DEVELOPMENT OF FLIPBOOK-BASED TEACHING MATERIALS ON BLOCKS AND CUBES TO ENHANCE ELEMENTARY SCHOOL STUDENTS' CRITICAL THINKING SKILLS

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ABSTRACT

The purpose of this study was to explore how to develop and evaluate the feasibility of using flipbook teaching materials for mathematics subjects, especially block and cube material. The research was conducted at SDN 1 Dawuan with 20 students from class IV B as research subjects. The type of research applied was R&D which refers to the ADDIE model. Data collection methods included interviews, observations, questionnaires, and pre-tests and post-tests. Based on the validation results, the use of flipbooks in the learning process was declared very feasible, with a feasibility percentage reaching 89%. After using flipbook media, the quality of student learning completeness reached 95%, this proves the effectiveness of flipbook media. Therefore, flipbook media encourages students to master the concept of block and cube material, and also stimulates their critical thinking skills. The results of validation and high student learning completeness indicate that flipbooks have succeeded in stimulating the critical thinking skills of class IV B students.

Keywords: *Flipbook, Blocks and Cubes, Critical Thinking Skills*

1. INTRODUCTION

H Mathematics education at the elementary school level plays an essential role in building students' cognition. Mathematics has a significant impact on the development of students' thinking skills, because it not only provides instruction in counting but also fosters logical, critical thinking, creativity, and problem-solving skills.(Samritin et al., 2023). Mathematics also teaches children to think systematically and structured. They learn to organize problem-solving steps logically, evaluate the results achieved, and generalize the results achieved. Through a good understanding of mathematics, children can be more mature to understand abstract ideas in these fields. These abilities are very necessary in facing the challenges of this increasingly complex era. Digital technology has expanded the range of learning methods and media that are very useful for students, to develop the effectiveness and efficiency of the learning process. Although with the increase in digital innovation, there are learning methods that are more collaborative, communicative, and problem solving. In this digital era, students already have access to various digital resources, namely books, journals, learning videos and flipbooks (Sakti, 2023). This digital technology program provides students with the opportunity to get information more easily and better, as well as quickly and provides services. information interactively and attractively. Use in educational platforms increases the efficiency of the learning process and presentation of teaching materials. Learning platforms are also used to respond to students so that they can interact and communicate with each other.(Sacred, 2023).

Technological advances that support innovation in learning help students' needs and desires, thereby increasing the effectiveness and efficiency of learning. The use of technology increases collaboration between students and educators through online platforms and communication tools. Technological innovations such as online learning platforms can make education more accessible and expandable. Students can use learning materials from any location and time using available devices, namely the internet. In order to create a more interactive and effective learning environment(Ambarwati et al., 2022). Ulandari et al., (2022)said that flipbook is a book in digital format can produce animation, illustrations, and video recordings as supporting materials or inclusion of multimedia elements into can be changed and flipped like a real book. Currently, the teaching materials that are in great demand by students are flipbook media because this flipbook media is very interesting for students in learning, there are also various elements in flipbooks and funny animations in their contents such as images, video recordings, and text.(Arifin & Lestari, 2020). We hope that the use of digital flipbook media can further improve students' knowledge and understanding in critical thinking. If we look at the daily activities of students in this digital technology era, students prefer learning through digital technology. Students find it easier to understand and apply the information they learn. In addition, flipbooks that include various interactive, fun and life-related activities for students. Flipbooks are a powerful tool for developing independent learning and critical thinking in elementary school children. Digital media today is a new way to learn mathematics. Learning mathematics is one effort to explore or train students' brains to think critically and systematically in the learning process. However, mathematics is considered a very difficult and boring subject so that students have great difficulty understanding the material that has been explained by educators. The problems experienced by these students were successfully resolved by utilizing digital technology learning media or flipbook media. Learning block and cube material in elementary school is not just memorizing formulas. These simple geometric concepts are the gateway for students to develop critical and spatial thinking skills. By studying blocks and cubes, students are invited to observe three-dimensional shapes around them, compare sizes, and identify the properties of geometric shapes. This process stimulates students to think critically, analyze visual information, and solve problems related to shape and size.

