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Development of Interactive Flipbooks on Positive and Negative Integer Arithmetic Operations for Elementary School Students

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Abstrak

Pembelajaran interaktif dengan menggunakan teknologi harus dikembangkan untuk membangun motivasi serta pemahaman konsep siswa terkait suatu mata pelajaran. Penelitian ini berfokus dalam mengembangkan *flipbook* interaktif yang layak, dan praktis digunakan pada materi operasi hitung bilangan bulat positif dan negatif. Subjek pada penelitian ini mencangkup siswa kelas VI SD Negeri Bawuran. Metode penelitian merujuk pada *Research and Development* (R&D) model ADDIE dengan tahapan analisis, desain, pengembangan, implementasi, dan evaluasi. Pengambilan data dilakukan dengan instrumen wawancara dan angket. Hasil data wawancara dianalisis secara deskriptif dan data angket dianalisis secara statistik deskriptif. Pengembangan *flipbook* interaktif didapati skor rerata validasi kelayakan materi dengan presentase 89.75%, termasuk sangat layak dan skor rerata validasi kelayakan media dengan presentase 94%, termasuk sangat layak. Hasil respon siswa terkait kepraktisan *flipbook* interaktif didapati skor rerata dengan presentase 85,7%, termasuk sangat praktis sehingga penggunaan *flipbook* interaktif baik digunakan dalam pembelajaran matematika.

Abstract

Technology must be utilized to develop interactive learning to build students' motivation to learn and deepen their understanding of subject-related concepts. This study focuses on the development of interactive page-turning instruction using positive and negative integer arithmetic as teaching materials to make it feasible and practical. The population of this study consists of sixth-grade students of SD Negeri Bawuran. The research methodology was based on the ADDIE model of Research and Development (R&D), which includes analysis, design, development, implementation, and evaluation stages. Data collection was conducted through interviews and questionnaires. The results of the interview data were analyzed descriptively, and the questionnaire data were analyzed statistically. The development of the interactive flipbook received a mean score of 89.75% for the material validation, including very feasible, and a mean score of 94% for the media validation, including very feasible. The results of students' responses on the usefulness of the interactive flipbook received a mean score of 85.7%, including very useful, thus the use of the interactive flipbook in mathematics learning is good.

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Introduction

In the context of elementary school education, mathematics learning is often still monotonous and does not sufficiently engage students. The research by Marlita et al. (2024) describes a mathematics learning process that does not involve the active participation of all students. In line with Anisa et al. (2021), it is stated that learning conducted in the classroom is considered less effective in making students actively develop their interests, talents, and potential. Students' focus on learning mathematics should not only be assessed based on the result, but should also emphasize student activities, such as when asking questions, discussing, or expressing opinions during the learning process (Amalia & Sutisnawati, 2022). This indicates that the issue of students' lack of activity in mathematics learning still needs attention. The lack of activities that encourage students to be active in learning can result in low student learning motivation (Farhana, S., Aam Amaliyah, Agustini Safitri, 2022). Referring to the research by Harleni and Asniar (2021), it is proven that by increasing student activity, students' motivation to learn mathematics will also increase. Students with high motivation or interest in learning will be more active during teaching and learning activities and will easily understand the teacher's explanations, which can further maximize learning outcomes. Supported by (Utaminingtyas et al., 2021), their research found that motivation and the learning environment can positively influence students' mathematics learning outcomes. This fact underscores the need for active learning to further develop student motivation and achieve maximum learning outcomes.

The role of the teacher is very important in guiding students to actively participate in learning (Mutrikah et al., 2021). According to Setiawan's (2022) research, teachers can present interactive learning so that students can develop their talents and skills. It is important to adopt an interactive learning approach in the modern era, utilizing technology to enhance the effectiveness of the learning process. Learning that combines technology tailored to school facilities has proven effective in supporting the learning process, such as in mathematics instruction (Alifah et al., 2023). According to Velinda and Hasanah (2024), the learning process can be effective if both students and teachers are proficient in using technology, especially the devices used during learning. This highlights the importance of considering user-friendly technology during the learning process.

