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Design and Development of Problem-Based Flipbook Media for Geometry Learning

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Abstract
This study aims to design and develop a problem-based flipbook media as an alternative solution for teaching geometric shapes in a relevant and engaging way. The research uses the ADDIE development model, which includes the stages of Analysis, Design, Development, Implementation, and Evaluation. The flipbook media is designed with 3D visualization features, problem-based questions, and step-by-step guides in accordance with the problem-based learning (PBL) approach. Trial results with 55 fifth-grade students show that this flipbook is effective in improving students' understanding of geometric shapes. Validation by experts in media, content, and language confirms that this media is valid for use in teaching. Additionally, 80% of students showed significant improvement in understanding, with the majority giving positive feedback about the use of the flipbook. The research concludes that the problem-based flipbook media can enhance students' concrete understanding and motivate them to think critically. However, the limited technology infrastructure in schools presents a challenge that requires solutions such as teacher training and the provision of technological facilities. With proper implementation, this flipbook can become an innovative learning media that supports more meaningful mathematics education.
Keywords: *Mathematics learning, problem-based flipbook, problem-based learning (PBL), ADDIE development model*

Abstrak
Penelitian ini bertujuan untuk merancang dan mengembangkan media flipbook berbasis masalah sebagai alternatif solusi pembelajaran bangun ruang yang relevan dan menarik. Penelitian menggunakan model pengembangan ADDIE, meliputi tahapan Analysis, Design, Development, Implementation, dan Evaluation. Media flipbook dirancang dengan fitur visualisasi 3D, soal berbasis masalah, dan panduan langkah demi langkah sesuai pendekatan problem-based learning (PBL). Hasil uji coba pada 55 peserta didik kelas V menunjukkan bahwa flipbook ini efektif meningkatkan pemahaman peserta didik terhadap bangun ruang. Validasi ahli media, materi, dan bahasa menyatakan media ini valid untuk digunakan dalam pembelajaran. Selain itu, 80% peserta didik mengalami peningkatan pemahaman yang signifikan, dengan mayoritas memberikan tanggapan positif terhadap penggunaan flipbook. Kesimpulan penelitian menunjukkan bahwa media flipbook berbasis masalah mampu meningkatkan pemahaman peserta didik secara konkret dan memotivasi mereka untuk berpikir kritis. Namun, keterbatasan perangkat teknologi di sekolah menjadi tantangan yang memerlukan solusi berupa pelatihan guru dan pengadaan fasilitas teknologi. Dengan implementasi yang tepat, flipbook ini dapat menjadi media pembelajaran inovatif yang mendukung pembelajaran matematika secara lebih bermakna.
Kata kunci: Pembelajaran matematika, flipbook berbasis masalah, problem-based learning (PBL), model pengembangan ADDIE.

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INTRODUCTION

Mathematics learning in elementary schools often faces challenges in attracting students' interest and improving their ability to understand abstract concepts such as three-dimensional shapes (Rahmananda et al., 2024). Innovative learning media are needed to help students connect mathematical concepts with everyday life. Moreover, conventional approaches that tend to focus on lecture methods are often less effective in engaging students actively (Durasa et al., 2024). As a result, many students struggle to understand the material due to the lack of concrete and relevant visualization. Therefore, learning media is needed that is not only interesting but also able to facilitate students in exploring concepts independently and interactively, making the learning process more meaningful.

According to Bruner in 1966 (Nafiah & Wuryandani, 2024), learning is more effective when students can build their understanding through direct experience and independent exploration. This is relevant in mathematics learning, especially for abstract concepts such as three-dimensional shapes, which require concrete visualization to be more easily understood by students. Meanwhile, Piaget (Farhana et al., 2023) emphasized that students in the concrete operational stage need learning media that can present abstract concepts in visual or manipulative forms to make the learning process more meaningful.

Furthermore, conventional approaches such as lecture methods often fail to engage students actively in learning, reducing motivation and interest in learning (Widayanti & Nur'aini, 2020). Therefore, innovative learning media is necessary to support students in connecting mathematical concepts with everyday life, as suggested by Jonassen (Martahayu & Yuanita, 2022), who stated that interactive media can help students understand the material through relevant and engaging learning experiences.

