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Development of the MARIBANG Pop-Up Book as a Learning Medium for Seventh-Grade Students at State Junior High School

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ABSTRACT

This study aimed to develop and evaluate the feasibility of the MARIBANG Pop-Up Book as an innovative learning medium for seventh-grade students at SMPN 2 Sampit. The research employed a Research and Development (R&D) approach using the ADDIE model, which includes the stages of analysis, design, development, implementation, and evaluation. The subjects of this study were 36 seventh-grade students, while the object of the research was the MARIBANG Pop-Up Book learning media. Data were collected through expert validation questionnaires, student and teacher response questionnaires, and learning outcome tests. The data were analyzed using descriptive statistics and N-gain analysis to measure improvements in students' learning outcomes. The results indicated that the MARIBANG Pop-Up Book demonstrated a very high level of validity based on evaluations from material, media, and language experts. In terms of practicality, both students and teachers gave very positive responses, indicating that the media was easy to use and engaging in classroom learning. Furthermore, the effectiveness of the media was confirmed by a significant increase in students' learning outcomes, as reflected in the N-gain scores and classical learning completeness. These findings suggest that the MARIBANG Pop-Up Book is a valid, practical, and effective learning medium. This study highlights the potential of pop-up book–based media to enhance student engagement and learning achievement, and provides practical implications for the development of interactive instructional media in junior high school education.

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A. INTRODUCTION

An educator must possess adequate competencies to implement effective, meaningful, and goal-oriented learning. According to the Constitution of the Republic of Indonesia No. 14 of 2005 concerning Teachers and Lecturers, competence is defined as a set of knowledge, skills, and behaviors that educators must possess, understand, and master in carrying out their professional duties. This regulation emphasizes that professional teachers are required to have at least four core competencies: pedagogical, personality, professional, and social competencies. Professional teachers are expected to implement student-centered learning, understand students' developmental needs, and select appropriate, interesting, and innovative learning tools. Teacher professionalism has a significant impact on students' academic achievement and character development, which plays a vital role in preparing future

generations (Rosli & Aliwee, 2021), reflected through both attitudes and behaviors (Tichenor & Tichenor, 2005).

Despite this expectation, many teachers still rely on traditional teaching methods with minimal use of creative learning media, resulting in passive learning conditions where students mainly listen and take notes without deep conceptual understanding. This condition is particularly evident in mathematics learning, a subject that is often perceived as difficult by students. International assessments indicate that Indonesian students' mathematics performance has not shown a consistent improvement (Muhtadi et al., 2022). Consequently, teachers are required to design learning experiences that foster students' creativity, conceptual understanding, and engagement. The use of instructional media has been proven to play a crucial role in increasing students' interest, reducing boredom, and supporting active and productive learning, as well as improving students' learning performance and conceptual understanding (Chansiri & Thongchai, 2025).

Mathematics is a fundamental discipline that supports the development of logical thinking, reasoning, and problem-solving skills required in everyday life. Mathematics learning trains students to think systematically, analytically, and critically, while also contributing to the development of self-confidence, persistence, and social interaction through collaborative problem-solving activities. Ernest (2015) emphasizes that mathematics education should not merely focus on procedural mastery, but also on the development of higher-order thinking skills, confidence, and social empowerment. Mathematics also serves as a foundation for learning in other disciplines (Mamalatifovna, 2023). Several national studies highlight that mathematical critical thinking and literacy are essential outcomes of effective instruction and play a significant role in enhancing students' reasoning processes (Haeruman et al., 2024; Kappassova et al., 2025; Stupnisky et al., 2008). Therefore, mathematics education is essential not only for academic achievement but also for preparing students to face social challenges and advances in science and technology.