Critical thinking is the ability to analyze, evaluate, strategize, make logical arguments, solve problems, and make decisions.(Ariani & Batubara, 2017). Critical thinking in mathematics is very significant because it helps students gain a deeper understanding of concepts, analyze errors from different perspectives, and realize logical solutions. This ability allows students to remember rules, understand the ideas behind the rules and methods of mathematics. All subjects can improve critical thinking, one of which is mathematics to achieve the goals of learning mathematics, it is very important for students to have critical thinking skills to solve mathematical problems. Mathematics learning is designed by developing mathematical concepts by developing mathematical ideas for students to solve mathematical problems, which aims to improve learning outcomes so that learning is effective. When students are involved in meaningful learning programs, students are more likely to develop that knowledge to a higher level.

2. RESEARCH METODOLOGY

The method used is Research and Development with the ADDIE model. This study involved students of grade IV B at SDN 1 Dawuan as subjects. Data collection methods include interviews, observations, questionnaires, and initial and final tests. Qualitative data analysis techniques used include interviews, needs analysis, and input from validators, while quantitative data analysis techniques are obtained from the results of pre-tests, post-tests, and validation assessments.

3. RESULTS AND DISCUSSION

The research results are presented according to the stages of the ADDIE model, which consists of 5 stages, namely; Analysis, Design, Development, Implementation, and Evaluation.(Mahmudi et al., 2023). The ADDIE model in R&D research can be applied to develop teaching material products, both in terms of material and design. The explanation is as follows:

Analysis

Developing effective mathematics teaching materials requires an in-depth and comprehensive needs analysis. For this reason, a study was conducted to analyze the needs of mathematics teaching materials in class IV B SDN 1 Dawuan. Data collection was carried out through interviews and pre-tests. The interview was conducted with the homeroom teacher of class IV on Tuesday, June 4, 2024. Some information was obtained based on the results of the interview.

Table 1. Interview results

No.	Question	Answer
1.	What curriculum is used at SDN 1 Dawuan especially in class IV B SD?	Independent curriculum.
2.	What is the learning style of grade IV B students in understanding the material that has been explained?	Grade IV B elementary school students tend to prefer learning styles that involve audio-visual elements, such as pictures and videos.
3.	What teaching materials are used specifically in grade IV B of elementary school for the material on blocks and cubes?	Textbooks from the government, as well as several reference videos from YouTube.
4.	Do students have difficulty understanding the material on blocks and cubes?	Students still face difficulties in critical thinking, especially when analyzing problems and providing logical answers without calculating.

Pre-test questions were given to grade IV B students on Tuesday, June 4, 2024. Students' errors when writing responses when solving math problems were used to assess their critical thinking skills.

Table 2. Pre-Test Questions

Question 1

Group the objects above into two categories: cubes and blocks!

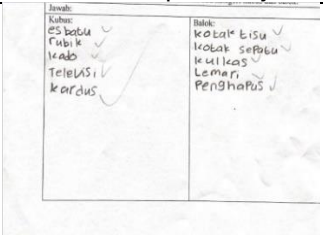


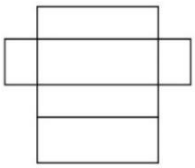
Figure 1. Subject A's answer

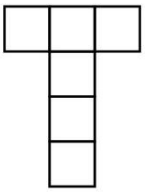
Figure 2. Subject B's answer

Figure 3. Subject C answer

Based on the pre-test results above, subject A has been able to write the answer correctly. Meanwhile, subjects B and C have not been able to write the answer correctly, only a few can be answered accurately.

Question 2





From the image above, explain the differences between the two nets!