One easily accessible and usable technology during the learning process is the flipbook. Flipbooks can be used on various digital media such as mobile phones, tablets, and laptops. Additionally, flipbooks are easy for teachers to develop on their own. According to (Sari & Ahmad, 2021), who conducted a study on Flipbooks, they define it as a type of technology structured with various components, including text, objects, and sound, presented in digital form and containing multimedia elements, thus creating a good interactive experience for students. The features accessible in a flipbook make it easy for students, as if they are opening a book directly, thanks to the animation that appears when students turn pages while reading (Cahyono, 2023). Thus, using a flipbook can make learning mathematics more interactive for students.

Several previous studies have developed flipbooks to support the learning process in the classroom. Cahyani et al. (2023) developed a mathematics flipbook containing material on flat shapes, focusing on fourth-grade elementary school students. Additionally, Unnafsah & Nur'aeni (2023) developed an e-flipbook containing learning materials related to whole number arithmetic operations, which was intended for use in third-grade elementary school. Khumairoh and Husnah (2023) also developed an E-Module based on a flipbook with learning materials about fractions and changing fraction forms, suitable for use in fourth grade. However, the existing development still contains limited material and levels, so there is a need to develop interactive flipbooks by expanding the material that is still a challenge for students, one of which is positive and negative integer calculations. In the application of learning integer arithmetic operations, many students still experience difficulties and challenges. Based on the interview results at SD Negeri Bawuran, there are still students who have not fully mastered the material on integer arithmetic operations. Specifically, the discussion focuses on the combination of positive and negative integers into word problems, which is caused by students not understanding the concept of integers in context (Sundari & Wulantina, 2022). Students' understanding of integer concepts can be better developed through constructive learning. Constructivism in learning has become a theory that builds abilities and understanding during instruction by actively involving students (Hoover, 1996). In this theory, the process is more important than the result, so interactive learning is necessary.

Based on the problems that have been presented, it is important to develop interactive learning using technology in the form of flipbooks so that students can be more motivated, thus maximizing their understanding and learning outcomes. This research focuses on developing flipbook teaching materials on positive and negative number operations for fourth-grade students, with the novelty of integrating various elements such as videos, games, evaluation questions, and content appropriate for student development. This research produced an output product that is expected to be used as a supporting medium during learning and to provide broad benefits to elementary school students.

Methods

The research method refers to the ADDIE model of Research and Development (R&D) with the stages of analysis, design, development, implementation, and evaluation (Branch, 2009). This research uses a qualitative approach to analyze needs and a quantitative approach to assess feasibility and practicality. The subjects of the study included 23 sixth-grade elementary school students at SD Negeri Bawuran. Data collection was conducted using an interview instrument for initial needs analysis and questionnaires validated by media and content experts from Yogyakarta State University's Elementary Education Department to determine the validity or feasibility of the interactive flipbook. Additionally, a questionnaire instrument was used to assess student responses to the field trial regarding the practicality of the flipbook. The research instrument was adopted from other studies that have been tested for validity and reliability. The interview data analysis results were analyzed descriptively, and

the material and media validation questionnaire data for the flipbook were analyzed statistically descriptively to determine their feasibility level using the following formula:

$$\text{Feasibility} = \frac{Total\ score\ obtained}{Total\ maximum\ score} \text{ x } 100\% \qquad (1)$$

Following the completion of the feasibility evaluation procedure, the feasibility is categorized (Arikunto, 2014). The requirements for eligibility can be seen in Table 1 bellow.

Table 1. Eligibility Criteria

Score	Category
0% − 20%	Not Feasible
21% − 40%	Less Feasible
41% − 60%	Decent Enough
61% − 80%	Feasible
81% − 100%	Very Feasible

Based on the validity or feasibility criteria in the table above, a flipbook can be considered feasible if it falls within the score range of (61% - 80%). Furthermore, the data from the practicality response questionnaire from students was calculated using the formula:

$$\text{Practicability} = \frac{Total\ score\ obtained}{Total\ maximum\ score} \times 100\% \qquad (2)$$

The outcomes of the students' evaluation of the flipbook's practicality were then grouped according to practicality criteria, as shown in Table 2 below.

Table 2. Practicality Criteria

Score	Category
0% − 20%	Not Practical
21% − 40%	Less Practical
41% − 60%	Practical Enough
61% − 80%	Practical
81% − 100%	Very Practical

Result and Discussion

Results

The process of developing this flipbook follows the ADDIE model, covering the stages of analysis, design, development, implementation, and evaluation to ensure the accuracy of the product in supporting mathematics learning. Each stage of product development is explained as follows.