This challenge becomes more apparent when students are faced with concepts that require visual and spatial understanding, such as three-dimensional shapes. Without supporting media, students often only memorize formulas without deeply understanding the concepts. Therefore, a learning solution is needed that can present an engaging, relevant, and motivating learning experience, encouraging students to think critically in solving problems.

Problem-based flipbook media presents itself as an alternative solution that combines interactive visualization with a problem-based learning (PBL) approach. The flipbook not only captures students' attention with visual elements but also actively engages them in solving contextual problems. According to Barrows (Siagian et al., 2019), the problem-based learning (PBL) approach is effective in encouraging students to think critically and solve problems independently, making it highly relevant to apply in learning media like flipbooks. This aligns with Mayer (Wajdi et al., 2022), who stated that interactive visual-based learning media can enhance students' understanding by helping them process information more concretely and systematically. Additionally, Hung (Suhartami et al., 2023) added that integrating PBL into digital learning media allows students to engage more actively in the learning process because they can relate the material to real-life contexts. This is reinforced by Clark and Mayer (Puspitasari et al., 2023), who mentioned that visually appealing learning media design can increase students' attention and motivation in understanding complex material.

this study aims to design and develop a problem-based flipbook media and explore its benefits in supporting the learning of three-dimensional shapes. The focus is to provide an alternative learning media that is relevant, easily accessible, and capable of increasing student involvement in the learning process. By utilizing technology and a problem-based approach, it is hoped that this media can become an innovative, engaging learning tool that addresses the challenges in elementary school mathematics education.

METHOD

This study uses the Research and Development (R&D) approach with the ADDIE development model, which consists of five main steps: Analysis, Design, Development, Implementation, and Evaluation (Almelhi, 2021). In the Analysis phase, learning needs are identified through interviews with teachers and students to understand difficulties in comprehending the concept of three-dimensional shapes. The Design phase focuses on designing a problem-based flipbook media involving visual and interactive elements according to the problem-based learning (PBL) approach.

In the Development phase, the flipbook prototype is developed using digital design software and then validated by media and education experts to ensure quality and content suitability. The Implementation phase involves a limited trial with 55 fifth-grade students to evaluate the effectiveness of the media in learning three-dimensional shapes. Finally, the Evaluation phase is conducted to gather feedback from users and refine the flipbook based on the trial results, so that the resulting media can be implemented more widely. The stages of the ADDIE development model, adapted from Branch ((Setiawan et al., 2021)), can be seen in the picture 1 below:

Picture 1. ADDIE Flowchart

RESULTS AND DISCUSSION

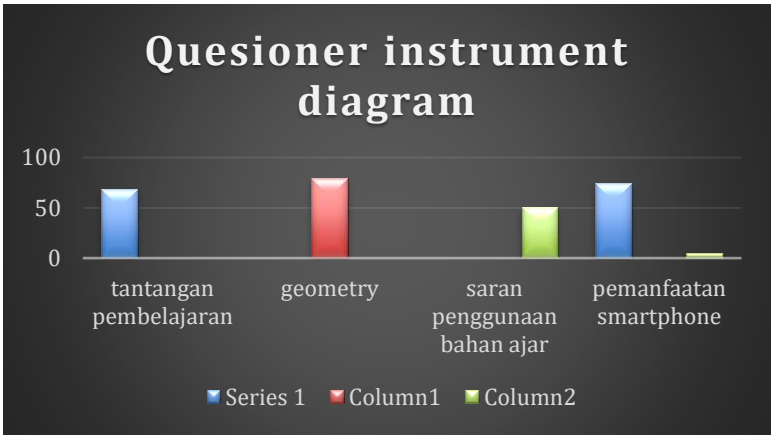
A. Result

1. Analysis Phase

The test results show that the majority of students have not fully understood the basic concepts of three-dimensional shapes. Many struggle with volume and surface area calculations of solid shapes, as well as understanding the geometric properties of these shapes. Most students admit to feeling confused about three-dimensional shapes, especially when asked to calculate the volume or surface area. They often find it difficult to imagine the shape in 3D based only on 2D images. Students need a more visual and interactive approach to learning the concepts of solid shapes, particularly regarding volume and surface area calculations. The use of 3D models or technology applications that allow students to manipulate and view solid shapes in three dimensions would be very helpful.