However, mathematics instruction often emphasizes memorization and repetitive practice rather than conceptual understanding, which limits students' mathematical knowledge (Mangarin & Caballes, 2024). Mathematics is frequently perceived as difficult due to its cognitive demands, including intelligence, working memory, and processing speed (Andreansyah & Sari, 2024; Gafoor & Kurukkan, 2015; Geary, 2011). In many classrooms, teachers explain concepts, provide examples, and assign similar exercises, which results in teacher-centered learning and passive student participation (Erchick et al., 2011). This approach reduces opportunities for meaningful interaction and deep understanding. Teachers are therefore encouraged to relate mathematical concepts to students' real-life experiences (Da, 2022; Orhani et al., 2025) and to view mathematics learning as a process of learning to learn rather than mere knowledge transmission (Zydziunaite et al., 2022). Professional mathematics teachers are those who can create meaningful learning experiences, select appropriate contexts, treat students as individuals, enhance motivation, and demonstrate high self-efficacy (Eminita et al., 2024; Koskinen & Pitkaniemi, 2022; Li et al., 2025).

To address these challenges, the development of appropriate learning media is essential to support effective learning experiences and behavioral change. Integrating technology into mathematics learning has been shown to positively influence students' academic achievement,

interest, and motivation, especially when combined with collaborative learning approaches (Boateng et al., 2024; Bright et al., 2024). Learning media can help transform abstract mathematical concepts into more concrete representations, thereby increasing students' engagement and understanding. Interactive and digital learning media have been found to significantly enhance student motivation and participation by providing enjoyable and contextual learning experiences (Akbar et al., 2025; Annail et al., 2025).

Innovative learning media are particularly effective when used at the initial stage of learning to stimulate students' interest and motivation. Such media can enhance realistic learning experiences, reduce boredom, and support active learning environments (Payadnya et al., 2023; Vale & Barbosa, 2023). Learning media can also be integrated with mathematical tasks to promote deeper understanding (Sullivan et al., 2013).

Observations conducted at SMPN 2 Sampit revealed that mathematics instruction still relies heavily on lectures, textbooks, worksheets, and board-based explanations. Teachers tend to have limited understanding of innovative learning media, which affects their ability to plan and implement effective learning activities (Zaporozhchenko et al., 2022). The lack of teacher-developed media results in less engaging lessons and difficulties for students in understanding mathematical concepts. Technology-based learning media can enhance student motivation and engagement, consistent with the expectancy–value model of motivation, which emphasizes students' beliefs, expectations, and affective aspects (Heafner, 2004), and supports high-quality engagement in mathematics learning (Gresalfi, 2013).

One learning medium that has the potential to improve students' understanding and interest in mathematics, particularly in the topic of three-dimensional shape nets for seventh-grade students, is the Pop-Up Book. A Pop-Up Book is a three-dimensional book in which images emerge when pages are opened, providing a more concrete and engaging visual experience. According to Haryanto & Karyono (2021), Pop-Up Books utilize folding, rolling, and rotating techniques to present content in a three-dimensional format. Although often associated with children's storybooks, Pop-Up Books can serve as effective instructional media due to their clear visuals and engaging characteristics, which support conceptual understanding.

Research indicates that Pop-Up Book media development based on teacher and student needs shows strong demand for innovative learning media, with visually based designs helping students better understand mathematical concepts. Pop-Up Books are portable, can be used anytime and anywhere, and can enhance students' imagination and motivation. Akina et al., (2023) confirm that Pop-Up Books have strong potential for use in mathematics learning. However, the use of Pop-Up Books in mathematics education remains limited, particularly for abstract topics such as three-dimensional geometry.

To address this research gap, MARIBANG (*Materi Jaring-Jaring Bangun Ruang*) was developed as an innovative Pop-Up Book learning media focusing on three-dimensional shape nets. MARIBANG is designed to help students visualize net patterns in two- and three-dimensional forms while integrating interactive games to stimulate visualization skills and conceptual understanding. A distinctive feature of MARIBANG is the integration of local wisdom, specifically the *Huma Betang* cultural element, which is linked to the mathematical content. This integration represents the novelty of the MARIBANG Pop-Up Book compared to

existing Pop-Up Book media, which rarely incorporate local cultural contexts into mathematics learning.