Analysis

To identify the needs for assisting students' learning in the classroom, a needs analysis is required. This needs analysis requires interviews with schools and classroom teachers related to learning activities. It was found that students need learning media that can build student activeness so that they are motivated during learning and maximize student learning outcomes. There are facilities owned by

the school to support learning to suit the needs, such as laptops and projectors. However, these facilities have not been used according to student needs during teaching and learning activities. Therefore, flipbook development is needed to increase student activity during learning activities. Additionally, a curriculum analysis was conducted thru interviews with the headmaster of SD Negeri Bawuran using an open interview guide. The curriculum used is the independent curriculum, so developing flipbooks will contain material that is in accordance with the curriculum used.

Design

The design phase aims to design the learning product in the form of an interactive flipbook by creating an initial draft. This flipbook is designed to allow students to actively participate in mathematics teaching and learning activities, thereby maximizing their understanding and learning outcomes. Developing flipbooks can provide a more engaging learning experience and allow students to acquire knowledge more easily. The planning stage consists of four steps.

The first stage is the development of a questionnaire instrument for feasibility and practicality. The result of this stage is a questionnaire evaluated by content experts, media experts, and student responses. The second stage is the selection of the product to be developed according to student needs, namely an interactive flipbook that utilizes facilities and technology. Next, the material in the flipbook was analyzed, concepts were developed, its feasibility was validated, and it was tested during the development phase. The third stage is choosing the flipbook format developed based on the Merdeka curriculum. The flipbook is A4 size, which is 21 x 29.7 cm. The fourth stage involves initial design, including the front cover, back cover, introduction, instructions for using the flipbook, content, sample questions, quiz time, videos, and developer profiles. The initial flipbook design can be seen in Figure 1 bellow.