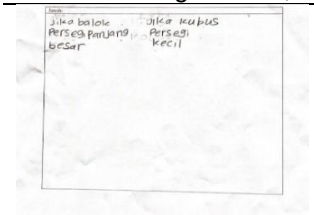


Figure 4. Subject A's response

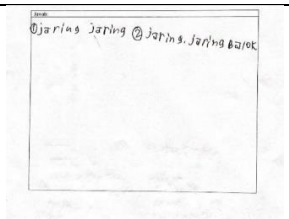


Figure 5. Subject B's response

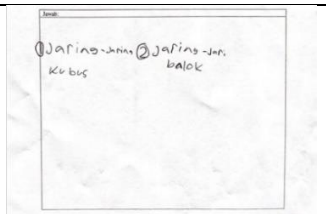
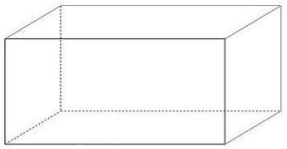
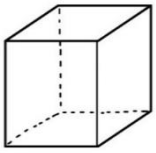


Figure 6. Subject C's response

In subject A, students have written the answer correctly but it is still too short. Students need to provide more detailed arguments to show a deep understanding of the concept. Subjects B and C still have difficulty in writing accurate and comprehensive answers.

Question 3





From the image above, explain the similarities between the two geometric shapes!

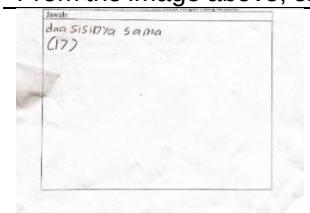


Figure 7. Subject A's response

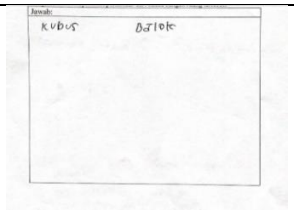


Figure 8. Subject B's response

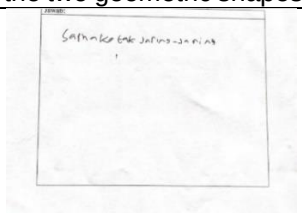


Figure 9. Subject C's response

Based on the pre-test results above (figures 7-9), it shows that subjects A, B, and C are not yet able to connect the basic concepts of spatial structures to explain the similarities between cuboids and cubes.

Design

The design stage is the initial planning process for developing a product. In this stage, we will create a conceptual design of the teaching material, including a more concrete theoretical and product design.

1. Design Theory

At this stage, we apply Van Hiele's learning theory as a basis for designing learning materials and processes in flipbooks to stimulate critical thinking skills. The stages of visualization, analysis, informal deduction, deduction, and rigor are the stages of students' geometric thinking development according to Van Hiele's theory.(Andriliani et al., 2022). This flipbook is designed based on Van Hiele's learning stages. This flipbook provides structured stimulation to guide students in the process of discovering geometric concepts and developing their critical thinking skills.

Table 3. Van Hiele's Theory Stages

No.	Van Hiele's theory stages	Learning Activities
1.	Visualization	By using flipbooks, students learn about cuboids and cubes through stories, and they can summarize the definitions of these solids themselves.
2.	Analysis	a. Students are asked to draw and mark the corner points, sides and edges of the geometric shape. b. Students are invited to mention the properties of cuboids and cubes.
3.	Informal Deduction	Students are invited to connect the properties between and among cuboids and cubes.
4.	Deduction	Students are invited to find out the surface area formula.
5.	Rigor	Students are invited to prove the surface area formula that they have previously found out by calculating it.

2. Product design

After the theoretical design stage is completed, the next step is to create a product design to design the product physically. The stages that must be carried out are as follows:

a) Selection of teaching materials

Based on the needs analysis that has been carried out, the teaching material chosen to be developed is a flipbook. The learning material to be used in making this flipbook is material about Blocks and Cubes. The title for the Flipbook design is "Blocks and Cubes Based on Van Hiele's Theory".

b) Flipbook design

The aim of designing a flipbook is to design an initial design that will be developed. The following are the steps in designing a flipbook:

1) Formulation of Learning Objective Flow.

The learning objectives that we apply in compiling flipbooks are adjusted to the materials and curriculum applicable in the school, namely the independence curriculum.