Through this media, students are expected not only to gain knowledge and understanding of three-dimensional shape nets but also to experience enjoyable and meaningful learning. Therefore, this study aims to examine the validity, practicality, and effectiveness of the MARIBANG Pop-Up Book learning media at SMPN 2 Sampit. Based on this rationale, the research entitled Development of MARIBANG Pop-Up Book Learning Media at SMPN 2 Sampit is considered important to conduct**.**

B. METHODS

This research uses the Research and Development (R&D) method which aims to assess the feasibility, practicality, and effectiveness of a developed product, and integrate innovation into its products and processes. The development product referred to in this research is a learning media in the form of the Pop-Up Book MARIBANG. In its development process, this research applies the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), which is a learning system design model that presents the basic stages in the development of a learning system in a systematic and easy-to-apply way). The ADDIE model is a systematic and structured instructional design model. The concept of the ADDIE model emphasizes researchers in building basic performance, namely the concept of developing a research product design (Aldoobie, 2015). This research was conducted at SMP Negeri 2 Sampit and involved 36 seventh-grade students and two mathematics teachers as research subjects. The study employed a mixed-methods approach, combining quantitative and qualitative techniques to obtain comprehensive data. The instruments used in this research included observation sheets, questionnaires, pre-tests and post-tests, and documentation.

Data collection was carried out by distributing questionnaires and validation sheets containing structured statements to the respondents. The respondents consisted of media experts, material experts, language experts, seventh-grade students, and mathematics teachers. Student and teacher questionnaires used a five-point Likert scale ranging from 1 (very poor) to 5 (very good) to measure responses toward the developed learning media. Data analysis focused on three aspects: validity, practicality, and effectiveness. Media validity was evaluated through expert validation involving media, material, and language experts. The validity scores were calculated in percentage form to determine the level of feasibility of the MARIBANG Pop-Up Book. Practicality was analyzed based on student and teacher response questionnaires to assess the ease of use and attractiveness of the media in the learning process. Effectiveness was measured using students' learning outcomes, which were analyzed through the normalized gain (N-gain) by comparing pre-test and post-test scores. Qualitative descriptive analysis was used to interpret observations, expert suggestions, and documentation results. Through these analysis techniques, the feasibility, practicality, and effectiveness of the MARIBANG Pop-Up Book learning media were systematically evaluated.

C. RESULT AND DISCUSSION

1. Results

The product developed in this research is a learning medium in the form of the MARIBANG Pop-Up Book for seventh-grade mathematics learning. The development process followed the ADDIE development model, which consists of the analysis, design, and development stages. Each stage was conducted systematically to ensure that the resulting product met the learning needs of students and teachers.

At the analysis stage, a needs analysis was conducted to identify problems encountered in mathematics learning. This stage involved open interviews with 36 seventh-grade students of class VII-A and two mathematics teachers at SMP Negeri 2 Sampit. The results showed that many students perceived mathematics as a difficult subject and reported experiencing boredom due to learning activities that relied mainly on textbooks and lecture-based methods. These conditions led to low learning motivation and difficulties in understanding abstract concepts. Interviews with teachers also revealed that limited learning resources were a major challenge, especially in teaching complex topics such as nets of three-dimensional shapes. Teachers observed low student enthusiasm and participation, which often resulted in gaps in conceptual understanding. These findings indicate the need for innovative, concrete, and engaging learning media to support mathematics instruction.

In addition to the needs analysis, a material analysis was conducted as the basis for media design. This analysis referred to the D phase of the Kurikulum Merdeka, in which learning outcomes are divided into general learning outcomes and element-specific learning outcomes for grades VII, VIII, and IX. The element-specific learning outcomes were further elaborated into "Learning Objectives" and arranged within the "Learning Objectives Framework". The material analyzed in this study focused on geometric nets for seventh-grade students, ensuring alignment with the Learning Outcomes, Learning Objectives, and Learning Objectives Framework under the Kurikulum Merdeka.

At the design stage, the product was designed based on the results of the analysis. The MARIBANG Pop-Up Book was designed using the Canva application. The design process included the development of the book cover, content layout, and visual appearance. The cover was designed on A3-sized art paper with a dominant brown color scheme and mathematical illustrations related to three-dimensional shapes to enhance visual appeal. The content of the book covers various three-dimensional shapes, such as cubes, rectangular prisms, triangular prisms, square pyramids, cones, and cylinders. Each shape is presented with its characteristics, nets, and examples of real-life applications. To increase student engagement, the book also includes interactive games related to identifying geometric nets. The visual design considered appropriate font selection, the use of illustrative images, and suitable pop-up techniques to support learning clarity and attractiveness.