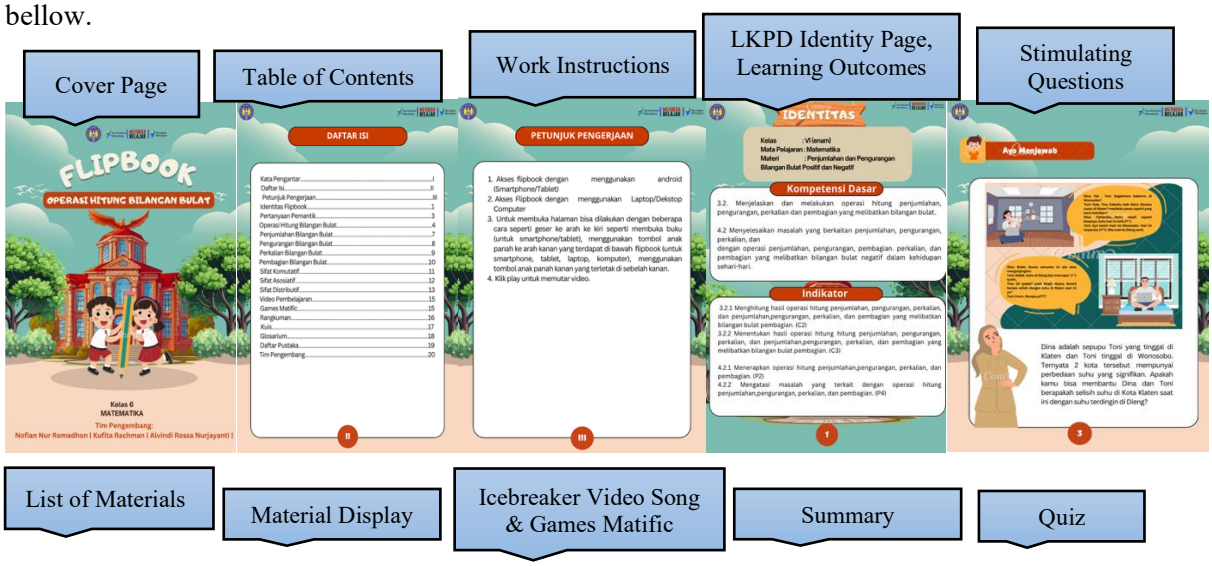

Figure 1. Initial Design of the Interactive Flipbook

Develop

The designed flipbook was evaluated by content experts and media experts who are lecturers from the Elementary School Teacher Education (PGSD) program at Yogyakarta State University. The results of the expert evaluation are used to determine the feasibility of the developed product. After the developed flipbook is completed, the results of the flipbook development are reviewed with subject matter experts. Assessment and evaluation of the material by experts to determine the feasibility of the flipbook and identify shortcomings that need to be modified to improve the product. Media experts evaluated the flipbook by completing a media assessment questionnaire. The purpose of media learning feasibility assessment by content experts is to ensure the accuracy of the content, its alignment with learning objectives, and its suitability before implementation with students. Based on the results of the media expert assessment and evaluation, the developed flipbook is ready to be tested with minor modifications. The subject matter expert only conducted one trial and assessed feasibility. The results of the material feasibility assessment for the interactive flipbook can be seen in Table 3 below.

Table 3. Results of Material Feasibility Assessment

Aspect					**Average**
Relevance of Material	Material Organization	Evaluation or practice questions	Language	Effect on Learning Strategies	
4	3.2	3.75	3	4	3.59
100%	80%	93%	75%	100%	89,75%
Category					
Very Feasible	Feasible	Very Feasible	Feasible	Very Feasible	Very Feasible

Referring to the Table. 3, the results of the material assessment, in the aspect of material relevance, the average score is 4 or 100%, including “Very Feasible”. The aspect of organizing the material obtained an average score of 3.2 or 80%, including “Feasible”. The aspect of evaluation/exercise questions received an average score of 3.75 or 93%, including “Very Feasible”. The language aspect received an average score of 3 or 75%, including “Feasible”. The effects of learning strategies aspect received a mean score of 4 or 100%, including “Very Feasible”. Cumulatively, the average score for the combined assessment of all aspects is 3.59 or in percentage terms 89.75%, including “Very Feasible”.

In the next stage, the interactive flipbook design was validated by design experts. The flipbook assessment in terms of design is reviewed based on aspects of language display, effects for learning strategies, software engineering, and flipbook visual appearance. After reviewing the developed flipbook, expert media validators assessed it using a design validation questionnaire and wrote down their opinions and suggestions regarding the flipbook's design so that it could be revised for improvement. The opinions and suggestions submitted, namely, the font size used, are adjusted to the overall size. The results of the improvement according to the validator's comments can be seen in Figure 2 bellow.

Figure (a) Figure (b)

Figure 2. (a) Before Revision and (b) After Revision

Next, the values were obtained based on a questionnaire filled out by media expert validators. The assessment of the media design's feasibility that has been conducted can be seen in Table 4 below.

Table 4. Media Design Feasibility Results

Aspect				**Average**
Language Display	Effect on learning strategies	Software engineering	Visual appearance	
3.66	3.6	4	3.8	3.76
91.5%	90%	100%	96.4%	94%
Category				
Very Feasible	Very Feasible	Very Feasible	Very Feasible	Very Feasible

Referring to Table 4, the interactive flipbook, which has been evaluated by media experts, shows an average score of 3.66 or 91.5% for the language display aspect, which is considered "Very Feasible." The average score for the learning strategy effect aspect is 3.6 or 90%, which is also considered "Very Feasible." The average score for the learning software engineering aspect is 4 or 100%, which is considered "Very Feasible." The average score for the visual display aspect is 3.8 or

94%, which is considered "Very Feasible." Cumulatively, the average score for the combined evaluation of all aspects by media experts is 3.76 or 94%, which is considered "Very Feasible."

Implementation

At the implementation stage, students were assessed on the interactive flipbook that had been developed. The assessment was conducted to determine the practicality level of the flipbook during the learning process. The flipbook assessment by students was done by filling out a practicality assessment questionnaire. The flipbook's practicality was evaluated by the students, and the results are shown in Table 5 below.

Table 5. Practicality Assessment Results

Aspect			**Average**
Ease of Use	Efficiency of Learning Time	Meaningfulness in Learning	
3.28	3.46	3.3	3.34
82%	86,4%	82,5%	83,5%
Category			
Very Practical	Very Practical	Very Practical	Very Practical

The average score for the practicality questionnaire results in the trials conducted by students overall was found to be 3.34 or 83.5%, which is considered "Very Practical." In terms of ease of use, the average score was found to be 3.28 or 82%, which is considered "Very Practical." In terms of learning time efficiency, the average score was found to be 3.46 or 86.4%, which is considered "Very Practical." In terms of meaningfulness in learning, the average score was found to be 3.3 or 82.5%, which is considered "Very Practical." Students in the large group almost unanimously commented that the interactive flipbook was very interesting and fun to use during math lessons.

