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RESEARCH ARTICLE

Development of Animated Learning Videos to Strengthen Elementary School Students' Mathematical Literacy Skills

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Abstract: The low mathematical literacy skills of students encourage the need for learning innovations that can improve this condition. Learning media are needed that can support the strengthening of students' mathematical literacy skills. The purpose of this study is to develop animated learning videos that are valid, practical, and effective in improving students' mathematical literacy in elementary schools. This research is a development research using the 4D model which includes the Define, Design, Develop, and Disseminate stages . The trial subjects in this study were fifth grade elementary school students. The research instruments were expert validation sheets, teacher and student activity observation sheets, teacher and student response questionnaires, and mathematical literacy tests. Data analysis was carried out descriptively quantitatively and qualitatively. The developed animated video was validated by the validator from the media and material aspects. The average score of the validator's assessment for the media aspect was 3.56 with a percentage of 89.06% and a very valid category. The average score of the validator's assessment for the material aspect was 3.81 with a percentage of 95.29% and a very valid category. In the practicality test, teachers rated the learning video with an average score of 3.58 or a percentage of 89.56%, and a very practical category, while students rated it with an average score of 3.04 or a percentage of 76.08%, and a practical category. The results of the implementation of animated learning videos in three different classes showed an N-Gain value of 0.72 or a high category, a learning implementation score of 3.87 or a very good category, a student learning activity score of 3.65 or a very active category, and a student response score of 3.23 . or very positive category . Thus, it can be concluded that the developed animated learning video is valid, practical, and effective in improving the mathematical literacy skills of fifth-grade elementary school students.

Keywords: Learning Videos, Animations, Mathematical Literacy, Elementary School

1. Introduction

Mathematical literacy is one of the essential competencies that students must possess in the 21st century. This capability encompasses the ability to formulate, apply, and understand mathematics in various real-life contexts, enabling students to use mathematical knowledge to solve problems and make logistical decisions. The importance of mathematical literacy is reflected in various international assessments, such as the Program for International Student Assessment (PISA), which uses mathematical literacy as one of the main indicators of a country's educational quality. However, PISA results indicate that Indonesian students'



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mathematical literacy skills remain low compared to the average for OECD member countries. This situation indicates that mathematics learning in schools still needs to be improved to develop students' higher-order thinking and problem-solving skills (OECD, 2023).

Mathematics is a basic science that plays a vital role in various aspects of human life. As a foundation for the development of various scientific fields, mathematics helps students develop logical thinking, analytical thinking, and problem-solving skills. Therefore, mastery of mathematics is crucial for students to apply in their daily lives (Musfira, 2025). One mathematical topic that plays a crucial role in developing mathematical literacy is integer arithmetic operations. Integer arithmetic operations are essential for elementary school students to understand because they are related to their calculation and problem-solving skills at subsequent levels of learning (Saleh et al., 2022). The use of learning media can help students understand the concept of integer operations in a more concrete and accessible way (Saleh et al., 2022). This material is a basic concept that is a prerequisite for learning mathematics at subsequent levels. However, various studies have shown that students still experience difficulties in understanding the concept of integer operations, especially when faced with contextual problems that require mathematical reasoning and interpretation. Teacher-centered learning, limited media use, and the dominance of lecture methods lead students to memorize procedures without understanding the meaning of the concepts being learned. Consequently, students' ability to connect mathematical concepts to everyday life situations is less than optimal (Nurlinda et al., 2023; Maharani et al., 2023).

The development of information technology provides opportunities for teachers to deliver more innovative and engaging learning through the use of digital media. One such medium is animated learning videos. Animated videos integrate visual, audio, text, and motion elements, helping students understand abstract mathematical concepts more concretely. In addition to increasing attention and motivation to learn, animated videos can also present contextual problems that support the development of students' mathematical literacy. Research shows that the use of animated videos in mathematics learning can improve conceptual understanding, learning outcomes, and student engagement during the learning process (Gea et al., 2025; Jimmy et al., 2024). However, previous research focused on developing mathematics instructional videos has focused on improving student learning outcomes or conceptual understanding. Research specifically developing animated instructional videos to improve mathematical literacy in integer arithmetic operations in elementary schools is still relatively limited. Furthermore, there is limited research integrating mathematical literacy indicators into animated instructional video designs, enabling students to not only understand calculation procedures but also identify, analyze, and solve mathematical problems related to everyday life (Budinan & Wahyuni, 2024; Maharani et al., 2024).