Table 4. Learning Objectives Flow

Learning Outcomes	Learning objectives
Students are able to construct and analyze geometric shapes such as cubes, blocks, and their combinations, and recognize spatial visualization from various viewpoints such as the front, top, and side. They can also compare the characteristics of geometric shapes.	1. Students are able to identify cuboids and cubes. 2. Students are able to identify the properties of cuboids and cubes. 3. Students are able to understand the concept of cuboid and cube nets. 4. Students are able to calculate the surface area of cuboids and cubes.

2) Determination of evaluation tools

In addition to designing materials based on Van Hiele's learning phases, this flipbook is also equipped with various questions to develop students' critical thinking skills.

3) Preparation of materials

The material in the flipbook is adjusted to the learning objectives to be achieved. This math flipbook based on Van Hiele's Theory uses material on Blocks and Cubes. The material is taken from the teacher's and student's books for grade IV elementary school mathematics lessons semester II, which are used as references in compiling the flipbook.

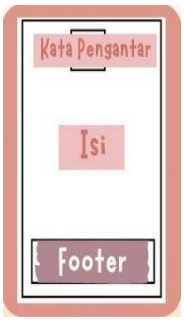
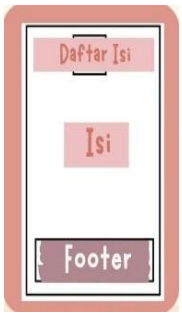
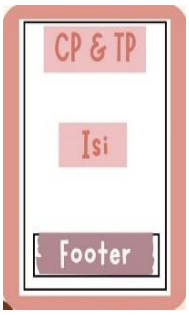
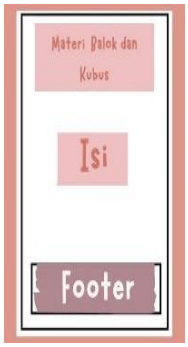
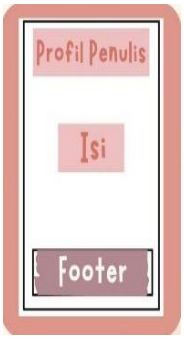
4) Pay attention to the flipbook structure

The structure of this flipbook includes a front cover, foreword, table of contents, core components, concept map, materials, bibliography, author profile, and back cover.

a. Storyboard

At this stage, the researcher prepared the flipbook design using a storyboard. The design process was carried out by making a sketch for a flipbook that discussed the material of blocks and cubes.

Table 5. Storyboard Flipbook Material Blocks and Cubes Based on Van Hiele's Theory

Front cover	Foreword	List of contents	Core competencies
			
Material	**bibliography**	**Author profile**	**Back cover**
			

Development

The third stage involves developing design specifications into physical form, which produces a flipbook to support the differentiated learning process in grade IV of elementary school. This mathematics module requires validation from experts, including linguists, material experts, and media experts. The validators of this study consisted of lecturers at the Swadaya Gunung Jati University and the homeroom teacher of grade IV B at SDN 1 Dawuan.

a. Product Specifications

At this stage is the stage of developing a flipbook. After that, the product is designed and consulted first with the lecturer of the course before conducting validation.(Siti Kholisah et al., 2024). At this stage, the product creation is adjusted to the specifications and product layout that have been designed in the previous stage. Flipbooks are created using Canva. After the creation on Canva is complete, editing is continued using Heyzine to change the form of the flipbook that can be accessed on the internet.