The development stage represented the realization of the initial design into a tangible product. At this stage, the MARIBANG Pop-Up Book learning media was produced using selected tools and materials in accordance with the designed specifications. This stage resulted in a complete pop-up book that integrates visual, interactive, and instructional elements to support the learning of geometric nets in seventh-grade mathematics, as shown in Figure 1.

Figure 1. The display of the developed Pop-Up Book MARIBANG media

The development stage was characterized by the validation of the initial prototype by media, material, and language experts. During this process, the validators evaluated the prototype based on predetermined validity criteria and provided constructive feedback in the form of suggestions and criticisms. The feedback obtained from these experts was then used as the basis for revising the product to improve its quality and suitability for learning purposes. This revision process was carried out to ensure that the MARIBANG Pop-Up Book met the required standards before being implemented in field trials with students in mathematics learning. The results of the validation of the MARIBANG Pop-Up Book learning media for seventh-grade students at SMPN 2 Sampit are presented below. Media expert validation was conducted using a questionnaire with a five-point Likert scale, which assessed several aspects, including readability, ease of use, display quality, and media management quality, as shown in Table 1.

Table 1. Media Expert Test

Aspect	Total Score	Average Score	Percentage	Conclusion
Readability	10	43	95.55%	Very valid
Ease of Use	5			
Display Quality	19			
Media Management Quality	9			

Table 1 presents the results of the media expert validation of the MARIBANG Pop-Up Book. The assessment covered several aspects, including readability, ease of use, display quality, and media management quality. Overall, the media obtained a high average score per indicator, resulting in a total percentage of 95.55%, which falls into the *very valid* category. These results indicate that the MARIBANG Pop-Up Book has met the required standards in terms of visual appearance, clarity of information, ease of operation, and systematic media organization. The high validity score suggests that the media is appropriate for use in mathematics learning and does not require major revisions from a media design perspective, as shown in Table 2.

Table 2. Material Expert Assessment

Aspect	Total Score	Average Score	Percentage	Conclusion
Alignment of material explanation with competencies	15	40	88.88%	Very Valid
Completeness of material	8			
Coherence of material	8			
Quality of material	10			

Table 2 presents the results of the material expert assessment of the MARIBANG Pop-Up Book learning media. The evaluation focused on several aspects, including the alignment of material explanations with the required competencies, the completeness of the material, the coherence of content presentation, and the overall quality of the material. The results indicate that the learning media achieved a high average score per indicator, resulting in an overall percentage of 88.88%, which falls into the *very valid* category. These findings suggest that the content of the MARIBANG Pop-Up Book is well aligned with the curriculum requirements, systematically organized, and presented in a clear and coherent manner. Therefore, from a material perspective, the MARIBANG Pop-Up Book is considered appropriate for use in seventh-grade mathematics learning without requiring major revisions, as shown in Table 3.

Table 3. Language expert test

Aspect	Total Score	Average Score	Percentage	Conclusion
Ease to Use	14	42	93.33%	Very Valid
Quality of Language Usage	28			

Table 3 presents the results of the language expert assessment of the MARIBANG Pop-Up Book learning media, which focused on aspects of ease of use and the quality of language usage. The findings show that the media achieved a high average score per indicator, with an overall percentage of 93.33%, categorized as very valid. This indicates that the language used in the MARIBANG Pop-Up Book is clear, consistent, and appropriate for the cognitive level of seventh-grade students, thereby supporting readability and instructional clarity in conveying mathematical concepts. After completing the validation process and implementing the necessary revisions, the research proceeded to the implementation stage to examine the practicality of the developed media in real classroom settings. At this stage, the MARIBANG Pop-Up Book was tested through small group and field trials involving seventh-grade students at SMPN 2 Sampit. The small group trial involved five students, while the field trial was conducted with a larger group of students in class VII-A. The implementation aimed to evaluate the practicality of the learning media during mathematics instruction, with data collected through student and teacher response questionnaires for further analysis, as shown in Table 4.

