

This research is motivated by the limited use of interesting and interactive learning media in Mathematics learning, which has an impact on low student learning motivation. This study aims to develop a valid, practical, and effective Pop Up Book-based 3D Book media in increasing student learning motivation. The study uses the Research and Development method with a 4D model that includes the define, design, develop, and disseminate stages. The research subjects were fourth-grade students at SD Kemala Bhayangkari, SDN 17 Gunung Pangilun, and SDN 03 Alai. The research instruments included validation sheets from media, language, and material experts, teacher and student practicality questionnaires, and pretest and posttest tests. The results showed that the media was in the very valid category with a validity percentage of 92.5% from media experts and 90% from language experts, and very practical with teacher and student responses above 89%. The effectiveness test through N-Gain analysis showed a value of 0.8111 very effective at SD Kemala Bhayangkari Padang, 0.7212 very effective at SDN 17 Gunung Pangilun, and 0.8897 very effective at SDN 03 Alai, so that the developed media is suitable for use in fourth grade Mathematics learning and supports the implementation of the Independent Curriculum.

1. Introduction

Mathematics instruction at the elementary school level often faces challenges in conveying concepts that are difficult for students to grasp. Using appropriate learning media can help overcome this obstacle. Obstacles in the learning process can be minimized through the use of appropriate learning media, as appropriate media can bridge gaps in understanding and increase student active engagement in learning activities (Mahmudah & Fikroh, 2021). The use of audio, visual, and audiovisual media has long been used in the learning process to improve student

understanding (Salsabila et al., 2020). The use of these media has been proven to improve students' understanding of mathematical material (Zahroh et al, 2025).

Audio, visual, and audiovisual media each have their own benefits, one of which is their ability to raise students' learning motivation, which is a key factor in the success of the learning process (Turmudli et al, 2025). High learning motivation can encourage students to be more active in the learning process and more persistent in facing challenges (Juraidah et al, 2025). Conversely, low learning motivation can cause students to be less interested and less likely to participate in learning. This is also explained according to (Azmi et al., 2024) stated that learning motivation is an important psychological aspect that can influence student achievement.

Student learning motivation is an important factor that influences the success of the learning process. According to (Hasan et al., 2020) Learning motivation is influenced by various factors, both internal and external. Internal factors include students' interests, needs, and expectations, which play a major role in motivating their enthusiasm for learning. On the other hand, external factors, such as support from parents, friends, and the school environment, also contribute to creating a supportive learning environment. In the context of mathematics learning, students who are interested in the material will be more engaged and active in participating in the learning process (Sholehah et al., 2018).

In learning mathematics, especially material that requires a strong visual understanding such as flat shapes, 3D Book media can help students to more easily understand these concepts (Ardany et al., 2024). With an interactive design that allows students to interact directly with the material, this media can increase student engagement, strengthen their understanding, and ultimately increase their motivation to learn. Pop-up books not only delivers material in a fun way but also provides a satisfying learning experience, which can fulfill students' basic needs for security and appreciation, and encourage them to actively learn (Pranada, 2022).

One innovation in learning media that can meet these needs is the use of pop-up book-based 3D Book media. This media combines visual and interactive elements to capture students' attention and increase their engagement in learning. According to (Izzah, A. N., & Setiawan, 2023) Pop-up books provide a more realistic and enjoyable learning experience, thereby increasing student motivation. The use of pop-up books can significantly improve students' mathematical literacy. The use of pop-up books in mathematics learning on plane geometry significantly improves the learning outcomes of fourth-grade elementary school students (Paulina et al., 2021).

Based on preliminary studies at SDN 17 Gunung Pangilun, SD Kemala Bhayangkari, and SDN 03 Alai, mathematics learning in grade IV is generally still dominated by conventional methods in the form of oral explanations, use of textbooks, and practice questions without the support of technology-based media, so that students tend to be less active, less motivated, and have difficulty understanding material that requires visualization such as fractions and geometric shapes; limited media, facilities, and preparation time are the main reasons teachers

have not used interactive media, but after being introduced to Pop Up Book concept, the three teachers at the school showed a positive response and believed that this media was able to enliven the learning atmosphere, increase motivation, and help students understand mathematical concepts in a more concrete and interesting way.