Table 6. Flipbook design

 The cover is made to illustrate or describe the material to be studied in the flipbook. This cover is designed as attractive as possible so that students can be interested in studying the material to be taught. This attractiveness can be in the form of a colorful design, so that users do not feel bored.	 The introduction menu contains the objectives and methods for compiling a flipbook about blocks and cubes.
 On the table of contents menu stands a guide to navigate the contents of the flipbook.	 The concept map menu contains a schematic of the mathematics lesson material that will be studied by students, namely the material on blocks and cubes.
 On the core competency menu, there are learning outcomes and objectives that students need to achieve, based on the applicable independent curriculum.	 In this menu, the discussion of the core material begins. The material is arranged according to the stages of Van Hiele's theory, and this menu reflects stage 0, which is the visualization stage. This menu introduces cuboid and cube geometric shapes through a story.
 This menu describes stage 1, which is the analysis stage. Students are asked to define the properties of cuboids and cubes through a series of instructions given.	 This menu describes stage 2, which is the informal deduction stage. Students are encouraged to find the involvement of the properties of cuboids and cubes, and to connect the properties of the two geometric shapes.

 This menu describes stage 3, which is the deduction stage. Students are encouraged to find the formula for cuboids and cubes.	 This menu presents stage 4, which is the rigor stage. Students are asked to prove the formulas they have learned by calculating the surface area of the two geometric shapes.
 This menu contains a summary of material about blocks and cubes which includes definitions, properties, and surface area formulas for these two geometric shapes.	 The image above shows several practice questions that are designed to test students' understanding after studying the material on cuboids and cubes through flipbook media.
 The image on the side shows a list of foreign words along with their explanations.	 This menu contains several articles that we have used as references in compiling the flipbook. This display can be seen in the image on the side.
 The image on the side contains several identities of the authors responsible for creating the flipbook.	 The image on the side shows the back cover design of the flipbook.

b. Product validation

At this stage, validation of the Block and Cube Material flipbook that has been designed is carried out. According toHayati et al., (2024)The purpose of media validation is to measure the level of feasibility of the flipbook developed before being used in the field at the next stage. The flipbook assessment uses a validation questionnaire containing 10 statements with a rating scale of 1-5 with an assessment qualification of 5 (very good), 4 (good), 3 (sufficient), 2 (less good), 1 (not

good).According to Ernawati (2017)types of eligibility based on the following qualifications:

Table 7. Flipbook eligibility qualifications

No.	Score in percent (%)	Eligibility categories
1.	< 21%	Totally unworthy
2.	21 - 40%	Not feasible
3.	41 - 60%	Quite decent
4.	61 - 80%	Worthy
5.	81 - 100%	Very worthy

a) Subject matter expert validation

The level of suitability of the flipbook is made to find out the advantages and disadvantages of the material. This is done as a basis for improving the material presented so as to produce a quality flipbook that is suitable for use.

Table 8. Material expert validation results

Validators	Score	Percentage
Validator 1	46 of 50	92%
Validator 2	41 of 50	82%
Total scores obtained	87 of 100	87%
Maximum score	100 of 100	100%
The validation of the material showed a result of 87%. Both material validators stated that this flipbook is very suitable for use. But it needs to be revised according to the suggestions of the validators.		

The level of suitability of the flipbook is made to find out the advantages and disadvantages of the language. This is done as a basis for improving the language presented so as to produce a quality flipbook that is suitable for use.

Table 9. Linguist validation results

Validators	Score	Percentage
Validator 1	46 of 50	92%
Validator 2	40 of 50	80%
Total scores obtained	86 of 100	86%
Maximum score	100 of 100	100%
Language validation showed a result of 86%. Both language validators stated that this flipbook is very suitable for use without revision, because the language used is clear and easy to understand.		

b) Media expert validation

The level of feasibility of the flipbook presented needs to be known as well as the material and language aspects in order to know the advantages and disadvantages of the media used. This is done as a basis for improving the language used so as to produce a quality and feasible flipbook.

Table 10. Media expert validation results

Validators	Score	Percentage
Validator 1	47 of 50	94%
Validator 2	46 of 50	92%
Total scores obtained	93 out of 100	93%
Maximum score	100 of 100	100%
Media validation showed a result of 93%. Both media validators stated that this flipbook is very suitable for use. But it needs to be revised according to the validator's suggestions.		