Table 4. Student Learning Outcome Data in Small Group Trial

No	Students	Learning Outcomes				*N-Gain*	Percentage
		Pre Test	**Mastery Criteria**	***Post Test***	**Mastery Criteria**		
1	MAT 1	80	Achieved	90	Achieved	0.50	50%
2	MAT 2	67	Not Achieved	100	Achieved	1.00	100%
3	MAT 3	80	Achieved	90	Achieved	0.50	50%
4	MAT 4	90	Achieved	100	Achieved	1.00	100%
5	MAT 5	67	Not Achieved	100	Achieved	1.00	100%
Total		384	-	480	-	4	
Average		76.8	-	96	-	0.80	80%
Classical Learning Mastery		60%	-	100%	-	-	

Based on the data, the analysis results showed that the average pre-test score of students was 76.8, and the average post-test score increased to 96 after learning with the Pop-Up Book MARIBANG media. After completing the test, students were given a questionnaire to assess the practicality of the media used. Field practitioners (teachers) were also provided with the same media and given a questionnaire to evaluate the developed media. According to the questionnaires, both students and teachers stated that mathematics learning using the Pop-Up Book MARIBANG media became more engaging, interactive, and enjoyable. This is presented in Table 5 below.

Table 5. Responses to the Pop-Up Book *MARIBANG* Media

Respondents	Percentage	Conclusion
Small Group Students	91.2%	Very Practical
Teacher	96.0%	Very Practical

Based on the results presented in the previous table, it can be concluded that the MARIBANG Pop-Up Book learning media is highly practical for use in mathematics learning on the topic of three-dimensional net structures for seventh-grade students at SMP Negeri 2 Sampit. Following the practicality assessment, the research proceeded to the field testing stage (large-scale testing), in which the MARIBANG Pop-Up Book learning media was implemented with 36 students. The following is a comparison chart of the average pre-test and post-test scores, presented in Figure 5.

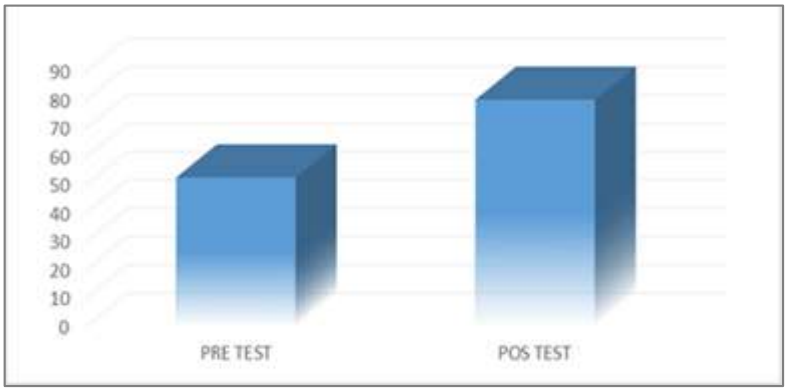

Figure 2. Improvement of Learning Outcomes in Field Testing

The results show that the average pre-test score was 52.6, while the average post-test score increased to 80.1. Furthermore, the effectiveness of the learning media was analyzed using the N-Gain test, the results of which are presented in Table 6. The analysis indicates an N-Gain value of 0.58, categorized as medium, demonstrating a significant improvement in students' learning outcomes after using the MARIBANG Pop-Up Book media and confirming its effectiveness in supporting mathematics learning.

Table 6. N-Gain Results in the Field Test

Average N-Gain	Interpretation	Number of Students
N-Gain > 0.7	High	17
0.3 < N-Gain ≤ 0.7	Medium	16
N-Gain < 0.3	Low	3

Based on the results presented in Table 6, the N-Gain analysis from the field test shows that 17 students achieved a high category (N-Gain > 0.7), 16 students were in the medium category (0.3 < N-Gain ≤ 0.7), and only 3 students were categorized as low (N-Gain < 0.3). These findings indicate that the majority of students experienced moderate to high improvement in learning outcomes after using the Pop-Up Book MARIBANG learning media. The dominance of the medium and high N-Gain categories confirms that the MARIBANG Pop-Up Book is effective in enhancing students' understanding of three-dimensional net structures. The presence of a small number of students in the low category suggests that individual differences in learning pace and comprehension still exist, highlighting the need for further refinement of the learning media.