This research focuses on the development of animated learning videos specifically designed to improve students' mathematical literacy in integer arithmetic operations. The videos developed not only present material and example problems, but also contain contextual problems, mathematical thinking activities, and animated visualizations that are appropriate to the characteristics of elementary school students. The development of this media is expected to create a more meaningful learning experience so that students can understand the concept of integer arithmetic operations while developing their mathematical literacy skills.

Therefore, the aim of this research is to develop a valid, practical, and effective animated learning video to improve students' mathematical literacy, particularly related to integer arithmetic operations in elementary schools. The resulting product is expected to serve as an alternative, innovative learning medium and support the implementation of mathematics learning oriented towards developing students' mathematical literacy.

2. Literature Review

2.1. *Mathematical Literacy*

Mathematical literacy is an individual's ability to use mathematics in a variety of real-life situations. According to the OECD, mathematical literacy is a person's ability to reason mathematically and to formulate, use, and interpret mathematics to solve problems in various life contexts. Mathematical literacy relates not only to mastery of mathematical concepts and procedures, but also to the ability to connect mathematics to real-life problems to produce logical and accurate decisions .

Within the PISA framework 2022 (OECD, 2023), mathematical literacy includes three main processes, namely formulating problems into mathematical form, using mathematical concepts and procedures to solve problems, and interpreting the results of the solution in the context of the given problem. These three processes are important indicators in measuring students' mathematical literacy abilities . At the elementary school level, mathematical literacy plays a role in helping students understand and apply mathematical concepts to solve everyday problems. Students who have mathematical literacy skills are able to identify important information, choose the right solution strategy, perform calculations, and explain the results obtained logically. Based on the framework (OECD , 2023) the indicators of mathematical literacy used in this study include: 1) Formulating real problems in mathematical models , 2) Using mathematical concepts, facts, procedures, and reasoning to solve problems , 3) Interpreting and solving the results of the solution in the context of the problem , 4) Communicating the results of the solution mathematically .

2.2. *Animated Learning Videos*

Animated learning videos are technology-based learning media that combine elements of images, text, audio, and moving animation to convey information in an engaging and interactive way. This medium enables students to gain a more concrete learning experience because abstract concepts can be visualized through easy-to-understand animation displays. According to research (Maharani et al., 2024), animated videos can increase student engagement in mathematics learning because they present material in an engaging, contextual manner, and are relevant to the characteristics of today's digital generation. The use of animated videos also provides opportunities for students to learn independently and repeat the material as needed.

(Nasution & Lailia , 2023) explains that animated video media has a positive influence on understanding concepts and mathematical problem-solving abilities because students receive visual assistance that facilitates the mathematical thinking process. Effective animated learning videos have the following characteristics : 1) Combining visual, audio, text, and animation elements , 2) Presenting material systematically and interestingly , 3) Using language that is easy for students to understand , 4) Showing contextual examples that are close to everyday life , 5) Facilitating students to think and solve problems. The advantages of animated learning videos include: 1) Increasing students' learning motivation, 2) Can be used repeatedly according to students' needs, 3) Supporting independent learning and learning in class, 4) Helping students understand the material more deeply.

2.3. *Integer Arithmetic Operations*

Integer arithmetic operations are a fundamental component of mathematics learning, encompassing addition, subtraction, multiplication, and division for positive, negative, and zero numbers. Mastering the concept of integer arithmetic operations is crucial because it serves as the foundation for students' understanding of higher-level mathematical concepts. Learning integer arithmetic operations focuses not only on the skill of performing calculation procedures but also on conceptual understanding and the ability to apply them in various real-life situations. Therefore, learning needs to be designed through a contextual approach so that students can understand the meaning of integer operations and relate them to

everyday experiences (NCTM, 2000; Ministry of Education, Culture, Research, and Technology, 2022).