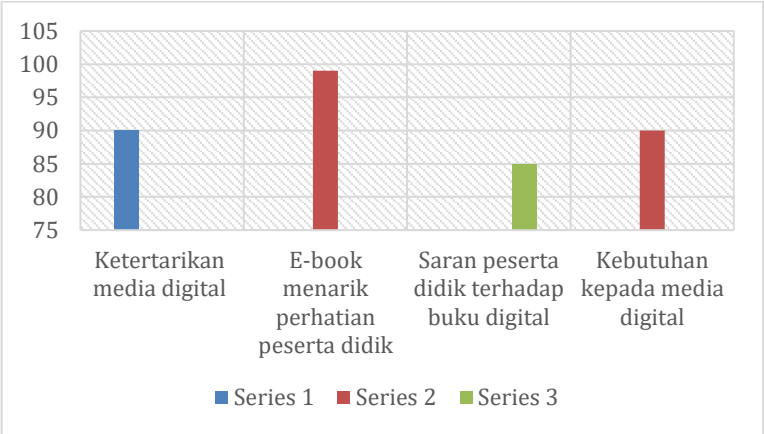
This section is the main part of the research article and is usually the longest part of an article. The research results presented in this section are “clean” results. Data analysis processes such as statistical calculations and hypothesis testing processes do not need to be presented. Only the results of the analysis and the results of hypothesis testing need to be reported. Tables and graphs can be used to clarify the presentation of research results verbally. Tables and graphs should be commented on or discussed.

This analysis stage employed a questionnaire instrument to examine the percentage of conventional media usage among students and teachers. The diagram below illustrates the teachers' use of conventional media.



Picture 2. Quesioner

The results indicate that mathematics learning activities face challenges (69%), geometry content (79%), advice obtained (50%), and HP utilization (80%). The questionnaire responses reveal that students can provide valuable insights into the learning activities conducted by teachers using spatial materials. Moreover, conventional media pose challenges in solving mathematical problems. To address this, the researcher recommends that teachers utilize problem-based flipbook media to enhance mathematical communication skills. The diagram below shows student responses to the use of digital teaching materials.

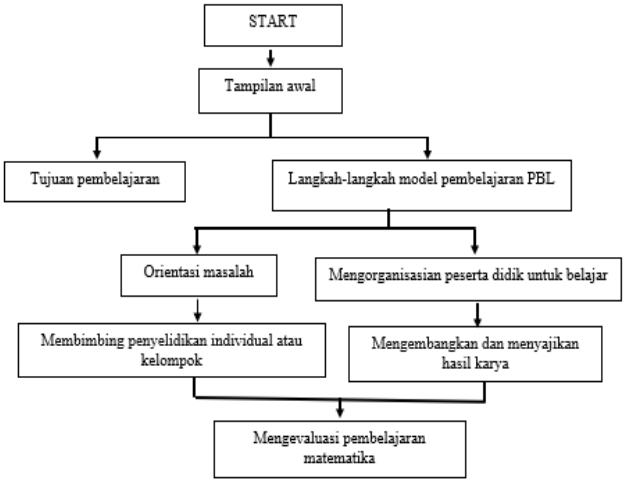


Picture 3. Students Respon

The data suggest that digital media loaded with problem-solving capabilities can elicit engaging responses, as teachers can involve students in the learning process.

2. Design Phase

The flipbook is designed with interactive features, such as 3D visualizations of solid shapes, problem-based story problems, and solution guides. The prototype of the flipbook is shown in Picture 4.



Picture 4. Prototype Flipbook Media

The image above shows the prototype of the workflow or content structure of the problem-based flipbook media designed for mathematics learning using the Problem-Based Learning (PBL) approach. The detailed explanation is as follows:

1) Start and Initial Display

The flow begins with the initial display, which is the main interface of the flipbook. This section presents introductory information, such as the title, introduction, or usage instructions for the media.

2) Learning Objectives

After the initial display, students are guided to understand the learning objectives. This section aims to provide an overview of the competencies that students will achieve after learning the material using this media. The design of the learning objectives, which has been carefully crafted to align with learning needs, can be seen more clearly in Picture 3.