Graph 1. Validation Percentage

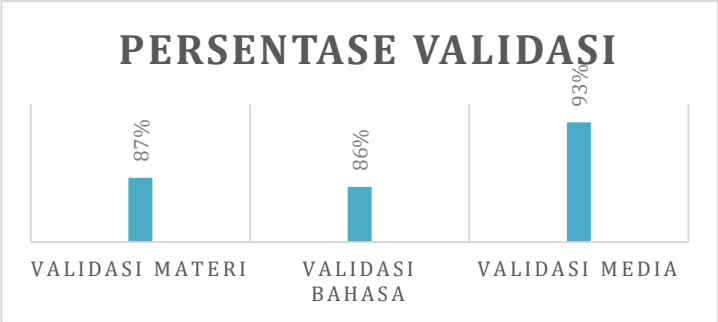


Table 11. Average expert validation rating

No.	Validators	Total Score (%)
1.	Subject Matter Expert 1	92%
2.	Subject Matter Expert 2	82%
3.	Linguist 1	92%
4.	Linguist 2	80%
5.	Media expert 1	94%
6.	Media expert 2	92%
Amount		532
Average		89%

The validation results show a material validation value of 87%, linguists 86%, and media experts 93%. Based on the table of calculations of the average expert validation, a percentage of 89% was obtained which was stated as "Very Eligible" but required revision according to the validator's suggestions. Revisions were carried out simultaneously after all input from the validators was collected.

c. Flipbook revision results

Input and suggestions from validators in developing flipbooks are used to make improvements with the following display:

Table 12. Comparison Before and After Revision of Validation Material

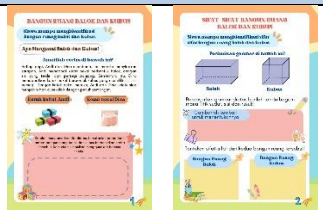
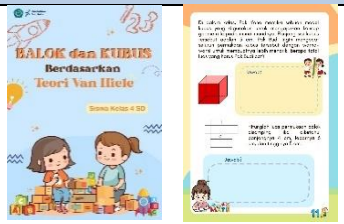
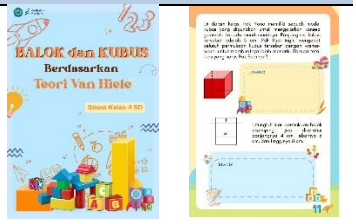
No.	Before Revision	After Revision
1.	 Learning objectives should also be included in each sub-material.	 Each sub-material is given learning objectives according to the validator's suggestions.

Table 13. Comparison before and after media validation revision

No.	Before Revision	After Revision
1.	 Cover/content design should remove images of faces/eyes.	 The cover design and contents containing images of faces/eyes were removed and replaced with images related to blocks and

		cubes and other interesting images.

Implementation

At this stage, the implementation of flipbooks in real classroom learning is carried out by involving teachers and students. The implementation of flipbooks was carried out on August 6, 2024 in class IV B with a total of 20 students. The following are learning activities at the implementation stage. The preliminary, core, and closing activities are 3 learning activities ((Dewi & Yuliana, 2018).

a. Preliminary activities

Learning activities begin with prayer. Continued with apperception, the teacher invites students to reflect on the lessons that have been learned first. Then, the teacher informs the learning tools that will be used today, namely flipbooks. By using flipbooks, the teacher then begins to deliver the lesson material.

Figure 10. The teacher opens the lesson

b. Core activities

This activity begins with the teacher conducting learning using flipbook media with the help of a projector so that all students can pay attention to the product. During the learning process, students are very enthusiastic when learning, this is because students are given the opportunity to read together at the beginning of the flipbook. In addition, each student works on post-test questions.

Figure 11. The teacher displays a flipbook

c. Closing activities

The closing activity begins with filling out the evaluation questions independently. After the students complete the evaluation questions, the teacher gives praise to the students. After that, the teacher reflects on the learning material that has been taught previously and closes the learning by praying together.