2.4. Animated Learning Videos to Improve Mathematical Literacy

The development of animated learning videos in this study is based on multimedia learning theory, which states that students learn more effectively when presented with a combination of words and images than through text or verbal explanations alone. Animated visualizations can help students understand abstract mathematical concepts, making the learning process more meaningful. Several studies have shown that systematically developed animated videos have high levels of validity, practicality, and effectiveness in improving students' mathematical abilities. Research (Firdaus et al., 2023) shows that animation-based learning videos effectively improve students' mathematical literacy because they are able to connect mathematical concepts to real-life contexts. In addition, research (Febiani et al, 2023) shows that the use of interactive animated videos in mathematics learning has a positive influence on students' numeracy and problem-solving abilities.

3. Research Method and Materials

This research is a research and development (R&D) that uses the Four-D (4D) model developed by (Thiagarjan, Semmel, and Semmel, 1974). This model consists of four stages, namely Define, Design, Develop, and Disseminate. The research aims to develop animated learning videos on the material of integer arithmetic operations to improve the mathematical literacy of elementary school students. The Define stage is carried out through needs analysis, student characteristics, concept analysis, and formulation of learning objectives. The Design stage includes the preparation of research instruments, storyboard design, and learning video design. The Develop stage is carried out through expert validation, product revision, and limited trials. Furthermore, the Disseminate stage is carried out by introducing the product to teachers and implementing it in mathematics learning.

The research was conducted on fifth-grade students in the 2025/2026 academic year. The research validators consisted of subject matter experts and media experts. Product trials involved classroom teachers and students as users of the developed animated learning videos. The research instruments consisted of an expert validation sheet, a teacher and student activity observation sheet, a teacher and student response questionnaire, and a mathematical literacy test. The validation sheet was used to assess the material, media, and language aspects of the developed product. The teacher and student response questionnaire was used to measure the practicality of the product from a user perspective. The teacher activity observation sheet was used to determine the implementation of learning. The student activity observation sheet was used to determine the student's learning activity. The mathematical literacy test was used to measure the improvement in the mathematical literacy abilities of students who learned using animated learning videos. The test was compiled based on mathematical literacy indicators which include the ability to identify information, use integer operations, solve contextual problems, and explain the results of the solution. The instruments used in this study have gone through a validation stage by expert validators.

The research data was analyzed descriptively using quantitative and qualitative methods. Qualitative data, in the form of suggestions and input from validators, were used as the basis for product revisions. Quantitative data were obtained from validator assessments, observations, questionnaires, and mathematical literacy tests.

The criteria used in determining product validity are as follows:

Table 1. Validity Criteria

Percentage (%)	Criteria
81-100	Very Valid
61-80	Valid
41-60	Less Valid
21-40	Invalid
0-20	Totally Invalid

The product suitability category table is used to interpret the validation results. Products with a percentage greater than or equal to 60% are considered suitable for use, while products with a percentage below 60% require substantial revision or are considered unsuitable for use (Frisky, 2024).

Product practicality is measured by the responses of teachers and students who use animated learning videos. The criteria used to determine product practicality are as follows:

Practicality criteria can be seen in the following table:

Table 2. Practicality Criteria

Percentage (%)	Criteria
81-100	Very Practical
61-80	Practical
41-60	Less practical
21-40	Impractical
0-20	Very Impractical

A product is said to be practical if the percentage of responses is in the minimally practical category, which indicates that the product is easy to use and well received by students (Frisky, 2024).

The effectiveness of using animated learning videos to improve students' mathematical literacy skills is reviewed from four indicators, namely: mathematical literacy test results, learning implementation, student learning activity, and student responses.