3) Steps of the PBL Learning Model

This section explains the steps that must be followed according to the Problem-Based Learning (PBL) model. The flow includes several stages:

a) Problem Orientation

In this stage, students are introduced to a contextual problem related to the material on spatial shapes. The problem orientation, which serves as the focus of the learning activity, can be observed in detail in Picture 4, which visually illustrates the context and situation of the problem to facilitate understanding.

b) Organizing Students to Work Individually or in Groups to Analyze and Understand the Problem

This step involves organizing students to work either individually or in groups to analyze and understand the problem. The process of organizing students to work collaboratively and effectively is illustrated in Picture 5, which shows the steps or strategies applied to support group work in the learning process.

c) The Teacher, with the Aid of the Flipbook Media, Provides Step-by-Step Guidance to Help Students Solve the Problem

This step involves the teacher, using the flipbook media, providing step-by-step guidance to help students solve the problem. The step-by-step guide, designed to assist students in solving problems systematically, can be found in Picture 6, which offers structured directions to support effective problem-solving.

d) Students Formulate Solutions to the Given Problem and Present Their Results, Both Visually and Verbally

In this step, students formulate solutions to the given problem and present their results, both visually and verbally. This process can be observed in Picture 7, which showcases how students organize and communicate their solutions effectively using visual aids and verbal explanations.

e) Mathematics Learning Evaluation

The process concludes with an evaluation of learning, where students assess their understanding of spatial figures and reflect on the learning process. The evaluation consists of questions designed to test students' ability to analyze, think critically, and apply the concepts they have learned in a relevant context. The questions presented in Picture 8 are specifically crafted to challenge students' problem-solving skills and comprehension of spatial concepts.

3. Development Phase

The content of the flipbook media is designed to accommodate learning needs. Each material is systematically and structurally organized, including explanations of mathematical concepts, such as three-dimensional shapes, in an engaging visual format. The use of 3D images, animations, and other interactive elements is added to help students understand abstract concepts.

The flipbook prototype is developed using digital design software or specialized platforms for creating interactive media. At this stage, functional testing is conducted to ensure that all media elements work properly, such as interface navigation, visual display, and interactivity. Several prototype versions are tested to check whether the media meets the desired quality standards. Once the prototype is complete, the flipbook media is validated by experts in the fields of educational media, educational content, and language to ensure alignment with learning objectives and the effectiveness of the media in helping students understand the material. The validation process involves reviewing the design, content, and interactive elements used in the flipbook, with the results listed in Table 1.

Table 1. Example of a table with a two-column format.

No	**Expert**	V.hitung	V.tabel
1.	Medie Expert	0,85667	0,73
2.	Content Expert	0,83182	0,70
3.	Language Expert	0,875	0,78

Based on the expert validation table, the flipbook media used is considered valid. The media expert validation shows a V.hitung of 0.85667, which is greater than the V.tabel of 0.73. The content expert validation shows a V.hitung of 0.83182, which is greater than the V.tabel of 0.70. The language expert validation shows a V.hitung of 0.875, which is greater than the V.tabel of 0.78. Therefore, the media to be used in the experimental class can be considered valid. The media expert provided a positive assessment of the visual design and ease of use aspects of the flipbook.

4. Implementation Phase

In the implementation stage, the flipbook media was used in the teaching of three-dimensional shapes in a 5th-grade class in Kebumen District. Based on observations, students showed high enthusiasm while using the flipbook. They appeared active and engaged as they studied the topic of three-dimensional shapes with the help of this media. Almost all students were able to solve the problems in the flipbook correctly, indicating that the media was effective in helping them understand the concept of three-dimensional shapes. The teacher stated that the use of the flipbook was highly effective in enhancing students'

understanding of the material. The teacher noted that the media helped students visualize three-dimensional shapes more clearly and concretely.

5. Evaluation Stage

Based on the test results conducted after using the flipbook, 80% of students showed a significant improvement in understanding the material on three-dimensional shapes, as evidenced by their ability to complete the provided problems. Only a small number of students still required further assistance to understand some basic concepts. The majority of students gave positive feedback regarding the use of the flipbook. They felt that it was easier to understand the concept of three-dimensional shapes because the media helped them visualize the three-dimensional forms clearly. However, some students still wanted additional explanations or more exercises to strengthen their understanding.

The teacher expressed that the flipbook was very helpful in explaining the material on three-dimensional shapes, particularly in making it easier for students to understand difficult concepts like volume and surface area. However, the teacher also suggested that the media be further developed by adding more varied problems or interactive features to better motivate the students.