Figure 12. The teacher closes the lesson

Evaluation

After being implemented, an evaluation assessment was carried out to see the effectiveness of the flipbook used through 5 evaluation test questions. The

evaluation test questions filled in by students were essay questions consisting of material on the Flipbook. The test was conducted twice, namely before the teacher explained using the flipbook (pre-test) and after the teacher explained using the flipbook (post-test). The KKM for grade IV mathematics subjects is 70. The results of the student test assessment are as follows:

Table 14. Pre-test and post-test assessment

No.	Name	Pre-Test	Completed/Not Completed	Post-Test	Completed/Not Completed
1.	MR	50	Not finished	85	Completed
2.	MW	30	Not finished	70	Completed
3.	NS	85	Completed	100	Completed
4.	ND	80	Completed	85	Completed
5.	NA	75	Completed	100	Completed
6.	NH	65	Not finished	75	Completed
7.	NV	65	Not finished	75	Completed
8.	NQ	70	Completed	95	Completed
9.	PN	75	Completed	80	Completed
10.	RY	55	Not finished	95	Completed
11.	RF	65	Not finished	90	Completed
12.	RM	50	Not finished	95	Completed
13.	RK	65	Not finished	95	Completed
14.	RL	70	Completed	95	Completed
15.	RR	80	Completed	95	Completed
16.	SA	85	Completed	75	Completed
17.	SF	60	Not finished	75	Completed
18.	VO	30	Not finished	60	Not finished
19.	VA	75	Completed	95	Completed
20.	WD	80	Completed	80	Completed

	Pre-Test	Post-Test
Amount	1,310	1,715
Average	65.5	85.75
The highest score	85	100
Lowest Value	30	60
Completed	10	19
Not Completed	10	1
Average Completion	50%	95%
Average Not Completed	50%	5%

The average post-test score of class IV B based on the table above is 65.5. After using flipbook media, the average post-test score increased to 85.75. Before using flipbook media, only 10 out of 20 students (50%) achieved the KKM (70). However, after using flipbook media, the number of students who completed increased significantly to 19 out of 20 students (95%). Students who did not complete decreased drastically to only 1 student (5%). The learning outcomes of class IV B students in mathematics subjects increased substantially after using flipbook media.

4. CONCLUSION

The results of the analysis concluded that schools need creative teaching materials. Therefore, it is recommended to design teaching materials in the form of flipbooks based on Van Hiele's Theory for cuboid and cube materials as a potential solution, this material can help understand the definition, properties, area formulas, and connect the two forms of geometric shapes. This flipbook is specifically designed to facilitate understanding of the concept of cuboids and cubes.

This study applies the ADDIE model which contains 5 stages. In the first stage, namely the analysis stage, interviews were conducted with the homeroom teacher of class IV B and pre-test questions were given to class IV B students. Based on the results of the analysis, it shows that schools need more innovative teaching materials. As a solution, it is recommended to create teaching materials in the form of flipbooks based on Van Hiele's Theory, especially for block and cube materials. The second stage is the design stage, this stage is divided into two parts, namely, theory design and product. In the theory design stage, the main focus is designing flipbooks based on Van Hiele's theory. The goal is to develop students' critical thinking skills. Meanwhile, in the product design stage, we will develop flipbooks by creating storyboards as the first step. This storyboard functions as a visual guide that will help in designing the content and flow of flipbooks systematically. By using storyboards, the process of making flipbooks becomes more structured and organized. The third stage, namely the development stage, we start by creating flipbooks, then continue with the validation process, including expert assessments of material, language, media, and revising the product. The fourth stage is the implementation stage of flipbooks that have been made by class IV B students at SDN 1 Dawuan. The fifth stage is the evaluation stage where we calculate the results of the initial and final tests, in order to prove whether the flipbooks we created have an impact on their learning process.

The results of the material validity reached 87%, language validity reached 86%, media validity reached 93%. All three validities are included in the very feasible category. The average expert validation measurement is 89%, according to the basis of statistical data transfiguration to qualitative, placing flipbooks in the "Very Feasible" category. In addition, the level of student learning completion which reached 95% after using flipbooks indicates that this media is effective in improving learning outcomes, especially in developing critical thinking skills.

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