The N-Gain value is interpreted based on the criteria in the following table :

Table 3. N-Gain Criteria

N-Gain Value	Criteria
$N\text{-gain} \geq 0.70$	Tall
$0.30 \leq N\text{-gain} < 0.70$	Currently
$N\text{-gain} < 0.30$	Low

The implementation of learning is categorized based on the following table:

Table 4. Categories of Learning Implementation

Percentage (%)	Category
81-100	Very good
61-80	Good
41-60	Enough
21-40	Not enough
0-20	Very less

The student activity categories can be seen in the following table:

Table 5. Categories of Student Activity

Percentage (%)	Category
71-100	Very Active
51-75	Active
26-50	Quite Active
0-25	Not active

Student responses are categorized based on the following table:



Table 6. Student Response Categories

Percentage (%)	Category
81-100	Very Positive
61-80	Positive
41-60	Quite Positive
21-40	Less Positive
0-20	Not Positive

Animated learning videos are declared effective in strengthening students' mathematical literacy skills if the results of the mathematical literacy test (N-Gain) are in the minimum moderate category, the implementation of learning is in the minimum good category, students' learning activity is in the minimum active category, and students' responses are in the minimum positive category.

4. Results and Discussion

4.1. Results

This research resulted in a product in the form of a PowToon- based animated learning video on the material of integer arithmetic operations to improve the mathematical literacy of elementary school students. Product development was carried out using a 4D model consisting of the Define , Design , Develop , and Disseminate stages . The developed video contains material on integer arithmetic operations, example questions and contextual exercises based on mathematical literacy. The video is equipped with animated characters, illustrations, and narration designed according to the characteristics of elementary school students.

In the Define stage , the results of the initial study analysis showed that students' mathematical literacy skills were still low. Students were less able to solve mathematical literacy problems well, especially those related to integer arithmetic operations. Teachers had made efforts to increase student learning activity by utilizing learning media, but still had difficulty finding learning media that were interesting for students and suited their learning needs. Therefore, it was necessary to develop media that could help teachers strengthen students' mathematical literacy skills in elementary schools. Based on the findings in the define stage, it was decided to develop animated learning videos that suited the characteristics of students.

Design stage , a storyboard for the video display and research instruments were developed . These instruments were validated by two experts from the mathematics education department. Next, the research instruments were revised according to the validators' suggestions until they were declared valid and could be used to test the validity, practicality, and effectiveness of the animated learning videos developed.

Develop stage , a product was developed in the form of an animated learning video using the PowToon application , based on the storyboard generated in the Design stage . This product was validated in terms of material and media aspects by expert validators. The results of the validator's assessment for the media aspect are shown in Table 7.

Table 7. Product Validation Results from Media Aspects

Media Aspects	Validator 1	Validator 2	Average	Percentage
<i>Layout</i> (Media Display)	3.75	3.75	3.75	93.75
Contents	3.25	3.25	3.25	81.25
Benefit	3.25	3.25	3.25	81.25
Language	4.00	4.00	4.00	100
Average	3.56	3.56	3.56	89.06

In terms of media, the average validator score was 3.56, with a percentage of 89.06. Therefore, the animated learning video falls into the very valid category for the media aspect.

The results of the validator's assessment for the material aspect are shown in table 8.



Table 8. Product Validation Results from Material Aspects

Material Aspect	Validator 1	Validator 2	Average	Percentage	Category
Contents	3.87	4.00	3.93	98.37	Very Valid
Language, writing, and appearance	3.50	4.00	3.75	93.75	Very Valid
Benefit	3.50	4.00	3.75	93.75	Very Valid
Average	3.62	4.00	3.81	95.29	Very Valid

In terms of material, the average validator score was 3.81, with a percentage of 95.29. Therefore, the animated learning video falls into the very valid category for the material aspect.

Next, the product was revised and refined according to the validator's suggestions and then piloted in a fifth-grade elementary school to test its practicality. Teachers and students who used the animated learning video responded positively. Table 9 shows teachers' assessments of the product's practicality.