Based on the evaluation results, it is recommended to add interactive elements to the flipbook, such as quizzes or additional exercises that can enhance student engagement. Additionally, teachers could provide more time for students to practice individually using this media to deepen their understanding.

B. Discussion

The use of problem-based flipbooks in teaching three-dimensional shapes has a significant contribution to improving students' understanding. By combining attractive and interactive visual elements, this media helps students comprehend abstract concepts such as volume, surface area, and the properties of three-dimensional shapes in a more concrete way. Moreover, the problem-based approach applied in the flipbook not only introduces the material but also encourages students to think critically and creatively when solving problems. This helps students develop analytical thinking skills and deepen their understanding of the material being taught.

According to Arsyad (Adam et al., 2024), the use of visual media in learning, such as flipbooks, can help students more easily understand abstract concepts because such media present information in a concrete and engaging way. This is also supported by the theory proposed by Bransford et al. (Hardiansyah & Mulyadi, 2022), which states that problem-based approaches can increase student engagement because they are encouraged to think critically and creatively to solve the challenges presented. This approach not only deepens understanding but also prepares students to face real-world situations using analytical thinking.

Mayer (Hairani & Amini, 2023) asserts that the use of visual media such as flipbooks can enhance students' understanding because it presents material more clearly and is easier to understand, especially for concepts that are difficult to represent with text alone. In addition, Vygotsky’s (Fitriani & Maarif, 2023) constructivist theory supports that problem-based approaches encourage students to actively build their own understanding through interaction and discussion, thus improving their critical and creative thinking skills. This aligns with Jonassen's (Marjan et al., 2021) view that problem-based learning helps students develop the ability to solve problems in more effective and innovative ways.

By combining visual elements and problem-based approaches, flipbooks not only help students understand material more concretely but also create opportunities for them to develop higher-order thinking skills. In line with constructivist theory, students do not just receive information; they actively engage in the learning process, which allows them to explore and apply the concepts of three-dimensional shapes in a broader context. This also supports Gagné's in 1985 opinion that the use of learning media can stimulate student engagement and encourage them to think more independently (Setyadi & Saefudin, 2019).

However, there are challenges in implementation, such as the need for adequate technological devices in schools. One proposed solution is to train teachers to maximize the use of flipbooks and provide adequate technological facilities in schools. According to Reeves (Mahmudi et al., 2022), one of the main challenges in implementing technology-based learning media is the limitation of devices available in schools, which may hinder the effectiveness of technology use in teaching. This is in line with Kennewell's (Fatwa et al., 2019)view, which states that although digital media such as flipbooks can enhance learning, their success heavily depends on the availability and effective use of technological devices.

To address this challenge, Clark and Mayer (Abdillah & Astuti, 2021) suggest providing proper teacher training to optimize the use of learning media, enabling teachers to make the most of technology in the learning process. Additionally, providing technological facilities in schools is crucial to support the effective implementation of learning media (Abidin et al., 2021). Spector (Hidayat & Ihsan, 2020) also notes that the lack of technological devices in schools is a significant barrier to the use of digital learning media, including flipbooks, which can reduce the effectiveness of learning. In this context, Liao (Zahwa Imala et al., 2024) emphasizes that the use of technology in education requires adequate infrastructure support to ensure that learning media can be accessed and used optimally.

To overcome this, teacher training is essential to help them effectively integrate technology into the learning process (Zulhelmi & Anwar, 2021). Additionally, another proposed solution by Anderson (Kiswanto Kenedi et al., 2019) is the provision of adequate technological facilities in schools, which would support the smooth implementation of technology-based learning and improve student learning outcomes.

CONCLUSION

The use of problem-based flipbooks in teaching three-dimensional shapes has a positive impact on students' understanding. This media is effective in helping students grasp complex concepts in a more visual and concrete manner, while also encouraging them to think critically and creatively when solving problems. However, challenges in implementation, such as limitations in technological devices, may hinder the effectiveness of this media in schools. Therefore, solutions that can be proposed include training teachers to maximize the use of flipbooks and providing adequate technological facilities in schools. By doing so, the proper integration of technology can enhance the quality of learning and improve student outcomes.

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