2. Methodology

The type of research used in this study is research and development (R&D). This research aims to produce a specific product and test its effectiveness in a learning context. Research and Development is the process of researching user needs, followed by product development to meet those needs. Research and development does not focus on theoretical discovery, but rather on product development that can be tested in terms of validity, practicality, and effectiveness. In this study, researchers developed a 3D Book media based on Pop Up Books designed to increase student learning motivation in Mathematics subjects in grade IV of elementary school. This media was developed through systematic stages using the 4D model (Four-D Models) from Thiagarajan in (Adriani et al., 2019), which consists of four main stages, namely: (1) Define (defining material needs), (2) Design (product design), (3) Develop (product development and testing), and (4) Disseminate (product distribution). By following these stages, the resulting product is expected to be able to answer the need for learning that is more interesting, interactive, and motivating for students.

The validity of the Pop-Up Book-based 3D Book media in fourth-grade mathematics learning was first tested before being implemented in the learning process. This validation process is an important stage in assessing the quality of the developed media and also serves as a basis for making improvements and refinements to the product in accordance with input from experts. Validation focused on three main aspects: material aspects, language aspects, and media aspects. The practicality test was carried out after the developed learning media went through a limited trial phase. The instrument used in the practicality test was a practicality questionnaire given to teachers and students. The practicality level of the Pop-Up Book-based 3D Book media in fourth-grade mathematics learning can be determined through the analysis of the questionnaires filled out by media users. Effectiveness analysis was carried out using the N-Gain Score technique to determine the increase in student learning outcomes quantitatively. The results of the N-Gain Score calculation were then analyzed to assess the extent to which the use of the Pop-Up Book-based 3D Book media was able to contribute to improving students' understanding of the mathematics material being studied.

3. Results and Conclusion

Data Presentation

The research was conducted at an elementary school in the Development Area I of North Padang District, involving fourth-grade students as research subjects. All

students participated in mathematics learning using the developed Pop-Up Book 3D media. This stage aimed to determine the level of effectiveness of the media in increasing student learning motivation, the attractiveness of the media display, and the ease of use of the learning media from the student's perspective. The development model used in this study was the 4D model consisting of four stages: define, design, develop, and disseminate. In the define stage, an analysis of learning needs and student characteristics was carried out. The design stage focused on designing the Pop-Up Book 3D media in accordance with the objectives of mathematics learning. The develop stage included the media development process accompanied by validation by experts and limited trials with students. Furthermore, the disseminate stage was carried out to disseminate the media that had been declared suitable for use. The data obtained from the results of expert validation and trials on students were used as a basis for revising and improving the media, so that the resulting Pop Up Book-based 3D Book media was truly suitable for use and was able to increase students' learning motivation in mathematics learning in grade IV elementary schools in the Development Area I, Padang Utara District.

a) Define Stage

The initial stage of this research began with school observations as part of the define stage to obtain a factual picture of classroom learning implementation. Observations were conducted at elementary schools in the Development Area I, North Padang District, specifically for mathematics learning in grade IV. Based on the observations, it was found that the learning process still requires the development of innovative learning media to increase student learning motivation and help students understand mathematics material more optimally.

b) Design Stage

The stages of this media design include the preparation of a material framework based on the learning outcomes of grade IV mathematics in the Independent Curriculum, designing the flow of material presentation through storyboards, selecting visual designs and pop-up mechanisms that suit student characteristics, and organizing the material into a 3D Book. All stages are designed systematically so that the resulting media can support the mathematics learning process effectively at SDN 03 Alai, SDN 17 Gunung Pangilun, and SDN 01 Kemala Bhayangkari. The following is a display of the 3D Book media based on Pop Up Books that have been designed.

The media (Figure 1) displays the initial display of a Pop-Up Book, designed in an attractive and colorful manner, thus fostering students' interest in learning. The visual design combines images, colors, and three-dimensional shapes, making the media appear more lively and interactive. This initial display serves as an introduction before students enter the learning material. Furthermore, the arrangement of images and text is kept simple for easy comprehension by elementary school students. The presence of pop-up elements creates a realistic impression, helping students visualize the concepts being learned.

Figure 1. shows the initial page of the pop-up book.

Media (Figure 2) This section displays teacher profiles as supporting information in the Pop-Up Book. Teacher profiles are presented concisely and clearly so students can identify the instructors involved in the learning process. Information displayed includes the teacher's name, photo, and brief identification. The profiles are also designed with an attractive appearance to align with the media design. With teacher profiles, the learning media becomes more comprehensive and provides a more personal impression for students.