Evaluation

The researcher makes final adjustments to the interactive flipbook media's design and content during the evaluation stage. Expert thoughts and remarks on the interactive flipbook form the basis of the evaluation. This evaluation stage's primary objective is to make sure the created flipbook can be utilised in a way that maximises learning outcomes for elementary school students.

Discussion

The development of an interactive flipbook product on integer arithmetic operations is based on student needs, namely, learning activities that can foster student engagement. Referring to constructivist learning theory, which involves building abilities and understanding during learning by actively engaging students (Hoover, 1996). Student activity is linked to student motivation during learning, which can further influence mathematics learning outcomes (Harleni & Asniar, 2021;

Utaminingtyas et al., 2021). The development of this flipbook includes activities that allow students to contribute to learning through short materials, example questions, quiz games, and interactive learning videos. The procedure for developing an interactive flipbook on integer arithmetic, consisting of five stages according Branch (2009), includes analysis, design, development, implementation, and evaluation. A development product is considered high-quality if it is valid and practical to use (Rockyane & Sukartiningsih, 2018). To determine the feasibility and practicality of an interactive flipbook, it must first be evaluated, assessed, and tested by experts.

The interactive flipbook on integer arithmetic needs to be evaluated for content feasibility and design feasibility. The aspects used in assessing the feasibility of the material are material relevance, material organization, evaluation/practice questions, language, and the effect on learning strategies. Referring to the research by Miranda and Wibowo (2023), the development of learning media was carried out and deemed feasible because it met those assessment aspects. This is supported by Kosasih (2021), who outlines the requirements for developing good learning materials, including didactic requirements that enable students to actively learn the material according to the learning topic, construction requirements using language appropriate for the students' age, and technical requirements covering component completeness. Meanwhile, the design feasibility aspect of the developed flipbook refers to language aspects, learning strategies, software engineering, and visual appearance. Learning strategies are used to support effectiveness during the learning process based on student needs (Rahmadani et al., 2024). Software engineering aspects, including ease of use, creativity, and the potential for product reuse, must be considered when developing learning media (Khosiyah, 2019). Additionally, visual appearance affects the level of learning motivation, which can support learning success (Murdianti, 2024). The assessment or evaluation of material and media experts on the interactive flipbook regarding these aspects, the average score has met the eligibility category.

The practicality of flipbooks encompasses aspects of ease of use, efficiency in learning time, and meaningfulness in learning. Supported by Ayunda et al. (2024), when developing learning media, it is necessary to meet the practicality aspect, which includes ease of use, efficiency of learning time, and meaningfulness or benefits. The aspects used in developing this interactive flipbook product are in line with the goals of a learning product, which is to make learning more meaningful and thus easier to understand (Daniyati et al., 2023). Related research that develops digital math learning media such as in this development and is considered practical and feasible to use (Rachman et al., 2025; Rachman et al., 2025). Based on the description from relevant theories and research, the development of interactive flipbooks is well-suited for teaching and learning activities at the elementary school level.

This research contributes theoretically by strengthening the application of constructivist theory through the development of media that promotes student activity and understanding. Practically speaking, the interactive flipbook product developed can be used directly by teachers to improve the effectiveness of mathematics learning in elementary schools. From a methodological standpoint, this

research demonstrates that the ADDIE model is effective in producing viable and practical learning products. This result can serve as a reference for developers of digital learning media based on student needs. However, the limitation of this study lies in the practicality test on a specific group of students in a particular class. Therefore, interactive flipbooks can be tested on a wider group of students to see their effectiveness.

Conclusion

The results of developing an interactive flipbook for positive and negative integers have shown that this learning medium is highly feasible, as assessed by content experts and media experts. The material assessment received a score of 3.59 or 89.75%, and the media assessment received a score of 3.76 or 94%. Additionally, student responses regarding practicality during the learning trial were evaluated, resulting in a score of 3.34 or 83.5%, which falls into the very practical category. It can be concluded that interactive math flipbooks can be part of a good learning tool that supports the math learning process.

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