These results are reinforced by the evaluation stage, which was conducted through the collection of students' feedback after the implementation of the Pop-Up Book MARIBANG learning media. The feedback revealed that the developed media is feasible and helpful for learning, while also providing valuable assessments, criticisms, and suggestions to identify its shortcomings. Based on this evaluation, the researcher carried out reflection, evaluation, and revision to improve the effectiveness of the media. Several revisions were made, including the addition of Huma Betang images in each geometric solid, which aimed to clarify the material and help students more easily relate abstract geometric concepts to contextual and familiar cultural elements. These improvements are expected to further enhance students' learning outcomes and reduce the number of students in the low N-Gain category in future implementations.

2. Discussion

This study aimed to develop and test the Pop-Up Book MARIBANG learning media to meet students' learning needs on the topic of three-dimensional shape nets for Grade VII students at SMPN 2 Sampit using a Research and Development (R&D) approach with the ADDIE model. The ADDIE model consists of five systematic stages that emphasize the construction of a solid performance framework in designing and developing research-based learning products. The MARIBANG Pop-Up Book was integrated with the topic of 3D shape nets and contextualized through the incorporation of local wisdom, namely Huma Betang, and was designed using Canva before being printed on Art Paper and Glossy Paper. The V-Folding technique was

applied, in which the pop-up elements are placed at the center fold, remaining hidden when closed and appearing when the book is opened, thereby enhancing students' visual engagement. The feasibility test results demonstrated that the developed learning media met the validity criteria, as evaluations by media, content, and language experts yielded an average score of 93%, indicating that the design, language use, and content quality are highly suitable for mathematics learning. Furthermore, the practicality test based on teacher and student questionnaires showed an average score of 94.16%, which falls within the "very practical" category according to the practicality interval of 85%–100%, confirming that the MARIBANG Pop-Up Book is easy to use and supports classroom learning effectively. This finding is consistent with the results reported by Akina et al. (2023), who concluded that the implementation of Pop-Up Book learning media in mathematics learning can improve students' learning outcomes. The effectiveness test also revealed that the MARIBANG Pop-Up Book significantly improved students' understanding of geometric nets, indicating its effectiveness in supporting conceptual comprehension. These results align with previous studies showing that Pop-Up Book learning media effectively improve students' geometry skills (Apriliana et al., 2023), enhance understanding of polyhedrons (Fazira & Qohar, 2021), and promote enjoyable and meaningful learning experiences that accommodate students' needs and characteristics (Andreansyah & Sari, 2024). In addition, the findings are relevant to the study by Bulkani et al., (2025), which emphasized that integrating educational elements into the formal curriculum through contextual learning and reflective teaching methods can improve critical thinking, collaboration, and problem-solving skills, which are essential competencies in mathematics learning. This study also highlights the importance of integrating assessment into R&D research, as emphasized by (Boadu & Boateng, 2024). Overall, the MARIBANG Pop-Up Book not only provides students with alternative learning resources beyond conventional textbooks and supports teachers in delivering abstract mathematical concepts through interactive media, but also contributes to the preservation of Central Kalimantan cultural values by incorporating Huma Betang as a representation of local wisdom.

D. CONCLUSION AND SUGGESTIONS

This research and development study concludes that the MARIBANG Pop-Up Book is a feasible and effective learning medium for seventh-grade mathematics learning at SMP Negeri 2 Sampit. The findings indicate that the developed media meets essential quality standards in terms of content, language, and design, making it suitable for classroom implementation. The media is also easy to use and well received by both students and teachers, which supports its practicality in real learning situations.

Furthermore, the use of the MARIBANG Pop-Up Book contributes positively to improving students' understanding of geometric nets and supports better learning outcomes. The interactive and concrete characteristics of the pop-up book help students visualize abstract mathematical concepts, increase learning motivation, and encourage active participation during the learning process. From a practical perspective, this learning media can assist teachers in delivering complex mathematical material more effectively by providing an alternative to conventional, textbook-based instruction. It also supports the implementation of student-centered learning approaches in line with the Kurikulum Merdeka. Overall, the

MARIBANG Pop-Up Book has the potential to enhance the quality of mathematics learning and can be adapted or further developed for other mathematical topics and grade levels.

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