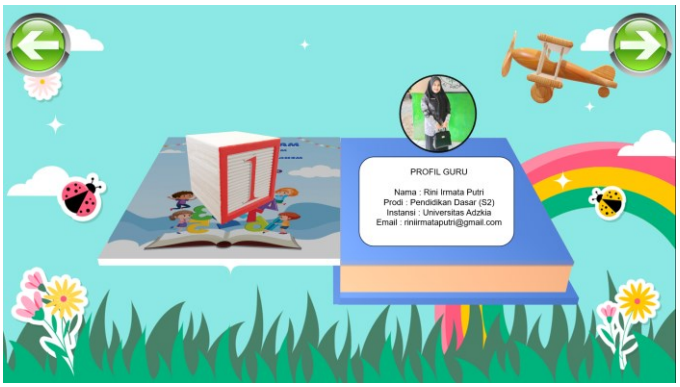

Figure 2. shows the teacher profile display in the pop-up book.

Media (Figure 3) This section presents the Learning Objectives and Learning Outcomes clearly and systematically as guidelines in the learning process. The information helps students understand the direction and expected results after participating in the learning activities. The presentation is made concise and easy to understand so that it suits the developmental level of elementary school students. In addition, the display is designed to be attractive so that it remains consistent with the design of the Pop Up Book media. With the presence of learning objectives and outcomes, the learning activities become more directed and structured.

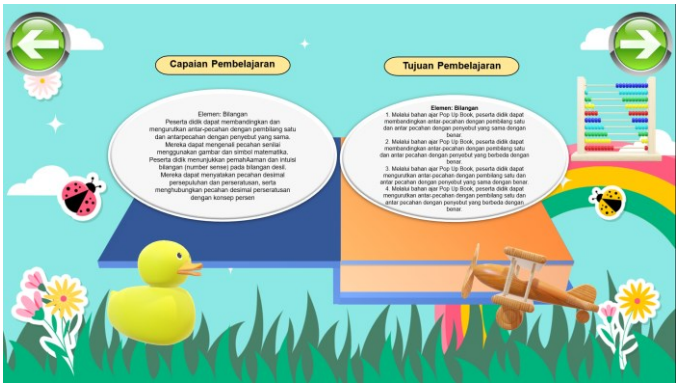

Figure 3. Display of Learning Outcomes and Learning Objectives

Media (Figure 4) This section presents fraction material that is displayed visually to help students understand the concept of fractions in mathematics learning. The material is arranged using interesting images and illustrations so that it is easier for students to understand the parts of a whole. The presentation of the material is made simple and systematic to suit the level of understanding of elementary school students. In addition, the use of visual elements in the Pop Up Book makes the material appear more concrete and engaging. Thus, students can more easily understand the concept of fractions through interactive learning media.

Figure 4. Display of Learning Material

The media in (Figure 5) displays practice questions on fraction material that are presented visually to train students' understanding in mathematics learning. The questions are designed using interesting images and illustrations so that students can more easily understand the problems given. The presentation is made simple and clear to suit the developmental level of elementary school students. In addition, the visual display in the Pop Up Book helps students relate the questions to the fraction concepts that have been learned. With these practice questions, students can test and strengthen their understanding of fraction material.

Figure 5. Display of Fraction Practice Questions

c) Develop Stage

At the Develop stage, the media that has been designed is developed into a tangible product. The 3D Book media based on a Pop Up Book begins to be created and refined. Furthermore, a validation test is conducted by material experts, media experts, and classroom teachers to assess the quality of the content and the appearance of the media. After going through the validation and revision process, the media is tested on students to determine its practicality and effectiveness in improving learning motivation.

d) Dissiminate Stage

The final stage is the dissemination of the developed media. After being declared feasible and effective, the 3D Book media based on a Pop Up Book is distributed on a limited basis to teachers and students in elementary schools in Cluster I of North Padang District. This dissemination is carried out as an effort to introduce this innovative media as an alternative for more enjoyable and easier-to-understand mathematics learning. With the presence of this media, it is expected that teachers will be assisted in delivering the material and students will become more motivated in learning.

Validation Test Results

This validation process not only aims to ensure the accuracy of the material presented in the learning media but also assesses the clarity of language used to ensure it is easily understood by elementary school students. Furthermore, the quality of the media's presentation is also a crucial aspect considered by experts in the assessment process. Through this validation, the developed media can determine its suitability and suitability for learning needs. The validators also provide various constructive suggestions and input to improve and refine the media.