Table 9. Practicality Assessment by Teachers

Assessment Aspects	Average	Percentage
Learning suitability	4.00	100.00
Ease of use	4.00	100.00
The appeal of video	3.00	75.00
Usefulness of video	3.33	83.25
Overall Average	3.58	89.56

Teachers' ratings averaged 3.58, with a percentage of 89.56%. Therefore, teachers rated the animated learning video as very practical.

Table 10 shows students' assessment of the practicality of the product.

Table 10. Practicality Assessment by Students

Aspect	Average	Percentage	Category
The appeal of video	2.88	72.00	Practical
Ease of use	3.05	76.25	Practical
Usefulness of video	3.20	80.00	Practical
Overall Average	3.04	76.08	Practical

Students' average score was 3.04, with a percentage of 76.08%. Therefore, students rated the animated learning video as practical.

In the Disseminate stage, the animated learning video product, which was declared valid and practical, was implemented in three different classes: class V Siti Khadijah, class V Abu Ubaidillah, and class V Husen Bin Ali. The implementation results showed an increase in students' mathematical literacy skills.

Figure 1 shows a comparison of the pretest and posttest scores of Siti Khadijah's class V students :

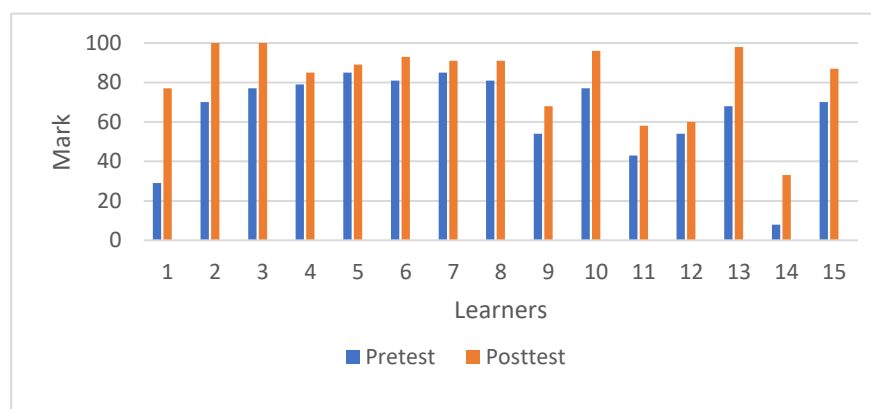


Figure 1. Siti Khadijah's Class V Pretest and Posttest Scores

Figure 2 shows a comparison of the *pretest* and *posttest* scores of grade V students. Abu Ubaidillah:

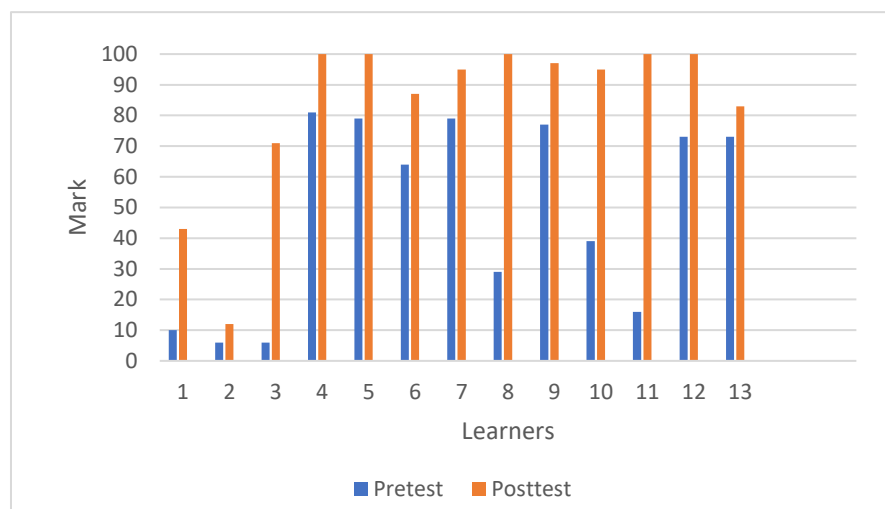


Figure 2. Abu Ubaidillah Class V *Pretest* and *Posttest* Scores

Figure 3 shows a comparison of students' *pretest* and *posttest* scores. Class V Husein Bin Ali:

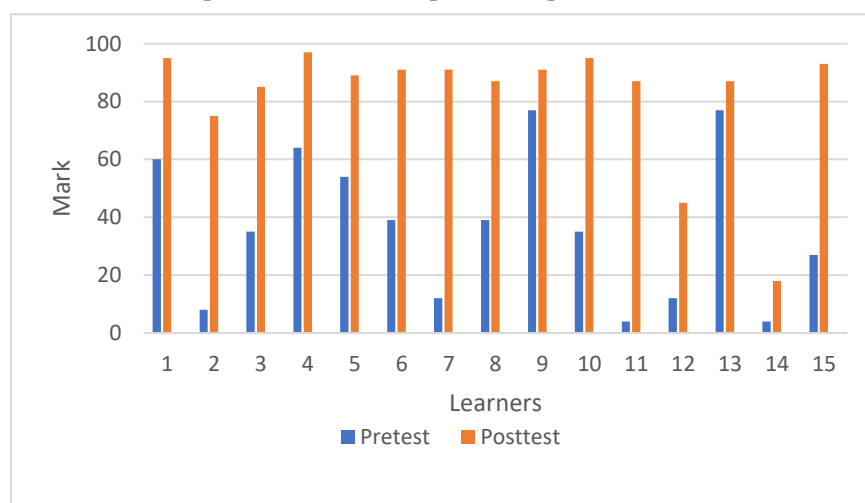


Figure 3. *Pretest* and *Posttest* Scores for Class V Husein Bin Ali

The N-Gain calculation results show an average of 0.72. Based on the N-Gain interpretation criteria ($g \geq 0.7$), this value is in the high category, which means that the increase in students' mathematical literacy abilities is classified as very good. Individually, most students are in the high category, even some students obtained an N-Gain above 0.8, which indicates a significant increase. This improvement demonstrates that animated learning videos can help students understand contextual problems in mathematical literacy, particularly those involving integers. Students learned how to transform problem statements into mathematical models, performed arithmetic operations correctly, and interpreted calculation results according to the problem context.

The implementation of learning by teachers in each implementation class was observed. This was done to demonstrate that teachers were effectively implementing the learning process using animated learning videos according to the prepared scenarios. The results of observations of the implementation of learning in the three classes are presented in Table 11.

Table 11. Learning Implementation

Observation Aspects	Class V Siti Khadijah	Class V Abu Ubaidillah	Class V Husein Bin Ali	Average	Percentage	Category
Preliminary activities	4.00	3.50	4.00	3.83	95.75	Very good
Core activities	4.00	3.42	4.00	3.80	95.00	Very good
Closing activities	4.00	4.00	4.00	4.00	100.00	Very good
Average	4.00	3.64	4.00	3.87	96.92	Very good

Overall, the average learning implementation score for the three classes reached 3.87, or 96.92%, and was in the very good category . These results indicate that animated learning videos can be used very well by teachers .

Student learning activity in each implementation class was observed. This was done to demonstrate increased student learning activity when using animated learning videos. The results of observations of student learning activity in the three classes are presented in Table 12 .

Table 12 Student Learning Activity

Aspect Observation	Class V Siti Khadijah	Class V Abu Ubaidillah	Class V Husein Bin Ali	Average	Percentage	Category
Preliminary activities	3.00	3.66	3.33	3.33	83.25	Very Active
Core activities	3.62	4.00	3.75	3.79	94.75	Very Active
Closing activities	4.00	4.00	3.50	3.83	95.83	Very Active
Average	3.54	3.89	3.53	3,65	91.00	Very Active

Overall, student activity in all three classes achieved an average score of 3.65, representing 91.00% of the students , and was categorized as very active . These results indicate that the use of animated learning videos can increase student engagement during the learning process.