1) Media Expert Validity Test Analysis

Validity test data on the graphic or media aspect was obtained from one media expert lecturer who has competence in the field of educational technology and learning media development. Media validity assessment was carried out using an instrument in the form of a media expert validation questionnaire. At this stage, the validator assessed the product developed in the form of a Pop Up Book-based 3D Book media used in mathematics learning for grade IV of elementary school. The

assessment focused on the quality of the display and the suitability of the media as a learning tool that supports increasing student learning motivation. Aspects assessed included the size and shape of the 3D Book media, cover design and layout, choice of typography on the cover, visual appeal and illustrations on the front page, the integration of the content layout, text readability through the choice of fonts and colors, and the quality of illustrations and images used in each part of the media. The validation process for the graphic or media aspect was carried out in two stages, namely initial validation before revision and final validation after improvements were made according to the validator's suggestions. presented in table 1.

Table 1. Media Validity Test

No	Assessment Aspects of 3D Book Media Based on Pop Up Books	Assessment Score
1	The layout and arrangement of elements in Book 3D is consistent and proportional.	4
2	The suitability of the contents of Book 3D with the sequence of fraction material	3
3	The use of text, image illustrations, and pop-up elements is balanced and supports the fractional material.	4
4	The background design and visual appearance of the 3D Book attract students' attention.	4
5	Images, pop-up shapes, and illustrations are appropriate to the content of the mathematics material.	4
6	Visual elements and pop ups help clarify math learning concepts.	4
7	The front cover (cover) of the 3D Book is attractive and reflects the content of the material.	4
8	The color selection in the 3D Book design is harmonious, harmonious, and not flashy.	4
9	The use of type and size of letters (fonts) is easy to read and not excessive	4
10	3D Media Book is easy to use and can be operated well during learning.	4
	Total Score	37

2) Analysis of Language Expert Validity Test

Validity test data for the linguistic aspects were obtained from a linguist with expertise in linguistics and education. The linguistic validity assessment was conducted using a linguist validation questionnaire. At this stage, the validator assessed the linguistic aspects of the product developed, a Pop-Up Book-based 3D Book media used in mathematics learning for fourth grade elementary school. The assessment focused on the clarity and accuracy of language used in presenting the material to ensure it was easily understood by students, in accordance with their level of cognitive development. The linguistic aspects assessed included text readability, the directness and clarity of language delivery, the appropriateness of language use to good and correct Indonesian language rules, and the effectiveness and efficiency of language use in presenting the learning material. The linguistic aspect validation process was carried out in two stages: initial validation before revisions were made and final validation after revisions were made based on the validator's suggestions. The results of the assessments from both validation stages are then presented in Table 2.

Table 2. Language Validity Test

No	Language Assessment Aspects of Pop-Up Book-Based 3D Book Media	Amount
1	The shape and size of the letters used in the Pop Up Book-Based 3D Media Book are easy for students to read.	4
2	The description of the information conveyed in the Pop Up Book-Based 3D Media Book is easy to understand for fourth grade elementary school students.	3
3	Pop Up Book-based 3D Book Media uses simple, clear sentences that are easy for students to understand.	4
4	The language used in the Pop Up Book-Based 3D Media Book is in accordance with the rules of good and correct Indonesian based on the Indonesian Spelling (EBI).	3
5	The sentences and vocabulary used in the Pop Up Book-Based 3D Media Book are appropriate to the language ability level of elementary school students.	4
	Score	18

3) Analysis of Material Expert Validity Test

The validity test assessment data on the material aspect was obtained from one learning material expert who has competence and experience in the field of elementary school education. The assessment of the validity of the material aspect was carried out using an instrument in the form of a material expert validation questionnaire. At this stage, the validator assessed the feasibility of the material presented in the Pop Up Book-based 3D Book media developed for fourth-grade elementary school mathematics learning. The assessment focused on the suitability of the material with the achievements and objectives of mathematics learning, especially on fractions, as well as its relationship to the characteristics and needs of fourth-grade students. The variables assessed in the validity test of the material aspect included the suitability of general information with the learning material, the completeness and accuracy of the components of the mathematics material, the suitability of learning activities with the characteristics of fourth-grade students, the application of learning strategies that support the achievement of learning outcomes, the clarity of learning assessments, the integration of student worksheets, the quality of material presentation, the media's contribution to increasing student learning motivation, and the positive impact of the media on student learning independence. presented in Table 3 below.

Table 3. Material Validity Test

No	Assessment Aspects of 3D Media Materials Based on Pop Up Books	Amount
1	Compliance of material content with the Independent Curriculum	4
2	The material presented in the learning media supports the achievement of learning objectives.	4
3	The description of the material in the learning media is delivered clearly, completely and is easy to understand.	3
4	The systematic presentation of the material is arranged consistently and logically.	3
5	3D Book Media developed according to the learning needs of fourth grade students	4

6	3D Book Media provides opportunities for students to learn independently according to their respective abilities.	3
7	Suitability of media content with teaching modules and learning outcomes	4
8	The content of the material in the media can increase students' knowledge and insight in learning mathematics.	4
9	The presentation of images, 3D animations, and pop-up elements helps students understand the material visually.	4
10	The accuracy of the images, 3D elements, and videos used in the media is in accordance with the concept of the material.	4
	Score	37

This validation process aims to ensure that the developed media meets the eligibility criteria for use in learning. Validation is conducted by experts who comprehensively assess the media, language, and materials. This assessment aims to assess the appropriateness of the presentation, clarity of language, and accuracy of the content presented. Furthermore, the validators also provide suggestions and input for improving the developed product. Through this validation process, the resulting learning media is expected to be of good quality and suitable for use in the learning process. The results from the three validators are presented in Table 4.

Table 4. Validation Results

No	Validated Aspects	Validator Assessment Score	Information
1	Material Aspect	92.50%	Very Valid
2	Language Aspects	90.00%	Very Valid
3	Teaching Materials / Media Aspects	92.50%	Very Valid
	Average	91.67%	Very Valid

Practicality Test

The results of the practicality test provide an overview of the ease of use of the media, the attractiveness of the display, and the usefulness of the media in supporting the mathematics learning process. Assessments from teachers and students show the extent to which the Pop Up Book-based 3D Book media is easy to use, attracts students' attention, and helps increase students' learning motivation during mathematics learning activities in grade IV elementary schools in the Padang Utara District.The results of filling out the teacher response questionnaire regarding the practicality of the Pop Up Book-based 3D Book media in mathematics learning are presented in Table 5.

Table 5. Teacher Responses

Name	**Score**	**Criteria**
Kemala Bhayangakari Elementary School	95%	Very practical
SDN 17 Gunung Pangilun	97.5%	Very practical
SDN 03 Alai	92.5%	Very practical

A student response questionnaire was administered to obtain an overview of students' opinions regarding the learning media that had been developed and used in the learning process. Through this questionnaire, researchers were able to

determine the level of practicality of the media from the perspective of students as users. The statements in the questionnaire were structured simply to be easily understood by elementary school students. The results of student responses were used to assess ease of use, appearance, and student interest in the media. Thus, the data obtained can serve as a basis for assessing the practicality of the developed learning media. The questionnaire was completed by fourth-grade students, as presented in Table 6.

Table 6. Student Responses

Name	Score	Criteria
Kemala Bhayangakari Elementary School	89.29%	Very practical
SDN 17 Gunung Pangilun	94.64%	Very practical
SDN 03 Alai	90.28%	Very practical

Effectiveness Test

Effectiveness analysis was conducted using the N-Gain Score technique to quantitatively determine improvements in student learning outcomes. This technique is used to compare pretest and posttest results obtained by students after participating in the learning process. Through the N-Gain calculation, the level of improvement in students' understanding of the material studied can be determined. The results of this analysis are then used to assess the extent to which the use of the Pop-Up Book-based 3D Book media contributes to improved learning outcomes. Thus, the effectiveness of the learning media can be determined more objectively and measurably. The results of the effectiveness test are presented in Table 7.

Table 7. Results of Effectiveness Data

Name	Score	Criteria
Kemala Bhayangkari Elementary School	0.8111	Very Effective
SDN 17 Gunung Pangilun	0.7212	Very Effective
SDN 03 Alai	0.8897	Very Effective

4. Conclusion

Based on the research results, it can be concluded that the developed Pop Up Book-based 3D Book media has a very good level of validity, practicality, and effectiveness so that it is suitable for use in learning Mathematics for grade IV of elementary school. This media has met the eligibility criteria from the aspects of appearance, language, and material, and is considered easy to use and interesting by teachers and students. The implementation of the media at Kemala Bhayangkari 01 Padang Elementary School, Gunung Pangilun 17 Elementary School, and Alai 03 Elementary School shows that the use of Pop Up Book-based 3D Book media can increase student learning motivation, help understanding mathematical concepts more concretely, and have a positive impact on learning outcomes. Thus, this media can be used as an alternative effective innovative learning media to

create Mathematics learning that is more meaningful, interesting, and in accordance with the characteristics of elementary school students.

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