Student responses to learning using animated learning videos were obtained through questionnaire results. Table 13 shows student responses from the three implementation classes.

Table 13. Student Responses

Aspect Observation	Class V Siti Khadijah	Class V Abu Ubaidillah	Class V Husein Bin Ali	Average	Percentage	Category
Video View	3,27	3.19	3.36	3.27	81.83	Very Positive
Ease of Understanding the Material	3.2	3.12	3.21	3,18	79.42	Positive
Interest	3.22	3.15	3.31	3.23	80.67	Very Positive
Average	3.23	3.15	3.29	3,23	80.63	Very Positive

The research results showed an average student response score of 3.23 , or very positive. This indicates that the use of animated learning videos received a positive response from students in all implementation classes.

Based on the results of the implementation of animated learning videos in three classes, the results of the mathematical literacy test (N-Gain) were in the high category, the implementation of learning was in the very good category, the activeness of student learning was in the very active category, and the student response was in the very positive category. Thus, it was concluded that animated learning videos were effective in improving the mathematical literacy skills of fifth grade elementary school students .



4.2. Discussion

The validation results show that the animated learning videos achieve a very high level of validity. The high level of validity indicates that the developed media successfully integrates mathematical concepts with contextual situations that support the development of mathematical literacy. Through animation, narration, and visual illustrations, abstract concepts related to integer operations become more concrete and easier to understand.

Practical results further confirmed the feasibility of the developed media. Both teachers and students considered the videos easy to use and useful during the learning process. The integration of animation, sound, illustrations, and contextual examples increased students' attention and engagement. This finding is consistent with the research results of Nasution and Lailia (2023) and Arini et al. (2024), which showed that animated videos facilitate students' conceptual understanding by providing visual support that helps students process mathematical information more effectively. Furthermore, the positive responses indicate that the developed videos align with students' learning characteristics in the digital era, where visual and interactive learning resources are increasingly preferred.

The effectiveness of the developed video is reflected in the improvement of students' mathematical literacy skills. The N-Gain score is in the high category, indicating a significant increase between the pretest and posttest scores. These results indicate that the animated video successfully improves students' ability to formulate mathematical problems, apply mathematical procedures, interpret solutions, and communicate mathematical ideas. These competencies are in accordance with the mathematical literacy framework based on (OECD, 2023), which emphasizes the process of formulating, using, and interpreting mathematics in various contexts.

in students' mathematical literacy can be attributed to the contextual approach embedded in the videos. The learning content is not limited to procedural calculations but also presents real-life situations that require students to analyze problems and apply mathematical reasoning. Such learning experiences encourage students to connect mathematical concepts to everyday contexts, thereby strengthening their literacy skills. This finding aligns with that of Firdaus et al. (2023), who found that animated learning videos significantly contribute to the development of mathematical literacy because they provide meaningful learning experiences and contextual problem-solving opportunities.

video successfully created an interactive learning environment. Students actively participated in discussions, answered questions, and engaged with contextual problems presented in the video. The increased participation indicates that animated videos can function not only as a learning medium but also as a tool to promote learner-centered learning. Similar findings were found by Febiani et al. (2023), who concluded that interactive animated media increased student engagement, problem-solving skills, and learning outcomes in mathematics.

Overall, the findings indicate that the animated learning video developed using the method has considerable potential to support mathematics learning in elementary schools. The integration of visual animation, contextual problems, and mathematical literacy indicators contributes to increased student engagement and learning outcomes. Therefore, the developed product can be declared an effective learning medium for improving mathematical literacy in integer operations and can support the implementation of literacy-oriented mathematics teaching in elementary schools.

5. Conclusion

This study developed an animated learning video used to strengthen students' mathematical literacy skills, particularly related to integer operations. The product development procedure used the 4D development model stages that include define, design, develop, and disseminate. The results of the study indicate that the developed product has been declared valid, practical, and effective for use in improving students' mathematical literacy skills in

elementary schools. Further research can be directed at developing animated learning videos with different orientations to students' abilities at different levels.

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